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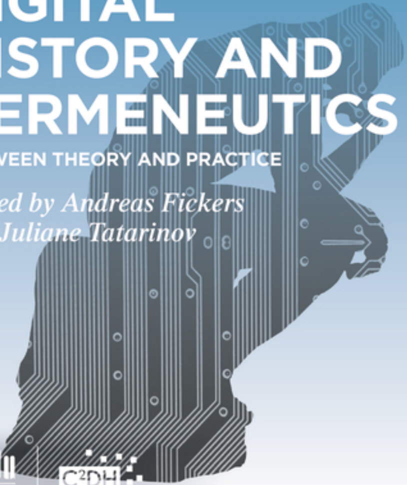
DIGITAL HISTORY AND HERMENEUTICS

BETWEEN THEORY AND PRACTICE

Edited by Andreas Fickers and Juliane Tatarinov



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Digital History and Hermeneutics

Studies in Digital History and Hermeneutics

Edited by
Andreas Fickers, Valérie Schafer, Sean Takats,
and Gerben Zaagsma

Volume 2

Digital History and Hermeneutics

Between Theory and Practice

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Introduction

In a 2020 special issue of the journal *Digital Humanities Quarterly*, Urszula Pawlicka-Deger proclaims a "laboratory turn" within the field of digital humanities, representing a paradigm shift in humanities research infrastructure in both Europe and the United States.[1] She locates this turn within discourses of knowledge production in academia and emphasizes a "shift from a laboratory as a physical location to conceptual laboratory."[2] This shift, she argues, implies certain values and a new way of thinking and communicating, mirrored in research and training programs. This volume aims to situate itself in the current debate on the so-called laboratory turn of digital humanities by offering experience-based insights into the learnings and failures, intellectual gains and conceptual struggles, and practical challenges and opportunities of a laboratory-like training environment: the Doctoral Training Unit "Digital History and Hermeneutics" (DTU-DHH), affiliated to the Luxembourg Centre for Contemporary and Digital History (C^2DH) at the University of Luxembourg.[3] The contributions to this volume reflect on the methodological and epistemological challenges and tensions that this DTU faced as a four-year interdisciplinary research program. As a laboratory setting, the DTU created an interdisciplinary home base for researchers from various epistemic cultures and disciplinary traditions. Framed by the concept of digital hermeneutics, the chapters offer a broad portfolio of reflexive approaches to the field of digital history, combining the individual research experiences of PhD students with more general reflections on the validity and heuristic potential of central concepts and methods in the field of digital humanities.

1 Urszula Pawlicka-Deger, "The Laboratory Turn: Exploring Discourses, Landscapes, and Models of Humanities Labs," *Digital Humanities Quarterly* 14, no. 3 (2020).

2 Pawlicka-Deger, "The Laboratory Turn," paragraph 2.

3 Financed within the PRIDE scheme of the Luxembourg National Research Fund (FNR) and supported by the University of Luxembourg, the Doctoral Training Unit "Digital History and Hermeneutics" provided an experimental training and research environment for 13 PhD students, their supervisors, and a coordinating postdoctoral researcher. For more information see the project website: https://dhh.uni.lu, accessed December 3, 2021.

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The Doctoral Training Unit was based on two central concepts: the concept of trading zone and the concept of digital hermeneutics. In order to reflect on the ongoing developments in the field of digital history – which can be seen as a specific area within the broader field of digital humanities – the DTU was conceived as a space of experimentation where different epistemic cultures, disciplinary traditions and communities of practice would mangle and new forms of knowledge in the making would be negotiated.[4] As the members of the DTU consisted of historians, philosophers, computer scientists, geographers, information scientists, and experts on human-computer interaction, collaborating in this interdisciplinary setting meant interacting in an intellectual climate characterized by experimentation, creative uncertainty, and appropriation of new tools and methodologies for doing digital history research. Framing the DTU in sociological terms as a "trading zone" in which different communities of practice interact, the unit was designed as a collaborative space of knowledge production in which methodological interdisciplinarity and theoretical bricolage formed the mental framework for critical debate and discussion. Inevitably, this asked for serious intellectual and communicative investments by all partners involved, including supervisors and external experts, as well as the doctoral students.

In this sense, the DTU approached digital history as what Julie Thompson Klein refers to as "deep interdisciplinarity":[5] a modus of collaboration that can alter disciplinary practices and create new hybrid languages. But how can one constitute and operate such an interdisciplinary trading zone *in practice*? How can one design such a collaborative space within the existing structures of a university environment?[6] In contrast to similar interdisciplinary setups which generally share a topical or methodological focus, the themes and approaches within the DTU-DHH framework were very broad, reflecting the wide range of research questions and methodological designs of the individual research projects. This diversity of topics and approaches was mirrored by the broad range of sources and data to be studied: these ranged from textual data (corpora of

4 On the concept of "mangle", see: Andrew Pickering, "The Mangle of Practice: Agency and Emergence in the Sociology of Science," *American Journal of Sociology* 99, no. 3 (1993): 559–89.
5 Julie Thompson Klein, *Interdisciplining Digital Humanities: Boundary Work in an Emerging Field* (Ann Arbor: University of Michigan Press, 2015), 142.
6 For a discussion of the role of digital humanities centres in the facilitation of interdisciplinary knowledge see: Mila Oiva, "The Chili and Honey of Digital Humanities Research: The Facilitation of the Interdisciplinary Transfer of Knowledge in Digital Humanities Centers," *Digital Humanities Quarterly* 14, no. 3 (2020). On C^{2}DH's establishment at the University of Luxembourg see: Max Kemman, *Trading Zones of Digital History* (Oldenbourg: De Gruyter, 2021), 69–81.

nineteenth century psychiatric journals, twentieth century Indigenous Australian autobiographies, transcripts of US presidential television debates), oral testimonies (toponymies, oral interviews), pictures (photographs, early modern *constcamer* paintings), material objects (computers, museum objects), archaeological data (Roman inscriptions, excavations of Stone Age settlements) to computer models (historical networks, agent-based models). All of the resulting datasets were used to test assumptions, to question existing field knowledge, and to develop new layers of interpretative framing. Inspired by the call of Fred Gibbs and Trevor Owens to "publicly experiment with ways of writing about their methodologies, procedures, and experiences with historical data as a kind of text,"[7] we encouraged our PhD students to reflect on the "usage" of historical data not simply as evidence and "self-identical"[8] but from multiple viewpoints and based on the principles of digital hermeneutics.

Building a trading zone

The DTU was designed and conceptualized as an interdisciplinary trading zone within the field of digital history.[9] We define a trading zone as an intellectual space and social place for knowledge transfer and exchange between different knowledge domains and their "communities of practice": groups of people who collectively engage in shared learning activities and base their group identity on a shared craft, domain and practice.[10] Translated to the field of digital history, the concept seems useful for studying and analyzing how different communities of practice interact and negotiate within an interdisciplinary setting. In *Trading Zones of Digital History*, Max Kemman describes digital history as a trading zone between the "two cultures" of humanities and computational research.[11] In this

7 Frederick W. Gibbs and Trevor J. Owens, "Hermeneutics of Data and Historical Writing (Fall 2011 Version)," in *Writing History in the Digital Age*, ed. Jack Dougherty and Kristen Nawrotzki, 2011.

8 Johanna Drucker, "Humanistic Theory and Digital Scholarship," in *Debates in the Digital Humanities*, ed. Matthew K. Gold (Minneapolis: University of Minnesota Press, 2012), 85–95.

9 See for a detailed reflection on the DTU as interdisciplinary digital history trading zone: Andreas Fickers and Tim van der Heijden, "Inside the Trading Zone: Thinkering in a Digital History Lab," *Digital Humanities Quarterly* 14, no. 3 (2020).

10 On situated practices in the field of digital humanities, see the special issue "Lab and Slack" of the journal *Digital Humanities Quarterly* vol. 14, no. 3 (2020).

11 Kemman, *Trading Zones of Digital History*, 40. Cf. C.P. Snow, *The Two Cultures and the Scientific Revolution* (Cambridge: Cambridge University Press, 1959).

trading zone, Kemman argues, both historians and computer or data scientists are mutually involved in developing new research questions, designing methodological approaches and experimenting with new research practices. While historians collaborate with computational experts aiming at adjusting digital tools and methods in order to produce new or alternative interpretations of the past, computational experts are driven by a problem-solving approach, testing how computational methods and techniques can help to make sense of heterogeneous, imperfect, and often incomprehensive data collections.[12] As such, the trading zone has proven to be a useful heuristic concept for the analysis of sociocultural interactions, conceptual negotiations, and interactional practices that have emerged during the lifetime of the DTU.

Three aspects of trading zones

Based on our experiences with running the DTU-DHH, three elements of the unit as a trading zone are important to emphasize: (1) locality, (2) interdisciplinarity, and (3) the establishment of a common ground and shared language.[13] Historian of science Peter Galison defined a trading zone as "an arena in which radically different activities could be *locally*, but not globally, coordinated."[14] This definition of the trading zone concept emphasizes the role of *locality* and the importance of a collaborative space to facilitate interactions between different communities of practice. In the design of the DTU, the aspect of locality played an important role. Instead of working in different offices and departments, the PhD students were offered one shared office space: the so-called "open space." Apart from having a shared office space, the group frequently interacted in other localities of the C^{2}DH, most importantly the Digital History Lab where the DTU skills trainings and research seminars took place.

Besides locality, *interdisciplinarity* is a central characteristic of a trading zone: the transfer and exchange of concepts, methods, tools, techniques and skills between or across different disciplinary fields or knowledge domains. Since digital historians have been using research methods and tools from the computer sciences and other knowledge domains such as geographical information systems,

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12 Kemman, *Trading Zones of Digital History*, 3.

13 For a more detailed analysis of these three aspects of digital history trading zones, see: Fickers and van der Heijden, "Inside the Trading Zone."

14 Peter Galison, "Computer Simulations and the Trading Zone," in *The Disunity of Science: Boundaries, Contexts, and Power*, ed. Peter Galison and David J. Stump (Stanford, California: Stanford University Press, 1996), 119. Original emphasis.

human-computer interaction, computational linguistics, and network analysis, digital history can be understood as an interdisciplinary field by definition. At the same time, some of the long-standing "epistemic differences"[15] between historians, computer scientists, and other disciplines continue to exist. While computer scientists, for instance, make use of quantitative methods and computational models to produce scientific evidence and to "explain" or "simulate" the world, historians mostly deploy qualitative and hermeneutic methods in trying to "understand" the complexities of past realities.[16] These different scientific traditions – despite the shared use of digital infrastructures, data, and tools – continue to have a strong resonance when it comes to the epistemological and methodological foundations of disciplines and the self-understandings of researchers within those communities of practice. Differences in research design and methodology (quantitative versus qualitative), approach (i.e. machine-based "distant reading" versus individual "close reading" of text corpora), and ambitions (to find general scientific laws versus the production of original subjective interpretations in the humanities) created challenging "boundary objects"[17] in our trading zone.

The aim of the DTU was to overcome such epistemic differences by establishing a *common ground*. As interactional expertise is based on successful communication, a shared vocabulary is a crucial element in all interdisciplinary research. After all, certain terms and concepts can mean different things to different scholars or communities of practice. Whereas historians speak about "sources," librarians and archivists talk about "documents," and computer scientists refer to "data." Such terms and concepts are typical boundary objects, which have to be negotiated in order to enable a shared understanding. Whether such a common vocabulary or language really emerges, however, depends very much on the *type* of trading zone one is interacting with. In their article "Trading Zones and Interactional Expertise," Collins, Evans and Gorman distinguish between four types of trading zones: inter-language, subversive, enforced, and fractionated.[18]

15 Karin Knorr Cetina, *Epistemic Cultures: How the Sciences Make Knowledge* (Cambridge, Mass.: Harvard University Press, 1999).

16 Andreas Fickers, "Veins Filled with the Diluted Sap of Rationality: A Critical Reply to Rens Bod," *BMGN – Low Countries Historical Review* 128, no. 4 (2013).

17 Susan Leigh Star and James R. Griesemer, "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39," *Social Studies of Science* 19, no. 3 (1989): 387–420; Pascale Trompette and Dominique Vinck, "Revisiting the notion of Boundary Object," *Revue d'anthropologie des connaissances* 3, no. 1 (2009): 3–25.

18 Harry Collins, Robert Evans, and Mike Gorman, "Trading Zones and Interactional Expertise," *Studies in History and Philosophy of Science Part A* 38, no. 4 (December 2007): 657–66.

According to the sociologists of knowledge, the type of trading zone depends on whether a group is homogeneous or heterogeneous, and whether the "trading" or group dynamics are based on collaboration or coercion. They argue that "inter-language trading zones" may only develop in groups with strong collaboration and high homogeneity – as opposed to enforced trading zones, which are characterized by high heterogeneity and high coercion. The DTU has been characterized by such high heterogeneity since the beginning of the project, given the groups' diverse mix of disciplinary backgrounds, ages, and nationalities. Being familiar with the work of Julie Thompson Klein, we were cautioned that, although the heterogeneity of our DTU could potentially generate highly innovative outputs, it could also turn into a source of conflict.[19] By means of the so-called "digital humanities incubation phase," we aimed to establish a common ground and shared language in order to stimulate interdisciplinary exchanges and collaborations within the project team, and so to transform the DTU into an *inter-language* trading zone in digital history.

Digital hermeneutics as critical framework and research agenda

While the concept of a trading zone is helpful in gaining a better insight into the complexity of interdisciplinary research practices, with their multi-layered challenges, on a theoretical as well as a practical level, the DTU aimed at making these challenges explicit – and objects of critical reflection by all participants. Nowadays, all stages of realizing a digital history project are to a lesser or greater degree shaped by the use of digital infrastructures and tools. Be it browsing on the Internet, taking notes of an interview on a laptop, capturing digital photographs in archives or museum collections, recording an oral testimony on a mobile phone, or organizing crowdsourcing activities on the Web, the workflow of historical research is characterized by digital interventions.[20] We use "digital hermeneutics" as a concept that enables historians to critically reflect on the various interventions of digital research infrastructures, tools,

19 Klein, *Interdisciplining Digital Humanities*, 138.
20 On the notion of "digital intervention" in doing public history, see: Anita Lucchesi, "For a New Hermeneutics of Practice in Digital Public History: Thinkering with memorecord.uni.lu" (PhD dissertation, University of Luxembourg, 2020).

databases, and dissemination platforms in the process of thinking, doing and narrating history.[21]

Although one can argue that all historians have by now become digital,[22] one has to emphasize the fact that many remain strongly embedded in analog practices and traditions. This current duality or parallelism of analog and digital practices forces historians to experiment with the new while keeping established norms of valid historical practices alive. If we accept that "hybridity is the new normal,"[23] we need an update of historical hermeneutics problematizing the "in-betweenness" of current history practices.[24] Instead of falling into the trap of asymmetric conceptions ("analog" versus "digital"), the concept of digital hermeneutics proposes a critical framework for making the methodological and epistemological tensions in current history practices explicit.[25] Making the "interventions" of the digital into historical practices explicit first of all asks for a critical engagement with digital infrastructures, data, and tools – a hands-on approach that combines playful tinkering with critical thinking. This idea of "thinkering" as a heuristic mode of doing has informed both the individual work of PhD students and the organization of collective skills training and hands-on research seminars within the DTU. As the many reflexive blog entries under the "thinkering" label on the C²DH website[26] and DTU website[27] demonstrate, the

21 On the idea of digital hermeneutics see: Manfred Thaller, "The Need for a Theory of Historical Computing," *Historical Social Research/Historische Sozialforschung*, no. 29 (1991): 193–202; Joris J. van Zundert, "Screwmeneutics and Hermenumericals: The Computationality of Hermeneutics," in *A New Companion to Digital Humanities*, ed. Susan Schreibman, Ray Siemens, and John Unsworth (London: Wiley-Blackwell, 2016), 331–47; Stephen Ramsay, "The Hermeneutics of Screwing Around; or What You Do with a Million Books," in *Pastplay: Teaching and Learning History with Technology*, ed. Kevin Kee (Ann Arbor: University of Michigan Press, 2014), 111–20. From a philosophical perspective, see: Alberto Romele, *Digital Hermeneutics: Philosophical Investigations in New Media and Technologies* (New York: Routledge, 2020).

22 See: Daniel J. Cohen and Roy Rosenzweig, *Digital History: A Guide to Gathering, Preserving, and Presenting the Past on the Web* (Philadelphia: University of Pennsylvania Press, 2006).

23 Gerben Zaagsma, "On Digital History," *BMGN – Low Countries Historical Review* 128, no. 4 (December 16, 2013): 3–29.

24 Andreas Fickers, "Update für die Hermeneutik. Geschichtswissenschaft auf dem Weg zur digitalen Forensik?," *Zeithistorische Forschungen/Studies in Contemporary History* 17, no. 1 (2020): 157–68.

25 Reinhart Koselleck, "Zur historisch-politischen Semantik asymmetrischer Gegenbegriffe," in *Vergangene Zukunft: zur Semantik geschichtlicher Zeiten* (Frankfurt a.M: Suhrkamp, 1989), 211–59.

26 Luxembourg Centre for Contemporary and Digital History, https://c2dh.uni.lu/thinkering, accessed December 3, 2021.

27 Doctoral Training Unit "Digital History and Hermeneutics", https://dhh.uni.lu/category/blog/, accessed December 3, 2021.

concept of digital hermeneutics has been instrumental in critically reflecting on how digital tools and infrastructures are transforming historical research practices in all stages of the iterative research process. As a comprehensive framework of epistemological and methodological investigation, it invites us to approach the historical research practices of search, data management and curation, analysis and visualization, interpretation and publication, by:

- opening the black boxes of algorithm-driven search engines and reflecting on the heuristics of search in online catalogs and repositories[28]
- thinking about the six Vs of data integrity (volume, velocity, variety, validity, veracity, value) and training us in historical data criticism[29]
- understanding and critically reflecting on how digital tools co-create the epistemic objects of study and turn the user into a manipulator of highly specific research instruments[30]
- deconstructing the "look of certainty" of data visualization by exploring the indexical relationship between the "back end" and "front end" of dynamic interfaces[31]
- developing multimodal literacy in order to decode narrative conventions of transmedia storytelling and the relational logic of web-applications and archives when interpreting and publishing historical data.[32]

28 David Gugerli, *Suchmaschinen: die Welt als Datenbank* (Frankfurt a.M: Suhrkamp, 2009); Ronald E. Day, *Indexing It All: The Subject in the Age of Documentation, Information, and Data* (Cambridge, Mass.: MIT Press, 2014); Jessica Hurley, "Aesthetics and the Infrastructural Turn in the Digital Humanities," *American Literature* 88, no. 3 (September 2016): 627–37.

29 Carl Lagoze, "Big Data, Data Integrity, and the Fracturing of the Control Zone," *Big Data & Society* 1, no. 2 (July 10, 2014): 1–11; Bruno J. Strasser and Paul N. Edwards, "Big Data Is the Answer . . . But What Is the Question?," *Osiris* 32, no. 1 (2017): 328–45.

30 Marijn Koolen, Jasmijn van Gorp, and Jacco van Ossenbruggen, "Toward a Model for Digital Tool Criticism: Reflection as Integrative Practice," *Digital Scholarship in the Humanities* 34, no. 2 (June 1, 2019): 368–85; Karin van Es, Maranke Wieringa, and Mirko Tobias Schäfer, "Tool Criticism and the Computational Turn: A 'Methodological Moment' in Media and Communication Studies," *M&K Medien & Kommunikationswissenschaft* 69, no. 1 (2021): 46–64.

31 Johanna Drucker, "Performative Materiality and Theoretical Approaches to Interface," *Digital Humanities Quarterly* 7, no. 1 (2013); David M. Berry, *Critical Theory and the Digital* (New York: Bloomsbury, 2014); Alexander R. Galloway, *The Interface Effect* (London: Polity, 2012); Johanna Drucker, *Visualization and Interpretation: Humanistic Approaches to Display* (Cambridge, Mass.: MIT Press, 2020).

32 Steve F. Anderson, *Technologies of History: Visual Media and the Eccentricity of the Past*, Interfaces, Studies in Visual Culture (Hanover, NH: Dartmouth College Press, 2011); Niels Brügger, *The Archived Web: Doing History in the Digital Age* (Cambridge, Mass.: MIT Press, 2018); Tracey Bowen and Carl Whithaus, eds., *Multimodal Literacies and Emerging Genres* (Pittsburgh, Pennsylvania: University of Pittsburgh Press, 2013).

As mentioned earlier, the original idea of the DTU was to reflect on the multiple interferences of digital infrastructures and tools on the "classical" research flow of historical research – encompassing the search for sources, the data management and curation, the analysis and visualization, and finally the hermeneutic interpretation and storytelling. For this, we argued, new critical skills are necessary: algorithm criticism, digital source criticism, tool criticism, interface criticism, and simulation criticism. All these digital skills and competences should be part of the toolkit of digital historians, symbolizing the "reflexive turn" in digital humanities.[33]

Whereas the plasticity of the linear structure of a research process comprising clearly defined steps[34] provided a good starting point to engage the interdisciplinary group with the concept of digital hermeneutics and to critically reflect on this process in practice, it soon became apparent that all stages were in fact fluent, interconnected, and often conducted in parallel (Fig. 1). Following Stephen Ramsay and Joris van Zundert one could stress that "the screwing around with data"[35] to test tools and methods during the research process implies that "our methodologies might not be as deliberate or as linear as they have been in the past."[36] Depending on how the research question is approached and modified over time, new searches for data have to be made, new tools to be tested, datasets to be adapted and modified, and visualizations or interpretations to be revised and refined.

To summarize, digital hermeneutics as a "hermeneutics of in-betweenness"[37] problematizes the many tensions between the analog and the digital, browsing and searching, scanning and reading, sharing and engaging, and accessibility

33 Petri Paju, Mila Ova, and Mats Fridlund, "Digital and Distant Histories. Emergent Approaches within the New Digital History," in *Digital Histories: Emergent Approaches within the New Digital History*, ed. Mats Fridlund, Mila Oiva, and Petri Paju (Helsinki: HUP – Helsinki University Press, 2020), 3–18, here p. 5; Mareike König, "Die digitale Transformation als reflexiver turn: Einführende Literatur zur digitalen Geschichte im Überblick," *Neue Politische Literatur* 66, no. 1 (March 2021): 37–60.

34 See the graphical research and training design 2019 underlying the programme, published 2020 in: Fickers, "Update für die Hermeneutik".

35 van Zundert, "Screwmeneutics and Hermenumericals"; Ramsay, "The Hermeneutics of Screwing Around".

36 Gibbs and Owens, "Hermeneutics of Data and Historical Writing (Fall 2011 Version)."

37 Andreas Fickers, "Hermeneutics of In-Betweenness: Digital Public History as Hybrid Practice," in *Handbook of Digital Public History*, ed. Serge Noiret, Mark Tebeau, and Gerben Zaagsma (Oldenbourg: De Gruyter, forthcoming).

Fig. 1: Ideal-typical scheme of the research process, demonstrating the concept of digital hermeneutics as a combination of digital literacy (skills) and critical reflection. © Andreas Fickers and Ghislain Sillaume et al., 2021. Attribution-NonCommercial_ShareAlike 4.0 International.

and interpretation that are inscribed into current practices of digital history.[38] Applied digital hermeneutics is as much a "theory of practice" as a "practice of theory":[39] by exploring the intellectual space in between the "unknown" and the "familiar," digital hermeneutics occupies exactly the space that the philosopher of knowledge Hans-Georg Gadamer had identified as the "locus" of hermeneutics – that is, its in-betweenness.[40]

Turning theory into practice

It is by undertaking heads-on and hands-on experiences that both students and supervisors can "grasp" the methodological and epistemological challenges inscribed into the practices of digital hermeneutics. The training concept of the DTU-DHH therefore followed the pedagogical principle of learning by doing.[41] At the core of this approach were the nine skills trainings offered during the project's DH incubation phase. These trainings introduced the PhD students to the following topics: text mining; digital source criticism; database structures; introduction to programming with Python; data visualization; tool criticism; algorithmic critique; GIS analysis, mapping and cartography; and experimental media ethnography.

In retrospect, one can argue that the skills trainings at least partially succeeded in establishing a common ground for all DTU participants, by creating a shared set of practical knowledge originating from different disciplinary traditions. This stimulated a transfer of knowledge and skills across the participants involved and contributed to a better understanding of how students who had trained in different epistemic communities were able, or not, to appropriate research concepts, methods, and tools from other disciplines. The training furthermore encouraged the PhD students to critically reflect on the use of digital methods and tools in their own research projects. By means of lectures and

38 On the notion of inscription and the role of the digital infrastructures, objects, and tools as "actants," see: Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory* (Oxford, New York: Oxford University Press, 2005).
39 Theodore R. Schatzski, Karin Knorr Cetina, and Eike von Savigny, eds., *The Practice Turn in Contemporary Theory* (London, New York: Routledge, 2001).
40 Hans-Georg Gadamer, *Wahrheit und Methode: Grundzüge einer philosophischen Hermeneutik* (Tübingen: Mohr Siebeck, 2010[1960]), 300.
41 Jean Lave and Etienne Wenger, *Situated Learning: Legitimate Peripheral Participation* (Cambridge, UK: Cambridge University Press, 1991); Peter Heering and Roland Wittje, eds., *Learning by Doing: Experiments and Instruments in the History of Science Teaching* (Stuttgart: Franz Steiner Verlag, 2011).

hands-on exercises, for instance, they learned and experienced how digital tools (e.g. Voyant, QGIS, and Tableau) could be useful heuristic instruments for text analysis and data visualization, in general terms. But they simultaneously reflected on how these tools could potentially shape their own research practices and interpretative frameworks. Yet the DH incubation phase did not serve everyone equally. Since the skills trainings came with a significant time investment, the question of whether or not they should be compulsory or not was extensively debated within the project team. Eventually, halfway through the project's first year, we decided to no longer make the training compulsory. Once the courses became optional, the PhD students could choose which to follow, based on an assessment of the relevance to their individual research projects.

In the second and third years of the DTU, training formats were adapted to the specific needs of each researcher. The PhD students were encouraged to organize workshops discussing specific aspects of their research projects or fields. In addition, a lecture series hosting international guest speakers was organized.[42] These formats were designed to be initiated by the PhD researchers themselves, offering opportunities to meet individual training needs and broadening their academic networks. At the same time, these activities provided a framework for fostering the constant exchange between DTU members and an academic public interested in joining the lectures or workshops. An international masterclass involving the scientific partner institutions of the DTU generated constructive feedback for the PhD students in their third year and initiated synergetic discussions within the program.[43]

Unsurprisingly, establishing the DTU as a collaborative working environment also faced several challenges. One structural problem was that all the PhD students had a double affiliation. As members of the DTU, they were affiliated to the C²DH as hosting institution, which offered them both the "open space" and the Digital History Lab as collaborative work spaces. In addition, the individual PhD students were affiliated to the faculty or department of their respective supervisors, where they were partly embedded into ongoing research and the teaching activities of their supervisors. This dual affiliation created a potential conflict of interest between the "DTU logic" and the "department logic." The various disciplinary embeddings of the supervisors involved in the unit created some tensions in terms of expectations and responsibilities, which had to be mediated by the DTU management team. Some supervisors offered their PhD

42 Doctoral Training Unit "Digital History and Hermeneutics", https://dhh.uni.lu/category/activities/lecture-series/, accessed December 3, 2021.
43 Doctoral Training Unit "Digital History and Hermeneutics", https://dhh.uni.lu/event/international-master-class-digital-history-and-hermeneutics/, accessed December 3, 2021.

students a second office in their departments, thereby creating a physical distance between these students and the rest of the group working in the C^{2}DH open space. In our view, this constituted a crucial limitation to the trading zone concept as it fostered an atmosphere of individual rather than collective working environments. It took considerable effort in terms of project management and leadership to redirect this tendency and refocus the DTU on gaining common achievements.

The coordinating postdoctoral researcher played a crucial role in mediating institutional tensions, aligning the team members in terms of expectation management, and in organizing regular team meetings and team-building activities, as well as in guaranteeing a constant flow of information.[44] Of importance for the governance of the unit was the creation of a management team consisting of the head of the DTU, two supervisor professors, the coordinating postdoctoral researcher, and one representative of the doctoral students (the latter being elected by the PhD students and having a non-renewable term of one year). Following Anna Maria Neubert, navigating these interdisciplinary differences, including in terms of desirable outcomes and expected results, requires the use of professional project management tools and techniques, as well as continuous investment in communication – both face-to-face and through digital means.[45]

Being aware of the key importance of close proximity and random encounters for creativity and team-building, the coronavirus pandemic of 2020–2021 came as an unpleasant surprise to the project, forcing the team into a remote-working mode during the successive shutdowns. Luckily, the crisis hit the DTU in the final phase of the project, when most PhD students were focusing on writing their PhD dissertations and preparing their defenses. Although planned on-site workshops and lectures had to be canceled and new initiatives became nearly impossible, the team continued to discuss the progress of research projects online and shared their experiences and the new challenges of work-life balance using online communication channels, such as Slack. With communication moving entirely to online formats, the importance of physical co-location as a crucial element for interdisciplinary collaboration became obvious to all in a rather abrupt and unexpected way. Whereas the writing up of individual research results was possible in remote working mode – although not without problems, due to a lack of access to libraries and archives – it became increasingly arduous

44 Klein, *Interdisciplining Digital Humanities*, 138.

45 Anna Maria Neubert, "Navigating Disciplinary Differences in (Digital) Research Projects Through Project Management," in *Digital Methods in the Humanities: Challenges, Ideas, Perspectives*, ed. Silke Schwandt (Bielefeld: Bielefeld University Press, 2020), 59–85.

to keep the team spirit alive, something we had previously tried to actively promote through team retreats and excursions.

Organization of this book

This volume does not aim to offer a synthesis of the multilayered research activities that have characterized the interdisciplinary setting of the DTU. Neither does it argue that there are "best practices" for how to organize such collaborative settings for doctoral training. While using the concept of digital hermeneutics as both an epistemological and a methodological framework for the project, we embrace the "interpretative flexibility" of the different disciplinary appropriations of the concept that we see in the individual research projects. When looking at the thirteen contributions by the PhD students to this volume, we observe a great variety of ways in which the concept of digital hermeneutics has shaped individual research practices and how it has affected the interpretation of research results. While some PhD theses engage with the concept in a deeper theoretical or epistemological manner, others demonstrate a more pragmatic translation of methods and tools between disciplinary domains and traditions. As all PhD theses in the DTU were designed by the PhD students and their supervisors as individual research projects, they have to be seen as independent projects – but nevertheless they also aim to speak to the larger research agenda of the DTU as a whole. For the purposes of this book though, all PhD students were asked to reflect more systematically on how the interdisciplinary setting of the DTU, with its many skills training and collaborative activities, had an impact on their individual PhD research projects. In addition, we encouraged the authors to think about the added value of the concept of digital hermeneutics as a heuristic tool, or interpretative framework, for their research. The book is therefore a continuation of the original effort by all DTU members to share experiences, to document struggles and failures, and to promote a self-reflexive approach to doing digital humanities and history research. These auto-ethnographic practices are intended to contribute to the growing interest in the pragmatics of digital hermeneutics and praxeological studies in the field of history and humanities.[46]

46 See: Lucchesi, "For a New Hermeneutics of Practice in Digital Public History"; Herman Paul, "Performing History: How Historical Scholarship Is Shaped by Epistemic Virtues," *History and Theory* 50, no. 1 (2011): 1–19; Tracie L. Wilson, "Coming to Terms with History: Translating and Negotiating the Ethnographic Self," *H-Soz-Kult*, June 14, 2012.

In the first section of this book, entitled "Hermeneutics of machine interpretation," we present five case studies originating from the fields of computational linguists, computer science, digital archaeology, and philosophy. The common thread of these chapters is that they aim to disclose the added heuristic and pragmatic value of computer sciences methods and tools for humanities research: from historical network analysis in large-scale professional networks (Antonio Fiscarelli) to agent-based modeling in Stone Age settlement patterns (Kaarel Sikk), from natural language processing and argument-mining in political debates (Shohreh Haddadan) to word embeddings in literary studies and autobiographical writings (Ekaterina Kamlovskaya) and text mining and topic modeling in philosophical texts (Thomas Durlacher).

The second section, headed "From 'source' to 'data' and back," thematizes the many challenges historians face when modeling content for historical research by transforming complex, inconsistent, fragmented historical "sources" into structured data or unstructured datasets.[47] The case studies collected here were originally intended to focus on a single step or phase in the research process, such as data search, curation, analysis, or visualization. But all the chapters in fact emphasize the non-linear and highly iterative nature of the hermeneutic exercise characterizing any research process: from "continuous searching" as gradual refinement of the research question (Eva Andersen) to the ephemeral nature of "living sources" such as place names (Sam Mersch), from fragmented datasets about Roman trade networks (Jan Lotz) to the "translation" of Renaissance paintings into a relational database (Floor Koeleman) and the problem of source abundance and digital asset management systems (Sytze Van Herck).

The final section of the volume, called "Digital experiences and imaginations of the past," problematizes the impact of digital tools and infrastructures in interacting with the past and simulating new environments that shape our historical imagination. Historical research is increasingly challenged to reflect on new forms and formats of storytelling and engaging with the broader public – be it in schools, museums, or video games. In this section, we look at the pedagogical value of a 3D model of a medieval castle (Marleen de Kramer), the learning experience of creating a mobile app walking tour on Jewish history (Jakub Bronec), and the importance of a user-centric design within digital museum contexts (Christopher Morse).

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47 Compare the experiences of humanist researchers of the SFB 1288 "Practices of Comparing: Ordering and Changing the World" at the Bielefeld University: https://www.uni-bielefeld.de/(en)/sfb1288, accessed December 3, 2021. Cited in Silke Schwandt, ed., *Digital Methods in the Humanities: Challenges, Ideas, Perspectives* (Bielefeld: Bielefeld University Press, 2020).

We hope that this volume offers interesting insights into the laboratory of digital history as an interdisciplinary endeavor. We would like to thank all 13 PhD students for their willingness to share their thoughts and reflections, or, in other words, to allow us to have a view into their "digital kitchen": turning the "raw" into the "cooked" is a process asking for creativity and rigorousness, conceptual thinking and hands-on experiences, and – in the specific case of this Doctoral Training Unit – both team-playing spirit and individual initiative.[48] The book is a thoughtful documentation of that "thinkering" process, aimed at both educating and encouraging other scholars in the rich trading zone of digital humanities. As Patrick Svensson stated in 2012: "The digital humanities can be seen as a twenty-first-century humanities project driven by frustration, dissatisfaction, epistemic tension, everyday practice, technological vision, disciplinary challenges, institutional traction, hope, ideals and strong visions."[49] It was in exactly this spirit that the Doctoral Training Unit "Digital History and Hermeneutics" was driven and experienced. It was, we believe, a worthwhile journey.

References

Anderson, Steve F. *Technologies of History: Visual Media and the Eccentricity of the Past*. Interfaces, Studies in Visual Culture. Hanover, NH: Dartmouth College Press, 2011.

Berry, David M. *Critical Theory and the Digital*. New York: Bloomsbury, 2014.

Bowen, Tracey, and Carl Whithaus, eds. *Multimodal Literacies and Emerging Genres*. Pittsburgh, Pennsylvania: University of Pittsburgh Press, 2013.

Brügger, Niels. *The Archived Web: Doing History in the Digital Age*. Cambridge, Mass.: MIT Press, 2018.

Cohen, Daniel J., and Roy Rosenzweig. *Digital History: A Guide to Gathering, Preserving, and Presenting the Past on the Web*. Philadelphia: University of Pennsylvania Press, 2006. Accessed December 3, 2021. https://chnm.gmu.edu/digitalhistory/book.php.

Collins, Harry, Robert Evans, and Mike Gorman. "Trading Zones and Interactional Expertise." *Studies in History and Philosophy of Science Part A* 38, no. 4 (December 2007): 657–66. https://doi.org/10.1016/j.shpsa.2007.09.003.

Day, Ronald E. *Indexing It All: The Subject in the Age of Documentation, Information, and Data*. Cambridge, Mass.: MIT Press, 2014.

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48 Michael Frisch, "From 'A Shared Authority' to the Digital Kitchen, and Back," in *Letting Go?: Sharing Historical Authority in a User-Generated World*, ed. Bill Adair, Benjamin Filene, and Laura Koloski (Philadelphia: Pew Center for Arts and Heritage, 2011), 126–37.

49 Patrik Svensson, "The Digital Humanities as a Humanities Project," *Arts and Humanities in Higher Education* 11, no. 1–2 (2012): 42.

Drucker, Johanna. “Humanistic Theory and Digital Scholarship.” In *Debates in the Digital Humanities*, edited by Matthew K. Gold, 85–95. Minneapolis: University of Minnesota Press, 2012.

Drucker, Johanna. “Performative Materiality and Theoretical Approaches to Interface.” *Digital Humanities Quarterly* 7, no. 1 (2013). Accessed December 3, 2021. http://www.digitalhumanities.org/dhq/vol/7/1/000143/000143.html.

Drucker, Johanna. *Visualization and Interpretation: Humanistic Approaches to Display*. Cambridge, Mass.: MIT Press, 2020.

Es, Karin van, Maranke Wieringa, and Mirko Tobias Schäfer. “Tool Criticism and the Computational Turn: A ‘Methodological Moment’ in Media and Communication Studies,” *M&K Medien & Kommunikationswissenschaft* 69, no. 1 (2021): 46–64. https://doi.org/10.5771/1615-634X-2021-1-46.

Fickers, Andreas. “Hermeneutics of In-Betweenness: Digital Public History as Hybrid Practice.” In *Handbook of Digital Public History*, edited by Serge Noiret, Mark Tebeau, and Gerben Zaagsma. Oldenbourg: De Gruyter, forthcoming.

Fickers, Andreas. “Update für die Hermeneutik. Geschichtswissenschaft auf dem Weg zur digitalen Forensik?” *Zeithistorische Forschungen/Studies in Contemporary History* 17, no. 1 (2020): 157–68. https://doi.org/10.14765/zzf.dok-1765.

Fickers, Andreas. “Veins Filled with the Diluted Sap of Rationality: A Critical Reply to Rens Bod.” *BMGN – Low Countries Historical Review* 128, no. 4 (2013). Accessed December 3, 2021. http://hdl.handle.net/10993/22715.

Fickers, Andreas, and Tim van der Heijden. “Inside the Trading Zone: Thinkering in a Digital History Lab.” *Digital Humanities Quarterly* 14, no. 3 (2020). Accessed December 3, 2021. http://digitalhumanities.org/dhq/vol/14/3/000472/000472.html.

Frisch, Michael. “From ‘A Shared Authority’ to the Digital Kitchen, and Back.” In *Letting Go?: Sharing Historical Authority in a User-Generated World*, edited by Bill Adair, Benjamin Filene, and Laura Koloski, 126–37. Philadelphia: Pew Center for Arts and Heritage, 2011.

Gadamer, Hans-Georg. *Wahrheit und Methode: Grundzüge einer philosophischen Hermeneutik*. Tübingen: Mohr Siebeck, 2010[1960].

Galison, Peter. “Computer Simulations and the Trading Zone.” In *The Disunity of Science: Boundaries, Contexts, and Power*, edited by Peter Galison and David J. Stump, 118–57. Stanford, California: Stanford University Press, 1996.

Galloway, Alexander R. *The Interface Effect*. London: Polity, 2012.

Gibbs, Frederick W., and Trevor J. Owens. “Hermeneutics of Data and Historical Writing (Fall 2011 Version).” In *Writing History in the Digital Age*, edited by Jack Dougherty and Kristen Nawrotzki, 2011. Accessed December 3, 2021. https://writinghistory.trincoll.edu/data/hermeneutics-of-data-and-historical-writing-gibbs-owens.

Gugerli, David. *Suchmaschinen: die Welt als Datenbank*. Frankfurt a.M: Suhrkamp, 2009.

Heering, Peter, and Roland Wittje, eds. *Learning by Doing: Experiments and Instruments in the History of Science Teaching*. Stuttgart: Franz Steiner Verlag, 2011.

Hurley, Jessica. “Aesthetics and the Infrastructural Turn in the Digital Humanities.” *American Literature* 88, no. 3 (September 2016): 627–37. https://doi.org/10.1215/00029831-3650271.

Kemman, Max. *Trading Zones of Digital History*. Oldenbourg: De Gruyter, 2021.

Klein, Julie Thompson. *Interdisciplining Digital Humanities: Boundary Work in an Emerging Field*. Ann Arbor: University of Michigan Press, 2015. Accessed December 3, 2021. http://www.jstor.org/stable/10.2307/j.ctv65swxd.

Knorr Cetina, Karin. *Epistemic Cultures: How the Sciences Make Knowledge*. Cambridge, Mass.: Harvard University Press, 1999.

König, Mareike. "Die digitale Transformation als reflexiver turn: Einführende Literatur zur digitalen Geschichte im Überblick." *Neue Politische Literatur* 66, no. 1 (March 2021): 37–60. https://doi.org/10.1007/s42520-020-00322-2.

Koolen, Marijn, Jasmijn van Gorp, and Jacco van Ossenbruggen. "Toward a Model for Digital Tool Criticism: Reflection as Integrative Practice." *Digital Scholarship in the Humanities* 34, no. 2 (June 1, 2019): 368–85. https://doi.org/10.1093/llc/fqy048.

Koselleck, Reinhart. "Zur historisch-politischen Semantik asymmetrischer Gegenbegriffe." In *Vergangene Zukunft: zur Semantik geschichtlicher Zeiten*, 211–59. Frankfurt a.M: Suhrkamp, 1989.

Lagoze, Carl. "Big Data, Data Integrity, and the Fracturing of the Control Zone." *Big Data & Society* 1, no. 2 (July 10, 2014): 1–11. https://doi.org/10.1177/2053951714558281.

Latour, Bruno. *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford; New York: Oxford University Press, 2005.

Lave, Jean, and Etienne Wenger. *Situated Learning: Legitimate Peripheral Participation*. Cambridge, UK: Cambridge University Press, 1991.

Lucchesi, Anita. "For a New Hermeneutics of Practice in Digital Public History: Thinkering with memorecord.uni.lu." PhD dissertation, University of Luxembourg, 2020. https://orbilu.uni.lu/handle/10993/45831.

Neubert, Anna Maria. "Navigating Disciplinary Differences in (Digital) Research Projects Through Project Management." In *Digital Methods in the Humanities: Challenges, Ideas, Perspectives*, edited by Silke Schwandt, 59–85. Bielefeld: Bielefeld University Press, 2020.

Oiva, Mila. "The Chili and Honey of Digital Humanities Research: The Facilitation of the Interdisciplinary Transfer of Knowledge in Digital Humanities Centers." *Digital Humanities Quarterly* 14, no. 3 (2020). Accessed December 3, 2021. http://www.digitalhumanities.org/dhq/vol/14/3/000464/000464.html.

Paju, Petri, Mila Oiva, and Mats Fridlund. "Digital and Distant Histories. Emergent Approaches within the New Digital History." In *Digital Histories: Emergent Approaches within the New Digital History*, edited by Mats Fridlund, Mila Oiva, and Petri Paju, 3–18. Helsinki University Press, 2020. https://doi.org/10.33134/HUP-5.

Paul, Herman. "Performing History: How Historical Scholarship Is Shaped by Epistemic Virtues." *History and Theory* 50, no. 1 (2011): 1–19.

Pawlicka-Deger, Urszula. "The Laboratory Turn: Exploring Discourses, Landscapes, and Models of Humanities Labs." *Digital Humanities Quarterly* 14, no. 3 (2020). Accessed November 10, 2021. http://www.digitalhumanities.org/dhq/vol/14/3/000466/000466.html.

Pickering, Andrew. "The Mangle of Practice: Agency and Emergence in the Sociology of Science." *American Journal of Sociology* 99, no. 3 (1993): 559–89.

Ramsay, Stephen. "The Hermeneutics of Screwing Around; or What You Do with a Million Books." In *Pastplay: Teaching and Learning History with Technology*, edited by Kevin Kee, 111–20. Ann Arbor: University of Michigan Press, 2014. https://doi.org/10.3998/dh.12544152.0001.001.

Romele, Alberto. *Digital Hermeneutics: Philosophical Investigations in New Media and Technologies*. New York: Routledge, 2020.

Schatzki, Theodore R., Karin Knorr Cetina, and Eike von Savigny, eds. *The Practice Turn in Contemporary Theory*. London; New York: Routledge, 2001.

Schwandt, Silke, ed. *Digital Methods in the Humanities: Challenges, Ideas, Perspectives*. Bielefeld: Bielefeld University Press, 2020.

Snow, C.P. *The Two Cultures and the Scientific Revolution*. Cambridge: Cambridge University Press, 1959.

Star, Susan Leigh, and James R. Griesemer. "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39." *Social Studies of Science* 19, no. 3 (1989): 387–420.

Strasser, Bruno J., and Paul N. Edwards. "Big Data Is the Answer . . . But What Is the Question?" *Osiris* 32, no. 1 (2017): 328–45. https://doi.org/10.1086/694223.

Svensson, Patrik. "The Digital Humanities as a Humanities Project." *Arts and Humanities in Higher Education* 11, no. 1–2 (2012): 42–60. https://doi.org/10.1177/1474022211427367.

Thaller, Manfred. "The Need for a Theory of Historical Computing." *Historical Social Research/ Historische Sozialforschung*, no. 29 (1991): 193–202.

Trompette, Pascale, and Dominique Vinck. "Revisiting the notion of Boundary Object." *Revue d'anthropologie des connaissances* 3, no. 1 (2009): 3–25.

Wilson, Tracie L. "Coming to Terms with History: Translating and Negotiating the Ethnographic Self." *H-Soz-Kult*, June 14, 2012. Accessed December 3, 2021. www.hsozkult.de/debate/id/diskussionen-1798.

Zaagsma, Gerben. "On Digital History." *BMGN – Low Countries Historical Review* 128, no. 4 (December 16, 2013): 3–29. https://doi.org/10.18352/bmgn-lchr.9344.

Zundert, Joris J. van. "Screwmeneutics and Hermenumericals: The Computationality of Hermeneutics." In *A New Companion to Digital Humanities*, edited by Susan Schreibman, Ray Siemens, and John Unsworth, 331–47. London: Wiley-Blackwell, 2016.

I Hermeneutics of machine interpretation

Antonio Maria Fiscarelli

Social network analysis for digital humanities

Challenges and use cases

1 Introduction

The field of digital humanities has grown rapidly in recent decades thanks to the greater availability of online digital sources, and new software and tools. Nevertheless, there are still some challenges that must be faced. During the same period, and due to the growing computing power and availability of online databases, network analysis has gained popularity: researchers from different fields have jumped on the network science bandwagon, and words such as "network" and "complexity" have become increasingly commonly used.

Network analysis can be used to model different systems such as biological networks,[1] the World Wide Web,[2] organizations, and societies. A social network can be described as a collection of "social actors" who are connected to each other if they form some sort of relationship. Social network analysis focuses on the relationships among these social actors and is an important addition to standard social and behavioral research, which is primarily concerned with the attributes of social units.[3] Not only is it important to acknowledge that social relationships are relevant, but also to understand how ties such as this work and how they relate to the many underlying social mechanisms governing these networks.

Social network analysis is one of the tools that have become particularly popular among humanities scholars. Even though social networks may seem to be a fairly recent invention, with the term calling to mind Facebook and other

1 Hawoong Jeong et al., "The Large-Scale Organization of Metabolic Networks," *Nature* 407, no. 6804 (2000): 651–54.

2 Réka Albert, Hawoong Jeong, and Albert-László Barabási, "Internet: Diameter of the World-Wide Web," *Nature* 401, no. 6749 (1999): 130–31.

3 Stanley Wasserman and Katherine Faust, *Social Network Analysis: Methods and Applications*, vol. 8 (Cambridge University Press, 1994).

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online platforms, they are in fact not limited to modern days.[4] For example, analysis of social networks has been used to model networks as diverse as the marriage and business relationships of the Medici family in fifteenth-century Florence,[5] the evolution of women's social movements in the nineteenth century,[6] the personal support network of Jewish refugees during the Second World War,[7] and visibility networks of Neolithic long barrows in the United Kingdom.[8]

The rest of this article is organized as follows: Social network analysis and some of its tools are introduced in Section 2. Section 3 presents an in-depth review of the latest historical network research. Finally, a use case drawn from my collaboration with a historian colleague is presented in Section 4.

1.1 Challenges in digital humanities

The first challenge in digital humanities is of a methodological nature.[9] On the one hand, and particularly in the use of network analysis, there is a risk that humanities research will limit itself to the "drawing of complicated graphs"[10] – yet the use of a certain method or digital tool should not be the main objective of research. On the other hand, some scholars may be hesitant to introduce digital tools into their research, fearing that these will take them out of the realm of history. It is therefore important to understand what digital tools can really offer in support of historical research.

4 Bonnie H Erickson, "Social Networks and History: A Review Essay," *Historical Methods: A Journal of Quantitative and Interdisciplinary History* 30, no. 3 (1997): 149–57.

5 John F. Padgett and Christopher K. Ansell, "Robust Action and the Rise of the Medici, 1400–1434," *American Journal of Sociology* 98, no. 6 (1993): 1259–319.

6 Naomi Rosenthal et al., "Social Movements and Network Analysis: A Case Study of Nineteenth-Century Women's Reform in New York State," *American Journal of Sociology* 90, no. 5 (1985): 1022–54.

7 Marten Düring, "The Dynamics of Helping Behavior for Jewish Refugees during the Second World War: The Importance of Brokerage," *Online Encyclopedia of Mass Violence*, 2016.

8 Tom Brughmans and Ulrik Brandes, "Visibility Network Patterns and Methods for Studying Visual Relational Phenomena in Archeology," *Frontiers in Digital Humanities* 4 (2017): 17.

9 James E. Dobson, *Critical Digital Humanities: The Search for a Methodology* (University of Illinois Press, 2019).

10 Claire Lemercier, "Formal Network Methods in History: Why and How?," in *Social Networks, Political Institutions, and Rural Societies, ed.* Georg Fertig (Turnhout: Brepols Publishers, 2015), 281–310.

The second challenge relates to the interdisciplinary nature of digital humanities. Humanities research can manifest in two forms. In the first case, scholars may show interest in a digital tool, start experimenting with it, and include it in their workflow. This approach could lead to the tool being used rather as a "black box" – i.e. given some input, the black box will produce a certain output, while everything in between is unknown. Therefore, it will not be possible to understand how the tool works, how to interpret the output, or how to recognize any potential bias inherent in that tool. In the second case, scholars may seek help, or a collaboration with an expert from another field, for example a computer scientist with a solid background in a specific method or tool. In this case, there is the risk that the humanities scholar will become a simple "data provider" for the model maker.[11] It is also essential to find a common vocabulary and be able to conciliate the two different perspectives in this scenario. Only if this is achieved can the two researchers start negotiating new forms of knowledge and successfully undertaking historical research together. In fact, my role in this project was to assess all these issues and ensure a fruitful collaboration between humanists and computer scientists.

Another issue relates to the data themselves. Historians nowadays have access to much larger amounts of data than their predecessors, whether from digitized classical sources (scans of books, digitized old photographs and recordings) or born-digital sources (websites, social networks). They can also access these sources at high speed and relatively low cost. For that reason, historians may be experiencing a paradigm shift, going from a scarcity to an abundance of sources,[12] while traditional methods used by historians may be failing to deal with such a volume of information. One example of such methods is close reading, which may fail in its purpose when the researcher is faced with very large collections of texts without the support of computer-based techniques. The easy accessibility of data comes with new questions too. Which sources have been digitized, which were discarded and what criteria were used to select those retained? It is also important to identify the origin of such sources. What was the provenance of the original sources? For born-digital sources, how were they generated?

Data storage has also changed with the advent of the digital era. The use of new technologies has made storing data far easier – a single hard drive can now store thousands of documents, and is cheap, small, and easy to transport. It can be easy to think that digital data will last forever. Unfortunately, data

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11 Lemercier, "Formal Network Methods," 281–310.

12 Roy Rosenzweig, "Scarcity or Abundance? Preserving the Past in a Digital Era," *The American Historical Review* 108, no. 3 (2003): 735–62.

stored in digital form do not have any intrinsic meaning without the specific software or technology that can read them, and these technologies can become obsolete within a decade or even less. One may also think that digitally stored data is safe from aging. Indeed, unlike analog sources, digital data do not deteriorate. However, a single malfunction of the storing volume could render an entire data collection inaccessible and irretrievably lost.[13]

1.2 Project summary

The main objective of my doctoral project is to show how humanities research can benefit from network analysis by providing PhD students from other disciplines – such as history, psychology, linguistics, and archaeology – with the right tools to help them answer their historical questions and by adapting these tools to their research projects. In this way, a fruitful collaboration is sought, where each side can benefit from the other: humanities scholars gain a critical understanding of digital tools and their functionalities, while computer scientists find new use cases and applications, at the same time learning to appreciate the needs of humanists. Understanding each other's needs is crucial to the collaboration. Instead of two distinct groups with separate interests, I envision humanists and computer scientists joining forces to share their knowledge and expertise in order to tackle the new challenges that are emerging in digital humanities. Only with a common goal and a shared vision can this collaboration be effective and still worth the time and effort required.

2 Social network analysis

Historically, the first encounter with network analysis is seen in the "Seven Bridges of Königsberg" problem.[14] The then Prussian city of Königsberg was built on four main areas: the two sides of the Pregel River and two small islands, connected by seven bridges. The problem consisted in finding a route that reached all the areas of the city by crossing each bridge exactly once. Euler

13 Christine Barats, Valerie Schafer, and Andreas Fickers, "Fading Away . . . The Challenge of Sustainability in Digital Studies," *Digital Humanities Quarterly* 14, no. 3 (2020).
14 Norman Biggs, E. Keith Lloyd, and Robin J. Wilson, *Graph Theory, 1736–1936* (Oxford University Press, 1986).

modeled this problem using what we now call graph theory – representing the city areas as nodes and the bridges as edges connecting nodes – and proved it to be unfeasible: it has no solution.

2.1 Complex networks

Complex networks are those that exhibit unusual properties that make them different from other, simple networks. Some of these properties have played an important role in the development of the field of social network analysis and are worth examining.

2.1.1 Some definitions

A graph, or network (the terms are often used interchangeably), can be *directed* or *undirected*, depending on whether the direction of a connection is relevant. It can also be *weighted* or *unweighted*, where the weight represents cost, strength, or the importance of a connection.

The *degree* of a node v_i represents the number of incident edges it possesses – in other words, the number of the node's direct connections. In the case of a directed network, its *in-degree* and *out-degree* are also defined, and these refer to the number of ingoing or outgoing edges of a node.

The *average path length* of a network is defined as the average shortest path between any two nodes in that network. The *diameter* of a network is defined as its maximum shortest path. These two metrics represent how easily information can travel through a network.

The *clustering coefficient* of a network is defined as the average local clustering coefficient of each node in the network. The *local transitivity* of a node is the ratio of the triangles connected to the node and the triples centered on the node.[15] This metric is related to the concept of transitivity: given that v_i is connected to v_j, and v_j is connected to v_k, what are the odds that v_i is also connected to v_k?

15 Christine Barats, Valerie Schafer, and Andreas Fickers, "Fading Away . . . The Challenge of Sustainability in Digital Studies," *Digital Humanities Quarterly* 14, no. 3 (2020).

2.1.2 Small world phenomenon

The *small world* phenomenon was first identified during Milgram's experiments regarding social networks.[16] The experiments' objective was to send a letter from a source person in Nebraska to a target person in Massachusetts. The source person was asked to send the letter to whichever of their acquaintances was most likely to be connected to the target person, with the objective of reaching the target within as few steps as possible. Milgram noticed that source and target were, on average, between five and six people apart. This average path length figure was much lower than the number of people involved in the experiments, and became associated with the term "six degrees of separation."

Later on, Watts and Strogatz discovered that many real-world networks – such as the Western US power grid, the brain network of the nematode species *C. elegans*, and the World Wide Web – even though of different types, all had the same two properties: low average path length and a high clustering coefficient.[17] The network models known at that time – regular lattices and the random network model developed by Erdős and Rényi[18] – failed to capture these properties. In fact, regular lattices have high average path lengths and high clustering coefficients, while random networks have low average path lengths and low clustering coefficients. Watts and Strogatz proposed a model that, starting from a regular lattice, randomly rewires edges according to a certain probability p between zero and one. If this probability is properly chosen, the model can generate small-world networks. In fact, these networks still preserve the high clustering coefficient of regular lattices, but the rewiring of a few edges makes the distance between nodes much smaller.

2.1.3 Scale-free networks

Barabási and Albert noticed that, for many complex networks, the degree distribution does not follow a Poisson distribution with a peak around the mean value, but rather a power-law distribution.[19] This means that a very small number of

16 Stanley Milgram, "The Small World Problem," *Psychology Today* 2, no. 1 (1967): 60–7.

17 Duncan J. Watts and Steven H. Strogatz, "Collective Dynamics of 'Small-World' Networks," *Nature* 393, no. 6684 (1998): 440.

18 Paul Erdős and Alfréd Rényi, "On the Evolution of Random Graphs," *Publications of the Mathematical Institute of the Hungarian Academy of Sciences* 5, no. 1 (1960): 17–60.

19 Albert-László Barabási and Réka Albert, "Emergence of Scaling in Random Networks," *Science* 286, no. 5439 (1999): 509–12.

nodes (or hubs) in the network have a very high degree – something that the Watts-Strogatz model was missing. Barabási and Albert realized that many real-world networks show a preferential attachment: nodes do not connect randomly but, rather, favor more "popular" nodes. For example, novice researchers in a collaboration network are more likely to aim to collaborate with researchers who are further on in their careers and already have many connections. Furthermore, complex networks are not static but instead grow in size. In fact, every year, new researchers start their careers and are added to the network. Barabási and Albert proposed a model that, based on these two mechanisms, can generate networks with a power-law degree distribution. The network starts with a fixed number of nodes. New nodes are then added and are connected to other nodes with a probability based on their degree. The networks generated with this model are called scale-free networks.

2.1.4 Emergence of communities in complex networks

Another important property of complex networks is their organization into communities. A community consists of a group of nodes that are highly connected to each other but loosely connected to the rest of the network.[20] For example, researchers in a collaboration network tend to connect to other researchers in the same field, resulting in the emergence of communities that represent similar research topics. Communities can be disjoint if nodes can only belong to a single community, or overlapping if they can belong to many.

2.1.5 The importance of weak ties

So far, we have seen that complex networks show high transitivity. Because of transitivity, nodes become highly connected to each other – and as a consequence, the network self-organizes into communities. We have also seen that, in a complex network, the average path length must be low. Therefore, it is necessary that some nodes act as "bridges" between communities. These connections are called *weak ties*. Sociology identifies two different kinds of ties in social networks: *strong ties* represent established interpersonal relationships, and are found in intracommunity connections; weak ties represent acquaintances, and are found in intercommunity connections. Granovetter, in his study, showed that

20 John Scott, "Social network analysis," *Sociology* 22, no. 1 (1988): 109–27.

people are more likely to find a new job through their acquaintances rather than through close friends.[21] This proved that weak ties are very important when it comes to the transmission of information within the network. While individuals in the same community can only share information that most of them probably already know, acquaintances can provide access to novel information.

2.2 Centrality metrics

Centrality metrics represent an important tool for the analysis of social networks. These metrics are defined on the nodes, and they rank nodes according to their position in a network.[22] *Degree centrality* measures the number of direct connections of a node and can be used to identify actors who are highly connected. *Betweenness centrality* is computed as the number of shortest paths between any two nodes in the network that go through a certain node. It measures to what extent an actor has control over the information flowing between other actors and can be used to identify those actors who occupy strategic positions in the network in terms of information exchange. *Closeness centrality* is computed as the average shortest path between a node and any other node in the network, and measures how long it will take for information to flow from one node to the rest of the network. The first person to experiment with centrality metrics was Bavelas, who showed that centrality measures were linked with group performance and that centrality metrics can help identify people with different roles in the network.[23]

2.3 Orbit analysis

Graphlets are small connected graphs with a size of between two and five nodes. Graphlet analysis is a useful tool for analyzing the global topological structure of networks and, locally, of a node's ego network. Figure 1 shows all the graphlets with up to four nodes. Some well-known examples are the "star" graphlet and the "triangle" graphlet. Some graphlets are characteristic of certain

21 Mark S. Granovetter, "The Strength of Weak Ties," *American Journal of Sociology* 78, no. 6 (1973): 1360–80.
22 Ulrik Brandes, "A Faster Algorithm for Betweenness Centrality," *Journal of Mathematical Sociology* 25, no. 2 (2001): 163–77.
23 Alex Bavelas, "A Mathematical Model for Group Structures," *Applied anthropology* 7, no. 3 (1948): 16–30; and Alex Bavelas, "Communication Patterns in Task-Oriented Groups," *The Journal of the Acoustical Society of America* 22, no. 6 (1950): 725–30.

types of network. For instance, the triangle is more likely to be found in social networks, due to high transitivity, while the star is more likely to be found in visibility networks. Graphlet counts, defined as the number of times that each graphlet appears in a network, can be used to characterize networks.

Nodes within a specific graphlet can have different roles. For example, in the star graphlet, one node can be identified as the center and the other three nodes as the leaves. Similarly, an orbit count can be defined as the number of times a node appears in each orbit, and can be used to identify groups of nodes that play different roles in the network. The orbit count for the central position of the "brokerage" graphlet can, for instance, be used to identify "mediator" nodes in collaboration networks.

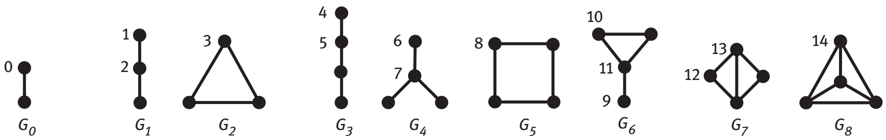

Fig. 1: Graphlets with up to four nodes, with their different orbits. 2020. © Antonio Fiscarelli.

2.4 Exponential random graph models

Exponential random graph models (ERGMs) are a family of statistical models that help us discover and understand the processes underlying network formation.[24] They have been used extensively in social network analysis and are popular in various fields such as sociology,[25] archaeology,[26] and history.[27] ERGMs

24 Carolyn J. Anderson, Stanley Wasserman, and Bradley Crouch, "A p* Primer: Logit Models for Social Networks," *Social Networks* 21, no. 1 (1999): 37–66; Garry Robins et al., "An Introduction to Exponential Random Graph (p*) Models for Social Networks," *Social Networks* 29, no. 2 (2007): 173–91; and Garry Robins et al., "Recent Developments in Exponential Random Graph (p*) Models for Social Networks," *Social Networks* 29, no. 2 (2007): 192–21.
25 Steven M. Goodreau, James A. Kitts, and Martina Morris, "Birds of a Feather, or Friend of a Friend? Using Exponential Random Graph Models to Investigate Adolescent Social Networks," *Demography* 46, no. 1 (2009): 103–25; and Thomas U. Grund and James A. Densley, "Ethnic Homophily and Triad Closure: Mapping Internal Gang Structure Using Exponential Random Graph Models," *Journal of Contemporary Criminal Justice* 31, no. 3 (2015): 354–70.
26 Tom Brughmans, Simon Keay, and Graeme Earl, "Introducing Exponential Random Graph Models for Visibility Networks," *Journal of Archaeological Science* 49 (2014): 442–54.
27 Abraham Breure and Raphael Heiko Heiberger, "Reconstructing Science Networks from the Past," *Journal of Historical Network Research* 3, no. 1 (2019): 92–117.

provide a model for networks that includes covariates – variables that relate to two or more nodes – which cannot be addressed using traditional methods. They can represent effects such as:

- *homophily*: the tendency of similar nodes – i.e. nodes having the same attributes – to form relationships.
- *mutuality*: the tendency of node B to form a relationship with node A, if node A is connected to node B.
- *triadic closure*: the tendency of node C to form a relationship with node A, if node A is connected to node B, and node B is connected to node C.

ERGMs also provide maximum-likelihood estimates for the parameters governing these effects. For example, they can estimate the increased likelihood of a tie existing between two nodes when these nodes have the same attributes. ERGMs also provide a "goodness-of-fit" test for the model, in order to verify whether the effects included in the model are sufficient to explain the structure of the observed network. Furthermore, they can simulate networks that match the probability distributions estimated by the model. In other words, they can be used to generate artificial networks that reflect the characteristics of the observed network.

3 Current trends in historical network analysis

There are already several examples of historians incorporating network analysis into their research. In this section I review some of their work, including how they translated historical questions into a social network analysis perspective, and identify what I consider to be the missed opportunities in these studies.

Breure and Heiberger, in their study, argue that eponyms serve as a proxy for contact and are a promising way to explore historical relationships between natural scientists.[28] Eponyms are used in taxonomy when an author describes a new species for which they use the name of a person – usually a field collector or colleague.

Breure and Heiberger tested this hypothesis on the community of malacologists (i.e. zoologists studying mollusks) in the nineteenth century, analyzing the recorded activity of malacological authors between 1850 and 1870. The dataset used contained authors' information such as age and home country, as well as performance measures like their numbers of publications, pages, coauthored publications, and coauthors. Each connection between authors was

28 Breure and Heiberger, "Reconstructing Science Networks," 92–117.

classified as an eponym, an exchange of material, or a coauthorship. Therefore, these authors had, effectively, built a collaboration network, in particular a multiplex network, where nodes interact within different layers (depending on the type of interaction) but there is no interaction between the different layers themselves. This network, consisting of 476 nodes and 1,822 edges, can be considered of medium size. The authors in the network were ranked according to their number of publications, and elite authors were identified as those who contributed to 80 percent of the total publications.

Breure and Heiberger noticed that few authors published a large number of papers, something that has been widely recognized in bibliometrics. They also identified two heavily linked communities that represented authors dealing with recent shells and those dealing with fossil (paleontological) shells. They manually assigned authors to one of the two communities, depending on their research interests. It would have been interesting to use a community detection algorithm to compare the communities found with the ones identified by the authors, using metrics such as normalized mutual information[29] or adjusted randomized index[30] to quantify the agreement of the result, and thus assess any bias in the manual assignment.

The authors used ERGMs to find out what effects had shaped the network of collaboration and found that authors from the same country were more likely to connect with each other, and that higher publication numbers increased the odds of a tie between authors. They also discuss how eponyms could result in a collaboration between authors, but this hypothesis was not tested, even though ERGMs offer the possibility of testing whether a tie in one layer increases the odds of a tie in a different layer.

Fernandez Riva, in his work, introduced a new method for analyzing shared manuscript transmission of medieval German texts, based on network analysis.[31] Medieval manuscripts contain several texts that were brought together according to certain criteria – both cultural (common genre) and practical (availability, size, etc.) – rather than being randomly grouped. Fernandez Riva modeled the transmission of shared manuscripts as a network, where nodes represent texts

29 Leon Danon et al., "Comparing Community Structure Identification," *Journal of Statistical Mechanics: Theory and Experiment* 2005, P09008; and Zhao Yang, René Algesheimer, and Claudio J. Tessone, "A Comparative Analysis of Community Detection Algorithms on Artificial Networks," *Scientific Reports* 6 (2016): 30750.

30 Lawrence Hubert and Phipps Arabie, "Comparing Partitions," *Journal of Classification* 2, no. 1 (1985): 193–218.

31 Gustavo Fernandez Riva, "Network Analysis of Medieval Manuscript Transmission," *Journal of Historical Network Research* 3 (2019): 30–49.

that are deemed connected if they appear in the same manuscript, and a weight is assigned if texts appear together in more than one manuscript. He does not mention the size of the network, however he specifies that the largest connected component of the network included 76 percent of the nodes, while several smaller components (of two to eight nodes) included 6 percent of the nodes, and the remaining 18 percent consisted of isolated nodes. Fernandez Riva decided to name these three different parts of the network "Continent," "Archipelagos," and "Islands." He proceeded by applying a community detection algorithm on the largest component to identify communities, although the algorithm used is not mentioned. Since the nodes had no attribute data – such as genre, time, or location – available, the author manually inspected the outcome of the algorithm to verify whether any of these characteristics correlated with the communities found, and came to the conclusion that there was a high overlap between communities, even for different genres. He used eigenvector centrality to identify texts that tended to appear in large collections, and betweenness centrality to identify texts that connected different communities in the network and fitted into more than one genre. These metrics helped him identify texts that occupied strategic positions in the network, something that would have been impossible by human inspection. Although the author does not really provide statistical methods for his analysis of the network of interest – instead limiting his work to the visualization of the network and the computation of centrality metrics – it must be recognized that the data available to him were rather limited.

Valleriani et al. analyzed the emergence of epistemic communities during the early modern period.[32] They worked on a corpus of printed cosmology textbooks used at European universities, dividing each book into several text parts, representing "atoms" of knowledge. The authors built a directed, weighted, multilayer network where nodes represented books that were connected to each other, on different layers, if they contained text parts that reoccurred in time (i.e. if they contained the same text, adaptations or translations of the same text, commentaries on the same text, or commentaries on the same adaptation), for a total of five layers. The network was a directed one, with the directionality being chronological, from older to more recent occurrences. The weight of connections, on the other hand, was given by the number of text parts that reoccurred in two different books. The corpus contained 563 text parts, but the authors decided to consider only those parts reoccurring at least once, and with at least

32 Matteo Valleriani et al., "The Emergence of Epistemic Communities in the 'Sphaera' Corpus: Mechanisms of Knowledge Evolution," *Journal of Historical Network Research* 3 (2019): 50–91.

one year between reoccurrences. Therefore the network, which can be considered of small-to-medium size, consisted of 239 text parts and 1,625 reoccurrences. The authors also analyzed the aggregated graph, which included the same set of nodes – two nodes were deemed connected if they were connected in any of the five layers. The authors performed a longitudinal analysis by first looking at the age distribution of connections for each layer of the network – computed as the difference between years of publication of the two text parts at the ends of each connection – and found substantial differences between layers. They then looked at the various connected components of the network in order to identify the different epistemic communities. Using a series of plots, they analyzed the distribution of nodes' out-degrees, normalized by the publication date of the text. For each plot, the visualization was further enhanced with different colors representing the nodes' attributes such as in-degree, publication place, book format, and network layer. The analysis is followed by an in-depth interpretation of the results, and discussion on the emergence and evolution of the different families of editions. Again, the methodology provided is based more on data visualization than statistical analysis or advanced modeling techniques. Cline, in her work, has used social network analysis to study political life in Athens between the 460s and 450s BC.[33] She builds three increasingly broad social networks using selected biographies from Plutarch's *Lives*, from which she retrieves all actors and their interrelationships. The first network uses Plutarch's "Life of Pericles" and consists of 54 actors and 79 ties, which essentially equates to Plutarch's ego network. She then enlarges this by adding actors from "Life of Alcibiades." This second version of Athens' social network contains 106 nodes and 145 connections. Lastly, she includes "Life of Cimon" and "Life of Nicias," for a total of 133 nodes and 191 ties across this largest network, formed from all four biographies' actors. These networks are all of a small size, undirected, and unweighted. The author says she is working with a multiplex network, since ties between actors are of different natures (family, work, friendship), even though there is no distinction between these ties in the analysis. Her objective is to demonstrate that the social network of Athens' political life was a small world. Her argument is that democratic institutions in Athens enabled people belonging to different circles and social classes to meet, hence favoring innovation and the diffusion of new ideas. From a network perspective, this would reflect in Athens' social network having a low average path length, high level of transitivity and a core-periphery structure where degree distribution follows a power law, with few

33 Diane Harris Cline, "Athens as a Small World," *Journal of Historical Network Research* 4 (2020): 36–56.

highly connected nodes and most nodes having a low degree. Indeed, she computes transitivity, average path length, and diameter for all the networks, and compares them with the same quantities computed on a random network of the same size. All these measures confirm that Athens at the time was indeed a small world. For the core-periphery structure, Cline computes the degree distribution but does not perform any statistical tests to verify whether a power law is the best fit. She also computes betweenness for each actor to confirm that women tend to occupy central positions in the network, connecting different families via marriage. For this work, information such as gender, family, and social status was available. Therefore, it would have been interesting to test whether any of these attributes had an influence on the network of connections.

Schauf and Escobar Varela[34] used network analysis techniques to identify characters who play structural roles in the Javanese *wayang kulit* incarnation of the *Mahabharata* epic, which involves representations of the series of stories – here called *lakon* – from the epic. They build a weighted, undirected co-occurrence network, where nodes represent the characters of the epic and these characters are deemed connected if they are mentioned in the same scene of any story. Weights indicate how many times two characters appear in the same scene. Each node is enriched with several attributes such as characters' tribe affiliation, origin, species, and gender. The authors also build two different null models that preserve, on average, the degree distribution of nodes. They compute betweenness centrality and closeness centrality for each character in the empirical network, as well as in the two null models. In this way, it is possible to identify outliers whose centrality values are significantly higher or lower than expected, i.e. compared to the same quantity computed in the null models. For example, the authors find that female characters, despite being few in number and appearing relatively infrequently, seem to dominate the top ranks for betweenness. They also propose a variation of these centrality metrics that is based on the attributes of nodes. For example, the inter-faction betweenness centrality is used to identify those characters who act as "bridges" within their tribe, while the faction-world betweenness centrality identifies characters who act as bridges between their tribe and the rest of the network.

One of the challenges that emerges from historical network research working with historical data is dealing with missing and incomplete data.[35] Networked data have to be extracted from sources such as books, bibliographies, and diaries that were originally analog and only digitized later, if needed. These

34 Andrew Schauf and Miguel Escobar Varela, "Searching for Hidden Bridges in Co-Occurrence Networks from Javanese Wayang Kulit," *Journal of Historical Network Research* 2 (2018): 26–52.
35 Erickson, "Social Networks and History."

sources are often incomplete or do not provide enough information to build the network of interest. Additionally, missing data in network research are more critical than in social and behavioral research. Even a small portion of missing data can be problematic if those data are related to crucial nodes (see *hubs* in Section 2.1.3) or ties (see *weak ties* in Section 2.1.5) This is also in contrast to historical research working with born-digital data, such as online databases or data scraped from social networks, where data are rather abundant.

4 Use case: Gender and ethnic collaboration patterns in a temporal co-authorship network

Sytze Van Herck is one of the PhD students at the University of Luxembourg's doctoral training unit in digital history and hermeneutics. Her main research interests are intersectionality and gender within the history of computing – and her work examines occupational segregation, working conditions, and gender stereotypes in advertising from the 1930s until the end of the 1980s. Sytze and I applied social network analysis techniques to analyze the gender and ethnicity gap in computer science research.[36] During the last few decades many bibliographic databases containing the publication records of scientists from different fields have been published online. Starting from these records, a collaboration network can be built where nodes represent authors, and authors are deemed connected if they have coauthored one or more papers together. This network of scientists can provide many insights into collaboration patterns in the academic community.

The dataset that Sytze and I used for the use case discussed here was one derived from a snapshot of the DBLP bibliographic database taken on 17 September 2015 and publicly available.[37] It contains 112,456 papers, written by 126,094 authors and published at 81 different computer science conferences between 1960 and 2015. The dataset includes author gender, which was generated by the Genderize API based on the first forename of an author.[38] For ethnicity data we

36 Sytze Van Herck and Antonio Maria Fiscarelli, "Mind the Gap Gender and Computer Science Conferences," in *This changes everything – ICT and Climate Change: What can we do? IFIP International Conference on Human Choice and Computers,* ed. David Kreps et al. (Cham: Springer Nature Switzerland, 2018), 232–49.

37 Agarwal Swati et al., "*DBLP Records and Entries for Key Computer Science Conferences,*" Mendeley Data, V1, 2016.

38 Genderize API, accessed April 21, 2021, https://genderize.io.

decided to use the R package called *wru* that uses the algorithm implemented by Kosuke and Kabir to predict ethnicity based on last name and gender.[39]

Our research was driven by the following questions:

- Do minorities in computer science demonstrate different collaboration patterns?
- As we saw in Section 2.1.1, metrics such as clustering coefficient, average path length, and diameter can characterize entire networks. A large clustering coefficient can be used to identify densely connected networks with high transitivity, while low average path length and diameter can identify networks in which information flows faster. For this reason, we decided to extract male and female subnetworks from the dataset, as well as networks of white researchers and researchers of color, by considering only the nodes with the selected attribute and the connections between those nodes. We then computed clustering coefficient, average path length, and diameter on these networks and compared the results. We found that the female researchers had a more close-knit network than the male researcher network – and that white researchers, even though they were not a minority, showed a similar behavior.
- Do minorities in computer science struggle to be successful?
- The metrics commonly used to quantify the success or popularity of a researcher are based on the numbers of their publications and citations. We decided, instead, to use network metrics (presented in Section 2.2) that were based on the position that researchers occupied in the coauthorship network and metrics based on a researcher's ego network structure. We computed some local network metrics such as betweenness centrality, closeness centrality, local clustering coefficient, and degree centrality, and then ranked male and female researchers, as well as white researchers and researchers of color. We found that female researchers generally scored lower than their male counterparts in terms of network connections, and had more closely knit networks. However, those ranked at the top obtained better results. Researchers of color, who were mostly Asian researchers, occupied more strategic and central positions in collaborations, outperforming white researchers.
- Do minorities play different roles in the network?
- To answer this question we used orbit analysis (discussed in Section 2.3) to compute the average orbit count for female and male researchers, as well as for white researchers and researchers of color, and compared the results. We

39 Kosuke Imai and Kabir Khanna, "Improving Ecological Inference by Predicting Individual Ethnicity from Voter Registration Records," *Political Analysis* 24, no. 2 (2016): 263–72.

found that male researchers dominated central roles, corresponding for example to the central orbit in the star graphlet, while female researchers tended to occupy the peripheral positions. In particular, in the brokerage graphlet, male researchers more often occupied a brokerage position, corresponding to the central orbit of this graphlet, while a pair of female researchers and an individual female researcher were more likely to be found in the peripheral orbits of the same graphlet – implying the male researcher played a mediating role between these female researchers.

- Does the minority bias become mitigated over time?
- We built a temporal version of the coauthorship network and answered the same questions to see if there were any changes over time. Firstly, we found that the size of minority groups had expanded over time, with their intragroup homophily increasing even faster. Female researchers performed better at higher ranks only during specific periods, such as in the middle of the 1980s and toward the end of the 1990s. The trend for ethnicity, on the other hand, inverted over time: researchers of color, mostly Asian, occupied more central positions until the mid-1990s, while they have become more closely knit in recent years. In the orbit analysis we found that gender differences had narrowed over time, while we observed a complete inversion of the trend for ethnicity.

4.1 Reflections and challenges

The aim of this collaboration was to build a bridge between the very different disciplines of humanities and computer science. We faced several challenges during this work. The first was related to the algorithmic bias associated with the gender and ethnicity prediction algorithms. The gender prediction was based on the given name (or forename) of an author. This was a generalization that was necessary given the large number of authors and the limited personal information available. First of all, we assumed that gender is binary, rather than more complex. Secondly, the same given name may be more commonly associated with being a male or female name depending on the country of origin. For example, the name "Andrea" is commonly feminine, while it is widely used as masculine in Italy. Additionally, the gender identity of a person may not match their biological sex.

The ethnicity prediction algorithm, on the other hand, is based on the family name (surname) and gender of an author. This is also a generalization, since a person's cultural identity may be different from their ancestry (or indeed from their spouse's ancestry where family names are changed on marriage). For example, many second- and third-generation American citizens have Italian surnames due to their Italian ancestry, while embracing an American identity. We also noticed that the gender prediction algorithm was less accurate for ethnic minorities. We therefore decided to build two separate networks for our analysis: one containing all authors whose gender prediction had at least 99 percent accuracy (i.e. a 99 percent likelihood of being correctly assigned as male or female), and another containing all authors whose ethnicity prediction score had at least 50 percent accuracy (i.e. 50 percent likelihood of belonging to a certain ethnicity versus all other ethnicities).

The fact that the algorithms do not have 100 percent accuracy shows that the use of digital tools does not remove bias. Algorithms contain an intrinsic bias because they are designed by humans, and researchers also introduce bias when choosing a certain algorithm.

5 Conclusion

The main objective of this project was to show how humanities research can benefit from network analysis, by providing PhD students from different fields with the right tools to help answer their historical questions, and adapting these tools to their research projects. In this way, a fruitful collaboration – where both sides can benefit from each other – may be sought: humanities scholars gain a critical understanding of digital tools and their functionalities, while computer scientists find new use cases and applications, at the same time learning to understand the needs of humanists. Understanding each other's needs is crucial for such collaborations. Instead of two distinct groups with separate interests, I envision humanists and computer scientists joining forces and sharing their knowledge and expertise in order to tackle the new challenges that are emerging in digital humanities. Only with a common goal and a shared vision can this collaboration be effective and still worth the time and effort required.

This article describes how I reviewed the latest historical network research in order to assess the current practices of historians using network-based methods, and discusses some of the challenges faced in digital humanities. As part of this work I translated historical problems for computer science peers and explained the basics of social network analysis to historians. I have also presented a use case here, drawn from my collaboration with a historian colleague, showing how social network analysis can be used to answer historical research questions. In particular, I presented our joint research questions and the tools we used to answer them. Finally, I reflected on the challenges we encountered during our joint work, such as the generalizations that we made in order to model our scenario and the algorithm criticism regarding the gender and ethnicity predictions.

References

Albert, Réka, Hawoong Jeong, and Albert-László Barabási. “Internet: Diameter of the World-Wide Web.” *Nature* 401, 6749 (1999): 130–31.

Anderson, Carolyn J., Stanley Wasserman, and Bradley Crouch. “A p* Primer: Logit Models for Social Networks.” *Social Networks* 21, 1 (1999): 37–66.

Barabási, Albert-László, and Réka Albert. “Emergence of Scaling in Random Networks.” *Science* 286, 5439 (1999): 509–12.

Barats, Christine, Valerie Schafer, and Andreas Fickers. “Fading Away . . . The Challenge of Sustainability in Digital Studies.” *Digital Humanities Quarterly* 14, 3 (2020). Accessed November 18, 2021. http://www.digitalhumanities.org/dhq/vol/14/3/000484/000484.html.

Barrat, Alain, Marc Barthelemy, and Alessandro Vespignani. *Dynamical Processes on Complex Networks*. Cambridge: Cambridge University Press, 2008.

Bavelas, Alex. “A Mathematical Model for Group Structures.” *Applied Anthropology* 7, 3 (1948): 16–30.

Bavelas, Alex. “Communication Patterns in Task-Oriented Groups.” *The Journal of the Acoustical Society of America* 22, 6 (1950): 725–30.

Biggs, Norman, E. Keith Lloyd, and Robin J. Wilson. *Graph Theory, 1736–1936*. Oxford: Oxford University Press, 1986.

Brandes, Ulrik. “A Faster Algorithm for Betweenness Centrality.” *Journal of Mathematical Sociology* 25, 2 (2001): 163–77.

Breure, Abraham S.H., and Raphael Heiko Heiberger. “Reconstructing Science Networks from the Past.” *Journal of Historical Network Research* 3, 1 (2019): 92–117.

Brughmans, Tom, and Ulrik Brandes. “Visibility Network Patterns and Methods for Studying Visual Relational Phenomena in Archeology.” *Frontiers in Digital Humanities* 4 (2017): 17.

Brughmans, Tom, Simon Keay, and Graeme Earl. “Introducing Exponential Random Graph Models for Visibility Networks.” *Journal of Archaeological Science* 49 (2014): 442–54.

Cline, Diane Harris. “Athens as a Small World.” *Journal of Historical Network Research* 4 (2020): 36–56.

Danon, Leon et al. “Comparing Community Structure Identification.” *Journal of Statistical Mechanics: Theory and Experiment* 2005, 09 (2005): P09008.

Dobson, James E. *Critical Digital Humanities: The Search for a Methodology*. Chicago: University of Illinois Press, 2019.

Düring, Marten. “The Dynamics of Helping Behavior for Jewish Refugees during the Second World War: The Importance of Brokerage.” *Online Encyclopedia of Mass Violence*, 2016. Accessed July 21, 2021. https://www.sciencespo.fr/mass-violence-war-massacre-resistance/en/document/dynamics-helping-behaviour-jewish-fugitives-during-second-world-war-importance-brokerage-se.

Erdős, Paul, and Alfréd Rényi. “On the Evolution of Random Graphs.” *Publications of the Mathematical Institute of the Hungarian Academy of Sciences* 5, 1 (1960): 17–60.

Erickson, Bonnie H. “Social Networks and History: A Review Essay.” *Historical Methods: A Journal of Quantitative and Interdisciplinary History* 30, 3 (1997): 149–57.

Fernandez Riva, Gustavo. “Network Analysis of Medieval Manuscript Transmission.” *Journal of Historical Network Research* 3 (2019): 30–49.

Genderize API. “API to predict the gender of a person given their name.” Accessed April 21, 2021. https://genderize.io.

Goodreau, Steven M., James A. Kitts, and Martina Morris. “Birds of a Feather, or Friend of a Friend? Using Exponential Random Graph Models to Investigate Adolescent Social Networks.” *Demography* 46, 1 (2009): 103–25.
Granovetter, Mark S. “The Strength of Weak Ties.” *American Journal of Sociology* 78 (1973): 1360–380.
Grund, Thomas U., and James A. Densley. “Ethnic Homophily and Triad Closure: Mapping Internal Gang Structure Using Exponential Random Graph Models.” *Journal of Contemporary Criminal Justice* 31, 3 (2015): 354–70.
Hubert, Lawrence, and Phipps Arabie. “Comparing Partitions.” *Journal of Classification* 2, 1 (1985): 193–218.
Imai, Kosuke, and Kabir Khanna. “Improving Ecological Inference by Predicting Individual Ethnicity from Voter Registration Records.” *Political Analysis* 24, 2 (2016): 263–72.
Jeong, Hawoong et al. “The Large-Scale Organization of Metabolic Networks.” *Nature* 407, 6804 (2000): 651–54.
Lemercier, Claire. “Formal Network Methods in History: Why and How?” In *Social Networks, Political Institutions, and Rural Societies*, edited by Georg Fertig, 281–310. Turnhout: Brepols, 2015.
Milgram, Stanley. “The Small World Problem.” *Psychology Today* 2, 1 (1967): 60–7.
Padgett, John F., and Christopher K. Ansell. “Robust Action and the Rise of the Medici, 1400–1434.” *American Journal of Sociology* 98, 6 (1993): 1259–319.
Robins, Garry et al. “An Introduction to Exponential Random Graph (p*) Models for Social Networks.” *Social Networks* 29, 2 (2007): 173–91.
Robins, Garry et al. “Recent Developments in Exponential Random Graph (p*) Models for Social Networks.” *Social Networks* 29, 2 (2007): 192–215.
Rosenthal, Naomi et al. “Social Movements and Network Analysis: A Case Study of Nineteenth-Century Women’s Reform in New York State.” *American Journal of Sociology* 90, 5 (1985): 1022–54.
Rosenzweig, Roy. “Scarcity or Abundance? Preserving the Past in a Digital Era.” *The American Historical Review* 108, 3 (2003): 735–62.
Schauf, Andrew, and Miguel Escobar Varela. “Searching for Hidden Bridges in Co-Occurrence Networks from Javanese Wayang Kulit.” *Journal of Historical Network Research* 2 (2018): 26–52.
Scott, John. “Social Network Analysis.” *Sociology* 22, 1 (1988): 109–27.
Swati, Agarwal, et al. *DBLP Records and Entries for Key Computer Science Conferences*. Accessed April 21, 2021. https://data.mendeley.com/datasets/3p9w84t5mr/.
Valleriani, Matteo et al. “The Emergence of Epistemic Communities in the ‘Sphaera’ Corpus: Mechanisms of Knowledge Evolution.” *Journal of Historical Network Research* 3 (2019): 50–91.
Van Herck, Sytze, and Antonio Maria Fiscarelli. “Mind the Gap Gender and Computer Science Conferences.” In *This changes everything – ICT and Climate Change: What can we do? IFIP International Conference on Human Choice and Computers*, edited by David Kreps et al., 232–49. Cham: Springer Nature Switzerland, 2018.
Wasserman, Stanley, and Katherine Faust. *Social Network Analysis: Methods and Applications*. Cambridge: Cambridge University Press, 1994.
Watts, Duncan J., and Steven H. Strogatz. “Collective Dynamics of ‘Small-World’ Networks.” *Nature* 393, 6684 (1998): 440.
Yang, Zhao, René Algesheimer, and Claudio J. Tessone. “A Comparative Analysis of Community Detection Algorithms on Artificial Networks.” *Scientific Reports* 6, 1 (2016): 30750.

Kaarel Sikk

Hunting for emergences in stone-age settlement patterns with agent-based models

1 Introduction

Complexity science focuses on explaining phenomena as systems composed of a multitude of components interacting with each other. This approach offers a good reflection of social systems which are composed of individuals. Social scientists have long been aware of how complex structures emerge from individual behaviors. During recent decades, researchers have also started to use complex systems to explore the past. These studies have mostly applied agent-based models in the field of archaeology[1] and in fields specializing in modeling, for example those under the umbrella term cliodynamics.[2] Until recently, the application of complexity science has largely been neglected by humanists and historians in particular.

This chapter discusses the opportunities offered by complexity science approaches, and particularly agent-based modeling (ABM), for humanities scholars studying the past. The discussion is based on explorative interdisciplinary research applied to the emergence of settlement patterns, as observed in archaeological material. Its main purpose is not to report the research results, which are published elsewhere,[3] but to discuss the explorative process of the

1 Mark W. Lake, "Trends in Archaeological Simulation," *Journal of Archaeological Method and Theory* 21, no. 2 (2014): 258–87; and J. Daniel Rogers and Wendy H. Cegielski, "Opinion: Building a Better Past With the Help of Agent-Based Modeling," *Proceedings of the National Academy of Sciences* 114, no. 49 (2017): 12841–44.

2 For examples see: "Cliodynamics," Wikipedia, accessed April 22, 2021, https://en.wikipedia.org/wiki/Cliodynamics.

3 Kaarel Sikk and Geoffrey Caruso, "A Spatially Explicit Agent-Based Model of Central Place Foraging Theory and Its Explanatory Power for Hunter-Gatherers Settlement Patterns Formation Processes," *Adaptive Behavior* 28, no. 4 (2020): 1–21; Kaarel Sikk et al. "Environment and Settlement Location Choice in Stone Age Estonia," *Estonian Journal of Archaeology* 24, no. 2 (2020): 89–140.

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ABM-driven research project, along with additional values and unexpected insights gained during the study. Elements of the research process that could apply to other studies and fields are reflected upon using digital hermeneutics as put forward by historians as a reference model.[4] Interdisciplinary contact points between the social and natural sciences and the humanities, that form the basis of the study, are discussed.

In the following sections, concepts of modeling, emergence, and complex systems are discussed from a humanist viewpoint, then an overview of a case study is presented and, based on the experience of the project, wider applications of ABM practices are discussed.

The research presented here is based on ideas and cooperation with people from an interdisciplinary context including fields like archaeology, history, quantitative geography, economy, computer science, and complex systems modeling.[5]

2 Concepts and methods

2.1 Emerging complexity

Adoption of complex systems approaches becomes reasonable if the research object exhibits emergent behavior, which means that the system in general possesses properties that its individual elements do not have. Although research on complex systems has escalated quite recently, the general ideas behind complexity science are in fact very old.

Emergence was already being described in the ancient world by philosophers like Aristotle who, in the earliest known such record, wrote in his *Metaphysics*: "In the case of all things which have several parts and in which the totality is not, as it were, a mere heap, but the whole is something besides the parts, there is a cause; for even in bodies contact is the cause of unity in some cases, and in others viscosity or some other such quality."[6]

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4 Andreas Fickers, "Hermeneutics of In-Betweenness: Digital Public History as Hybrid Practice," in *Handbook of Digital Public History*, ed. Serge Noiret, Mark Tebeau, and Gerben Zaagsma (Berlin: De Gruyter, forthcoming).

5 The author wishes to thank Andreas Fickers for building the research environment behind this research, Geoffrey Caruso for his guidance on quantitative geography, Aivar Kriiska for archaeological data and insights, Juliane Tatarinov for initiating this volume, and Iza Romanowska for very helpful feedback on the research and text.

6 Aristotle, *Metaphysics*, trans. William D. Ross (Oxford: Clarendon Press, 1908), 980a.

During the nineteenth century the axiom that the whole is greater than the sum of its parts (Renouvier), and Boutroux's idea that higher levels of analysis are irreducible to the lower levels, became known among scholars studying society. Durkheim used these ideas to deduce the central concept of the newly born discipline of sociology: the *sui generis*, now referred to as emergence.

There are some well-known iconic examples of emergent systems observed by science. For example, through physics we know about rules governing subatomic particles, but those rules do not inform us about the chemical properties of the substance formed by those particles. Rules and theories in chemistry are formulated for another scale of analysis. The science of biology in turn considers life as an emergent property of chemical systems. Likewise human culture is not explained by the biological characteristics of humans but requires another level of observations. These gaps are unintuitive for the human mind and often form the boundaries of disciplines.[7]

Social emergence can be illustrated by the power law governing the distribution of the connections that individuals have in a society, and which emerges as a result of a preferential attachment process. Individuals often prefer connections with others who already have more connections, for example because of better access to information or higher perceived trustfulness (doing business with rich people, being friends with people with more friends). This preference develops an exponential distribution of connections (friends, wealth) and the dynamic process described as "the rich get richer" emerges (the Matthew effect).[8] From an individual's point of view or level of analysis it might not be intuitive that the general trend of being friends with popular people leads to an increase in social inequality. This illustrates how phenomena usually observed at different levels of analysis are interrelated.

The remarkable thing about society is the ease with which simple individual rules and changes in individual connection lead to complexity – and, quoting Epstein and Axtell, "it is not the emergent macroscopic object per se that is surprising, but the generative sufficiency of the simple local rules."[9] This quote expresses that only very basic rules governing individual choices are required to form complex systems with new properties.

7 See, for example, Mark Bedau and Paul Humphreys, *Emergence: Contemporary Readings in Philosophy and Science* (Cambridge, MA: MIT Press, 2008), 10–8.
8 Simulation of evolution of power-law distribution of node degrees on synthetic network by using: Uri Wilensky, "NetLogo Preferential Attachment Model," (Center for Connected Learning and Computer-Based Modeling, Northwestern University, 2005), accessed December 1, 2020, http://ccl.northwestern.edu/netlogo/models/PreferentialAttachment.
9 Joshua M. Epstein and Robert Axtell, *Growing Artificial Societies: Social Science From the Bottom Up* (Washington, DC: Brookings Institution Press, 1996), 52.

Analyzing emergent relations between different analytical levels became possible only after new fields of systems theory and cybernetics arose during the 1940s. New ideas morphed into the discipline of complexity science, which provided a toolkit for studying complex systems involving relations between their components and properties like adaption, nonlinearity, spontaneous order, feedback loops, and emergence. Agent-based modeling (ABM), an analytical approach to solving systemic issues, was developed and became practically applicable during the computational revolution of the 1980s.

2.2 Agent-based modeling – a tool for exploring complexity

ABM is a computational simulation method developed to explore complex systems by combining different levels of analysis. It lets us explore how the relatively simple behaviors of system components lead to the general emergence of complex phenomena. Building on the classical definition from Clarke, "a model is a mechanism which connects theory to data,"[10] ABM is a mechanism that enables us to connect the theory of one level of analysis to data on another level.

The agent-based modeling process is accomplished in a number of key steps:[11]

1) The characteristics of the environment and the rules governing individual agents (ontology) are defined.
2) These characteristics and rules are then formalized as algorithms and their configurations, so that the latter can be executed as a computer program.
3) The created models are calibrated to fit available observations.
4) The models are validated to behave as expected (face validation).
5) Any further analytical processes are performed, such as running simulations of scenarios which can be compared to empirical observations or theories, and model exploration to explain phenomena and build theories.

ABM as a simulation technique enables us to explore scenarios that cannot be observed in empirical reality[12] and thus involves the experimental method in disciplines usually limited to descriptions and the comparative method.

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10 David L. Clarke, "Models and Paradigms in Contemporary Archaeology," in *Models in Archaeology*, ed. David L. Clarke (London: Methuen, 1972), 1–60.

11 For an overview of the ABM workflow carried out for this research see Section 3, including Figure 1.

12 James McGlade, "Systems and Simulacra: Modeling, Simulation, and Archaeological Interpretation," in *Handbook of Archaeological Methods*, ed. Herbert D. G. Maschner and Christopher Chippindale (Oxford: Altamira Press, 2005), 558.

ABM can be used to build and test theories of individual behaviors by projecting them onto different social and spatial scales.[13] These scales constitute different levels of observation and analysis. For example, written sources describe individuals' perceptions, while archaeological observation could provide an aggregate understanding of dynamic phenomena in general.

The literature of ABM for historical scholarship has so far mainly been limited to discussion on the potential use of ABM.[14] Nanetti and Cheong discussed how narrative-driven analysis of historical big data can lead to the development of explanatory agent-based models in the genre of counterfactual history, one possible application of ABM.[15] Some studies utilizing ABM[16] include research on infantry tactics,[17] antiquities infrastructure projects[18] and maritime trade.[19]

The situation is different in the field of archaeology where ABM has seen considerable success in recent years. This may be due to the more quantitative nature of the discipline, having its sources reflecting the aggregated activities of people of the past and thus being easier to project onto different scales of time and space.[20]

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13 Timothy A. Kohler, George J. Gumerman, and Robert G. Reynolds, "Simulating Ancient Societies," *Scientific American* 293, no. 1 (2005): 76–84.

14 Michael Gavin, "Agent-Based Modeling and Historical Simulation," *Digital Humanities Quarterly* 8, no. 4 (2014); Marten Düring, "The Potential of Agent-Based Modelling for Historical Research," in *Complexity and the Human Experience: Modeling Complexity in the Humanities and Social Sciences*, ed. Paul A. Youngman and Mirsad Hadzikadic (Singapore: Pan Stanford Publishing, 2014), 121; and Edmund Chattoe-Brown and Simone Gabbriellini, "How Should Agent-Based Modelling Engage With Historical Processes?," in *Advances in Social Simulation 2015,* ed. Wander Jager et. al. (Cham: Springer, 2017), 53–66.

15 Andrea Nanetti and Siew Ann Cheong, "Computational History: From Big Data to Big Simulations," in *Big Data in Computational Social Science and Humanities*, ed. Shu-Heng Chen, Computational Social Sciences (Cham: Springer International Publishing, 2018), 337–63.

16 For an overview see: Dominik Klein, Johannes Marx, and Kai Fischbach, "Agent-Based Modeling in Social Science, History, and Philosophy. An Introduction," *Historical Social Research/Historische Sozialforschung* 43, no. 1 (2018): 7–27.

17 Xavier Rubio-Campillo, José María Cela, and Francesc Xavier Hernàndez Cardona, "The Development of New Infantry Tactics During the Early Eighteenth Century: A Computer Simulation Approach to Modern Military History," in *Agent-Based Modeling and Simulation*, ed. Simon Taylor (Cham: Springer, 2014), 208–30.

18 J. Riley Snyder et al., "Agent-Based Modelling and Construction – Reconstructing Antiquity's Largest Infrastructure Project," *Construction Management and Economics* 36, no. 6 (2018): 313–27.

19 Ulf Christian Ewert and Marco Sunder, "Modelling Maritime Trade Systems: Agent-Based Simulation and Medieval History," *Historical Social Research/Historische Sozialforschung* 43, no. 1 (2018): 110–43.

20 Lake, "Trends in Archaeological Simulation," 258–87.

ABM has been used to explore hominid dispersal,[21] hunter-gatherer foraging[22] and settlement choice,[23] the agriculture and economy of Neolithic village communities,[24] the social and economic organization of ancient civilizations,[25] and cultural transmission,[26] among other topics.

The essence of ABM practice in archaeology lies in formulating the individual behaviors as choice rules, running the model, and comparing the simulation output to corresponding observations from empirical material. As archaeologists do not typically have access to knowledge about individual behaviors in the past, anthropological universals, contemporary analog, and other disciplines are used to define them.

3 Studying settlement choice using ABM

3.1 Case study: The Stone Age settlement of Estonia

The research question for this case study was initiated by the notion among a group of Estonian and Finnish archaeologists that it is relatively easy to find settlement sites from the late Mesolithic Narva stage (5200–3900 BC) and early

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21 Steven Mithen and Melissa Reed, "Stepping Out: A Computer Simulation of Hominid Dispersal from Africa," *Journal of Human Evolution* 43, no. 4 (2002): 433–62; Iza Romanowska et al., "Dispersal and the Movius Line: Testing the Effect of Dispersal on Population Density Through Simulation," *Quaternary International* 431 (2017): 53–63.

22 Mark W. Lake, "MAGICAL Computer Simulation of Mesolithic Foraging," in *Dynamics in Human and Primate Societies: Agent-Based Modelling of Social and Spatial Processes*, ed. Timothy Kohler and George Gumerman (Oxford: Oxford University Press, 2000), 107–43; Marco A. Janssen and Kim Hill, "An Agent-Based Model of Resource Distribution on Hunter-Gatherer Foraging Strategies: Clumped Habitats Favor Lower Mobility, but Result in Higher Foraging Returns," in *Simulating Prehistoric and Ancient Worlds, Computational Social Sciences*, ed. Juan A. Barceló and Florencia Del Castillo (Cham: Springer, 2016), 159–74.

23 John H. Christiansen and Mark Altaweel, "Simulation of Natural and Social Process Interactions: An Example from Bronze Age Mesopotamia," *Social Science Computer Review* 24, no. 2 (2006): 209–26.

24 Timothy A. Kohler et al., "Settlement Ecodynamics in the Prehispanic Central Mesa Verde Region," in *The Model-Based Archaeology of Socionatural Systems*, ed. Kohler Timothy and Sander Van Der Leeuw (Santa Fe, NM: School for Advanced Research Press, 2007), 61–104.

25 Timothy A. Kohler, George J. Gumerman, and Robert G. Reynolds, "Simulating Ancient Societies," *Scientific American* 293, no. 1 (2005): 76–84.

26 Enrico R. Crema and Mark W. Lake, "Cultural Incubators and Spread of Innovation," *Human Biology* 87, no. 3 (2015): 151–68.

Neolithic Comb Ware period (3900–1800 BC) (which we will refer to together as NCW) on the landscape, but that sites from the Corded Ware stage (CWC; 2800–2000 BC) are only found by chance.[27] We can rephrase this by saying that archaeologists' implicit mind-models can predict the locations of the first group of sites but are unsuccessful for the second group.

The effectiveness of archaeological predictive models (here, we consider mind-models to belong to this group) has been thoroughly discussed and it has been hypothesized that, as social complexity grows, the direct relationship between settlement choice and environmental conditions decreases.[28] The case study presented here explored this hypothesis as a cause of differences in the environmental predictability of settlement locations.

To do so, the research project integrated empirical data and theories of settlement pattern formation, including two levels of analysis. The empirical level was represented by the settlement locations of the given periods and the environmental conditions associated with those locations. Settlement systems can be approached as emergent phenomena formed by individuals making their decisions of where to live, which constitutes another theoretical level of analysis. Scholars have implicitly used this perspective but explicit approaches have been less explored so far. Separate levels of analysis and the complex nature of the formation process suggested ABM as an appropriate research tool to propose hypothesized models of individual behavior and test them against empirical observation.

Using ABM set several requirements that needed to be met to build, calibrate, validate, and interpret an ABM model. Although ABM can be developed based on verbal theories[29] and validated qualitatively against descriptions, quantitative modeling steps were essential and considerably influenced the current research process. Those research steps created a research framework illustrated in Fig. 1 and discussed in the following sections.

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27 Sikk et al., "Environment and Settlement," 91.

28 Jeffrey H. Altschul, "Models and the Modelling Process," in *Quantifying the Present and Predicting the Past: Theory, Method, and Application of Archaeological Predictive Modeling*, ed. James Judge and Lynne Sebastian (Denver: US Department of the Interior, Bureau of Land Management, 1988), 61–96; Kenneth L. Kvamme, "There and Back Again: Revisiting Archaeological Locational Modeling," in *GIS and Archaeological Site Location Modeling,* ed. Mark W. Mehrer, and Konnie L. Wescott (Raton, FL: CRC Press, 2005), 23–55.

29 Paul Smaldino, "How to Translate a Verbal Theory into a Formal Model," preprint (MetaArXiv, 26 May 2020).

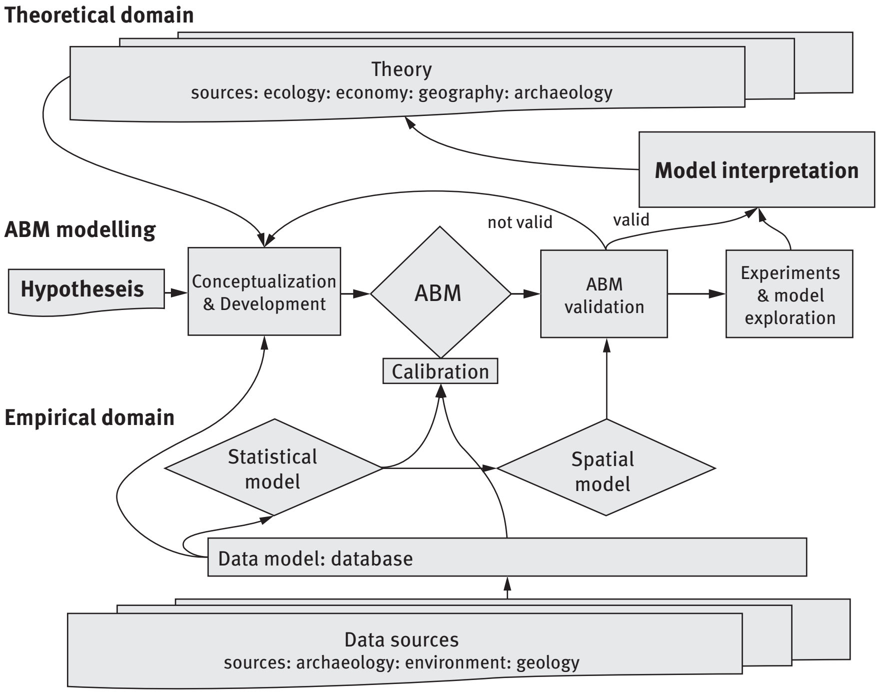

Fig. 1: ABM-driven research process used in the current research. The flowchart illustrates the process starting from a hypothesis, through proposing a model, and ending with model interpretation which results in new theory building. 2020. © Kaarel Sikk.

3.2 Data modeling

Data extraction and modeling involve defining entities of interest and their available and relevant characteristics.[30] Being a prerequisite for following modeling practices it does, however, require a knowledge of both empirical data and the related theoretical frameworks. In the current study, preliminary development of both the empirical and the conceptual model was required before the final data structure was decided upon, requiring synchronous development.

30 The annual conference series “Computer Applications and Quantitative Methods in Archaeology” dedicated to this topic has been running since 1973. For proceedings see: https://caa-international.org/proceedings/published/, accessed July 27, 2021.

In addition to both empirical and theoretical explorations of available knowledge, data modeling also exposed three essential issues typical of quantitative studies of the past:

- contemporary conditions (environment) are different from those of the past
- the extent to which past environmental attractions can be observed in available variables is not known
- whether the mind-model of the archaeologists has already introduced a bias in the current knowledge.

To address these issues several new steps were introduced into the research process. The first of them required interdisciplinary cooperation with geologists who provided past landform and shoreline reconstruction models representing the periods of interest.

The second issue was solved by constructing a statistical model which proved the strong relation between environmental variables (e.g., distance to water, soil type, geomorphological derivatives) and settlement choice (see Section 3.3).

Data bias is a well-known issue to archaeologists[31] and, as one critical comment by a reviewer stated, it is often considered to invalidate the results, without delving into complex theoretical frameworks. In the current case the survey strategies were studied and it was found that most recent surveys have ventured past predicted areas and undertaken additional trips in order to validate knowledge.[32] This made the current knowledge significantly stronger, although awareness of possible bias is universally required during interpretation of archaeological results.

3.3 Statistical model of empirical data

A statistical model was created mainly as an evaluation of available environmental variables, to explore their relation to settlement choice. Statistical analysis was used to find and describe regularities in the empirical data. The dependence of settlement patterns on environmental conditions has been thoroughly researched in archaeology, with studies carried out since the 1970s. Later the exploration continued mostly with GIS-based predictive models for archaeological site prospection.[33]

31 David Wheatley, "Making Space for an Archaeology of Place," *Internet Archaeology* 15 (2004).

32 Sikk et al., "Environment and Settlement," 110.

33 William James Judge and Lynne Sebastian, *Quantifying the Present and Predicting the Past: Theory, Method, and Application of Archaeological Predictive Modeling* (Denver: US Department of the Interior, Bureau of Land Management, 1988); Mark W. Mehrer and Konnie L. Wescott, *GIS and Archaeological Site Location Modeling* (Raton, FL: CRC Press, 2005).

The analysis of the current data showed the existing relation between environment and settlement choice and exposed useful variables describing it. Some of the results, like the sites' proximity to water bodies in dry, sandy areas were already known to archaeologists. The results added new insights including the rugged nature of the preferred environment and the relative position of sites in local topography. The statistical analysis served as a tool for data reduction and helped to assess which variables were reflecting changes in settlement choice and were thus useful to include in further analysis.

This step revealed differences in settlement choice logic between the CWC and NCW settlements, with the first being less constrained by water bodies and in general situated in higher locations.[34] The selection of variables (e.g., distance to water, soil type) and measures of their effect on settlement choice pushed the boundaries of interpretation and led to alternative hypotheses for explaining the data.

3.4 Spatial model

A spatial model was constructed in order to quantitatively assess the initial observation that the settlement choice of the CWC phenomenon was less predictable than that of the earlier periods. The analysis was done using methodologies from archaeological predictive modeling and eco-cultural niche modeling – the latter provided several additional measures and niche-related concepts from ecology.

Knowledge of the relation of environmental variables to settlement choice was extrapolated to the whole research area by creating a spatial inductive logistic regression model. The resulting probability rasters represented the environmental residential suitability maps associated with the two studied settlement systems. Created models could be compared for both the environmental influences and the spatial configurations of suitable areas. Comparison of the features confirmed the hypothesis that during the CWC stage the settlement choice was less restricted by environmental conditions.

Several spatial measures like spatial clustering and niche breadth were experimented with and provided measures to compare simulation results to empirical reality, thus helping to validate them. Through the modeling process the epistemological meaning changed from economically evaluating individual locations for potential archaeological remnants to reconstruction of the past

34 Sikk et al., "Environment and Settlement," 107–10.

vision of the landscape. The spatial interpretation of empirical data was a step closer to expressing individual perception of the landscape.

In addition to confirming the initial hypothesis of decreasing environmental influence this enabled formulation of new interpretations of the importance of spatial structure of past perception of the habitation areas. For this, the new concept of a residential suitability model (RSM) was developed, which was interpreted as the perceived potential of locations in an area for living and which is technically identical to niche models and archaeological predictive models. It could be asked: What are the differences between the suitable habitation areas, as perceived by people of the early Neolithic and the CWC cultures? It also helped to define hypotheses for explaining differing spatial structure RSMs of the settlement systems. Those hypotheses included the different mobility modes of the periods, growing social complexity, and technological innovation making wider areas usable by agriculture.

3.5 Agent-based framework

The central goal of ABM is to explain complex relations between processes that are out of the reach of verbal arguments by proposing a model which can be validated to empirical data. The model can then be explored further, thus building theory through interpreting it. For the current study the goal was to build a simulation model that produced synthetic data that could be compared to archaeological empirical data and through it to explain the observed variations in settlement systems. The foundation of such a model is the conceptualization of theoretical knowledge of individual behaviors.

The conceptual model was constructed to formally describe the settlement pattern formation process as cumulative settlement choices. The conceptualization drew from studies in ethnography and economic geography, incorporating abstract concepts most of which have previously been discussed in the context of archaeology. The conceptual model describing how people choose a place to live was based on theories from archaeology where most of the basic principles had been debated during the 1970s.[35]

Constructing the abstract conceptual model was helped by the fact that general theories of settlement choice are similar in those fields and the main differences come from the empirical data used to back them. For example, archaeologists

35 Carole L. Crumley, “Three Locational Models: An Epistemological Assessment for Anthropology and Archaeology,” *Advances in Archaeological Method and Theory* 2 (1979): 141–73.

could categorize influences on choice as social (hypothetical) and environmental (partly observable) influences, but geographers would group influences by their spatial characteristics.

Individual agents' selection of residence was formulated using principles of discrete choice, with every location having an abstract utility value for a settlement. From contemporary experience we know that there exist a multitude of factors influencing residential choice, for example access to a workplace and essential services, social context, the feeling of belonging to a group, and general environmental conditions. Such factors depend on observed society, but to abstract prehistoric settlement choice we categorized them into two major groups: influences arising from the social domain (other people) and those related to the physical environment.

The utility value of each location was then determined by a utility function composed of factors categorized as access to either ecosystem services or social services. Under ecosystem services we grouped factors like access to local shelter, drinking water, and a dry location, as well as access to fertile agricultural lands and hunting grounds. Social services include the benefits of keeping in contact with other people, including the availability of specialized goods, trade, and cultural and other benefits which can be associated with greater social complexity. It must be noted that neither group is completely nor directly observable in the archaeological record, but ecosystem services is certainly better represented through environmental variables.

A functional simulation model was constructed based on the conceptual model, and synthetic environments were generated, with ecosystem services and agent populations forming dynamic social attractions. Each agent in the system model represented a community that formed a residential settlement. Agents were made mobile and assigned a goal of searching for the best location in the randomly generated environments, using varying influences.

One of the powers of ABM is the ease of going directly from the conceptual model to the simulation model, thus enabling model exploration techniques to be used to gain theoretical insights. Exploration of the conceptual model showed that, for settlement choice, the factors which required access over longer distances, like trade, were of lesser importance in validating the significance of the relation between different environmental data for this decision. Although the result may be intuitive, ABM provided quantitative assessment of significant ranges of individual environmental influences. For example, local conditions influence specific location choice significantly more than access to resources in daily walking distance does.

3.6 ABM experiments

Three extended models were created to run simulation experiments testing the hypotheses. The first experiment was designed and run to explore the resource depletion that has long been considered to be the driving force of hunter-gatherer mobility. A central place foraging (CPF) ABM implementation was created and illustrated that, although the resource depletion based model is very useful for explaining mobility, it has only a modest impact on settlement location choice principles.[36] The experiment indicated that the hypothesis of differing mobility was not the cause of differences between settlement systems of the periods concerned.

Another simulation experiment was conducted testing different variations of utility function, with agents prioritizing either environmental benefits or social connectivity. As expected in simulation runs with agents prioritizing social services more highly, the environmental value of location was sacrificed, resulting in greater population clustering (Fig. 2) – and, in the reverse case, population was generally more dispersed.[37] The model confirmed the intuitive idea that, with greater social complexity, the selection of suitable sites was less environmentally determined – but it added a spatial factor: i.e. it should also result in higher population clustering.

Running a dedicated simulation experiment testing different spatial configurations of the environment led to another unexpected insight. The simulations revealed the idea that the spatial autocorrelation of attractions in the landscape influences the emergence of settlement systems and population clustering.

ABM enabled the conceptualization of the rather abstract but essential idea of a residential suitability model, as mentioned in Section 3.4. The most fruitful of the unexpected insights that came purely from ABM simulations was the understanding that the spatial configuration of attractions in the landscape influences the emergence of settlement systems and population.

It was personally interesting to observe how the ABM modeling process surprised and played with the researchers' intuition.[38] The simulation results were sometimes the opposite of their initial intuition but, after visual observation of the simulations, previously counterintuitive results started to seem intuitive. I

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36 Sikk and Caruso, "Spatially Explicit Agent-Based Model," 1–21.

37 Kaarel Sikk, Geoffrey Caruso, and Aivar Kriiska, "Conceptual Framework of Assessing the Influence of Cultural Complexity to Settlement Pattern Formation," (paper presented at Conference on Complex Systems, Thessaloniki, 2018).

38 Andre Costopoulos and Mark W. Lake, *Simulating Change: Archaeology into the Twenty-First Century* (Salt Lake City: University of Utah Press, 2010).

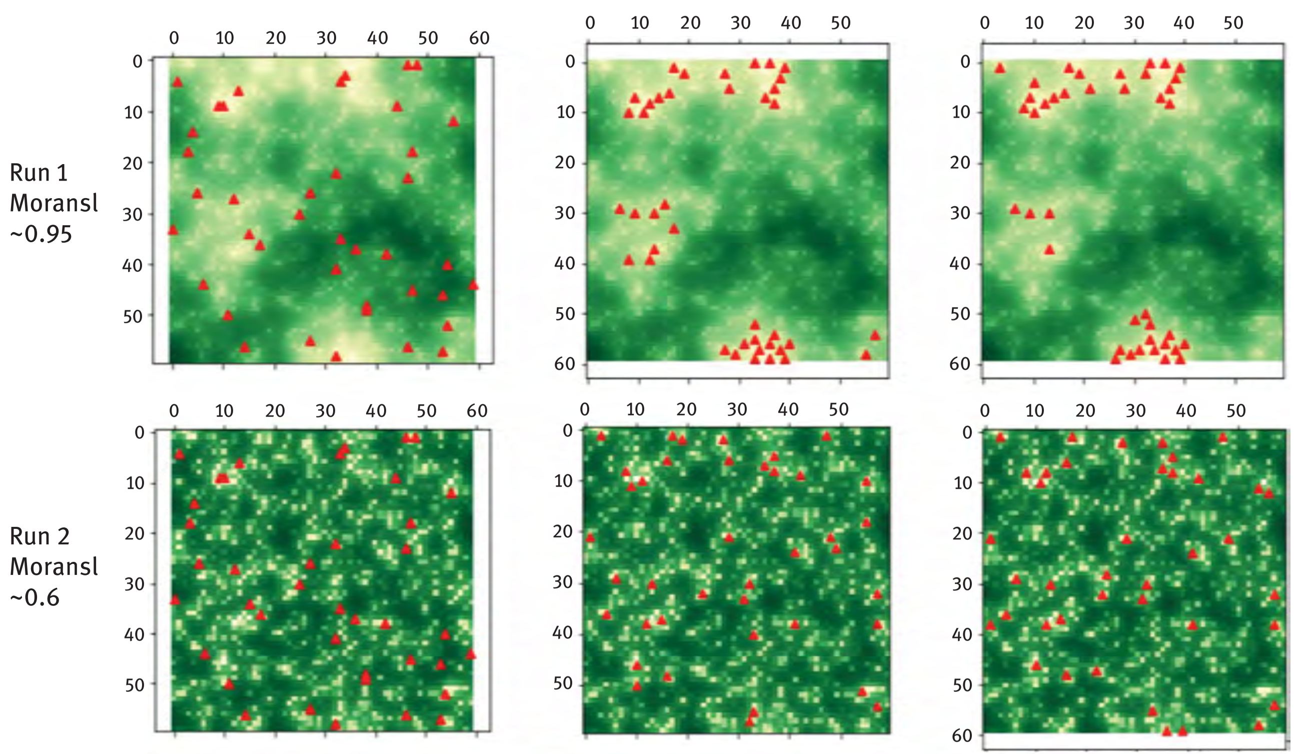

Fig. 2: Varying spatial configuration of environmental suitability has an impact on clustering of the population as visualized by theoretical ABM simulation. Two simulation runs are visualized, with images showing settlement locations after 5, 10, and 50 steps. Upper row shows that more “smooth” environments lead to population clustering. 2020. © Kaarel Sikk.

experienced a similar situation while observing how smoother environments resulted in clustered populations and vice versa (Fig. 2), depending on the scale and importance of environmental variables. The intuition tricked researchers' minds again when the resulting dynamics changed while introducing the mechanics of resource depletion.

4 Discussion on ABM and studies of the past

4.1 ABM as a "thinkering" tool

ABM is intended for exploring complex systems with emergent properties and other characteristic features. Some results of the current as well as other archaeological papers can also be described using simpler analytical models. As using the simplest possible method is a general scientific principle,[39] a critique toward the use of ABM in archaeology is to ask: Is ABM really needed to confirm a theory?

Experience in archaeology, including the current project, indicates that ABM has proven its value as a tool to "thinker" with,[40] even if emergent properties are not expected to be found. We argue that the process of developing ABM through formulating theories algorithmically is a very rewarding part of the research. Its unexpected additional knowledge gain often leads to new approaches, concepts, and research questions.[41] This benefit of modeling is especially rewarding when dealing with the complexity of social systems, still relatively unexplored in humanities.

The explorative power of ABM is realized through the development process and the methodological toolkit associated with it. In addition to domain knowledge of the subject matter, this development requires researchers to be able to express their ideas algorithmically – a formal expression that forces them to explicitly state their knowledge and re-evaluate existing perspectives. It also opens up new angles to a research subject, with the challenge to select the most relevant one, thus requiring multiperspective exploration.

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39 Iza Romanowska, "So You Think You Can Model? A Guide to Building and Evaluating Archaeological Simulation Models of Dispersals," *Human Biology* 87, no. 3 (2015): 169–92.
40 Erkki Huhtamo, "Thinkering with Media: On the Art of Paul DeMarinis," in *Paul DeMarini: Buried in Noise*, ed. Ingrid Beirer et. al. (Heidelberg: Kehrer Verlag, 2010), 33–46; and Andreas Fickers and Tim van der Hejden, "Inside the Trading Zone: Thinkering in a Digital History Lab," *Digital Humanities Quarterly* 14, no. 3 (2020).
41 Costopoulos and Lake, "Simulating Change."

Archaeologists have rather successfully developed a gut feeling for settlement locations from their experience of different landscapes. While searching for undiscovered settlement sites they use their mind-model empathetically: Where would I have camped or settled, in the past? The process is similar to agent-based modelers modeling the social system and describing the rules governing an individual (self) making a choice: “If I were to move it would (probably) be to a better place.” This very basic starting statement already raises several new questions that need to be solved and leads to a chain of “thinkering” exercises, experimenting with the synergy of empathetic and rule-based thinking.

If familiar with the algorithmic toolkit, ABM provides the researcher with a surprisingly intuitive process giving reflexive feedback and new perspectives on existing knowledge. These perspectives often lead to reconceptualizations of subject matter. In the current research a significant development was the reconceptualization of archaeological predictive models as residential suitability models.

4.2 ABM as an interdisciplinary trading ground

The research process showed that the skeptical view that modeling practices suppress multiperspective approaches was unfounded – and that in fact the opposite was true: describing influences on human choices required searching for new perspectives in order to describe the system as a whole in the most effective way.

Using ABM almost universally forces the researcher to enter an interdisciplinary trading ground and search for fields where specific problems have been solved in the most efficient way. A sentence in Section 4.1 reflected settlement choice as perceived by a person: questions on how to formally describe a choice can be studied in anthropology, psychology, or economics, as archaeologists often do. Although the developed settlement choice model was focused on spatial aspects it required mapping a wide range of literature from different sources and used input from various different domains, including geology and ecology.

Formal models are descriptions of a phenomenon with all irrelevant domain knowledge stripped out, which makes it possible for specialists from different fields to understand and evaluate the model and reproduce the research results. As a visual diagram can generally be read without knowing the scientific details of a topic, so an ABM can also be read and understood by anyone who has mastered the language of its development. This makes formal models efficient interdisciplinary communication tools.

In the case of ecology and archaeology, for example, there has been an exchange regarding predictive models of animal niches and archaeological settlement sites. Despite these being different domains the literature is easily understandable by researchers – and joint methodological developments have even led to the new field of eco-cultural niche modeling.[42] In the current research, geological paleoreconstruction models were directly usable as a direct input to archaeological models.

Following are some of the interdisciplinary points of contact that were communicated through modeling practices:
– archaeological and environmental data, through data modeling
– a paleoenvironment reconstruction model, with geologists using GISs and existing paleoenvironmental proxies
– spatial statistics, with inductive spatial models and geographical tools to compare them
– conceptual ABM integrating theoretical frameworks from economics, urban geography, and ethnography
– model exploration techniques for assessing and building theories and interpreting empirical data.

The techniques used in the current study also have surprising connections to very different fields. For example, inductive models used for predicting site locations are algorithmically identical to the ones used for text analysis, such as for topic modeling. They even share typical prediction algorithms (e.g., logistic regression and MaxEnt) and similarly produce a classification (e.g., habitation suitability versus topic) that can be used by scholars for searching (e.g., new sites versus new insights). These models add a new dimension of observation: in the case of topic modeling this might, for example, create a temporal dynamic description and in the case of archaeological sites the model can provide the spatial structure of a suitable area. Although having very different fields of research, scholars working with the same algorithm can create a surprisingly effective channel of communication.

ABM provides even more potential trading ground in the humanities. The individual-based approach enables more abstract models to be extended to represent particular cases in different fields. So a conceptual model of residential choice could be extended to represent hunter-gatherers on the landscape, or people living in early towns, but also global processes of immigration.

42 William E. Banks et al., "Eco-Cultural Niche Modeling: New Tools for Reconstructing the Geography and Ecology of Past Human Populations," *PaleoAnthropology* 4, no. 6 (2006): 68–83.

5 Conclusion: Remarks on the general usability of ABM for exploring the past

Systems modeling can be applied in cases where generalizations are relevant. When exploring an individual biography, or a narrative with no regularities, ABM practices might not contribute. But ABM can be applied when two levels of analysis – such as individuals and social groups – are included in the research. Navigating between these is quite intuitive in everyday life, for example when talking about individuals and their stories we tend to see them as unique, but when considering a person's social role we classify and generalize.

Because of its more general level of usage, ABM's potential use in humanities might have similarities with prosopography, the study of common features in historical social groups, as it is not in a constant search for the exceptional and unique.

In archaeology, ABM, among other modeling techniques, has seen considerable success. This may be explained by the discipline's close relation to natural sciences and the pattern-like nature of archaeological data. It is also relevant that the data collection procedure used in excavation is a quantitative process. The archaeological record is organized by units of different scale like region, site, archaeological context, and artifact. The essential element of archaeology, the dating of items and contexts, traditionally uses the stratigraphical method borrowed from geology and has developed its own statistical methods, from seriation (introduced by Petrie) to radiocarbon dating interpreted through Bayesian statistics.

This indicates that a successful ABM project depends on proven formal frameworks and sufficient amounts of quantitative data, collected in a systematic fashion, so as to serve as a proxy for studied phenomena. Additionally, the observed sociocultural processes must be of sufficient scale to generate regularities that can be isolated from chaotic or unobservable randomness.

References

Altschul, Jeffrey H. "Models and the modelling process." In *Quantifying the Present and Predicting the Past: Theory, Method, and Application of Archaeological Predictive Modeling*, edited by James Judge and Lynne Sebastian, Oxford: Clarendon Press, 1988.

Aristotle. *Metaphysics*, trans. William D. Ross. Oxford: Clarendon Press, 1908: 980a.

Banks, William E., Francesco d'Errico, Harold L. Dibble, and Leonard Krishtalka. "Eco-cultural niche modeling: new tools for reconstructing the geography and ecology of past human populations." *PaleoAnthropology* 4, 6 (2006): 68–83.

Bedau, Mark, and Paul Humphreys. *Emergence: Contemporary Readings in Philosophy and Science*. Cambridge, MA: MIT Press, 2008.

Chattoe-Brown, Edmund, and Simone Gabbriellini. "How Should Agent-Based Modelling Engage With Historical Processes?" *Advances in Social Simulation 2015*, edited by Wander Jager, Rineke Verbrugge, Andreas Flache, Gert de Roo, Lex Hoogduin, and Charlotte Hemelrijk, 53–66. Cham: Springer, 2017.

Christiansen, John H., and Mark Altaweel. "Simulation of natural and social process interactions: An example from Bronze Age Mesopotamia." *Social Science Computer Review* 24, 2 (2006): 209–26.

Clarke, David L. "Models and paradigms in contemporary archaeology." *Models in archaeology*, edited by David L. Clarke, 1–60. London: Methuen, 1972.

Costopoulos, Andre, and Mark W. Lake. *Simulating change: archaeology into the twenty-first century*. Salt Lake City: University of Utah Press, 2010.

Crema, Enrico R., and Mark W. Lake. "Cultural Incubators and Spread of Innovation." *Human Biology* 87, 3 (2015): 151–68. Accessed June 09, 2021. https://doi.org/10.13110/humanbiology.87.3.0151.

Crumley, Carole L. "Three locational models: an epistemological assessment for anthropology and archaeology." *Advances in archaeological method and theory* 2 (1979): 141–73.

Düring, Marten. "The potential of agent-based modelling for historical research." In *Complexity and the human experience: modeling complexity in the humanities and social sciences*, edited by Paul A. Youngman and Mirsad Hadzikadic, 121–37. Singapore: Pan Stanford Publishing, 2014.

Epstein, Joshua M., and Robert Axtell. *Growing artificial societies: social science from the bottom up*. Washington D.C.: Brookings Institution Press, 1996.

Ewert, Ulf Christian, and Marco Sunder. "Modelling Maritime Trade Systems: Agent-Based Simulation and Medieval History." *Historical Social Research/Historische Sozialforschung* 43, 1 (2018): 110–43.

Fickers, Andreas, and Tim van der Hejden. "Inside the Trading Zone: Thinkering in a Digital History Lab." *Digital Humanities Quarterly* 14, 3 (2020). Accessed September 20, 2020. http://digitalhumanities.org/dhq/vol/14/3/000472/000472.html.

Fickers, Andreas. "Hermeneutics of in-betweenness: digital public history as hybrid practice." *Handbook of Digital Public History*, edited by Serge Noiret, Mark Tebeau, and Gerben Zaagsma. Berlin: De Gruyter, 2022 (forthcoming).

Gavin, Michael. "Agent-Based Modeling and Historical Simulation." *Digital Humanities Quarterly* 8, 4 (2014). Accessed November 18, 2021. http://www.digitalhumanities.org/dhq/vol/8/4/000195/000195.html#d3564e172.

Huhtamo, Erkki. "Thinkering with media: on the art of Paul DeMarinis." In *Paul DeMarinis: Buried in Noise*, edited by Ingrid Beirer, Sabine Himmelsbach and Carsten Seiffairth, 33–46. Heidelberg: Kehrer Verlag, 2010.

Janssen, Marco A., and Kim Hill. "An Agent-Based Model of Resource Distribution on Hunter-Gatherer Foraging Strategies: Clumped Habitats Favor Lower Mobility, but Result in Higher Foraging Returns." In *Simulating Prehistoric and Ancient Worlds*, edited by Juan Barcelo and Florencia Del Castillo, 159–74. Computational Social Sciences. Cham: Springer, 2016. Accessed June 12, 2021. https://doi.org/10.1007/978-3-319-31481-5_3.

Judge, William James, and Lynne Sebastian. *Quantifying the Present and Predicting the Past: Theory, Method, and Application of Archaeological Predictive Modeling*. U.S. Department of the Interior, Bureau of Land Management, 1988.

Klein, Dominik, Johannes Marx, and Kai Fischbach. “Agent-based modeling in social science, history, and philosophy. An introduction.” *Historical Social Research/Historische Sozialforschung* 43, 1 (2018): 7–27.

Kohler, Timothy A., and George J. Gumerman, eds. *Dynamics in Human and Primate Societies: Agent-Based Modeling of Social and Spatial Processes*. Oxford: Oxford University Press, 2000.

Kohler, Timothy A., George J. Gumerman, and Robert G. Reynolds. “Simulating ancient societies.” *Scientific American* 293, 1 (2005): 76–84.

Kohler, Timothy A., and Sander Van Der Leeuw. “Settlement ecodynamics in the prehispanic central Mesa Verde region.” In *The model-based archaeology of socionatural systems*, edited by Timothy Kohler and Sander Van Der Leeuw, 61–104. Santa Fe: School for American Research Press, 2007.

Kvamme, Kenneth L. “There and back again: Revisiting archaeological locational modeling.” *GIS and archaeological site location modeling*, edited by Mark W. Mehrer, and Konnie L. Wescott, 23–55. Raton, FL: CRC Press, 2005.

Lake, Mark W. “MAGICAL computer simulation of Mesolithic foraging.” In *Dynamics in human and primate societies: agent-based modelling of social and spatial processes*, edited by Timothy Kohler and George Gumerman, 107–43. New York: Oxford University Press, 2000.

Lake, Mark W. “Trends in archaeological simulation.” *Journal of Archaeological Method and Theory* 21, 2 (2014): 258–87.

McGlade, James. “Systems and simulacra: Modeling, simulation, and archaeological interpretation.” In *Handbook of archaeological methods*, edited by Herbert D. G. Maschner and Christopher Chippindale, 554–602. Oxford: Altamira Press, 2005.

Mehrer, Mark W., and Konnie L. Wescott, eds. *GIS and archaeological site location modeling*. Raton, FL: CRC Press, 2005.

Mithen, Steven, and Melissa Reed. “Stepping out: A Computer Simulation of Hominid Dispersal from Africa.” *Journal of Human Evolution* 43, 4 (2002): 433–62. Accessed June 12, 2021. https://doi.org/10.1006/jhev.2002.0584.

Nanetti, Andrea, and Siew Ann Cheong. “Computational History: From Big Data to Big Simulations.” In *Big Data in Computational Social Science and Humanities*, edited by Shu-Heng Chen, 337–63. Computational Social Sciences. Cham: Springer International Publishing, 2018. Accessed June 12, 2021. https://doi.org/10.1007/978-3-319-95465-3_18.

Rogers, J. Daniel, and Wendy H. Cegielski. “Opinion: Building a better past with the help of agent-based modeling.” *Proceedings of the National Academy of Sciences* 114, 49 (2017): 12841–44.

Romanowska, Iza et al. “Dispersal and the Movius line: testing the effect of dispersal on population density through simulation.” *Quaternary International* 431 (2017): 53–63.

Romanowska, Iza. “So You Think You Can Model? A Guide to Building and Evaluating Archaeological Simulation Models of Dispersals.” *Human Biology* 87, 3 (2015): 169–92. Accessed June 12, 2021. https://doi.org/10.13110/humanbiology.87.3.0169.

Rubio-Campillo, Xavier, José María Cela, and Francesc Xavier Hernàndez Cardona. “The development of new infantry tactics during the early eighteenth century: a computer simulation approach to modern military history.” In *Agent-Based Modeling and Simulation*, edited by Simon Taylor, 208–30. Cham: Springer, 2014.

Sikk, Kaarel, Geoffrey Caruso, and Aivar Kriiska. "Conceptual framework of assessing the influence of cultural complexity to settlement pattern formation". Paper presented at Conference on Complex Systems, Thessaloniki, 2018.

Sikk, Kaarel et al. "Environment and Settlement Location Choice in Stone Age Estonia." *Estonian Journal of Archaeology*, 24, 2 (2020): 89–140. Accessed June 12, 2021. https://orbilu.uni.lu/handle/10993/43168.

Sikk, Kaarel, and Geoffrey Caruso. "A Spatially Explicit Agent-Based Model of Central Place Foraging Theory and Its Explanatory Power for Hunter-Gatherers Settlement Patterns Formation Processes." *Adaptive Behavior*, 28, 5 (2020): 377–97. Accessed June 12, 2021. https://doi.org/10.1177/1059712320922915.

Smaldino, Paul. "How to translate a verbal theory into a formal model." Preprint. MetaArXiv, 2020. Accessed June 12, 2021. https://doi.org/10.31222/osf.io/n7qsh.

Snyder, Riley J., Ozge Dilaver, Lucy Stephenson, Jan E. Mackie, and Simon D. Smith. "Agent-based modelling and construction – reconstructing antiquity's largest infrastructure project." *Construction Management and Economics* 36, 6 (2018): 313–27. Accessed June 12, 2021. https://doi.org/10.1080/01446193.2017.1403639.

Wheatley, David. "Making space for an archaeology of place." *Internet archaeology* 15 (2004). Accessed June 13, 2021. https://intarch.ac.uk/journal/issue15/.

Wilensky, Uri. "NetLogo Preferential Attachment Model," (Center for Connected Learning and Computer-Based Modeling, Northwestern University, 2005). Accessed December 1, 2020. http://ccl.northwestern.edu/netlogo/models/PreferentialAttachment.

Shohreh Haddadan

Argument structures of political debates

Annotation, extraction, and applications

1 Introduction

Argument mining has been a popular application in natural language processing (NLP) in recent years. Finding the structure of an argument from unstructured resources facilitates the analysis of the huge amounts of data that are available in these modern times, whether born-digital web content or digitized resources processable by machines. One of the potential fields of argument is that of the political debates in which candidates argue adversarially over topics put to them, in order to persuade the audience of their competence to be appointed by them to a post. Presidential election debates in the United States have, in some cases, been proven effective in this persuasion.

In this study I am interested in the algorithmic extraction of the argument structures in these debates. In Section 2 of this chapter, I discuss why this study is considered an interdisciplinary field and how the study and its results could relate to digital history and hermeneutics Section 3 investigates in detail the need for annotation in digital humanity studies and the annotation process approach I took in this research. In Section 4 I explain how, in my research, I have implemented NLP algorithms to extract the argument structures from a political debate dataset and evaluate the results – while in Section 5 I describe some applications of the extracted argument structures.

Finally, in Section 6, I critically reflect on the transformation of the digital data source as well as the methodology, including the annotation process and NLP techniques used in this research.

1.1 Research goal and questions

In this study, I focus firstly on annotation and then extraction of the logical structure of the arguments provided by presidential candidates in the US presidential election debates from 1960 to 2016.

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Most prominently in argument mining research, an argument's main component is a claim which embeds the goal of the argument. Thereafter the claim needs to be supported by evidence or premises.

The main goal of my research is to algorithmically identify the argument structure in political debate data – i.e. to find an algorithm which can identify how the argument is shaped, ultimately achieving an argument structure such as that depicted in Fig. 1, which is based on a statement made by Senator John F. Kennedy in the 26 September 1960 debate against Vice President Richard Nixon.

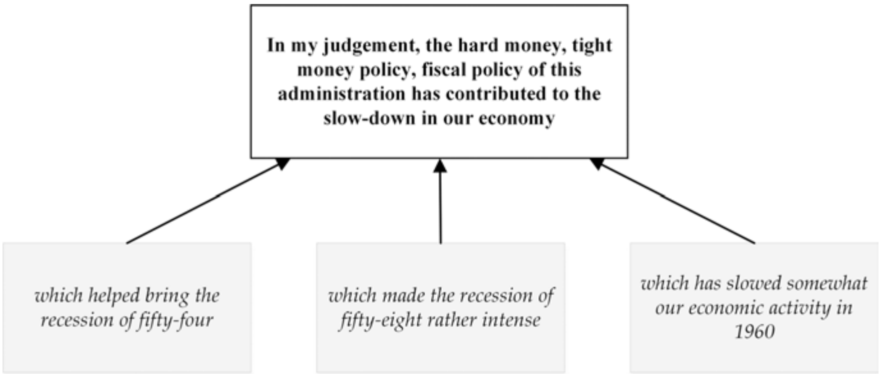

Fig. 1: Argument structure extracted from Kennedy-Nixon debate on 26 September 1960. KENNEDY: In my judgment, the hard money, tight money policy, fiscal policy of this Administration has contributed to the slow-down in our economy, which helped bring the recession of fifty-four; which made the recession of fifty-eight rather intense, and which has slowed, somewhat, our economic activity in 1960. 2020. © Shohreh Haddadan.

One approach toward extraction of structures of this type from plain textual resources is to implement an argument mining pipeline – this is considered the main methodology in this field of research.

In my research, I focus on answering the following questions:

- How can political debate transcript data be defined in the argument analysis domain?
- Is an artificial intelligent agent in the form of a computer program able to reproduce the thought processes of a human in structuring an argument, given the political debate text data? And what aspects of argument structure should an algorithm learn in order to reshape a political debate transcript into argument structures illustrating how candidates formulate their arguments in debates?
- What means of analysis can argument structures extracted from text provide for media historians, political scientists, or social scientists?

2 Interdisciplinary aspect of the project

Argument mining research is by definition an interdisciplinary study. The two disciplines from which this area of research has originated are argumentation theory and NLP. Argumentation theory analyses the nature of arguments from a logical perspective. The basis of this research field is the study of argument structures. Meticulously speaking, argumentation theory is in itself an interdisciplinary field composed of rhetoric and logic.[1]

Furthermore, the research applies NLP techniques in order to extract what we define as arguments from language resources which potentially contain arguments.

Thirdly, the dataset determines the field(s) of science in which the results are interpreted, in this case contemporary history, political science, and public discourse. Zarefsky describes the study of public discourse as a "subfield [that] has developed [. . .] that is devoted to the historical-critical study of specific texts or moments of rhetorical significance,"[2] – moments, for example, such as those of presidential debates. As will be discussed in Section 3, the dataset at hand is a collection of debates from the election periods in the United States between 1960 and 2016. The interpretation of this dataset from the perspective of how the arguments have been shaped, changed, reformed, and evolved during a relatively short period of time falls into the field of history, as well as that of political sciences. Thus, the interdisciplinary aspect of this research project touches on three main fields at various levels of basic definition, methodology and practical interpretation.

Zarefsky points out that the goal of studying public discourse is to redirect it firstly into what he calls *artistic goals*, where scholars investigate the dynamics of the text to further evaluate its effectiveness or persuasiveness, which can in argumentation theory be mapped to evaluating the strength of the arguments. The second aspect is that of *historical goals*, which aim at understanding how a certain public discourse affected the flow of history.[3] This goal can be mapped to evaluating, from a distant reading view, how different topics have been structurally formed within arguments in the debates throughout a time line.

1 Manfred Stede and Jodi Schneider, "Argumentation mining," *Synthesis Lectures on Human Language Technologies* 11, no. 2 (2018): 1–191.

2 David Zarefsky, *Political argumentation in the United States: Historical and contemporary studies. Selected essays by David Zarefsky* (Amsterdam: John Benjamins Publishing, 2014), 2.

3 David Zarefsky, "Political argumentation," 2.

We therefore expect that the extraction of the structure of arguments can indeed provide a tool for historians and public discourse analysts to facilitate both types of goals mentioned.

3 Annotation

Annotation bridges various fields of science by adding metadata or knowledge from other perspectives to plain data (e.g. text, images). NLP profits from many linguistic annotation schemes applied to plain textual resources, such as annotation of parts of speech, various parsing syntaxes, and even semantic and pragmatic level annotations.

Furthermore, the field of digital humanities benefits from annotated resources arising from mark-up annotation schemes such as reviews of cultural artifacts.[4] It also connects computational linguistics with the field of digital humanities – for instance, Schmidt uses semantic annotation of named entities to facilitate a historical study of German plays in order to interpret their role in historical narratives.[5]

New machine learning techniques like deep learning are known for their data-devouring characteristics. Annotation is the means of providing them with the data they need to consume to enable them to recognize patterns using their generalization and specification algorithmic mechanisms.

In this research, I first had to specify an annotation scheme to represent argument structures so that it could be applied to the data.

The structure of arguments may vary depending on the domain in question. For instance, in an argument essay, students describe their stance for or against a predefined issue (referred to as the major claim) to outline their thought processes and structure them for the teacher or the readers of the article. However, televised debates for the presidential elections take place in a competitive atmosphere, with arguments being made for self-promotion purposes in this adversarial context. The debaters support their claims in each monological argument and other debaters attack (or in rare cases support) those arguments in a dialogical

4 Kristin Kutzner et al., “Reviews of Cultural Artefacts: Towards a Schema for their Annotation,” (Workshop on Annotation in Digital Humanities conference co-located with ESSLLI, Sofia, 2018), 17–23.

5 Thomas Schmidt, Manuel Burghardt, and Katrin Dennerlein. “Sentiment annotation of historic German plays: An empirical study on annotation behavior,” (Annotation in Digital Humanities conference, Sofia, 2018), 47–52.

setting. Therefore, the annotation scheme used will also vary according to the setting of the argumentation.

I discuss selection of the annotation scheme from three aspects: reproducibility, practicality, and refinement.

An annotation scheme needs to be reproducible independent of the annotator and the annotation platform. In order to bring about reproducibility in any annotation scheme on a language corpus, measuring methods are proposed during the annotation process.

The practicality of the annotation denotes the applicability of the extracted structure in the required domains. For instance, the persuasive essay project has defined an argument scheme which incorporates "major claim" as an argument component since, as I discuss later, in most cases there are no explicit major claims in dialogical arguments in our political debate dataset.[6]

The process of interchangeably converting one annotation scheme to another, in order to make use of various datasets as inputs to reasoning engines, can be handled if the annotation scheme has the capacity for refinement. A simple annotation scheme may later be expanded on matters such as the distinctions between relations, or the classification of components.

These three aspects guide us in selecting an appropriate annotation scheme while considering the trade-off between a scheme simple enough for annotators and the incorporation of enough information for further practical purposes.

The selected annotation scheme is composed of two classes of argument component – namely claims and premises – and two classes of relations which connect the argument components to form the structure of the argument's (support/attack) relations. This annotation scheme can serve in the monological speeches made by each candidate in the debates to represent the structure of their argument as shown in the argument structure diagram in Fig. 1.

Moreover, the relations can be extended to depict supporting or attacking arguments in candidates' speeches in the dialogical setting of political debates. Figure 2 shows an argument diagram extracted from the annotated dataset. Each monologue speech is annotated with argument components and relations from the argument structure. Relations depict the relations between argument components in a dialogical setting.

6 Christian Stab and Iryna Gurevych, "Annotating argument components and relations in persuasive essays," (COLING, the 25th international conference on computational linguistics: Technical papers, Dublin, 2014), 1501–10.

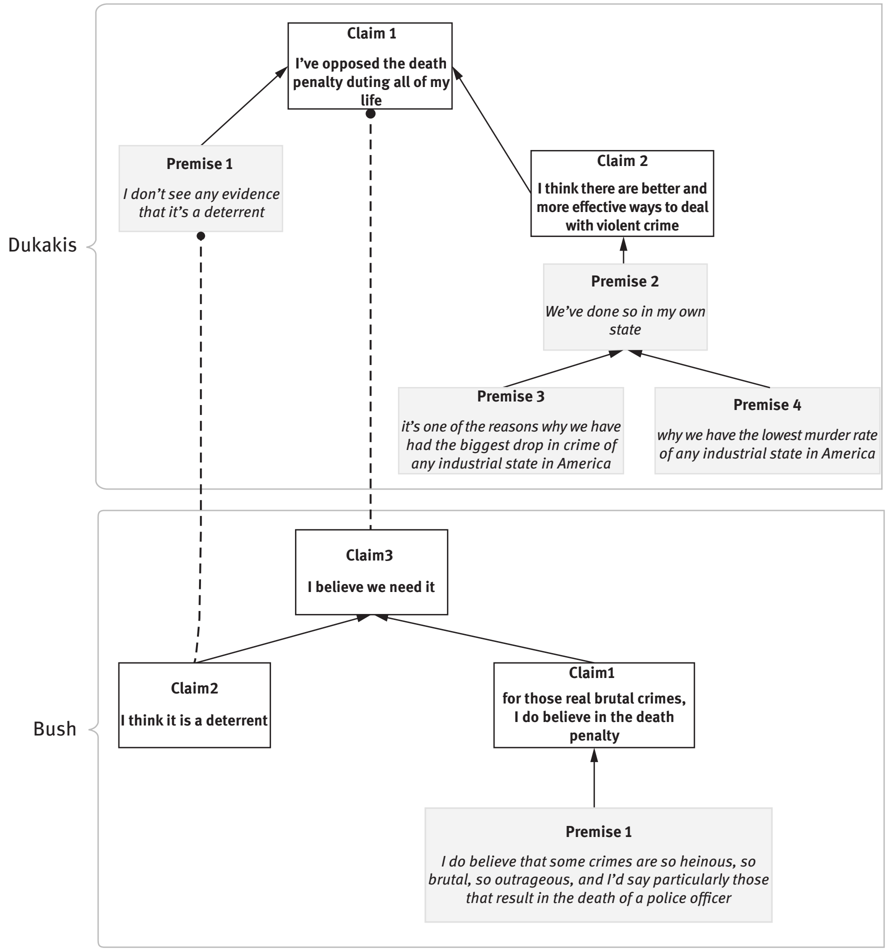

Fig. 2: Argument structure diagram using a claim-premise annotation scheme. Claims are depicted in white rectangles; shaded rectangles represent premises. Arrow-headed connectors represent support relations; circle-headed dotted connectors show attack relations. 2020. © Shohreh Haddadan.

3.1 Dataset

Data was gathered from the website of the Commission on Presidential Debates (CPD),[7]which provides transcriptions of the debates held among the leading

7 "The Commission on Presidential Debates," accessed July 26, 2021. https://www.debates.org.

candidates for the presidential and vice-presidential offices in the US. This organization is a non-profit which has been responsible for regulating the debates leading up to the US presidential elections since 1987. The website also contains transcripts of debates held earlier than the establishment of the CPD. For this study, transcripts of the televised debates which were broadcast from 1960, between Kennedy and Nixon (the earliest such debate), until 2016 between Clinton and Trump, were selected. The dataset consists of 42 transcripts between major party candidates, divided in 12 different election years. In the years 1964, 1968, and 1972, no debates were held between the major candidates from the Republican and Democratic parties.

Table 1 summarizes the size of the dataset with respect to the number of speech turns, sentences, and tokens during all debates in each year of the presidential elections. This dataset has significant features such as its size (well over 6,000 turns, over 38,000 sentences, and nearly 690,000 tokens), its peculiar nature of containing reciprocal discussions, and its time line structure.

Tab. 1: Raw dataset of transcripts, number of turns, sentences and tokens in the dataset. 2020. © Shohreh Haddadan.

Year	Types	Candidates	Turns No	Sent No	Token No
1960	4 pres	Kennedy – Nixon	257	2,313	48,445
1976	3 pres	Carter – Ford	270	2,090	46,583
1980	2 pres	Anderson – Carter – Reagan	201	1,247	28,775
1984	2 pres + 1 vice	Mondale – Reagan	362	2,605	49,574
1988	2 pres + 1 vice	Bush – Dukakis	491	2,828	53,202
1992	3 pres + 1 vice	Bush – Clinton – Perot	928	4,713	78,878
1996	2 pres + 1 vice	Clinton – Dole	280	2,381	39,090
2000	3 pres + 1 vice	Bush – Gore	564	3,331	55,320
2004	3 pres + 1 vice	Bush – Kerry	598	4,806	78,310
2008	3 pres + 1 vice	McCain – Obama	669	3,849	76,591
2012	3 pres + 1 vice	Obama – Romney	1,102	4,997	82,921
2016	3 pres + 1 vice	Clinton – Trump	944	3,171	50,565
Total	33 pres + 9 vice		6,666	38,331	688,254

3.2 Annotation tool

For this study I chose the *brat* annotation tool. This is an open-source web-based tool which provides functionality for annotating text collaboratively. Brat is a platform in which text segments can be annotated at character level – it is thus applicable for using as an annotation platform where annotation boundaries are not limited to sentences (Fig. 3).

In order to facilitate setting up annotation at the workstations of several annotators, brat provides a server code snippet. To configure the brat server, the annotation manager defines the annotations for entities, events, and relations, depending on the annotation scheme. For this annotation task, the brat annotation standalone server software was set up on the university domain.[8]

The mark-ups by annotators are saved in a text file formatted with a specific extension for annotated files: *ann*. The annotation identification number, the offsets of the beginning and end of the text segments, and the annotation labels are written to files saved on the server file system in a *standoff format*.

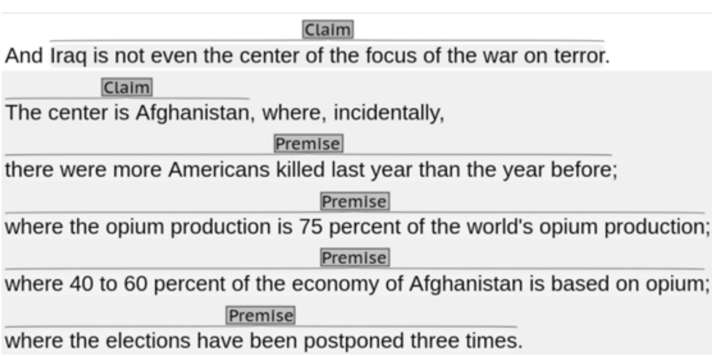

Fig. 3: Mock-up of a text segment from the dataset, annotated with premises and claims. 2020. © Shohreh Haddadan.

8 Pontus Stenetorp et al. "BRAT: a web-based tool for NLP-assisted text annotation." (Demonstrations at the 13th Conference of the European Chapter of the Association for Computational Linguistics, Avignon, 2012), 102–7; Brat annotation tool: brat.uni.lu:8001.

3.3 Annotation cycle

The annotation process for the dataset of my research was divided into two stages.

In the first stage, three non-expert annotators annotated the dataset with component arguments using the brat annotation software, which is a web-based annotation tool.

In this section I describe how I carried out the annotation of the dataset of US presidential election debate transcripts from 1960 to 2016.

I devised annotation guidelines for three non-expert annotators to perform the annotation task. The guidelines described the annotation scheme in which arguments consist of argumentative discourse units, classified as claims and premises. In each annotation cycle (Fig. 4) I evaluated reproducibility based on qualitative and quantitative measures to improve the annotation. The qualitative analysis included looking at the disagreements of annotators on the same data, in order to improve the annotation guidelines,[9] and for the quantitative analysis I computed the inter-annotator agreement based on the average of Cohen's kappa between each pair of two annotators.[10]

The annotation cycle consists of following the stages of the guidelines in annotating the argument components.[11] In further studies, the guidelines were developed to add the annotation of relations between the components.

The annotation scheme adopted in my research considers the argumentative discourse units (ADUs), their distinction as claims or premises, and the relations between them which form the structure of the arguments. Relations are further classified into *support* and *attack* relations.

Limitations were set – for example, each ADU could either be a claim or a premise but not both, and no more than one outgoing relation from each component could be valid. In order for the argument to be structured, the annotation scheme also used relations in either support or attack form between the

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9 Milagro Teruel et al., " Increasing argument annotation reproducibility by using inter-annotator agreement to improve guidelines." (Eleventh International Conference on Language Resources and Evaluation, LREC, Miyazaki, Japan, 2018), 4061–64.

10 Ron Artstein and Massimo Poesio. "Inter-coder agreement for computational linguistics." *Computational Linguistics* 34, no. 4 (2008): 555–96.

11 Shohreh Haddadan, Elena Cabrio, and Serena Villata. "Annotation of argument components in political debates data." (Workshop on Annotation in Digital Humanities conference co-located with ESSLLI, Sofia, 2018), 12–6.

argumentative utterances. In the following, I mention some examples from the guidelines on how to identify the annotation concepts.[12]

The main purpose of an argument is to derive a conclusion or justify a claim. In political debates, claims are uttered for the purpose of defending a policy that a candidate or their party advocates, or a stance for or against a controversial subject, or even personal judgments.

Example A is one the many cases where the candidate is defending a policy of their own. Claims of this type also include supporting policies of the administration the candidates are associated with or claims against the policy their opponent is representing.

Example A: Bush – Kerry, 30 September 2004

BUSH: My administration started what's called the Proliferation Security Initiative. Over 60 nations involved with disrupting the trans-shipment of information and/or weapons of mass destruction materials. And **we've been effective**. *We busted the A.Q. Khan network. This was a proliferator out of Pakistan that was selling secrets to places like North Korea and Libya. We convinced Libya to disarm.*

Taking a stance toward a controversial subject, or expressing an opinion toward a specific issue is also considered as a claim. In example B, Dukakis opposes the death penalty, a controversial topic in US presidential elections.

Example B: Bush – Dukakis, 13 October 1988

DUKAKIS: . . . I've opposed the death penalty during all of my life. *I don't see any evidence that it's a deterrent* and *I think there are better and more effective ways to deal with violent crime.*

In some cases, the explicit choice of expressions indicates the nature of the arguments. A useful clue for identifying claims in speeches is to find some indicators which are usually exploited to state opinions or judgments, or to form a conclusion such as "I think," "in my judgment" and "in my opinion." However, the presence of these expressions does not guarantee the presence of a claim. On the contrary, the candidates do not necessarily use these indicators to assert their claims: in example B, "I think" is used in expressing a premise rather than a claim.

Premises are utterances asserted by the debaters to back up their claims. A premise is a reason or justification for a claim. One type of premise consistently used by candidates contains references to the past: more experienced candidates

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12 In the examples, claims are marked in bold, premises in italics, and the component boundaries by [square brackets].

occasionally exploit this factor to argue that their claims are more relevant, given their expertise, than their opponents (example C illustrates this kind of premise).

Example C: Carter – Ford, 23 September 1976
CARTER: Well among my other experiences in the past, I've – I've been a nuclear engineer, and did graduate work in this field. I think I know the – the uh capabilities and limitations of atomic power.

Statistics are very commonly used as evidence for the justification of claims, as in example D.

Example D: Clinton – Dole, 6 October 1996
CLINTON: *We have the biggest drop in the number of people in poverty in 27 years*. . . . *The average family's income has gone up over $1,600 just since our economic plan passed*. So **I think it's clear that we're better off than we were four years ago**.

Premises may be asserted in the form of examples to prove that a claim is justified, as seen in example E.

Example E: Carter – Ford, 6 October 1976
FORD: **I believe that we have uh – negotiated with the Soviet Union since I've been president from a position of strength**. And let me cite several examples. *Shortly after I became president in uh – December of 1974, I met with uh – General Secretary Brezhnev in Vladivostok and we agreed to a mutual cap on the ballistic missile launchers at a ceiling of twenty-four hundred* . . .

Premises may also be accompanied by indicators which help detect the exemplification and justification of a claim. Some of these indicators are "because," "since," and "that's why."

3.4 Annotation results

In order to compute inter-annotator agreement as the qualitative measure of the reproducibility of the annotated dataset, 19 of the debate transcriptions were annotated by two of the annotators and their agreement was reported.

Observed agreement of annotators on whether a sentence contained an argumentative segment or not was 83%; based on Cohen, kappa was $\kappa = 0.57$; so this is considered a moderate agreement. Agreement of an average kappa coefficient of $\kappa = 0.4$ (fair agreement) for the argument components indicates whether an argumentative unit is a claim or a premise.

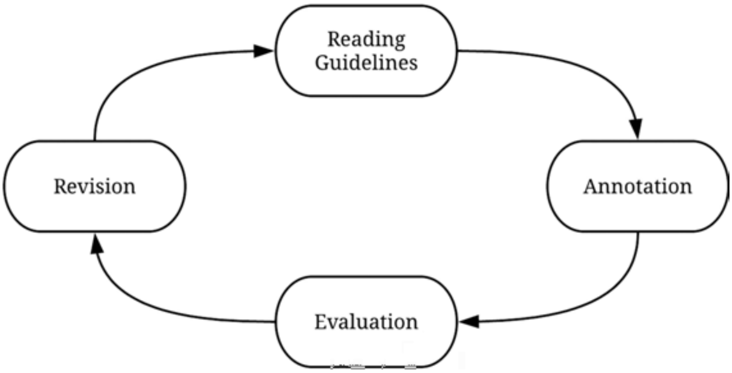

Fig. 4: The annotation cycle depicting stages of annotation until a fair agreement is reached. 2018. © Haddadan, Shohreh et al. "Annotation of argument components", 14.

3.5 Annotation challenges inherent to the dataset

Observing the inter-annotator agreement on argument components, I discuss the sources of disagreement during the annotation cycle. Uncovering the sources of disagreement between annotators in the early stages facilitates the revision of the guidelines for further repetitions of the annotation cycle, and also allows for easier refinements later on.

- Context-based claims: The task of identifying premises and claims in public discourse is highly subjective, which also results in a high disagreement percentage in the annotation of the argument components. Consider example F, for instance: the phrase "Communism is the enemy of all religions" is provided to support the claim for why "we who do believe in God must join together." Although there is no justification as to why that is a true statement and Nixon uses it as a premise.

Example F: Nixon – Kennedy, 13 October 1960
NIXON: Communism is the enemy of all religions; and we who do believe in God must join together. We must not be divided on this issue.

- Implicit claims: Claims are sometimes made implicitly. In example G, Nixon states that "it would be rather difficult" to cover his proposals in a short time, which implicitly indicates that he has a lot of relevant experience. After this he mentions a few of his travels abroad during his vice presidency, however the premises he uses are not related to an explicit claim of “I have sufficient relevant experience.”

Example G: Kennedy – Nixon, 26 September 1960
NOVINS: Would you tell us please specifically what major proposals you have made in the last eight years that have been adopted by the administration?
NIXON: It would be rather difficult to cover them in eight and – in two and a half minutes. I would suggest that these proposals could be mentioned.

- Absence of major claims: In general, the arguments do not have any major claims. In the few cases when a controversial issue – such as the death penalty, legalization of abortion, or gun control – is being discussed, when a major claim can be identified it can be distinguished from the question being asked by the moderator.
- Macro relations: Since I chose a micro-level annotation scheme rather than a macro- level annotation one, some of the relations annotations could be lost in the annotation process. An argument component can attack a complete argument made previously by another candidate for which a single component cannot be specified as being related. Menini et al. annotate the relation between two separate monologue debates as supporting or attacking each other.[13] However, the annotation scheme cannot capture the relation of the following statement (example H) with a specific argument component from the speech of the other candidate.

Example H: Reagan – Mondale, 21 October 1984
REAGAN: I’m not going to continue trying to respond to these repetitions of the falsehoods that have already been stated here.

- Relation spans: The length of each speech turn somehow made it challenging to identify the argumentative units and the relations across these components. In order to overcome this challenge, I divided each debate session into sections, at the turn of the subject initiated by the moderator.

13 Stefano Menini et al., “Never retreat, never retract: Argumentation analysis for political speeches.” (32nd AAAI Conference on Artificial Intelligence, New Orleans, USA, 2018), 4889–96.

3.6 Annotation refinement

The steps described above resulted in an annotated dataset that fulfilled the requirements of basic argument structures. However, for further development of the dataset I suggest some refinements which can be implemented with regard to the challenges mentioned in Section 3.5.

Each speech from a candidate can be regarded as a macro-level argument, for which the later arguments may be generally supporting or attacking, or even neutral.

Each section of the debate, between which the moderator changes the subject, can be identified with a major claim. The major claim may pertain to the question asked or the summary of the argument taking place.

One other aspect I took into account in choosing my annotation scheme was how straightforward it would be to transform the scheme. One such type of transformation is to break down the higher-level annotation labels into finer concepts. Contrary to the micro-text scheme used by Peldszus and Stede,[14] I made no distinction between different types of attack, but this distinction can be added later as a refinement step to the annotation process.

In my chosen annotation scheme, the annotation of components was limited to the identification of argumentative versus non-argumentative utterances. Subsequently, it is possible to mark a distinction between which argumentative utterances are put forward as claims or conclusions, and which are put forward as evidence which embodies the premises of the arguments. Classification of claims as epistemic, practical, or moral – and premises as study, expert, or anecdotal – can also further be applied to the annotation.[15]

4 Argument mining pipeline

As mentioned before, argument mining is the extraction of argument structures from argument resources. One of the most prominent frameworks for argument mining is to deconstruct the methodology into stages and bring these together as a pipeline.

14 Andreas Peldszus and Manfred Stede, “From argument diagrams to argumentation mining in texts: A survey,” *International Journal of Cognitive Informatics and Natural Intelligence (IJCINI)* 7, 1 (2013): 1–31.

15 Marco Lippi and Paolo Torroni, “Argument Mining from Speech: Detecting Claims in Political Debates,” (30th AAAI Conference on Artificial Intelligence, Phoenix, USA, 2016), 2979–85.

These stages include:

- identification of argument boundaries (distinction between argumentative vs. non-argumentative utterances)
- classification of argumentative utterances into component types (which, in the selected annotation scheme for this study, include claims and premises)
- reconstruction of the structure of the argument from plain text resources (in this research) by identifying the relations between the argument components.[16]

The first two stages come together as component detection and the last stage above includes the argument structure prediction. Each stage is fed by the output of the previous stage, with the annotated dataset used as the input for the first stage.

In this research, multiple NLP methods were applied[17] for each stage of the pipeline.

4.1 Component identification and detection

The boundary detection problem can be viewed from two perspectives. Relaxing the boundaries and confining them in whole sentences would reduce the problem of boundary detection to the classification of sentences as *argumentative* or *non-argumentative*. On the other hand, there are certain motivations for considering the boundary detection problem not on a sentence level but at a token-based level. Firstly, the dataset is a transcribed dialogue, which alters the concept of a sentence with respect to how it would be transcribed and edited later. Secondly, in previous studies, supporting or attacking argument components have been defined inside the boundaries of one sentence,[18] and in some cases there have been correspondences between argument relations and discourse analysis which might also occur inside the boundaries of sentences,[19]such as in example I. Finally, there are a few

16 Marco Lippi and Paolo Torroni, "Argumentation mining: State of the art and emerging trends." *ACM Transactions on Internet Technology (TOIT)* 16,2 (2016): 1–25.

17 Shohreh Haddadan, Elena Cabrio, and Serena Villata, "Yes, we can! Mining Arguments in 50 Years of US Presidential Campaign Debates," (57th Annual Meeting of the Association for Computational Linguistics, Florence, Italy, 2019), 4684–90.

18 Christian Stab and Iryna Gurevych, "Parsing argumentation structures in persuasive essays." *Computational Linguistics* 43, 3 (2017): 619–59.

19 Elena Cabrio, Sara Tonelli, and Serena Villata, "From Discourse Analysis to Argumentation Schemes and Back: Relations and Differences," in *Computational Logic in Multi-Agent Systems*, ed. João Leite et al., CLIMA 2013. Lecture Notes in Computer Science, vol 8143. (Berlin: Springer, 2010), 1–17.

cases in the annotated dataset where the boundaries of one argument exceed the limits of what is identified as a sentence. Example J, for instance, is an example of how a component crosses the boundaries of a so-called sentence.

Example I: Bush – Gore, 11 October 2000
GORE: **I think states should do that for new handguns**, because *too many criminals are getting guns*

Example J: Obama – McCain, 7 October 2008
McCain: – at the diminished value of those homes and let people be able to make those – be able to make those payments and stay in their homes. *Is it expensive? Yes*.

The component classification, followed by either a sentence-level or token-level approach argument boundary detection, is carried out as a text classification task.

I implemented several methods to detect sentence-based and token-based component boundaries. In this section, I focus on just one of the applied supervised machine learning methods used in NLP applications to classify text based on extracted features – this one being the *support vector machine* (SVM).

Statistical machine learning methods – as opposed to rule-based methods, which define straightforward rules to identify a pattern in text – make use of statistical and mathematical methods to extract patterns from text and generalize these patterns onto text which they have not previously observed. In supervised machine learning methods, unlike in unsupervised methods, the training data are already annotated with the target classes (in the case of this research: argumentative vs. non-argumentative sentences and claim vs. premise sentences).

The first step in using this method is to transform the text sentences into vectors of features. A set of features – including lexical ones such as frequency of words, importance of a term in a document (based on the tf-idf measure), and n-grams, and linguistic ones such as parts of speech, syntax of sentences, and also some features pertaining to the indicators of components – is extracted and applied for classification.

In order to apply the SVM method to our data, I used a Python-implemented library called *scikit-learn*,[20] firstly to transform the extracted features into numerical vectors (vectorization) and then to train the SVM learner on the annotated

20 Fabian Pedregosa et al., "Scikit-learn: Machine learning in Python." *Journal of Machine Learning Research* 12 (2011): 2825–30.

data. I also applied more statistical machine learning methods, including neural network based methods.

In the next section I show how I evaluated the performance of this method in identifying text segments according to argumentative/non-argumentative and claim/premise classes.

4.2 Evaluation

In order to evaluate supervised machine learning based methods, a dataset is usually divided into two sets. The first is the training set, which the algorithm uses to learn patterns from data. The second is the test set, which contains samples that the algorithm will not observe until the evaluation phase. Following this methodology, the dataset for this research was also divided into training and test sets. For this purpose, 13 of the debate transcriptions were set aside as the test set and the rest were used in the training phase.

Several metrics are leveraged to quantitatively evaluate a machine learning method. The first is *precision*, which indicates what percentage of the test data is identified correctly over all items that were assigned to this class by the algorithm. *Recall* measures what percentage of the items in the test set have been correctly labeled with respect to the actual number of that class in the test set. In other words, precision describes the "validity" of the results, and recall describes the "completeness" of the results with respect to the labels in the annotated test set.

The *F-score* is a combination of precision and recall that is used to quantitatively evaluate the performance of a supervised machine learning algorithm. In the following, I report the results based on these metrics, comparing a baseline method with our trained SVM method using two different sets and kernels. A majority baseline was used as a comparative baseline.

An improvement in classification results can be observed using the SVM classifier, compared to the majority baseline. Considering all the features in the feature set also improves the results for both component detection tasks.

The feature ablation method is a technique used to recognize how different features affect the results of a statistical machine learning algorithm. In this technique, the algorithm is trained with and without considering one of the features and then the results are compared to evaluate the effect of removing the feature. In a feature analysis approach I observed that lexical features (n-grams) were the most prominent in the identification and classification of components. These results confirmed again the highly context-dependent nature of the task.

5 Application

The main objective of my research is to provide a platform for facilitating the analysis of the argument structures of political debates. In support of this purpose I have developed an argumentative analysis tool called DISPUTOOL.[21] DISPUTOOL provides the functionality to explore debates annotated with claims and premises, and to search for argument components surrounding a keyword in different debates – it also provides the environment to detect argument components with a new argumentative text input.

DISPUTOOL also integrates named entities automatically annotated by the Stanford CoreNLP tagger and provides the functionality to explore, filter, and visualize them.

5.1 Fallacies

One of the potential applications of extracting the argument structure of debates is to detect fallacies.

Fallacies are types of argument that lack the correct reasoning process.

By using the argument structures extracted from the proposed method, some types of fallacy can potentially be detected – for instance, fallacies which occur due to the relevance of the premise provided for a certain claim. Consider example K, where the "red herring" fallacy pertains to the relevance of the premises provided to the claim which Mondale claims that President Reagan is making.

Example K: Mondale – Reagan, 7 October 1984

MONDALE: Now, the example that the President cites has nothing to do with abortion. Somebody went to a woman and nearly killed her. That's always been a serious crime and always should be a serious crime.

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21 Shohreh Haddadan, Elena Cabrio, and Serena Villata, "DISPUTool–A tool for the Argumentative Analysis of Political Debates," (*Twenty-Eighth International Joint Conference on Artificial Intelligence*, Macao, 2019), 6524–6.

6 Critical reflection

This research aims at algorithmic extraction of argument structures from political debate data by designing an argument mining pipeline. A dataset of transcriptions of US presidential debates from 1960 to 2016 was annotated with argument components and the relations between them (in this chapter, I have focused only on the argument components).

By applying NLP techniques, I trained a statistical machine learning algorithm to detect argument components and evaluate the results based on standard metrics.

6.1 Digital source criticism

It has been discussed that success in a debate depends not only on verbal skills but also on non-verbal cues and the visual imagery of a public figure (such as a politician). Persuasive techniques that rely on the analysis of text alone can eliminate the influence of these non-verbal cues from the overall judgment that the audience makes on a speaker's personality, which also affects the persuasiveness of their rhetoric (arguments).

With regard to the data used in this research, the issue of the effect of visual media on the audience's interpretation of the debate results was most clearly highlighted in the analysis of the first televised debates between Nixon and Kennedy in 1960, where many audiences only heard the debate on a radio, while others watched it on their television sets. Research shows that the audience who listened to the debate on the radio mostly favored Nixon, while those watching on TV agreed upon Kennedy's success in the debate. This hypothesis was later explicitly investigated in the work of Druckman.[22]

One other aspect in the transformation of a dataset into text files is the elimination of the verbal cues which exist in sound but not in text, such as putting stress on a word in a sentence, using a sarcastic tone to express a claim, etc.

In Section 4.1, I mentioned yet another aspect of this conversion, which is the transformation of verbal dialogues into transcripts since the concept of sentences, and the boundary between sentences, are vague in oral speech, and the appearance of sentence boundaries is due to the mapping of oral speech to text.

22 James N. Druckman, "The power of television images: The first Kennedy-Nixon debate revisited," *The Journal of Politics* 65, 2 (2003): 559–71.

The above critical issues should make us vigilant that we do not base the analysis of arguments solely on argument structures.

6.2 Algorithmic criticism

Inter-annotator agreement is used to measure how reliable an annotated dataset is, as mentioned in Section 3.4. I was able to train a statistical machine learning algorithm, based on an annotated dataset, with moderate reliability. It has been discussed that in subjective tasks we need to make sure that the machine learning algorithm is not learning the annotators' behavior but that it is truly learning the task. This issue has been discussed before and there are already some solutions for eliminating annotator bias from annotated data for NLP applications.[23] In this research, I relied solely on the comparison of the annotators' annotations with the expert annotation and on creating a gold-standard dataset as the human upper limit for the task at hand.

A recent concern of the artificial intelligence (AI) community has been the lack of transparency and explainability of complicated statistical machine learning algorithms. We define explainability as the extent to which a human can describe the behavior of the algorithm and justify how it concludes its results. In recent years, with the emergence of deep learning algorithms, this issue has become more severe, particularly in fields where machines are ethically responsible, such as with health-care models.[24] Although these complicated models output more accurate results, they lack explainability and transparency. Thus, until the AI research community tackles the problem of explainable AI, a trade-off has to be maintained between the explainability and the accuracy of such algorithms. In this study, I have therefore tried to add some explainability to the algorithm by using the feature ablation method.

23 Mor Geva, Yoav Goldberg, and Jonathan Berant, "Are We Modeling the Task or the Annotator? An Investigation of Annotator Bias in Natural Language Understanding Datasets." (Conference on Empirical Methods in Natural Language Processing and the 9th International Joint Conference on Natural Language Processing (EMNLP-IJCNLP), Hong Kong, 2019) 1161–6.

24 Rich Caruana et al., "Intelligible models for healthcare: Predicting pneumonia risk and hospital 30-day readmission." (21th ACM SIGKDD international conference on knowledge discovery and data mining, Sydney, 2015), 1721–30.

References

Artstein, Ron, and Massimo Poesio. “Inter-coder agreement for computational linguistics.” *Computational Linguistics* 34, 4 (2008): 555–96. https://doi.org/10.1162/coli.07-034-R2

Cabrio, Elena, Sara Tonelli, and Serena Villata. “From discourse analysis to argumentation schemes and back: Relations and differences.” In *Computational Logic in Multi-Agent Systems*, edited by João Leite, et al. Lecture Notes in Computer Science, vol 8143. 1–17. Berlin: Springer, 2010.

Caruana, Rich, Yin Lou, Johannes Gehrke, Paul Koch, Marc Sturm, and Noemie Elhadad. “Intelligible Models for Healthcare: Predicting Pneumonia Risk and Hospital 30-day Readmission.” In *Proceedings of the 21th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*, August 10–13, 2015, Sydney, 1721–30. New York: Association for Computing Machinery, 2015. https://doi.org/10.1145/2783258.2788613.

Druckman, James N. “The power of television images: The first Kennedy-Nixon debate revisited.” *The Journal of Politics* 65, 2 (2003): 559–71.

Geva, Mor, Yoav Goldberg, and Jonathan Berant. “Are we modeling the task or the annotator? An investigation of annotator bias in natural language understanding datasets.” In *Proceedings of the Conference on Empirical Methods in Natural Language Processing and the 9th International Joint Conference on Natural Language Processing* (EMNLP-IJCNLP), Hong Kong, edited by Kentaro Inui, Jing Jiang, Vincent Ng, and Xiaojun Wan, 1161–6. Hong Kong: Association for Computational Linguistics, 2019. Accessed June 14, 2021. https://arxiv.org/abs/1908.07898.

Haddadan, Shohreh, Elena Cabrio, and Serena Villata. “Annotation of argument components in political debates data.” In *Proceedings of the Workshop on Annotation in Digital Humanities co-located with ESSLLI*, Sofia, Bulgaria, August 6–10, 2018, edited by Sandra Kübler and Heike Zinsmeister, 12–6. Accessed November 18, 2021. http://hdl.handle.net/10993/37877.

Haddadan, Shohreh, Serena Villata, and Elena Cabrio. “DISPUTool–A tool for the Argumentative Analysis of Political Debates,” In *Proceedings of the Twenty-Eighth International Joint Conference on Artificial Intelligence*. Demos, Macao, 10–16 August 2019, edited by Sarit Kraus, 6524–6. International Joint Conferences on Artificial Intelligence, 2019. https://doi.org/10.24963/ijcai.2019/944.

Haddadan, Shohreh, Elena Cabrio, and Serena Villata. “Yes, we can! Mining Arguments in 50 Years of US Presidential Campaign Debates.” In *Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics*, Florence, Italy, 2019, edited by Anna Korhonen, David Traum, Lluís Màrquez. 4684–90. Florence: Association for Computational Linguistics, 2019. http://dx.doi.org/10.18653/v1/P19-1463.

Kutzner, Kristin, Anna Moskvina, Kristina Petzold, Claudia Roßkopf, Ulrich Heid, and Ralf Knackstedt. “Reviews of Cultural Artefacts: Towards a Schema for their Annotation.” In *Proceedings of the Workshop on Annotation in Digital Humanities* co-located with ESSLLI, Sofia, Bulgaria, August 6–10, 2018, edited by Sandra Kübler and Heike Zinsmeister, 17–23. Accessed November 18, 2021. http://ceur-ws.org/Vol-2155/kutzner.pdf.

Lippi, Marco, and Paolo Torroni. “Argument Mining from Speech: Detecting Claims in Political Debates.” In *Proceedings of the Thirtieth AAAI Conference on Artificial Intelligence*, February 12–17, 2016, Phoenix, Arizona USA, by Association for the Advancement of

Artificial Intelligence, 2979–85. Palo Alto, California USA: AAAI Press, 2016. Accessed November 18, 2021. https://ojs.aaai.org/index.php/AAAI/article/view/10384.
Lippi, Marco, and Paolo Torroni. “Argumentation mining: State of the art and emerging trends.” *ACM Transactions on Internet Technology* (TOIT) 16, 2 (2016): 1–25. https://doi.org/10.1145/2850417.
Menini, Stefano, Elena Cabrio, Sara Tonelli, and Serena Villata. “Never retreat, never retract: Argumentation analysis for political speeches.” In *The 32nd AAAI Conference on Artificial Intelligence*, February 2–7, 2018, New Orleans, United States, by Association for the Advancement of Artificial Intelligence, 4889–96. Palo Alto, California USA: AAAI Press, 2018. Accessed November 18, 2021. https://hal.archives-ouvertes.fr/hal-01876442.
Pedregosa, Fabian et al. “Scikit-learn: Machine Learning in Python.” *Journal of Machine Learning Research* 12 (2011): 2825–30.
Peldszus, Andreas, and Manfred Stede. “From argument diagrams to argumentation mining in texts: A survey.” *International Journal of Cognitive Informatics and Natural Intelligence (IJCINI)* 7, no. 1 (2013): 1–31.
Schmidt, Thomas, Manuel Burghardt, and Katrin Dennerlein. “Sentiment annotation of historic German plays: An empirical study on annotation behavior.” Paper presented at Annotation in Digital Humanities conference, Sofia, 2018.
Stab, Christian, and Iryna Gurevych. “Annotating argument components and relations in persuasive essays.” In *Proceedings of COLING 2014, the 25th international conference on computational linguistics: Technical papers*, Dublin, 2014, edited by Junichi Tsujii and Jan Hajic, 1501–10. Dublin City University and Association for Computational Linguistics. Accessed November 18, 2021. https://aclanthology.org/C14-1142.
Stab, Christian, and Iryna Gurevych. “Parsing argumentation structures in persuasive essays.” *Computational Linguistics* 43, 3 (2017): 619–59. https://doi.org/10.1162/COLI_a_00295
Stede, Manfred, and Jodi Schneider. “Argumentation mining.” *Synthesis Lectures on Human Language Technologies* 11, 2 (2018): 1–191.
Stenetorp, Pontus, Sampo Pyysalo, Goran Topić, Tomoko Ohta, Sophia Ananiadou, and Jun’ichi Tsujii. “brat: a Web-based Tool for NLP-Assisted Text Annotation.” In *Proceedings of the 13th Conference of the European Chapter of the Association for Computational Linguistics*, Avignon, France, 2012, edited by Frédérique Segond, 102–107. Association for Computational Linguistics. Accessed November 18, 2021. https://aclanthology.org/E12-2021.
Teruel, Milagro, Cristian Cardellino, Fernando Cardellino, Laura Alonso Alemany, and Serena Villata. “Increasing argument annotation reproducibility by using inter-annotator agreement to improve guidelines.” In *Proceedings of the Eleventh International Conference on Language Resources and Evaluation (LREC 2018)*, Miyazaki, Japan, May, 2018, edited by Nicoletta Calzolari et al., 4061–4. European Language Resources Association (ELRA). Accessed November 18, 2021. https://aclanthology.org/L18-1640.
Zarefsky, David. *Political argumentation in the United States: Historical and contemporary studies. Selected essays by David Zarefsky*. Amsterdam: John Benjamins Publishing, 2014.

Ekaterina Kamlovskaya

Exploring a corpus of Indigenous Australian autobiographical works with word embedding modeling

A methodological reflection

1 Introduction

Data-intensive research,[1] data-rich literary history,[2] distant reading,[3] macroanalysis,[4] algorithmic criticism,[5] cultural analytics,[6] digital literary studies[7] – these are just some of the names that could describe the field to which my project relates. All these names refer to the use of computational tools and methods to investigate research questions from the humanities and, more precisely, to analyze literary and historical textual sources. The research pipeline in such investigations usually consists of standard steps like research question formulation, source identification, data collection and analysis, and visualization and interpretation of the results. One peculiarity, though, is that researchers often borrow tools and methods from a field to which they are not "native"; in most cases, we see historians, linguists, or literary scholars applying methods developed in computer science. As digital tools transform traditional source types (e.g. text) and therefore inevitably change the way we interact with our sources, new perspectives may be created, new doors opened. However, phrases like "applying computational/digital methods," "running an algorithm on your dataset," or "running your data through an algorithm" often make the research process

1 Nina Tahmasebi et al., "A Convergence of Methodologies: Notes on Data-intensive Humanities Research," (Digital Humanities in the Nordic Countries 4th Conference, Copenhagen, 2019), 438.

2 Katherine Bode, *A World of Fiction: Digital Collections and the Future of Literary History* (Ann Arbor: University of Michigan Press, 2018), 3.

3 Franco Moretti, *Distant Reading* (London: Verso, 2013).

4 Matthew Lee Jockers, *Macroanalysis: Digital Methods and Literary History* (Urbana: University of Illinois Press, 2013).

5 Stephen Ramsay, *Reading Machines: Toward an Algorithmic Criticism* (Urbana: University of Illinois Press, 2011).

6 Lev Manovich, "The Science of Culture? Social Computing, Digital Humanities and Cultural Analytics," *Journal of Cultural Analytics* (May 2016).

7 Jean-Gabriel Ganascia, "The Logic of the Big Data Turn in Digital Literary Studies," *Frontiers in Digital Humanities* 2, 7 (2015).

https://doi.org/10.1515/9783110723991-005

seem straightforward and even mechanical, as if it simply involves automating a step that would otherwise have taken a researcher significantly more time and resources. Yet it is not just about automating and fast-tracking research: the implications of using digital tools concern the reliability and validity of the study, its results and interpretations, and therefore also of the potential contribution we are hoping to make.

In this chapter I reflect on the use of one particular computational method – namely, word embedding modeling – to explore a humanities dataset in the context of my ongoing doctoral research project. I discuss the suitability of this approach for my goals; the decisions and choices I have been making at each stage of the research process; the impact of my decisions on the results of a computer-assisted study; and the importance of digital source and digital tool criticism.

2 Summary of the project and research questions

My PhD study takes as its subject a collection of Indigenous Australian autobiographical narratives and is an attempt at a distant (or, rather, hybrid) reading of the corpus. I examine how the writers (as a collective) represent their experiences in life writing and how this representation is related to the historical, social, and political context within which the works were created.

The genre of Indigenous Australian life writing emerged around 1950s, with the rise of the Aboriginal rights movement. It is considered a literature of significant sociopolitical and historical importance,[8] as the authors share an alternative history different to the one that had been previously asserted by the European settlers, where Indigenous peoples and cultures were either misrepresented or disregarded.[9]

What exactly is said by the Indigenous Australian life writing authors in the corpus in relation to the most prominent themes in the genre (for example,

8 Adam Shoemaker, *Black Words, White Page: Aboriginal Literature 1929–1988* (Canberra: ANU E Press, 2004), 132.

9 John Joseph Healy, " 'The True Life in Our History': Aboriginal Literature in Australia," *Antipodes* 2, no. 2 (1988): 79–85; Oliver Haag, "From the Margins to the Mainstream: Towards a History of Published Indigenous Australian Autobiographies and Biographies," in *Indigenous Biography and Autobiography*, ed. Peter Read, Frances Peters-Little, and Anna Haebich (Canberra: ANU Press, 2008), 5–28; and Anita Heiss, *Dhuuluu-Yala = To Talk Straight: Publishing Indigenous Literature* (Canberra: Aboriginal Studies Press, 2003).

identity, family,[10] and land[11])? How is the reality represented (and constructed) in the corpus? Does the corpus demonstrate any changes in discourse throughout the decades of the genre's existence? These were some of the questions guiding my study.

The project is interdisciplinary and draws insights from such fields as corpus and computational linguistics, Australian history, literary studies, Indigenous and postcolonial studies, history of concepts,[12] natural language processing, and computer science. As it is a computer-assisted study, transforming research questions into formal computational enquiries (operationalizing)[13] has been a crucial step. What do we mean by "themes" or "discourses" and what operations must be performed to examine them within the corpus? This question is best answered through a discussion of the methodology and the theoretical assumptions behind it.

3 Distributional semantics and vector space modeling for exploring semantic fields

Vector space modeling was developed in computer science as a method for information retrieval.[14] It was designed to represent textual documents as numerical vectors based on the frequency of occurrence of individual words in them. In word embedding modeling, a more recent development of vector space modeling, vectors are used to represent individual words and reflect how they are positioned relative to each other in the space of all words from a corpus, based on their co-occurrence patterns. Thus, such vectors are believed to reflect the words' semantic and syntactic properties. This method is grounded in distributional semantics and distributional hypothesis, according to which words

10 Anne Brewster, *Reading Aboriginal Women's Autobiography* (Melbourne: Sydney University Press in association with Oxford University Press, 1996), 5.

11 Oliver Haag, "Indigenous Australian Autobiography and the Question of Genre: an Analysis of Scholarly Discourse," *Acta Neophilologica* 44, 1–2 (2011): 69–79.

12 Melvin Richter, *The History of Political and Social Concepts: A Critical Introduction* (New York: Oxford University Press, 1995).

13 Franco Moretti, *'Operationalizing': Or, the Function of Measurement in Literary Theory* (Stanford, California: Stanford Literary Lab, 2013).

14 Gerard Salton, Andrew Wong, and C. S. Yang, "A Vector Space Model for Automatic Indexing," *Communications of the ACM* 18, 11 (1975): 613–20.

that share similar contexts (i.e. are surrounded by similar words) tend to have similar meanings.[15]

Word embeddings are used in natural language processing in tasks like classification, question answering, and many others. In digital humanities, word vector representations are a valuable output in themselves – they are often not fed into any further algorithm but rather explored in terms of distance between them as a measure of semantic closeness. By exploring the vector space of words in a corpus, and the words in proximity to certain target words (related to the concepts we are interested in), we can discover the situated meaning of these words defined by the way they are used in the corpus. Word embedding modeling has been recognized in the digital humanities community for facilitating exploration of diachronic meaning shifts, domain-specific language use and discursive spaces.[16] For the purposes of my study I considered these discovered sets of words ("nearest neighbors") as discourses or semantic fields[17] – networks of related words with underlying social and political meaning, each representing a slice of reality as it is perceived by a specific group of people in a defined period of time and reflected in language in use.[18] Word embedding modeling has demonstrated its potential for highlighting semantic fields and discourses in textual data and therefore was the main method I chose for my project.

15 Zellig S. Harris, "Distributional Structure," *Word* 10, 2–3 (1954): 146–62.

16 Nikhil Garg et al., "Word Embeddings Quantify 100 Years of Gender and Ethnic Stereotypes," *Proceedings of the National Academy of Sciences of the United States of America* 115, no. 16 (2018): E3635–E3644; Johannes Hellrich and Udo Hahn, "Bad Company – Neighborhoods in Neural Embedding Spaces Considered Harmful," (26th International Conference on Computational Linguistics COLING: Technical Papers, Osaka, 2016), 2785–96; and Melvin Wevers and Marijn Koolen, "Digitale Begriffsgeschichte: Tracing Semantic Change Using Word Embeddings," *Historical Methods: A Journal of Quantitative and Interdisciplinary History* 53, no. 4 (2020): 226–43.

17 Iain Hampsher-Monk, Karin Tilmans, and Frank van Vree, eds., *History of Concepts: Comparative Perspectives* (Amsterdam: Amsterdam University Press, 1998); and Richter, *Political and Social Concepts*.

18 Laurel J. Brinton and Donna M. Brinton, *The Linguistic Structure of Modern English* (Amsterdam: John Benjamins Publishing, 2010); and Melvin Wevers, Tom Kenter, and Pim Huijnen, "Concepts Through Time: Tracing Concepts in Dutch Newspaper Embeddings" (paper presented at the Annual Conference of the Alliance of Digital Humanities Organizations, Sydney, Australia, June 29–July 3, 2015).

4 The "lure of objectivity" – and transparency as a way to resist it

4.1 Does using a computational tool make a study more objective?

It seems to me that the "lure of objectivity" that Rieder and Röhle[19] describe as one of the challenges faced by digital humanities scholars is one of the reasons word embedding modeling has become so attractive. It has been argued that traditional humanities approaches (e.g. close reading) are prone to researcher bias, which is especially important when dealing with emotionally charged topics – and word embedding modeling has been suggested as an effective way to make the study more impartial.[20] I have been exploring a corpus containing traumatic memories which are sometimes extremely sad or even shocking to the average reader. Using computational technologies in general seems a solution for distancing from such texts, allowing an impartial assistant, an algorithm, to "run through" the data and mine it for some precious pieces of knowledge without being affected by the emotions and biases inherent to humans.

However, a closer look at how word embedding modeling works shows that it is not reasonable to view this method – or indeed any computational method – as an impartial, unbiased helper. It is important to remember that in addition to the biases a researcher inevitably introduces at every stage of the research process – from data collection to modeling and interpretation, through the choices they have to make – the computational tool itself is a product of its designer's choices and decisions and, therefore, by its very nature cannot be objective.

Thus, instead of relying blindly on the tool or arguing that it is objective, or, to the contrary, rejecting the tool as not being impartial because of such a "flaw", we should instead admit to and embrace the subjective nature of computer-assisted humanities research and commit to transparency in our research.

19 Bernhard Rieder and Theo Röhle, "Digital Methods: Five Challenges," in *Understanding Digital Humanities*, ed. David Berry (London: Palgrave Macmillan UK, 2012), 67–84.

20 Milan M. van Lange and Ralf D. Futselaar, "Debating Evil: Using Word Embeddings to Analyze Parliamentary Debates on War Criminals in The Netherlands" (paper presented at Conference on Language Technologies & Digital Humanities 2018, Ljubljana, September 2018).

4.2 Unboxing the black box tools: Transparency in digital humanities research

Transparency in research concerns making all aspects of the study process more visible and strengthening its credibility by, for example, sharing data and code, and disclosing the decisions involved in the research process. However, there is an extra step that can often be neglected – especially, it seems to me, in interdisciplinary studies using methods from a field to which the researcher is not "native" – that is, ensuring transparency of the "black boxes," not just to others but first of all to ourselves. Thus, transparency should also concern "our ability to understand the method, to see how it works, which assumptions it is built on, to reproduce it, and to criticise it."[21] How does the tool I use manipulate the data and change the way I, the researcher, interact with the data and draw insights from it? Not only should I aim to understand it myself and critically reflect on it, but also to disclose my conclusions to others.

In a project like mine, one of the ways to make the research process more transparent is to publish code, trained models, and corpus metadata. Code documentation is a good practice in both the software and science worlds. When done well, documentation helps future readers and users of the code understand what each line does to the data and how this in turn impacts the research output. Making the models available lets other researchers explore the data and conduct their own experiments. Although not having access to the raw data (due to copyright) will be a limitation for them, being able to examine the model's outputs should provide an interesting way to complement or guide a close reading. Although I will not be able to share the full texts from the modeled corpus because the books are copyrighted, corpus metadata will be an important window to my data.

Moreover, when using software solutions (such as, in my case, the Gensim or NLTK packages) or tools with a graphical user interface (e.g. Embedding Projector), transparency would also mean understanding how they work and disclosing this information along with the critical discussion, instead of just presenting impressive visualizations and hiding methodological decisions.

21 Rieder and Röhle, "Digital Methods."

5 Digital tool criticism: Choosing between count-based and predictive modeling

A traditional count-based co-occurrence model is a word-context matrix showing how often each corpus vocabulary item co-occurs with every other vocabulary item. Each word is represented as a corresponding row of such a matrix through its relationship with all other words. Therefore, each matrix value demonstrates the strength of association between two words, and words with similar co-occurrence patterns will be mapped to similar vectors.

The more recent approaches to word vector representations are based on neural networks inspired by the way our brains work. One widely used algorithm is *word2vec*.[22] In the resulting representation of a word, vector dimensions, in contrast to count-based models, are not interpretable but are believed to capture some aspects of the word meaning.[23] This type of word embedding modeling is called predictive because word vectors are essentially a by-product of the algorithm performing a prediction task (predicting context of a keyword, or a keyword for a given set of context words, depending on the algorithm's variation). The word2vec algorithm takes a large amount of text as an input and, through working on a prediction task, learns vector representations of each vocabulary item based on their semantic similarity.

So how do we select an approach that is suitable for our data and goals? Word2vec, like any other machine learning algorithm, requires a large dataset to learn representations accurately. It has been noted that small dataset sizes can affect the accuracy and reliability of modelling[24] and that, for such corpora, co-occurrence matrices could be a better solution. Furthermore, a comparative study requires models to be trained on subcorpora (for example, based on the publication date for a diachronic investigation), but each subcorpus may contain too few examples for the algorithm to learn reliable word representations. In addition, word2vec modeling has been criticized for the inherent randomness involved in its generation of word vectors, which affects the reproducibility of studies.[25] This property stems from random vector initialization at the beginning of

22 Tomas Mikolov et al., "Efficient Estimation of Word Representations in Vector Space" (paper presented at the International Conference on Learning Representations, Scottsdale, Arizona, May 2–4, 2013).

23 Yoav Goldberg, *Neural Network Methods for Natural Language Processing* (San Rafael, California: Morgan & Claypool, 2017).

24 Wevers and Koolen, "Digitale Begriffsgeschichte"; and Tahmasebi et al., "A Convergence of Methodologies."

25 Hellrich and Hahn, "Bad Company," 2785.

each experiment run, and the order in which the examples are processed. Lastly, if a researcher chooses to apply subsampling of frequent words, which the algorithm allows, this probabilistic procedure will introduce even more randomness and thus contribute to the reliability issue.

My corpus, like so many other digital humanities datasets, is relatively small. So, to avoid the issues related to data size described above, I could have used count-based methods instead of a neural network-based one. Indeed, it has been argued that if the corpus is relatively homogeneous, with texts belonging to a narrow domain and one genre, the number of words required to build a reliable model may be smaller, as such texts may offer more consistent contexts.[26] The randomness problem is just as important – and count-based modeling is a definite winner here. However, for a more comprehensive picture, using both types of model and comparing (or even consolidating) their outputs could be a promising scenario.

I began with using Gensim's word2vec implementation[27] in Python – this was not without its challenges. In 2018, Gensim's creators ran a user survey and learned that their documentation was considered lacking. This was indeed an issue that I had encountered previously. However, the situation seems to have improved since then: there are now helpful tutorials available and the code is better documented. But while I could have used a tutorial without fully understanding what it does to the data, this would have diminished the transparency of my project and therefore its reliability. I had committed to learning more about the algorithm, machine learning, and neural networks in general.

I had to make multiple decisions when applying the algorithm to model my data – for example, choosing the algorithm architecture, vector size, number of words in the context window, and minimum count parameter (the algorithm would ignore words with total frequencies lower than this number), to name just a few. It has been argued that there is no optimal combination of parameters and that the choice of parameters is generally based on the researchers' experience in training such models, as well as on the research questions and the nature of the data.[28]

How do such decisions impact the research process, its outcomes, and interpretation? One example: in both predictive and count-based models, the size of the context window and its type (symmetrical/asymmetrical) must, as mentioned

26 Wevers and Koolen, "Digitale Begriffsgeschichte," 233.
27 Radim Řehůřek and Petr Sojka, "Software Framework for Topic Modelling with Large Corpora," (LREC 2010 Workshop on New Challenges for NLP Frameworks, Valletta, Malta, 2010), 46–50.
28 Wevers and Koolen, "Digitale Begriffsgeschichte," 229.

earlier, be pre-defined by the researcher. The impact of this decision on the learned vectors is quite significant: it has been suggested that larger context windows tend to provide more semantic information, while smaller ones provide more syntactic context. This and many other algorithm parameters are "built-in" and, while a user (a researcher) can opt out of defining some of them, many must still be set, and such choices should be justified and disclosed.

To conclude, we should not refrain from using tools from a new and often unfamiliar field, but should remember that using them without learning the fundamentals of how they work, how they manipulate the data and change our perspectives on the data, may lead to misunderstanding the study's potential and reducing its reliability.

6 Corpus design: Digital source (and tool) criticism

My research questions and the envisioned computational approach required creating a corpus: a digital collection of texts meeting certain criteria. In this section, I reflect on the nature of the data from the perspective of digital source criticism and digital tool criticism. Data is not, in fact, "data" but rather, as

Drucker puts it, "capta" – it is not "a 'given' able to be recorded and observed" but rather is "'taken' actively."[29] It is important to understand and be transparent about the constructed and selective nature of the corpus used for modeling and subsequent analysis. While the computational tools themselves introduce subjectivity, the processes of data collection and remediation (digitization) cannot be seen as objective and impartial either.

6.1 Creating a bibliography: Search and critical evaluation

At virtually every stage of a digital humanities (DH) project, data undergoes certain reductions,[30] – a fact that has been one of the main criticisms of DH as a

29 Johanna Drucker, "Humanities Approaches to Graphical Display," *Digital Humanities Quarterly* 5, no. 1 (2011).
30 Tahmasebi et al., "A Convergence of Methodologies," 441.

field.[31] The very first reduction happens at the stage of selecting texts to include in the bibliography.

At the beginning of my study there was no existing corpus of Indigenous Australian autobiographical works. Therefore, the first step was to create one – and before that to compile a bibliography of all published works that met certain selection criteria.

One of the challenges in creating a full bibliography of Indigenous Australian autobiographies concerns the definitions and resulting classifications.[32] Who should be considered an Indigenous Australian author? What about co-authored works? "As-told-to" works? What indeed is an autobiography?

There were two existing bibliographies: Horton's (1988) "non-exhaustive" list of Indigenous Australian literature that had been published between 1924 and 1987, including 21 works classified by him as life writing,[33] and Haag's (2011) bibliography of 177 autobiographies published between 1950 and 2004.[34] As for the more recently published works, to the best of my knowledge, there was no bibliography that listed them.

There is a noticeable difference between the existing classifications of Indigenous Australian writing in the academic literature: for example, Brewster in her article "Aboriginal life writing and globalisation"[35] discusses the book Follow the Rabbit-Proof Fence by Doris Pilkington,[36] which she describes as "biographical story" and "documentary life writing." However, Haag does not include this work in his bibliography. He also excludes I, the Aboriginal (the autobiography of Phillip Roberts, an Indigenous Australian, written based on multiple interviews by Douglas Lockwood),[37] arguing that whether to consider it an autobiography or not "is a matter of perspective."[38] Pilling, on the other hand, calls it an autobiography in his book review (although he adds that it

31 Johanna Drucker and Claire Bishop, "A Conversation on Digital Art History," in *Debates in the Digital Humanities 2019*, ed. Matthew K. Gold and Lauren F. Klein (Minneapolis: University of Minnesota Press, 2019), 321.

32 Tim Rowse, "Public Occasions, Indigenous Selves: Three Ngarrindjeri Autobiographies," *Aboriginal History Journal* 30 (2006): 187.

33 Wesley Horton, "Australian Aboriginal Writers: Partially Annotated Bibliography of Australian Aboriginal Writers 1924–1987," *Kunapipi* 10, no. 1 (1988): 275–304.

34 Haag, "Indigenous Australian Autobiography."

35 Anne Brewster, "Aboriginal Life Writing and Globalisation: Doris Pilkington's Follow the Rabbit-Proof Fence," *Southerly* 62, no. 2 (2002): 153–61.

36 Doris Pilkington, *Follow the Rabbit-Proof Fence* (St Lucia, QLD: University of Queensland Press, 1996), 136.

37 Douglas Lockwood and Waipuldanya, *I, the Aboriginal* (Adelaide: Rigby, 1962).

38 Haag, "Margins," 5.

was "edited and re-written somewhat by Lockwood" – Lockwood being a European anthropologist).[39] At the same time, Horton notes that the book is "a biography of Roberts, however, the author, Lockwood, has chosen to make him the implied author of the text which results in a text that is not completely authentic. The language used by the implied author far exceeds the ability of any "Noble Savage" created by Lockwood."[40] This case demonstrates the subjectivity of the data I was modeling, as I had to consider the often controversial definitions and classifications conceived by others, including those based on rather discriminatory assumptions.

With these two lists as a starting point, I started searching the Internet for other works. The Google search engine played a crucial role in this process of bibliography creation. Its decision-making, though similar to any other computer system, is based on rules and criteria defined by human designers who decide which resources will be shown to me first – and last. For example, webpages with better usability and accessibility for various types of browsers and devices will be ranked higher; and my location will be taken into account (unless I switch this function off) when displaying search results the system considers more relevant for the query.[41]

Moreover, I have to critically evaluate any information I find about the genre and the works supposedly belonging to it. Is the information authoritative, genuine? Who created this list? What classifications and definitions is it based on? If one uses a query like "Indigenous Australian autobiography" for a Google search today, among the top search results it is likely to return a link to the two-part Goodreads list that I myself have been compiling over the last three years.[42] At the current stage of development this list is not well documented, but to ensure its transparency and allow users to make decisions on its trustworthiness I am planning to add more information about the choices I have made to create it (e.g. the definitions of "an Indigenous Australian author" or "autobiography" that I have used).

Lastly, there is one case that demonstrates the perils of online search and the importance of digital source criticism – but also the complexities of the Indigenous Australian literary scene. Here is what was written on the back cover

39 Arnold Pilling, "I, the Aboriginal. Douglas Lockwood. Reviewed by Arnold R. Pilling," *American Anthropologist* 65, no. 5 (1963): 1152–3.

40 Horton, "Australian Aboriginal Writers," 279.

41 "Google Search – How Search Algorithms Work," accessed June 17, 2021, https://www.google.com/search/howsearchworks/algorithms/.

42 Goodreads list: Indigenous Australian Autobiographies, accessed June 17, 2021, https://www.goodreads.com/list/show/111425.Indigenous_Australian_autobiographies_1.

of the 1994 (first) edition of *My Own Sweet Time*: "This is a lively, gutsy story of an urban Aboriginal girl making it in the tough city counter culture of the mid-sixties."[43] The author herself is described in the book as follows: "Wanda Koolmatrie was born in the far north of South Australia in 1949. Removed from her Pitjantjara mother in 1950, she was raised by foster parents in the western suburbs of Adelaide, where she went to school, leaving in 1966 and moving to the eastern states. [. . .] She is currently living in London UK and among other things working on her next novel."[44]

Fast-forward 12 years, and here is the book's second (2006) edition and the corrected information about the author: "Leon Carmen was born and educated in South Australia. Wearied by a string of menial jobs, such as cabbie, musician, et cetera, he turned to story telling. As Wanda Koolmatrie, he wrote 'My Own Sweet Time', which won the $5,000 Dobbie Award, the prize later being recalled when the author drew attention to Wanda's fictional status. Mr. Carmen now lives in Ireland."[45]

In 1997, the book had been discovered to be a hoax, a fiction written by a white male taxi driver rather than an autobiography of an Indigenous Australian woman.[46] However, it had already won an award for a first novel by a female writer and been included in numerous Indigenous Australian studies reading lists.

If I had come across the 1994 first edition without having access to any supplementary information about the book and the hoax, I could have been misled and included this first edition in my bibliography and the publicly available Goodreads list, with the image of the "About the author" page, thus unwittingly misinforming whoever decided to rely on my list. This example shows how important it is to critically reflect on the reliability of the digital – especially online – sources we plan to use for our research.

As a result of merging and editing the two bibliographies described earlier, and supplementing them with the works I found during my online search, I constructed a bibliography of 289 entries (where I considered short stories included in a book or published as part of an online project, as well as full-size literary works, as separate entries) spanning the period between the 1950s and 2020.

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43 Wanda Koolmatrie, *My Own Sweet Time* (Broome: Magalaba Books, 1994), 214.

44 Koolmatrie, *My Own Sweet Time*.

45 Wanda Koolmatrie, *My Own Sweet Time* (Victoria, Vancouver Island, British Columbia: Trafford, 2006), 196.

46 Linda Westphalen, "Betraying History for Pleasure and Profit: Leon Carmen's My Own Sweet Time," *Overland* 150 (1998): 75.

6.2 From bibliography to corpus as a model

Creating a corpus from a bibliography can be seen as modeling – mapping from the original (for example, language used by a particular social group or, as in my study, a genre) to a representation which we believe reflects the qualities of the original. However, to be truly representative and thus allow for generalization (that is, using the corpus as a proxy for the whole universe of Indigenous Australian life writing), a sample must be random, which was not the case in my project. Therefore, I set a goal not to provide a generalizable outcome but rather to investigate the use of language in this particular corpus which, I believe, is suitable for the task.

6.3 Digitization and born-digital materials

Digitizing was the next data reduction stage. The books in my corpus were scanned with a Treventus ScanRobot automatic book scanner at the University of Luxembourg's DH Lab, and I was personally involved in the digitization process, thus learning about the scanning and post-processing technology (including skew correction, rotation, and cropping of page images) and gaining a good understanding of how remediation may transform the data. The output PDF files were then processed with ABBYY FineReader optical character recognition software and converted into text files. In addition to the digitized data, I also included in my corpus the born-digital short autobiographical stories published as part of the University of Queensland's "Growing up Indigenous in Australia" project.[47]

6.4 Preprocessing

Before proceeding to modeling, the corpus had to be preprocessed to make modeling more computationally efficient. Reducing vocabulary size when using word embedding modeling is a double-edged sword: on the one hand, it should help create a more accurate model; on the other hand, reducing the size of a corpus that is already quite small may impact the model quality.

47 Kerry Kilner, ed., *Growing Up Indigenous in Australia* (AustLit, The University of Queensland, 2018).

6.4.1 Removing irrelevant text sections

My first manipulation of the data from the raw text files was removing material written by people other than the Indigenous Australian authors (image captions, introductions, and acknowledgments), tables of contents, text on the back cover, and other textual elements outside of the autobiographical portion of the book. Each of these transformations would impact the resulting data to be modeled, and I had to consider every decision carefully, including such delicate cases as books with large portions of text in an Indigenous Australian language, or co-authored books in the form of questions and answers, or those in the form of a mixture of scientific and testimonial writings.

6.4.2 Tokenizing

The next step was splitting the texts into smaller chunks (tokenizing): to prepare input for word embedding modeling the corpus was turned into a list of sentences,

with each sentence represented by a list of tokens. Tokens may include not only words but also numbers and punctuation marks.

6.4.3 Stopwords, numbers, and punctuation

There are words that are very common and seem to be of relatively low value for text analysis – these are referred to as stopwords.[48] Removing such words helps reduce noise in the data and as a consequence makes the model more memory-efficient and accurate.

I used the stopword list from the NLTK package,[49] which includes words like "I," "me," "my," "by," "for," "some," "other," and "haven't," among others. However, the list is generic and does not take into account specific aspects of the domain under study. Another option would have been to create a custom list based on my corpus, where the discriminative power of words could have been measured more precisely. Alternatively, I could have used the "noun-only"

48 Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schutze, *Introduction to Information Retrieval* (Cambridge: Cambridge University Press, 2008), 27.
49 Steven Bird, Edward Loper, and Ewan Klein, *Natural Language Processing with Python* (Sebastopol, CA: O'Reilly Media, 2009).

approach (filtering based on the part of speech) – but then there was a chance of missing some aspects of the texts presented in other parts of speech.

While removing non-alphabetic symbols (e.g. punctuation and numbers) is a common preprocessing step, for some tasks it may be disadvantageous or even harmful: thus, for example, stylometry and author identification research may require leaving punctuation (and pronouns) in the corpus, whereas for my project punctuation was removed.

6.4.4 Lowercasing

Lowercasing is another common preprocessing step in natural language processing (NLP) that is helpful in many use cases – for example, in information retrieval applications, where it helps the search engine to find, say, Apple applications even if a user does not capitalize the word "apple."

If I did not lowercase my corpus then the model would treat capitalized words at the beginning of sentences differently from the same words occurring elsewhere (and not capitalized), which would negatively impact accuracy. At the same time, "Liberal" ("a member of a liberal party in politics, especially of the Liberal party in Great Britain") and "liberal" ("favorable to progress or reform, as in political or religious affairs"),[50] for example, would be treated as the same word. Moreover, when applying a neural network method like word2vec, one must remember that the learned word representations will be greatly affected by the number of occurrences presented to the algorithm, and that lowercasing has a certain impact on this number for each vocabulary item.

7 "The power of visual evidence" and a brief discussion of initial experimental results

In digital humanities, images are used not only as a communication tool but, and perhaps more importantly, as an analytical tool allowing the output of algorithms to be investigated more thoroughly. First of all, following Rieder and

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50 Dictionary.com, "Liberal," accessed June 17, 2021, https://www.dictionary.com/browse/liberal.

Röhle's advice,[51] I want to note that the visualizations I present in this section showcase an interim result of the ongoing and iterative research process. Visualizing word embeddings is a challenging task primarily because of the high dimensionality of the learned word vector space.

To incorporate my first experimental results in this discussion of visualization, I will use an example from my study and explore the discourse of sport by drawing on the paper by Osmond investigating the discussions of sport in Indigenous Australian autobiographies.[52] Osmond emphasizes the importance of sport for Indigenous Australian communities and with his study aims to "re-read" memoirs to explore how sport is discussed in life writing. I expected that word embedding modeling could help do exactly that – explore "what is said and why" about particular concepts and topics. Osmond argues that life writing can highlight the subjective meaning of sport as represented by language in use. While he focuses on a specific geographic location – four Indigenous Australian communities with which he works – I attempted to investigate the language use related to sport in the whole corpus I had created, which can be seen as an extension to his study.

The most straightforward and accessible way to present and analyze results from word embedding modeling is to generate a list of a user-defined number of the words positioned nearest (based on their presumed semantic similarity) to a certain keyword.

How many neighboring vectors should be considered as the most important for analysis? What if I decide to only look at the top 20 but number 21 is more insightful in the context of the study? Often, cosine distances between neighboring words and the keyword are very similar and a researcher has to decide which words to include in the analysis (for example, by setting a cut-off threshold). It is easy to see how even decisions made at the visualization stage can impact the interpretation of the results.

Analysis of the names of the sports disciplines in the list of nearest neighbors shows that the top results include "softball," "athletics," "rugby," "soccer," "tennis," "hockey," and "netball." This supports the claim by Osmond that, according to the analysis he had conducted on his corpus, "all works referring to sport focus primarily on introduced sports rather than traditional sporting, physical, or recreational activities," which is explained by "the early imposition of Western cultures and the suppression of traditional pursuits."[53]

51 Rieder and Röhle, "Digital Methods."

52 Gary Osmond, "Playing the Third Quarter: Sport, Memory and Silences in Aboriginal Memoirs," *Australian Aboriginal Studies* 2 (2019): 73–88.

53 Osmond, "Playing the Third Quarter," 79.

However, one of the top ten words appears to be "didge" – short for "didgeridoo," a traditional Indigenous Australian musical instrument used for ceremonies or recreation. This can be interpreted as a continuing role of Indigenous Australian traditions, but of course close reading would have helped understand the context better. In addition, words such as "prowess," "elite," "excelled," and "career" may signify what Osmond describes as "the link between sport and self-esteem," as playing sports served as a confidence boost for Indigenous Australian people, as a "ticket out," and a tool for building community. In general, the terms associated with sport seem to be neutral or positive.

To visualize the vector space, the number of its dimensions must be reduced to two or three for it to be comprehensible by humans. Tensorflow's *Embedding Projector* is one popular tool allowing visualization of word2vec output.[54]

First, the tool's usability is worth commenting on. Embedding Projector requires a user to upload two separate files: one with vectors and one with corresponding labels (tokens). However, Gensim's word2vec outputs only one file with the model and so some additional steps on the part of the researcher are required to extract the two files. Further, Embedding Projector is not very well documented and would have benefited from additional online tutorials and case studies on topics related to digital humanities to facilitate its use. Moreover, in my opinion, it is another example of the "lure of objectivity" and may be misleading for humanities scholars because the visualization is not based on the original data the researcher uploads.

To transform the multidimensional vectors into 2- or 3-dimensional ones for further visualization, Embedding Projector applies one of the dimensionality reduction algorithms (UMAP, t-SNE, or PCA). Selecting one of these is another decision to be made and justified by the researcher, who should understand how choosing to use the tool and a certain dimensionality reduction method may impact the results interpretations. For example, while PCA does not try to preserve all distances between the vectors but does aim to maximize the variance of the information encoded in the few dimensions after the transformation, t-SNE tries to preserve distances but is stochastic and therefore can produce different results for every run, even with the same data and parameters.[55] To avoid this randomness, instead of using the Projector visualizations it is possible to build a t-SNE

54 Daniel Smilkov et al., "Embedding Projector: Interactive Visualization and Interpretation of Embeddings" (paper presented at 30th Annual Conference on Neural Information Processing Systems, Barcelona, November 2016).

55 Chris Culy, "Word Vectors with Small Corpora: Visualizing Word Vectors," accessed June 17, 2021, https://www.chrisculy.net/lx/wordvectors/wvecs_visualization.html.

visualization using the scikit-learn machine learning library for Python.[56] The advantage of using this library is that there is the possibility to select a value for the "random state" parameter to get the same visualization at each algorithm run.

Embedding Projector allows users to build a customized projection based on specific keywords used as axes to find how words are located in the space in relation to these defined axes and explore if this relationship is meaningful. Thus, Fig. 1 shows how "softball" seems to be located more to the left on the "woman–man" (left–right) axis than "footy," or "football," or "basketball." This can be seen as supporting the fact that softball is traditionally considered a female sport.

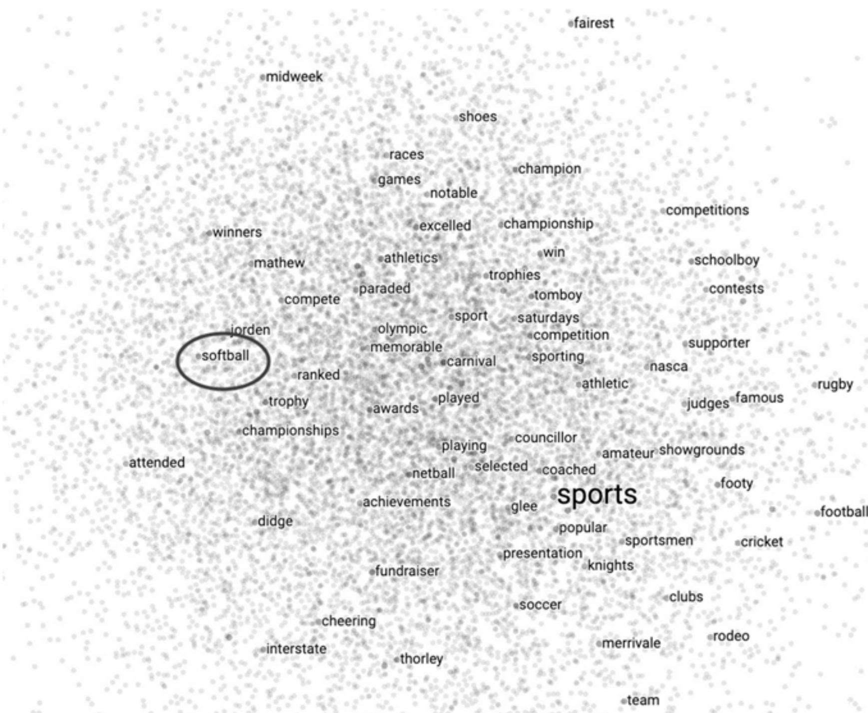

Fig. 1: Projection of the word "softball" on the "woman–man" (left–right) axis. 2020. © Ekaterina Kamlovskaya.

56 Fabian Pedregosa et al., "Scikit-learn: Machine Learning in Python," *Journal of Machine Learning Research* 12 (2011): 2825–30.

To sum up, my first experimental results suggested that word embedding modeling is a promising method for a corpus investigation in the humanities but needs to be used with caution, after careful consideration of numerous factors that may influence the algorithm output and model interpretation, and hence close reading is recommended to support the analysis.

8 Conclusion

Using computational methods and tools for an exploration of a usually relatively small and domain-specific humanities corpus is often a difficult task due to the limitations imposed by these tools and methods. However, instead of rejecting a computational approach altogether it is worth investigating the opportunities this may offer while ensuring transparency of the project methodology and making oneself aware of the implications of the used methods for the results and interpretations. In this chapter, I have reflected on the challenges I am encountering in my corpus-based study of the genre of Indigenous Australian autobiography, from the corpus construction stage, through modeling, to interpretation of the algorithm outputs and visualizations. Digital source and tool criticism are important for ensuring the transparency and reliability of a study, and understanding and documenting the inner workings and decisions to be made while using tools and methods borrowed from a different field are challenging but extremely important aspects of an interdisciplinary digital humanities project.

References

Bird, Steven, Edward Loper, and Ewan Klein. *Natural Language Processing with Python*. Sebastopol, CA: O'Reilly, 2009.

Bode, Katherine. *A World of Fiction: Digital Collections and the Future of Literary History*. Ann Arbor: University of Michigan Press, 2018.

Brewster, Anne. "Aboriginal Life Writing and Globalisation: Doris Pilkington's Follow the Rabbit-Proof Fence." *Southerly* 62, 2 (2002): 153–61. Accessed June 17, 2021. https://search.informit.org/doi/10.3316/informit.597088859392905.

Brewster, Anne, *Reading Aboriginal Women's Autobiography*. Melbourne: Sydney University Press in association with Oxford University Press, 1996.

Brinton, Laurel J., and Donna M. Brinton. *The Linguistic Structure of Modern English*. Amsterdam: John Benjamins Publishing, 2010. https://doi.org/10.1075/z.156.

Culy, Chris. Open source software platform. “Word Vectors with Small Corpora: Visualizing Word Vectors.” Accessed June 17, 2021. https://www.chrisculy.net/lx/wordvectors/wvecs_visualization.html.

Drucker, Johanna. “Humanities Approaches to Graphical Display.” *Digital Humanities Quarterly* 5, 1 (2011). Accessed June 17, 2021. http://www.digitalhumanities.org/dhq/vol/5/1/000091/000091.html.

Drucker, Johanna, and Claire Bishop. “A Conversation on Digital Art History.” In *Debates in the Digital Humanities 2019*, edited by Matthew K. Gold and Lauren F. Klein, 321–34. Minneapolis: University of Minnesota Press, 2019. https://doi.org/10.5749/j.ctvg251hk.30.

Ganascia, Jean-Gabriel. “The Logic of the Big Data Turn in Digital Literary Studies.” *Frontiers in Digital Humanities* 2, 7 (2015): 1–5. https://doi.org/10.3389/fdigh.2015.

Garg, Nikhil, Londa Schiebinger, Dan Jurafsky, and James Zou. “Word Embeddings Quantify 100 Years of Gender and Ethnic Stereotypes.” In *Proceedings of the National Academy of Sciences of the United States of America* 115, 16 (2018): E3635–E3644. https://doi.org/10.1073/pnas.1720347115.

Goldberg, Yoav. *Neural Network Methods for Natural Language Processing*. San Rafael, California: Morgan & Claypool, 2017.

Google. “Google Search – How Search Algorithms Work.” Accessed June 17, 2021. https://www.google.com/search/howsearchworks/algorithms/.

Haag, Oliver. “From the Margins to the Mainstream: Towards a History of Published Indigenous Australian Autobiographies and Biographies.” In *Indigenous Biography and Autobiography*, edited by Peter Read, Frances Peters-Little, and Anna Haebich, 5–28. Canberra: ANU Press, 2008.

Haag, Oliver. “Indigenous Australian Autobiography and the Question of Genre: Analysis of Scholarly Discourse.” *Acta Neophilologica* 44, 1–2 (2011): 69–79. https://doi.org/10.4312/an.44.1-2.69-79.

Hampsher-Monk, Iain, Karin Tilmans, and Frank van Vree, eds. *History of Concepts: Comparative Perspectives*. Amsterdam: Amsterdam University Press, 1998.

Harris, Zellig S. “Distributional Structure.” *Word* 10, 2–3 (1954): 146–62. https://doi.org/10.1080/00437956.1954.11659520.

Healy, John Joseph. “‘The True Life in Our History’: Aboriginal Literature in Australia.” *Antipodes* 2, 2 (1988): 79–85. Accessed June 17, 2021. https://www.jstor.org/stable/41955962.

Heiss, Anita. *Dhuuluu-Yala = To Talk Straight: Publishing Indigenous Literature*. Canberra: Aboriginal Studies Press, 2003.

Hellrich, Johannes, and Udo Hahn. “Bad Company – Neighborhoods in Neural Embedding Spaces Considered Harmful.” In *Proceedings of the 26th International Conference on Computational Linguistics: Technical Papers*, edited by Yuji Matsumoto and Rashmi Prasad, 2785–96. Osaka: COLING 2016 Organizing Committee, 2016. Accessed June 17, 2021. https://www.aclweb.org/anthology/C16-1262.

Horton, Wesley. “Australian Aboriginal Writers: Partially Annotated Bibliography of Australian Aboriginal Writers 1924–1987.” *Kunapipi* 10, 1 (1988): 275–304. Accessed June 17, 2021. https://ro.uow.edu.au/kunapipi/vol10/iss1/30.

Jockers, Matthew Lee. *Macroanalysis: Digital Methods and Literary History*. Urbana: University of Illinois Press, 2013.

Kilner, Kerry, ed. "*Growing Up Indigenous in Australia*." AustLit: The Australian Literature Resource, The University of Queensland, 2018. Accessed June 17, 2021. https://www.austlit.edu.au/growingup.

Koolmatrie, Wanda. *My Own Sweet Time*. Broome: Magalaba Books, 1994.

Koolmatrie, Wanda. *My Own Sweet Time*. Victoria, Vancouver Island, British Columbia: Trafford, 2006.

Lockwood, Douglas, and Waipuldanya. *I, the Aboriginal*. Adelaide: Rigby, 1962.

Manning, Christopher D, Prabhakar Raghavan, and Hinrich Schütze. *Introduction to Information Retrieval*. Cambridge: Cambridge University Press, 2008. https://doi.org/10.1017/CBO9780511809071.

Manovich, Lev. "The Science of Culture? Social Computing, Digital Humanities and Cultural Analytics." *Journal of Cultural Analytics*, May 23, (2016): 55–68. https://doi.org/10.22148/16.004.

Mikolov, Tomas, Kai Chen, Greg Corrado, and Jeffrey Dean. "Efficient Estimation of Word Representations in Vector Space." Paper presented at the International Conference on Learning Representations, Scottsdale, Arizona, May 2–4, 2013.

Moretti, Franco. *Distant Reading*. London: Verso, 2013.

Moretti, Franco. *'Operationalizing': Or, the Function of Measurement in Literary Theory*. Stanford, California: Stanford Literary Lab, 2013. Accessed June 17, 2021. https://litlab.stanford.edu/LiteraryLabPamphlet6.pdf.

Osmond, Gary. "Playing the Third Quarter: Sport, Memory and Silences in Aboriginal Memoirs." *Australian Aboriginal Studies* 2 (2019): 73–88.

Pedregosa, Fabian, Gaël Varoquaux, Alexandre Gramfort, Vincent Michel, Bertrand Thirion, Olivier Grisel, Mathieu Blondel, "Scikit-learn: Machine Learning in Python." *Journal of Machine Learning Research* 12 (2011): 2825–30.

Pilkington, Doris. *Follow the Rabbit-proof Fence*. St Lucia, QLD: University of Queensland Press, 1996.

Pilling, Arnold. "I, the Aboriginal. Douglas Lockwood. Reviewed by Arnold R. Pilling." *American Anthropologist*, 65, 5 (1963): 1152–53.

Ramsay, Stephen. *Reading Machines: Toward an Algorithmic Criticism*. Urbana: University of Illinois Press, 2011.

Řehůřek, Radim, and Petr Sojka. "Software Framework for Topic Modelling with Large Corpora." In *Proceedings of the LREC 2010 Workshop on New Challenges for NLP Frameworks*, Valletta, Malta: University of Malta, 2010: 46–50. https://doi.org/10.13140/2.1.2393.1847.

Richter, Melvin. *The History of Political and Social Concepts: A Critical Introduction*. New York: Oxford University Press, 1995.

Rieder, Bernhard, and Theo Röhle. "Digital Methods: Five Challenges." In *Understanding Digital Humanities*, edited by David Berry, 67–84. London: Palgrave Macmillan UK, 2012.

Rowse, Tim. "Public Occasions, Indigenous Selves: Three Ngarrindjeri Autobiographies." *Aboriginal History Journal* 30 (2006): 187–207. Accessed June 17, 2021. http://press-files.anu.edu.au/downloads/press/p171301/pdf/article13.pdf.

Salton, Gerard, Andrew Wong, and C. S. Yang. "A Vector Space Model for Automatic Indexing." *Communications of the ACM* 18, 11 (1975): 613–20. https://doi.org/10.1145/361219.361220.

Shoemaker, Adam. *Black Words, White Page: Aboriginal Literature 1929–1988*. Canberra: ANU E Press, 2004.

Smilkov, Daniel et al., “Embedding Projector: Interactive Visualization and Interpretation of Embeddings.” Paper presented at 30th Annual Conference on Neural Information Processing Systems, Barcelona, November, 2016. Accessed June 17, 2021. http://arxiv.org/abs/1611.05469.

Tahmasebi, Nina, Niclas Hagen, Daniel Brod´en, and Mats Malm, “A Convergence of Methodologies: Notes on Data-intensive Humanities Research.” In *Proceedings of the Digital Humanities in the Nordic* Countries *4th Conference*, Copenhagen: University of Copenhagen, 2019: 437–49. Accessed June 17, 2021. http://www.ceur-ws.org/Vol-2364/40_paper.pdf.

Van Lange, Milan M., and Ralf D. Futselaar. “Debating Evil: Using Word Embeddings to Analyze Parliamentary Debates on War Criminals in The Netherlands.” Paper presented at Conference on Language Technologies & Digital Humanities 2018, Ljubljana, September 2018.

Westphalen, Linda. “Betraying History for Pleasure and Profit: Leon Carmen’s My Own Sweet Time.” *Overland* 150 (1998): 75–8.

Wevers, Melvin, Tom Kenter, and Pim Huijnen. “Concepts Through Time: Tracing Concepts in Dutch Newspaper Embeddings.” Paper presented at the Annual Conference of the Alliance of Digital Humanities Organizations, Sydney, Australia, June 29–July 3, 2015. Accessed June 17, 2021. http://tomkenter.nl/pdf/wevers_2015_concepts.pdf.

Wevers, Melvin, and Marijn Koolen. “Digitale Begriffsgeschichte: Tracing Semantic Change Using Word Embeddings.” *Historical Methods: A Journal of Quantitative and Interdisciplinary History* 53, 4 (2020): 226–43. https://doi.org/10.1080/01615440.2020.1760157.

Thomas Durlacher

Philosophical perspectives on computational research methods in digital history

The cases of topic modeling and network analysis

This chapter has three main objectives: firstly, to discuss several philosophical positions regarding research methods; secondly, to outline certain features of scientific methods; and, thirdly, to use this terminology to look at digital history.

In a brief sketch on several historically important philosophical positions concerning research methods I first aim to show that the search for the one "correct" scientific method has recently given way to a more pluralistic conception of research practices.

Next, I outline some of the general features of scientific methods – not as a comprehensive description of research methods, but rather as an attempt to shed light on the often neglected point that methods are closely related to the academic goals we are working toward. Although these goals may be uncertain or changing, critical reflection on the connection between methods and what we are trying to achieve in our research has the potential to increase our awareness of the limitations and possibilities of certain methods.

Lastly, I use this philosophical terminology to look at digital history – a comparatively new historical subdiscipline that is distinguished by its computational methods – and discuss two different digital methods. My PhD project is concerned with the investigation of a specific methodological practice, computational modeling, on which there are still ongoing debates as to what the feasible goals for this method could be. The following methodological reflections are part of my ongoing investigations into the nature of research methods.

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1 Historical perspectives on research methods and philosophy

Before the establishment of independent philosophical subdisciplines associated with individual scientific disciplines, philosophical investigations into the nature of research methods often coincided with the task of explaining human reasoning. Although these investigative attempts aimed for generality, they also emphasized the need to provide concrete instructions on what the scientific method should look like. Examples of this approach toward methods are well known. René Descartes suggested that knowledge proceeds from first principles known a priori and with certainty,[1] while Francis Bacon claimed that we gain knowledge of the world by collecting observable evidence and then extend this knowledge by generalization.[2]

During the course of the twentieth century this traditional philosophical view of research methods changed dramatically. The development can most easily be summarized under the label of diversification, which describes the process from the search for the one "correct" scientific method toward a more pluralistic conception of academic research in general. In this pluralistic landscape, general approaches and specific studies of individual elements of research can be seen as complementary, rather than in conflict with each other.

In the first half of the twentieth century, general approaches to methods and objectives in the humanities were less widespread than in the sciences but still common. In contrast to the philosophical discussion about natural science, which focused on the logical relationship between theories and evidence, the debate in the humanities focused on the question of how the human dimension of the research object requires a specific method and thus distinguishes natural science from the humanities.[3] Participants in these discussions emphasized that the study of human experiences depends on a specific form of understanding conceived as a distinct kind of hermeneutic practice, which is not adaptable to the natural sciences.

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1 René Descartes, "Rules for the Direction of the Natural Intelligence," in *Descartes: Selected Philosophical Writings*, ed. John Cottingham, Robert Stoothoff, and Dugald Murdoch (Cambridge: Cambridge University Press, [1701] 1999), 1–19.

2 Francis Bacon, *The New Organon*, ed. Lisa Jardine and Michael Silverthorne (Cambridge: Cambridge University Press, [1620] 2000), 33.

3 See for example Wilhelm Dilthey, *Introduction to the Human Sciences*, ed. Rudolf Makkreel and Frithjof Rodi, Selected Works I (Princeton: Princeton University Press, 1989); or Max Weber, "Objectivity in Social Science and Social Policy," in *The Methodology of Social Sciences*, ed. Henry Finch and Edward Shils (New York: Free Press, 1949), 50–112.

It is sometimes assumed that in the humanities the systematic discussion of methods is less widespread than in the sciences. That this is not the case can be seen by the recent work of Rens Bod.[4] In his innovative account of the historical development of the humanities, he carefully outlined the importance of methodological principles within the humanities.[5]

The philosophy of science has also moved away from the grandiose old philosophical systems toward more specific questions concerning scientific work, such as, What should be considered as evidence and how can it be related to theories?[6] A general and still fairly influential proposal in this regard was the hypothetico-deductive approach of Carl Hempel.[7] Put in simple terms, this approach considered the scientific method as consisting in the suggestion of a hypothesis, the derivation of consequences from this hypothesis, and the testing of whether those consequences can be observed. For Hempel, this approach provided a general procedure to get us closer to the conceived goal of science, i.e. the formulation of laws of nature.

Although philosophical accounts of research methods such as the hypothetico-deductive approach provide useful insights into the logic of research, it is clear that this kind of philosophical theorizing started with an already comparatively abstract picture of the objects of research and how they should be investigated. These accounts rarely reached the level of the working researcher and the more mundane problems of their work. The second half of the twentieth century saw considerably more attention being paid to the local circumstances of knowledge production. The watershed moment in this process toward more attention being paid to local research practices was the publication and reception of Thomas Kuhn's monograph *The Structure of Scientific Revolutions*.

4 Rens Bod, *A New History of the Humanities: The Search for Principles and Patterns from Antiquity to the Present* (Oxford: Oxford University Press, 2013), 364.

5 For a general examination of the role methods play in the sciences see Robert Nola and Howard Sankey, *Theories of Scientific Method: An Introduction* (Stocksfield: Acumen, 2007); Hugh Gauch, *Scientific Method in Brief* (New York: Cambridge University Press, 2012). For an overview of the role that methods play in the humanities and history see Simon Gunn and Lucy Faire, eds., *Research Methods for History* (Edinburgh: Edinburgh University Press, 2012); and James E Dobson, *Critical Digital Humanities: The Search for a Methodology* (Urbana: University of Illinois Press, 2019).

6 In this context, the discussion revolved around deductive, inductive, and abductive reasoning. See Nancy Cartwright, Stathis Psillos, and Hasok Chang, "Theories of Scientific Method: Models for the Physico-Mathematical Sciences," in *The Cambridge History of Science: The Modern Physical and Mathematical Sciences*, ed. Mary Jo Nye, 5 (Cambridge: Cambridge University Press, 2003), 21–35.

7 Carl G. Hempel, "Studies in the Logic of Confirmation," *Mind* 54, no. 213 (1945): 1–26.

According to the Kuhnian picture of science, methods are embedded in historically changing paradigms.[8] Kuhn questioned traditional distinctions between normative and descriptive approaches toward research methods and argued that the rules for their application and evaluation depend on the larger context of a paradigm. Philosophers like Paul Feyerabend further undermined the distinction between normative and descriptive approaches toward research methods by claiming that there are no genuine normative methodological principles at all.[9] In the aftermath of the Kuhnian revolution, the study of science took a variety of different forms, ranging from historical studies focusing on the epistemological principles behind methods and the sociological context of research,[10] to a more general practice-oriented approach.[11] These approaches found that research methods can have a wide variety of context-dependent functions, mirroring the heterogeneity of the different disciplines themselves.

After several decades of intense intellectual exchanges neither the older, more general, approaches nor the newer contextual approaches toward scientific research methods have prevailed. Currently, the status quo in the philosophy of science is characterized by the comparatively peaceful coexistence of the different approaches. In Section 2 I outline one central feature of research methods – their goal-directedness – which is especially important to understanding how such methods can be evaluated.

2 Methods and goals

Methods, in the sciences as well as the humanities, are means to attain the goals of individual disciplines such as history, biology, or physics. "Means" here primarily designate a set of activities a researcher can engage in. These activities range from what goes on in one's mind while doing research (reasoning, thinking, imagining, inferring) to actions that involve interaction with our

8 Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 4th ed. (Chicago: The University of Chicago Press, 2012), 8.

9 Paul Feyerabend, *Against Method*, 3rd ed. (London: Verso, 1993), 14.

10 See Bruno Latour and Steve Woolgar, *Laboratory Life: the Construction of Scientific Facts* (Princeton: Princeton University Press, 1979), 21–42; or Andrew Pickering, *Constructing Quarks: A Sociological History of Particle Physics* (Chicago: University of Chicago Press, 1984), x.

11 See Ian Hacking, *The Taming of Chance* (Cambridge: Cambridge University Press, 1990), 1–10; as well as Philip Kitcher, *In Mendel's Mirror: Philosophical Reflections on Biology* (Oxford: Oxford University Press, 2003), xi.

environment (observing, measuring, gathering data, reading, conducting interviews, writing, collecting specimens, performing experiments).

Methods provide a focal point for a discipline's self-identity. Traditionally, students are introduced to a research field by learning to master the most important methods of that field. This process leads the novice from the laborious study of procedures, principles, and rules, to full immersion in a discipline. Students thus acquire the ability to apply these methods, without assistance, in order to answer new research questions. Research questions often include the formulation of certain goals and in most cases also specify the methods to be used to reach those goals.

In practice, it is often the case that the proposed goals and methods of a research project change over time, in an iterative process, but this does not impair the close relation between methods and goals.

The goals of methods can encompass general objectives such as knowledge, prediction, control, explanation, and understanding, as well as domain-specific, lower-level objectives such as the accurate description of a historical event, the explanation of a physical phenomenon, the classification of biological species, or the collection of evidence. It is important to notice that when we talk about methods being goal-directed we use an ellipsis to express the fact that methods used by researchers are used to achieve certain goals. Therefore, it is not a method in itself that achieves a goal but the researcher implementing the method who achieves the goal.

Usually, it is assumed that the achievement of these goals is not the result of arbitrary luck, but rather the outcome of the systematic work of a community of researchers who think about and critically evaluate their methods. This already reveals one central point about methods. The evaluation of a method depends crucially on the goals we have. A method is not intrinsically good, bad, or adequate but is good, bad, or adequate in relation to a specified goal the method is directed toward, as well as in relation to the goals of the discipline. Goals in this sense are determined by individual researchers and the scientific community. Sometimes higher-level goals and lower-level goals conflict with each other or are not coordinated appropriately to further the progress of a discipline. A lower-level objective can be perceived as undesirable by some researchers because they are not aware of how it contributes to higher-level goals. On the other hand, it is also possible to criticize a method when it is not clear how the method contributes to the overall goals of the discipline.

A method can be said to be adequate if it helps us to achieve a certain objective. Wendy Parker defined adequacy to achieve a purpose, with the help of a tool, in the following way:

> ADEQUACYC: A tool M is ADEQUATEC-FOR-P if and only if, in C-type instances of use of M, purpose P is very likely to be achieved.[12]

We can reformulate this conception of adequacy for methods in general as:

> ADEQUACYM: A method M is ADEQUATEM-FOR-G if and only if, in C-type instances of use of M, goal G is very likely to be achieved.

The notion of ADEQUACYM helps us describe methods as a reliable way to reach a certain goal. In this sense, methods are fallible and depend on the presence of the right circumstantial factors. C-type instances designate the context in which a method is used. The method to measure temperature, for example, consists of the use of a thermometer in a certain unobstructed context. In this case, the goal is the representation of temperature. The establishment of the adequacy of a method is possible through one of two ways. Either the method has been successful in the past or we understand the underlying processes of the method well enough to be confident in its efficiency before actually testing it.

It is not always easy to say what the objectives of a method are. The objective cannot be a specific result. It rather has to be something like a range of possible outcomes informing us about the object under investigation. What I mean by a range of possible outcomes is that a tool, like a thermometer, or a procedure, like the measurement of temperature, is not used to depict a single temperature point but rather represents the temperature of the object it is applied to at the time of the measurement.

Consider a situation described by the historian and philosopher of science Hasok Chang.[13] In the early days of the history of thermometers, scientists had no way to judge the correctness of those instruments, except by comparing them with each other. It proved especially difficult to establish fixed temperature points (which in turn were needed to create quantitative scales), like the boiling point of water, in situations where there were no independent methods of temperature measurement available. This problem was particularly hard to solve because it was not known if certain physical phenomena, such as the boiling point of water, appear at a fixed temperature point at all. The problem persists even if we account for the exclusion of distorting factors like impurities in the water, atmospheric pressure, and so on. Here, the aim of the instrument – to measure temperature – was itself such an obscure notion that it was difficult

12 Wendy S. Parker, "Model Evaluation: An Adequacy-for-Purpose View," *Philosophy of Science* 87, no. 3 (2020): 461.
13 Hasok Chang, *Inventing Temperature: Measurement and Scientific Progress*, Oxford Studies in Philosophy of Science (Oxford: Oxford University Press, 2007), 57–102.

to assess the reliability of the methods used. In the end, a variety of different measurement methods (one of which was the experienced body temperature) were used to correct each other. This turned out to be useful for studying the phenomenon, as well as for improving the methods over time.

In general, research methods can assume two different roles.[14] The distinction between these roles shares similarities with the distinction between the *context of discovery* and the *context of justification* in the philosophy of science. In the first role, methods can encompass activities that have an auxiliary function in the research process.

Procedures used to acquire funding, determine how to get to conferences, or decide how to organize teaching activities are practical research-related activities. Such methods, although important to the research enterprise and probably systematic, do not play a role in the way in which we justify our knowledge claims, and they therefore belong to the context of discovery. This context also includes sources of inspiration outside the realm of rational justification, such as dreams, spiritual inspirations, and subjective preferences. In their second role, methods can also support the results of research in an epistemic manner. An example here is the use of comparative script analysis to date an inscription. In this case, the procedure we use to determine the date of a manuscript – i.e. the comparison of different texts – provides a reason for us to believe that the inscription has a certain age, and thus belongs to the context of justification. Faulty procedures undermine knowledge claims if, for example, the corpus of texts is incomplete. Proper procedures, in contrast, strengthen knowledge claims. In the following, I will be primarily concerned with methods in this narrower, epistemic sense. Since the second half of the twentieth century, the distinction between the context of discovery and the context of justification has been a point of contention. There is a sense that, even in the discovery process, epistemic considerations play a role – while, in actual research, what is claimed to be done or believed for epistemic reasons is sometimes influenced or distorted by external factors: non-epistemic factors. For conceptual clarification, it is nonetheless useful to distinguish between these two roles that methods play, even if the distinction cannot always be sharply drawn.[15] In history, the epistemic function of methods is generally accepted. In this respect Jörn Rüsen writes:

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14 Nola and Sankey, *Theories of Scientific Method*, 18–9.

15 This distinction was originally popularized by Hans Reichenbach. For a more recent discussion see Jutta Schickore and Friedrich Steinle, *Revisiting Discovery and Justification: Historical and Philosophical Perspectives on the Context Distinction* (Dordrecht: Springer, 2006), vii–xix.

> Why method? It is a matter of acquiring historical knowledge from the empirical facts that are left from the past and thereby, in general, accessible in the present (so to speak, in front of your eyes). The methodological procedures of this acquisition serve to strengthen this knowledge and to systematically justify its plausibility or validity. Methods make knowledge justifiable by verifiability of its statements.[16] (Translation my own.)

The application of methods also distinguishes research as a systematic enterprise. Doing research is having a plan – it embodies some kind of order, and is not arbitrary. Even when this order is intentionally given up, as in the case of exploratory or speculative research, it should be clearly distinguished from method-based research. This systematic approach also contributes to the progress of academic research, given that the progress of a discipline does not only depend on what we know but also on how we get to know it.

Establishing adequate goals for methods is in itself a sophisticated part of scientific research. With new areas of research especially, it usually takes time to figure out how certain methods can be used. One such comparatively new research field is the focus of the next section.

3 Digital history

In some instances, methods are influential enough to create scientific disciplines and subdisciplines around them. Digital history – a subdomain of history – is a case in point, but what is it about? In the following I present two proposals for defining the field.

We can define digital history in a first approximation as the historical subdiscipline concerned with the use of digital methods to study the past.[17] Digital methods used in digital history are dependent on computers and their various capacities, such as the performance of computations and the processing and storage of data. This definition presents digital history as an area characterized by the application of certain computational/digital techniques. It is not unusual to describe a historical subdiscipline in this way. Oral history, for example, is characterized by its focus on the acquisition and use of certain sources and not by a specific topic.[18]

16 Jörn Rüsen, *Historik: Theorie der Geschichtswissenschaft* (Cologne: Böhlau Verlag, 2013), 55.
17 For a recent review of the state of the digital history subdomain see Annemieke Romein et al., "State of the Field: Digital History," *History* 105, no. 365 (2020): 291–312.
18 Donald A. Ritchie, *Doing Oral History*, 3rd ed., Oxford Oral History Series (New York: Oxford University Press, 2015), xiv.

Unfortunately, this simple definition has the drawback that it is too broad to be very useful. It would make every historian a digital historian because the use of computers has permeated the academic landscape more or less completely. To characterize the whole of academic history as digital history would run counter to our desire to delineate an area within history in which the use of computational techniques has taken on a special role distinct from the everyday uses of those techniques.[19]

If we are interested in getting a better understanding of digital history on a theoretical level we have to further specify how the computer is used by digital historians. My second definition characterizes digital history not only by its use of computers but by the fact that this work could not be done without computers. In this sense, the digital historian is a historian whose work would not be possible without the help of a computer.[20] This also means that the computer plays a special role in the justification of the claims in this area. The definition could therefore be rephrased as: digital history is the historical subdiscipline in which a certain kind of knowledge of the computer as a tool to justify historical claims is indispensable. This definition has the advantage of capturing our intuitive feeling that not every use of the computer has the same importance for the outcome of our research. Using digitized pictures of historical events can be important, but our knowledge of the computer we use plays a comparatively minor role in the claims we make with the help of those pictures. But if we use a database to store and query a large number of pictures or other data, knowledge of how the query works is indispensable for the reliable use of the technique.[21]

Working with large amounts of data, and the sophisticated representation and visualization of these data with the help of automated algorithms, fall within this second definition. Given the comparatively recent origin of the field of digital history, this list of methods is not fixed – neither is it foreseeable which methods will be permanently established within history.[22] But there are,

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19 I assume that the establishment of specialized online platforms like https://ranke2.uni.lu/ and https://programminghistorian.org/ for teaching the application of the computer as a research tool, along with the establishment of specialized journals and research centers, is a manifestation of the process in which the computer has taken on this role.

20 Here, "would not be possible without the help of a computer," should be interpreted more in practical terms: it is of course imaginable in theory that, given enough time and resources, humans could perform the tasks of computers, but it is clear that this is not possible in practice.

21 This does not mean that everything about a tool has to be known in order to use it, but rather that, for certain uses, some sort of basic understanding is necessary.

22 Romein et al., "State of the Field," 310.

nonetheless, clear examples of the application of digital methods extending the horizons of traditional historical research.

I should also add another clarification. Digital history, although it involves the use of a computer, is not limited to computational methods. This is important because, in most cases, we see that computational methods are embedded in a web of other research activities. In Section 2, I argued that methods are directed toward certain goals. What about the goals of digital history? This question can only be answered by looking at specific methods. I will therefore look at two well-established methods in this area: topic modeling and social network analysis. At first sight, it may seem that digital history, because it is defined through its methods rather than through its goals, is directed toward the traditional goals of history. I also mentioned in Section 2 that different methods can be used to achieve the same goals – therefore a change in methods does not necessarily imply a change in goals. But changed methods certainly create the possibility for the consideration of new goals. We see this clearly with my first example of a computational method – topic modeling.

3.1 Topic modeling

The computational study of text corpora was one of the first applications in the humanities to use the calculating power of modern computing machines.[23] Nowadays, machine learning techniques such as topic modeling have become an attractive method for studying large amounts of textual data. Because of the highly structured way in which text is available, it is comparatively easy to transfer text documents into machine-readable form, thereby making the processing of large amounts of text possible.[24] The early use of computational text analysis coincided with the traditional role of text as the primary form of evidence in the humanities. The reading of a text provides humans with information that goes beyond the perception of markings on a page. The traditional way of describing this feature of language is that words and sentences have semantic meaning. A sentence can provide information about the intentions, beliefs, and desires of an author, and can constitute evidence if we are interested in exploring those things. A text, as the manifestation of the writing behavior of

23 Susan Hockney, "The History of Humanities Computing," in *Companion to Digital Humanities*, ed. Susan Schreibman, Ray Siemens, and John Unsworth (Oxford: Blackwell, 2004), 3–19.
24 For other text-based methods and natural language processing techniques see chapter 3 of Shohreh Haddadan, chapter 4 of Ekaterina Kamlovskaya, and chapter 6 of Eva Andersen in this volume.

an author, can also provide us with information beyond the conscious mental state of the author, allowing us to interpret the writing as the outcome of the cultural practices, social relations, and power structures of the time. Given the fundamental interest of historians in questions such as why somebody acted the way they did, or how somebody experienced something, textual evidence and methods related to textual sources have been of prime importance in historical research. In contrast to the automated processing of text, this traditional form of reading is known as close reading.

Topic modeling algorithms analyze text and calculate the probabilities for certain groups of words to co-occur.[25] The assumption here is that words that occur together share a semantic relationship. It is intuitively plausible that if the words "garden," "flower," and "earth" appear together in a text, there also exists a semantic relationship between them.

A well-known example of this is Robert K. Nelson's Mining the Dispatch project.[26] Nelson used topic modeling to mine a large number of fugitive slave advertisements from the *Daily Dispatch* newspaper of Richmond, Virginia in order to explore the changes of topic over time. A topic like military recruitment was identified by words like "service," "men," "company," "arms," "state," "companies," "Virginia," "war," and so on.[27] In this way, it was possible to discover some of the unexpected aspects of these ads, such as humor.[28] More recent applications of topic modeling have operated in a similar way and have shed new light on large-scale cultural developments in areas like the history of science, economics, and music production.[29]

Topic modeling assumes that the probability of words occurring together in a text is an expression of a semantic relationship. In practice, this is not always the case. Words may appear together by coincidence, without representing any semantic relationship. Before a text can be analyzed, words like "the," "of,"

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25 David Blei, Andrew Ng, and Jordan Michael, "Latent Dirichlet Allocation," *Journal of Machine Learning Research* 3 (2003): 993–1022.

26 "Mining the Dispatch," last modified November 2020, http://dsl.richmond.edu/dispatch/pages/home.

27 "Mining the Dispatch," last modified November 2020, https://dsl.richmond.edu/dispatch/topic/32.

28 "Mining the Dispatch," last modified November 2020, https://dsl.richmond.edu/dispatch/introduction.

29 Shawn Martin, "Topic Modeling and Textual Analysis of American Scientific Journals, 1818–1922," *Current Research in Digital History* 2 (2019); Lino Wehrheim, "Economic History Goes Digital: Topic Modeling the Journal of Economic History." *Cliometrica* 13, no. 1 (2019): 83–125; and Matthias Mauch et al., "The Evolution of Popular Music: USA 1960–2010," *Royal Society Open Science* 2, no. 5 (2015): 1–10.

and "to" have to be removed because they are less significant in determining the semantic topics in a text. In cases of words with little semantic value it is necessary for the researcher to manually distinguish significant from non-significant results.[30]

Historians have for a long time been interested in large-scale developments such as the changes in public opinion in a country or the existence of certain cultural practices over long periods of time. Without quantitative methods, arguments of this scope cannot be justified, as the cognitive abilities of humans are limited.[31] In such cases, automated procedures are needed to help researchers – and topic modeling can be seen as an auxiliary tool for automatically finding certain semantic correlations in texts. But, by providing new methods, computational tools also create new goals and transform older ones. The goal of training a machine learning model on a large corpus of texts in order to detect topics did not exist in the analog era. And a formerly unfeasible goal, such as the large-scale description of more major cultural developments – which at the same time captures at least some aspects of the outcome of cultural practices like writing texts – becomes much more tractable than with traditional methods.

3.2 Social network analysis

Social network analysis quantitatively describes the connections between different entities within a network. It thereby provides the possibility of representing certain relationships according to the rules of graph theory, the mathematical subdiscipline whose rigorous framework can be used to formulate explicit definitions about the constituents of a network.[32] A graph consists of a set of vertices (nodes) with lines (edges) between those vertices. Different kinds of centrality measures can be used to describe and visualize how the nodes representing the entities in the network are related. The formal representation of the relationship between different entities within a social network makes it

30 Matthew L. Jockers and Rosamond Thalken, *Text Analysis with R: For Students of Literature*, Quantitative Methods in the Humanities and Social Sciences (Cham: Springer International Publishing, 2020), 230.

31 Paul Humphreys, *Extending Ourselves: Computational Science, Empiricism, and Scientific Method* (New York: Oxford University Press, 2004), 6.

32 For more details about social network analysis see chapter 1 of Antonio Fiscarelli in this volume. See also Garry Robins, *Doing Social Network Research: Network-based Research Design for Social Scientists* (London: Sage, 2015).

possible to use automated algorithms to explore the properties of the network or to visualize it.

The entities represented in this way do not have to be individual humans but can also include words, institutions, material things, and so on. The only important thing is that the relationship between the entities can be expressed in mathematical form. The example in Fig. 1 shows the relationship between a set of school pupils. Every circle represents a child in a school class. The data were collected by Johannes Delitsch, a pioneer of social network analysis, in the 1880s.[33] Based on his observations in class he created a table of friendship gestures, reciprocal relationships, and other measures. The nodes in this figure were ordered according to the degree of connectedness to other nodes, with the nodes with the highest degrees of connectedness shown in the middle and colored in darker blue than the rest of the nodes.[34]

Network analysis is most applicable in cases where we assume we will find significant relationships between entities. The relationships which constitute a network are not only idle ways to describe individual facts but rather can be used to explain certain effects that are dependent on the existence of a network. These effects might include the spread of information, or a disease, as well as the likelihood that certain events will take place. Traditional history often depends on narratives as a main tool to represent the past. Network analysis extends the toolbox of possible representations of the past by use of a formally rigorous theory of networks. The interpretation of what exactly is represented with the help of networks is dependent on the historian. As in the case of topic modeling, the ability to automatically create and visualize networks from large datasets allows historians to bring new details into focus. Describing centrality, for example, is an easy way to formulate hypotheses about a social actor in a network.

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33 Richard Heidler et al., "Relationship Patterns in the 19th Century: The Friendship Network in a German Boys' School Class from 1880 to 1881 Revisited," *Social Networks* 37, no. 1 (2014): 1–13.

34 The original data used to create this network were compiled by the German primary school teacher Johannes Delitsch. Between 1880 and 1881, he observed the behavior of his pupils' school class. I created the picture with the Gephi graph visualization software. Data: https://github.com/gephi/gephi/wiki/Datasets. For the use of Gephi, see Bastian Mathieu, Sebastien Heymann, and Mathieu Jacomy, "Gephi: An Open Source Software for Exploring and Manipulating Networks" (Third International Conference on Weblogs and Social Media, ICWSM, San Jose, USA, 2009).

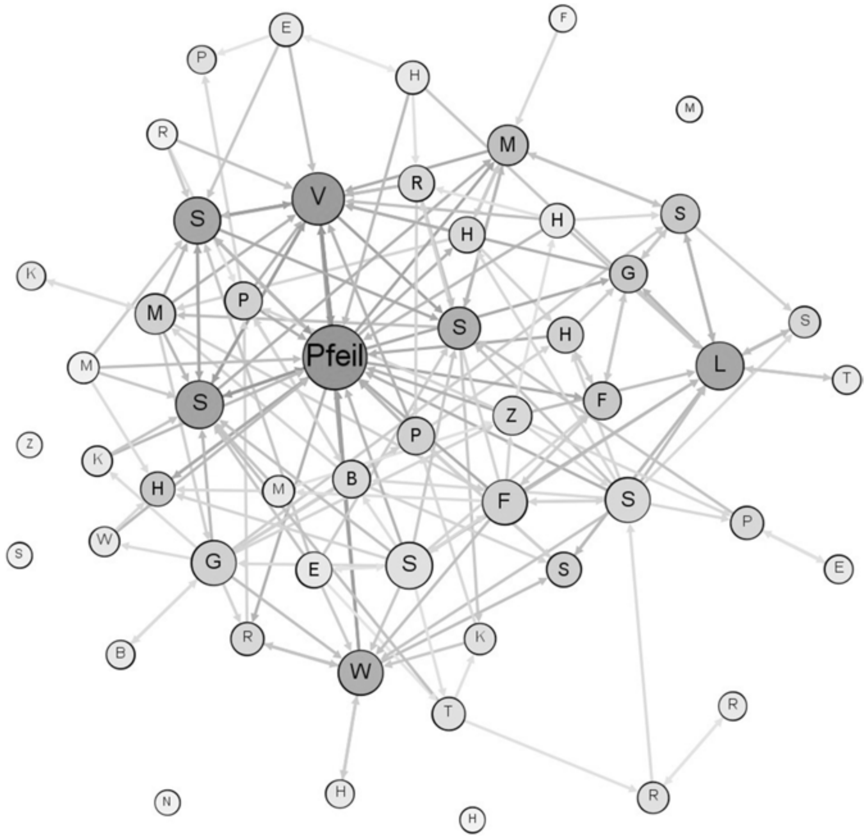

Fig. 1: Visualization of a friendship network between schoolchildren, created with Gephi. The surnames of children have, except for pupil Pfeil, been abbreviated to the first letter of their surname. The color densities indicate the number of gestures of friendship Delitsch observed; the arrows show whether the friendship was reciprocated or not reciprocated. 2019. © Thomas Durlacher.

3.3 The pitfalls of computational methods

Of course, digital (or computational) methods are not without their issues. So, what are some of these problematic features? I want to outline two such features which are especially relevant for the epistemic function of digital methods in the research process. The first concerns the plasticity of computational representations. Once data are in a machine-readable binary format it is easy to make changes to them and manipulate them. The way we visualize and represent something with the help of a computer, although it can be expressed explicitly, is also prone to being modified. This has to do with the flexibility of a computer as a universal computing machine.[35] In the examples I mentioned in Sections 3.1 and 3.2 it is easy to see that the careless interpretation of the output of computational methods could undermine the usefulness of the method. Personal biases, as well as a lack of understanding of what the computer is doing, magnify the problem.

The second problematic feature of computational methods I want to discuss here concerns *epistemic opacity*.[36] Computer programs often present themselves as black boxes where only the input and the output are accessible to the researcher. In the context of scientific research, this feature has been called epistemic opacity because the complex and autonomous structure of the programs used obscures the epistemic role that different program parts play. For non-epistemic tasks this is not problematic, because only the result, and not how it was generated, counts. In Section 2, I mentioned that methods and procedures can have an epistemic role. If it is not clear what is happening during a procedure then we do not know how it supports our claims. Therefore it is of great importance for historians to extend their critical methods and understand those parts of programs and algorithms that are relevant for their knowledge claims. In the context of digital hermeneutics, this task has been described as a continuous process that accompanies every step in the research process. Algorithm criticism, digital source criticism, tool criticism, interface criticism – all are part of a methodological reflective process aimed at ensuring the reliability of the methods we use.[37] In cases of novel techniques imported from other disciplines, this reflective process will be supported by experiments to reveal possible applications in the research process.

Plasticity, like epistemic opacity, is connected with the strengths of computational methods, automated processing, and rule-based representational techniques. In topic modeling, as with social network analysis, both of these features can undermine the results of our research. In the case of topic modeling, the machine learning algorithm searches for probabilities between words, but when we look at the results alone it is not immediately clear how they were generated. Important decisions have to be made by the researcher, the number of topics has to be chosen, and parameters configured. This makes the topic modeling method

35 Johannes Lenhard, *Calculated Surprises: A Philosophy of Computer Simulation* (New York: Oxford University Press, 2019), 10.

36 Humphreys, *Extending Ourselves*, 147.

37 Andreas Fickers, "Update für die Hermeneutik. Geschichtswissenschaft auf dem Weg zur digitalen Forensik?," *Zeithistorische Forschungen – Studies in Contemporary History* 17, no. 1 (2020): 157–68.

susceptible to being fitted toward a preferred outcome. To a certain degree, this may be true for all methods, but the novelty and lack of well-established standards is especially worrisome in the case of computational methods which have not been used in historical research before.

When it comes to social network analysis, these problems mainly appear in the ways in which networks are visualized. Automated algorithms are often used to bring networks into a visually appealing form. Here too, the way the network is presented often remains a mystery to the user. One way to counteract such problems is to reverse engineer the results and try to independently confirm that an outcome is meaningful and not just the artifact of an algorithm.[38] This requires time and resources but is of great epistemic importance with regard to the role that methods play in the research process.

4 Conclusion

Methods play a central role in academic research. Because of their importance, reflection on methods and their evaluation – from the perspective of historians as well as those collaborating with them – is critical to ensure that research is a systematic enterprise. For history, this is important for its internal, as well as its public, accountability. The evaluation of methods depends crucially on the goals those methods are directed toward, which are themselves part of an intricate web of goals and values in a discipline. A lower-level goal like the representation of a social network, or the automated detection of topics in a text corpus, does not always fit into the web of the higher-level goals of a research project or, on an even higher level, a discipline. When a research project is, for example, purely focused on individuals, it has to be argued how or whether these methods, usually aimed at the analysis of macrostructures, will contribute to the purpose of the project. Some hints of how this is possible have been given in Sections 3.1 and 3.2. Of course, the evaluation of these methods will not always result in a positive conclusion. The introduction of new methods also needs to be accompanied by discussion and reflection on the ways these methods can be integrated into and used in a discipline. Many of the chapters collected in this volume provide examples of this process and give a good account of how such developments are currently shaping digital history.

38 Juan M. Durán and Nico Formanek, "Grounds for Trust: Essential Epistemic Opacity and Computational Reliabilism," *Minds and Machines* 28, no. 4 (2018): 645–66.

In the field of history, the most recent methodological innovations in the form of computational techniques also require the critical assessment of those methods to make sure they reliably serve the epistemic aims of historians. In the case of computational methods, I have pointed out two features of these methods that could, if ignored, undermine their epistemic function: i.e. their plasticity and epistemic opacity.

Biases, lack of understanding, and unfeasible goals can be a detriment to research. This chapter can be understood as an invitation to critically compare the methods introduced by digital history with the general aims of the historical enterprise. In this regard, the cases of topic modeling and social network analysis are intended to show how computational techniques are related to the aims of history and how they can change our representations of the past.

References

Bacon, Francis. *The New Organon*. Edited by Lisa Jardine and Michael Silverthorne. Cambridge: Cambridge University Press, [1620], 2000.

Blei, David, Andrew Ng, and Jordan Michael. "Latent Dirichlet Allocation." *Journal of Machine Learning Research* 3 (2003): 993–1022.

Bod, Rens. *A New History of the Humanities: The Search for Principles and Patterns from Antiquity to the Present*. Oxford: Oxford University Press, 2013.

Cartwright, Nancy, Stathis Psillos, and Hasok Chang. "Theories of Scientific Method: Models for the Physico-Mathematical Sciences." In *The Cambridge History of Science: The Modern Physical and Mathematical Sciences*, edited by Mary Jo Nye, 5, 21–35. Cambridge: Cambridge University Press, 2003.

Chang, Hasok. *Inventing Temperature: Measurement and Scientific Progress*. Oxford Studies in Philosophy of Science. Oxford: Oxford University Press, 2007.

Descartes, René. "Rules for the Direction of the Natural Intelligence." In *Descartes: Selected Philosophical Writings*, edited by John Cottingham, Robert Stoothoff, and Dugald Murdoch, 1–19. Cambridge: Cambridge University Press, [1701], 1999.

Dilthey, Wilhelm. *Introduction to the Human Sciences*. Edited by Rudolf Makkreel and Frithjof Rodi. Selected works I. Princeton: Princeton University Press, 1989.

Dobson, James E. *Critical Digital Humanities: The Search for a Methodology*. Urbana: University of Illinois Press, 2019.

Durán, Juan M., and Nico Formanek. "Grounds for Trust: Essential Epistemic Opacity and Computational Reliabilism." *Minds and Machines* 28, 4 (2018): 645–66.

Feyerabend, Paul. *Against Method*. 3rd edition. London: Verso, 1993.

Fickers, Andreas. "Update für die Hermeneutik. Geschichtswissenschaft auf dem Weg zur digitalen Forensik?" *Zeithistorische Forschungen – Studies in Contemporary History* 17, 1 (2020): 157–68.

Gauch, Hugh. *Scientific Method in Brief*. New York: Cambridge University Press, 2012.

Gunn, Simon, and Lucy Faire, eds. *Research Methods for History*. Edinburgh: Edinburgh University Press, 2012.
Hacking, Ian. *The Taming of Chance*. Cambridge: Cambridge University Press, 1990.
Heidler, Richard, Markus Gamper, Andreas Herz, and Florian Eßer. "Relationship Patterns in the 19th Century: The Friendship Network in a German Boys' School Class from 1880 to 1881 Revisited." *Social Networks* 37, 1 (2014): 1–13.
Hempel, Carl G. "Studies in the Logic of Confirmation." *Mind* 54, 213 (1945): 1–26.
Hockney, Susan. "The History of Humanities Computing." In *Companion to Digital Humanities*, edited by Susan Schreibman, Ray Siemens, and John Unsworth, 3–19. Oxford: Blackwell, 2004.
Humphreys, Paul. *Extending Ourselves: Computational Science, Empiricism, and Scientific Method*. New York: Oxford University Press, 2004.
Jockers, Matthew L., and Rosamond Thalken. *Text Analysis with R: For Students of Literature*. Quantitative Methods in the Humanities and Social Sciences. Cham: Springer International Publishing, 2020.
Kitcher, Philip. *In Mendel's Mirror: Philosophical Reflections on Biology*. Oxford: Oxford University Press, 2003.
Kuhn, Thomas S. *The Structure of Scientific Revolutions*. 4th edition. Chicago: The University of Chicago Press, 2012.
Latour, Bruno, and Steve Woolgar. *Laboratory Life: the Construction of Scientific Facts*. Princeton: Princeton University Press, 1979.
Lenhard, Johannes. *Calculated Surprises: A Philosophy of Computer Simulation*. New York: Oxford University Press, 2019.
Martin, Shawn. "Topic Modeling and Textual Analysis of American Scientific Journals, 1818–1922," *Current Research in Digital History* 2 (2019). https://doi.org/10.31835/crdh.2019.11.
Mathieu, Bastian, Sebastien Heymann, and Mathieu Jacomy. "Gephi: An Open Source Software for Exploring and Manipulating Networks." Paper presented at Third International Conference on Weblogs and Social Media, ICWSM 2009, San Jose, California, USA, May 17–20, 2009.
Mauch, Matthias, Robert M. MacCallum, Mark Levy, and Armand M. Leroi. "The Evolution of Popular Music: USA 1960–2010." *Royal Society Open Science* 2, 5 (2015): 1–10.
Nelson, Robert K. "Mining the Dispatch." Last modified November 2020, http://dsl.richmond.edu/dispatch/pages/home.
Nola, Robert, and Howard Sankey. *Theories of Scientific Method: An Introduction*. Stocksfield: Acumen, 2007.
Parker, Wendy S. "Model Evaluation: An Adequacy-for-Purpose View." *Philosophy of Science* 87, 3 (2020): 457–77.
Pickering, Andrew. *Constructing Quarks: A Sociological History of Particle Physics*. Chicago: University of Chicago Press, 1984.
Ritchie, Donald A. *Doing Oral History*. 3rd edition. Oxford Oral History Series. New York: Oxford University Press, 2015.
Robins, Garry. *Doing Social Network Research: Network-based Research Design for Social Scientists*. London: Sage, 2015.
Romein, Annemieke, Max Kemman, Julie Birkholz, James Baker, Michel De Gruijter, Albert Meroño-Peñuela, Thorsten Ries, Ruben Ros, and Stefania Scagliola. "State of the Field: Digital History." *History* 105, 365 (2020): 291–312.

Rüsen, Jörn. *Historik: Theorie der Geschichtswissenschaft*. Cologne: Böhlau Verlag, 2013.
Schickore, Jutta, and Friedrich Steinle. *Revisiting Discovery and Justification: Historical and Philosophical Perspectives on the Context Distinction*. Dordrecht: Springer, 2006.
Weber, Max. "Objectivity in Social Science and Social Policy." In *The Methodology of Social Sciences*, edited by Henry Finch and Edward Shils, 50–112. New York: Free Press, 1949.
Wehrheim, Lino. "Economic History Goes Digital: Topic Modeling the Journal of Economic History." *Cliometrica* 13, 1 (2019): 83–125.

II From ‘source’ to ‘data’ and back

Eva Andersen

From search to digital search

An exploration through the transnational history of psychiatry

1 Introduction

Historians are trained to critically interpret the past. To do this they are instructed in a variety of archival and writing skills, as well as critical thinking, and are taught a research workflow in which searching for primary sources, verifying their authenticity, and undertaking close reading to understand, analyze, and interpret them, are all fundamental to writing critical and comprehensive reflections of past events.

Although, for historians, search is just one aspect of their repertoire, it is a vital skill and one in which they become very efficient. Historians have always relied on this competency: searching for people (e.g. librarians and archivists) or within archive catalogs to direct them to relevant material, as well as searching or browsing through primary sources in order to find useful information. Without search, there are no sources or text passages to be read and interpreted. Of course, the term "research" itself is a derivative of the word "search."[1] In other words, search is where all historical investigations start – hence why search – as opposed to other skills of the historian such as analyzing and interpreting – is central to this chapter.

Since the advent of digital history and digital humanities in the late twentieth century, the historian's "traditional" workflow has often been juxtaposed with these "new" forms of research practices and tools. Digital history has become associated with terms such as big data, algorithms, programming languages, text mining, topic modeling, network analysis, etc. Even now, some humanities scholars can be wary of incorporating certain approaches promoted within digital humanities. They have come to associate digital history with

1 "Definition of Research," Merriam Webster, accessed September 19, 2020, https://www.merriam-webster.com/dictionary/research.

Note: Part of this chapter is based on earlier blogposts as well as a draft version of the methodology chapter of my dissertation. I want to thank Lincoln Mullen (George Mason University) and Matteo Romanello (École polytechnique fédérale de Lausanne) for their useful and constructive feedback; my colleagues at the University of Luxembourg, Maria Biryukov, Lars Wieneke, and Roman Kalyakin for the fruitful collaboration described in Section 5.2., and the Luxembourg National Research Fund (FNR) (10929115), who funded my research.

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"black boxes," uncritical research outcomes, and computational approaches that replace or downplay the defining research skills of historians. However, this does not have to be the case.

At the same time, within digital history the concept of search has become an even more crucial feature of the historian's research repertoire and workflow, especially when big data is involved. Far from supplanting historians' original research practices, digital history can provide additional or extended forms of search to aid historians in the exploration and analysis of source material. Digital tools and approaches do not have to be something utterly foreign: text mining, topic modeling, and other derivates are in essence "different species of search."[2]

In the following paragraphs I want to challenge the reader to think about how essential search is, what the benefits and drawbacks of different digital search tactics are, and what the future of digital search might involve. I draw from my own educational background as a "traditionally schooled" historian, experimenting with digital sources and tools that enable me to use digital search in order to analyze the history of psychiatry from a transnational point of view. To contextualize this, I first explain my research project, as well as the meaning of search itself. I then focus on the different stages of the historian's research process – including searching for sources in order to find material with which to answer research questions, searching for tools in order to manage the exploration of large data sets of collected sources, and searching for relevant content within our sources that will facilitate reading, analysis, and interpretation – and the importance of search in each of these.

2 Search: A means to an end

During my time as an MA history student I developed an interest in the history of psychiatry and transnational history.[3] For my PhD project I wanted to pursue these domains on a bigger scale than I had done before[4] – to leave behind any form of nationally contained histories and instead investigate how psychiatric

2 Statement by Lincoln Mullen, Associate Professor at George Masson University, online meeting June 25, 2020.

3 For a basic introduction to both these subjects see: Andrew Scull, *Madness in Civilization: A Cultural History of Insanity, from the Bible to Freud, from the Madhouse to Modern Medicine* (London: Thames & Hudson, 2015); Akira Iriye and Pierre-Yves Saunier, *The Palgrave Dictionary of Transnational History* (Basingstoke: Palgrave Macmillan, 2009).

4 Eva Andersen, "De Société de Médecine Mentale de Belgique in Transnationaal Perspectief (1869–1900)," *Belgisch Tijdschrift Voor Nieuwste Geschiedenis* XLVII, no. 4 (2017): 50–82.

knowledge had circulated throughout Europe during the nineteenth and early twentieth centuries.[5] To answer my research questions I studied the main psychiatric journal of each of five different countries – Belgium, France, the Netherlands, Germany, and the United Kingdom – between 1843 and 1925 (an 82-year period).[6] Together, these sources amounted to a substantial corpus of over 460 volumes and more than 300,000 pages to investigate.[7]

Scale is undoubtedly one of the main challenges with transnational research. Digital history, and more specifically digital search, seemed at first sight to offer easy solutions to this problem.[8] The transnational and digital turns are becoming more and more intertwined due to source digitization which facilitates virtual cross-border research, as well as the growing possibilities of the search box which make (transnational) research possible at a pace and range that was not feasible before.[9] As Putnam aptly states, "Digital search has become the unacknowledged handmaiden of transnational history."[10]

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5 Some key questions in my research are: How did the transnational sphere influence thinking about and the reception of psychiatric concepts and practices? What kinds of negotiations took place in psychiatric circles before certain information or ideas were deemed important, true, false, or even useless? Why did or didn't knowledge transfers succeed?.

6 The reason I chose these countries was mostly a pragmatic one due to my knowledge of the languages spoken in these countries, but also already being familiar to some extent with the history of psychiatry in these specific countries. The reason for choosing this timeframe was based on two parameters. Firstly, 1843 is the earliest date that an issue of one of the journals under study appeared. Then 1925 was chosen as an end date because the journals were harder to acquire in a digital format after this date. The journals under study were: *Bulletin de la Société de Médecine Mentale de Belgique* (Belgium), *Annales de la Société Medico-Psychologiques* (France), *Psychiatrische Bladen* (the Netherlands), *Allgemeine Zeitschrift für Psychiatrie und psychisch-gerichtliche Medicin* (Germany), and *Journal of Mental Science* (the United Kingdom) – although their titles have changed over time.

7 Referring to my sources as a "substantial corpus" is of course relative in terms of the amount of data that is used in other historical research, such as the newspaper Impresso project, which contains over 5,445,822 pages (see: Matteo Romanello and Maud Ehrmann, "What's in Our Corpus?," impresso blog, January 23, 2020, accessed August 2, 2021, https://impresso-project.ch/news/2020/01/23/state-corpus-january2020.html) or the amount of data that is often used in computational sciences.

8 This does not mean that transnational research did not exist before the introduction of the search box and digital repositories, but it was much more time-consuming to write and expensive to investigate, often resulting in specifically selected examples rather than trying to study a particular subject in its entirety. Lara Putnam, "The Transnational and the Text-Searchable: Digitized Sources and the Shadows They Cast," *The American Historical Review* 121, no. 2 (2016): 382–3 and 394.

9 Putnam, "The Transnational and the Text-Searchable," 377 and 380.

10 Putnam, "The Transnational and the Text-Searchable," 377.

"Search" is not an end goal; it is always a means to an end regardless of whether we are talking about search in its analog or its digital form. The former consists in most cases of skim-reading page after page until a certain title, passage, phrase, or word catches our eye – often almost as if by accident – in our search for relevant material.[11] Depending on the type of source this can also be facilitated by searching through physical tables of contents or indexes. In essence this is what can be called a top-down approach to searching, whereas digital search applies a bottom-up approach dominated by the search box.[12]

But if digital search is a bottom-up approach, doesn't that mean that it is something different from what historians are taught? Yes and no. Instead of phrases or words catching our eye as we read for hours, they now come to us almost instantaneously via digital search.[13] The reason our eyes pick up on certain passages within a source when browsing manually is because we consciously or unconsciously build a list of words in our minds around the topic we are studying. For example, to explore the use of mind-altering substances in psychiatry we would pay attention to words like alcohol, morphine, addiction, or wine. When we search digitally, we still use our same background knowledge and word lists regarding this topic, only now we enter them into a digital interface. Suddenly, digital search seems less alien.

On the other hand, there are certain aspects of digital search that we need to be careful about, although through critical reflection and transparency potential issues can be mitigated. When it comes to historical research, one of its challenges and even dangers is its seeming simplicity. We all know the search box and use it daily, either in our personal lives or for our professional activities. Most of the time we do not think about how we use it or how it works, and do not take into account the variety of ways in which digital search can trigger different or skewed results – especially arising from the many forms that search and the search box can take.[14]

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11 Regarding the difference between manual browsing and digital searching, see Bob Nicholson, "The Digital Turn," *Media History* 19, no. 1 (2013): 59–73; Hieke Huistra and Bram Mellink, "Phrasing History: Selecting Sources in Digital Repositories," *Historical Methods: A Journal of Quantitative and Interdisciplinary History* 49, no. 4 (2016): 220–9; and Adrian Bingham, "The Digitization of Newspaper Archives: Opportunities and Challenges for Historians," *Twentieth Century British History* 21, no. 2 (2010): 225–31.

12 Nicholson, "The Digital Turn," 66–7.

13 This is not to say that this is without its problems. Many scholars have warned about the loss of context in these cases and the idea that what is in fact scarce now looks prominent or abundant.

14 Tim Hitchcock, for example, has warned scholars about this on multiple occasions. See, for instance, "Lecture Tim Hitchcock – Beyond Close and Distant Reading: Recording and Interview," June 18, 2019, accessed April 13, 2021, https://www.c2dh.uni.lu/data/lecture-tim-

3 Searching for the perfect digitized source

When we apply digital search, the first phase in which we do this is while searching for relevant digital sources. This often means searching with the Google search engine to, in my case, find different journals to investigate, or do a keyword search within the digital repositories of archives and libraries.

But keyword search is more than just typing words in a search bar. Depending on the platform, a variety of options can be offered. These can include "basic" options such as introducing a date range, or placing limits on titles, genres, source types, or places of publication, as well as using Boolean operators (such as "AND," "OR," and "NOT") between keywords or using multiword expressions.[15] But there are many other forms of search: fuzzy search, proximity search, the use of wildcards and query auto-complete options.[16] These types of search can be further optimized and improved via the use of correction after the optical character recognition (OCR) process (post-OCR correction), named entity recognition, entity linking, sentiment analysis, or topic modeling.[17] Many of these more advanced features are less integrated into the interfaces of online repositories and, if they are present, are often hidden.[18]

Because we are talking about searching for and identifying digital sources for our research it is also important to reflect on the digital sources themselves as, aside from the algorithms applied in a search environment, their quality has a tremendous impact on search functionality – as well as on the displayed results we will later have at our disposal. This is as true for the initial task of locating digital sources as for the application of search tactics within sources.

The quality and accuracy of a digital source is determined by the factors that help transform the analog source into a digital version. In this regard, Owens made the accurate observation that "all digitized objects are surrogates for the originals."[19] This transformation process can be captured in three stages: scanning

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hitchcock-beyond-close-and-distant-reading-recording-and-interview ("Recording of the conference" – see especially from 13 minutes 13 seconds onward).

15 Maud Ehrmann, Estelle Bunout, and Marten Düring, "Historical Newspaper User Interfaces: A Review" (IFLA WLIC, Athens, 2019), 12, accessed June 17, 2021, http://library.ifla.org/2578/1/085-ehrmann-en.pdf.

16 Ehrmann, Bunout, and Düring, "Historical Newspaper User Interfaces," 12.

17 Ehrmann, Bunout, and Düring, "Historical Newspaper User Interfaces," 14.

18 Ehrmann, Bunout, and Düring, "Historical Newspaper User Interfaces," 12.

19 Trevor Owens, "Digital Sources & Digital Archives: The Evidentiary Basis of Digital History". User centered digital memory blog, December 5, 2021, accessed August 2, 2021, http://www.trevorowens.org/2015/12/digital-sources-digital-archives-the-evidentiary-basis-of-digital-history-draft/.

the source; optimizing the source to enable more and better search functionalities; and the online consultation or downloading of sources.

Firstly, scans can be made by high definition cameras, (semi)automatic book scanners or overhead scanners (with or without the use of a V-shaped book cradle). All make the digital version of a source somewhat disparate from its original and can lead to visual and analytical discrepancies between the original and its digital copy, as well as between digital versions. This can have a lasting impact on the different search capacities that can be integrated. The severity of this impact depends on the accuracy and completeness of a source (missing, skewed, or badly scanned pages), its readability by humans and machines, and its aesthetics and visual representation (e.g. the difference between black-and-white, grayscale, or multitone scans, or the (dis)use of thumb-removal software).[20]

In a second stage, the sources are optimized to maximize the search functionalities. The three most important processes we find here are: creating single pages out of double scanned pages, which improves the OCR accuracy; applying OCR; and applying post-OCR corrections through software. Much can be said about OCR software and protocols, but what is important to note is that (re)search with digitized sources relies tremendously on the recognition of letters and words within a corpus. When sources are not properly optimized this can lead to discrepancies between the material that can be found within digital repositories and the search hits within a source. The impact that poor scanning can have on the readability of the source by a machine (due to inaccurate OCR), but also that the source becomes almost unreadable for the researcher too, making even analog search within this digital source less efficient.

Lastly, these digital sources are stored on personal hard drives or the servers of archives and libraries and, in the case of the latter two, made accessible via an online repository. Depending on how carefully the previous steps were carried out, digital sources can be found more or less easily. There are still some online platforms that do not apply OCR when scanning their source

20 Arindam Chaudhuri et al., "Optical Character Recognition Systems," in *Optical Character Recognition Systems for Different Languages with Soft Computing*, ed. Arindam Chaudhuri et al., Studies in Fuzziness and Soft Computing, vol. 352 (Cham: Springer International Publishing, 2017), 9–41; Simon Tanner, Trevor Muñoz, and Pich Hemy Ros, "Measuring Mass Text Digitization Quality and Usefulness: Lessons Learned from Assessing the OCR Accuracy of the British Library's 19th Century Online Newspaper Archive," *D-Lib Magazine* 15, no. 7/8 (2009); Maya R. Gupta, Nathaniel P. Jacobson, and Eric K. Garcia, "OCR Binarization and Image Pre-Processing for Searching Historical Documents," *Pattern Recognition* 40, no. 2 (2007): 389–97; and Rose Holley, "How Good Can It Get?: Analysing and Improving OCR Accuracy in Large Scale Historic Newspaper Digitisation Programs," *D-Lib Magazine* 15, no. 3/4 (2009), accessed June 17, 2021, http://www.dlib.org/dlib/march09/holley/03holley.html.

material, making search possible only via the metadata (e.g. title, year) that are provided by the institution that stores them.

Due to the mass digitization of sources, different copies of a single source can be found on the internet. This becomes especially visible in repositories such as *HathiTrust* and *Archive.org* and can potentially lead to different research results, depending on the accuracy and quality of each of these copies, which in turn determine the degree of search that is possible. It is not always clear which copies are better and should be preferred over other digitized copies. There are often no clear ways to notify providers about the discrepancies that are sometimes found within a digitized source either – nor to ask them to rectify this.

This whole transformation process lays bare two important shortcomings of digitized corpora: the historian's dependence on the input and diligence of others in their search for sources, and the efficiency of search and search results. We often rely on third-party data providers such as libraries or online archives – and the companies (e.g. Google) they work with – in order to deliver and provide complete and well-scanned historical material. Where it was previously just the historian and stacks of physical sources under their control, there is now an intermediator standing between the historian and the sources in the form of those who scan and provide the material, as well as the machines used to make those scans. Of course, some mediation also takes place between the historian and the archivist, as the latter often makes a selection of which documents are preserved and which are not. Likewise, intermediation has in some cases also become less extreme. This is, for example, noticeable in the online access of archival catalogues.

4 Searching for tools: A process of trial and error

"Searching for tools" does not mean the same as searching for sources in repositories, developing search tactics, or exploring search results. Nevertheless, searching for suitable tools is important when we want to apply digital search. Many of the search functionalities mentioned earlier are also found in standalone (re)search tools. The range of possibilities, algorithms, and online and standalone tools that offer all or some of these functionalities seems almost endless.[21] However, the internal mechanisms and modi operandi of these tools

21 For a broad introductory overview see, for example: Shawn Graham, Ian Milligan, and Scott Weingart, *Exploring Big Historical Data: The Historian's Macroscope* (London: Imperial College Press, 2016).

are not always explained, or they are difficult to use and understand for inexperienced users who are unfamiliar with this multitude of search functionalities and thus not able to use them properly.

This takes us to the dreaded "black box" of the digital humanities, which can become problematic during the use of digital search if we are not transparent about – and careful and consistent with – the research practices applied. This amalgam of tools is not necessarily a one-size-fits-all solution for each and every research project, although that can be a common misconception. Below I outline some of the tools I experimented with to find a form of digital search that fitted my project and research questions, and my research workflow as a historian – a tool that was also understandable to me. Corpus linguistics, text mining, and more specifically keyword search and topic modeling, were the search practices and techniques I used to digitally search for relevant content in order to be able to analyze the circulation of psychiatric knowledge later on in my research. The search tools I explored were *Voyant Tools*, *MALLET*, *AntConc*, and *histograph*.

Voyant Tools is a "web-based reading and analysis environment for digital texts"[22] that is "designed to facilitate reading and interpretive practices for digital humanities students and scholars as well as for the general public."[23] It is an example of text mining via "simple" keyword search – but, although it has an important goal in mind, I didn't find the tool suitable for my own research.

First of all, the web application often reacted extremely slowly or crashed due to the large amount of data I had.[24] Secondly, as with many other search and explorative tools, Voyant only shows plain text versions of the data, while it could also be valuable to see the original scans next to these. Thirdly, although Voyant Tools offers 28 different ways to explore and search through a corpus, this breadth of options is overwhelming for a beginner. Furthermore, not all sub-tools allow the user to switch between the visualization and the text file. Lastly, many of the visualization options – let's call them "visual search" options – are nice to look at but, for detailed search tactics and source analysis, they will scarcely provide the researcher with the information they are looking for (Fig. 1). This is a problem very common with visualizations in the humanities, as "beautiful" graphs are often bad representations of data or easily open to misinterpretation.

22 Stéfan Sinclair and Geoffrey Rockwell, "Voyant Tools," accessed September 19, 2020, https://voyant-tools.org/.

23 Stéfan Sinclair and Geoffrey Rockwell, "About – Voyant Tools Help," accessed September 19, 2020, https://voyant-tools.org/docs/#/guide/about.

24 Although running Voyant Tools on your own computer is possible, I was not aware of this feature before I abandoned this tool.

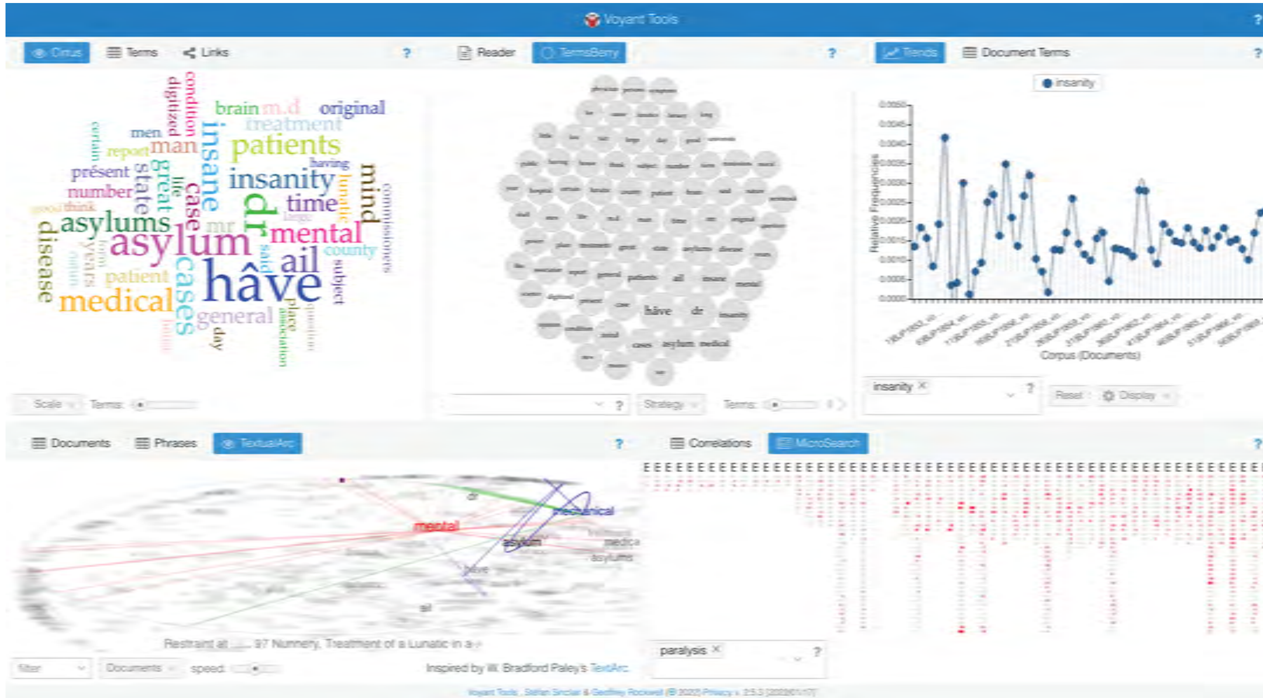

Fig. 1: Five different ways of corpus exploration in Voyant Tools: (1) a table view of terms that appear in the corpus; (2) a way to explore high frequency terms and their collocates; (3) a line graph with the distribution of a word's occurrence across a corpus; (4) a "visualization of the terms in a document that includes a weighted centroid of terms and an arc that follows the terms in document order"; and (5) a visualization of the frequency and distribution of terms in a corpus. Source: https://voyant-tools.org/. © Stéfan Sinclair and Geoffrey Rockwell (cc 2021). Data processing and visualization by Eva Andersen.

Aside from the use of keyword search, where a certain amount of background knowledge is required from the researcher, another tool that allows digital search is topic modeling. In a very simplistic manner, a computer algorithm tells the researcher which topics or subjects are present in a certain corpus. Topic modeling works as follows: a document (e.g. a book, journal issue, or article) consists of a collection of words and via a statistical process the computer classifies these words into sets of words that occur frequently together, forming different topics in the process.

One of the topic modeling tools that I briefly explored was the Topic Modeling Tool (TMT), which provides a graphical user interface (GUI) for MALLET.[25] MALLET, which is used via the command line, is a topic modeling algorithm that is very frequently used within the humanities.[26] I only conducted a few experiments with the GUI for MALLET because the tool represented a black box for me. The exact mechanics behind the algorithms and the different settings and options that could be selected and implemented were not clear to me. In cases like this especially, continuing to use this kind of search tool would have led me to make errors in my analysis and conclusions later on.

Aside from these explorations I also began to work with AntConc and histograph. Both tools were used extensively during my (re)search process. In Section 5 I highlight and explain the different digital search tactics I applied in order to show their drawbacks and benefits.

5 Applying search tactics to locate what to read

The main reason I made use of various different forms of search was to overcome the obstacle of the overabundance of source material that I had acquired. This overabundance was often problematic to my starting to perform a valuable and thorough analysis of my sources. Without computational support it was not only difficult to search for and provide answers to specific research questions but also to, for example, locate interesting and useful subjects that could serve as case studies.

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25 Jonathan Scott Enderle, "Senderle/Topic-Modeling-Tool," August 30, 2020, https://github.com/senderle/topic-modeling-tool.

26 Other functionalities include: statistical natural language processing, document classification, clustering, information extraction, and other machine learning applications to text. See: "MALLET," accessed September 19, 2020, http://mallet.cs.umass.edu/.

So how to search this goldmine of psychiatric journals? How could I harness digital search to get control over the sheer volume of my sources? These questions were a constant concern. Without a digital search tactic, I could not start to carry out this essential step of my research workflow as a historian. Without it I would not be able to close-read crucial parts of these journals for my analysis of psychiatric knowledge circulation across Europe.

Historians Damerow and Wintergrün have demonstrated the importance of having full control over a corpus even within "a digital framework" because "historical research relies on trust in its sources."[27] This trust in sources is a precarious balancing act for historians. How can we find and trace knowledge circulation in these substantial corpora? Where and how should we start distant reading, and later on close reading? How can we find relevant information for close reading? How do we zoom in and out of the material? How accurate is the output of the search tools? These were some of the challenges I faced in seeking one or multiple search tactics. As will become clear in this section, keyword search would form a major part of my research tactics but would take on different forms.

5.1 AntConc

AntConc is an off-the-shelf application developed in 2014 by Laurence Anthony.[28] Its goal is to make textual analysis and explorative research of text files easier and more manageable. The tool can create concordance tables, n-gram clusters, and collocations, among other outputs. To make my use of this tool more explicit, and to contextualize it within the scope of the transnational history of psychiatry, I framed my search exploration with AntConc around the non-restraint system that came into vogue during the nineteenth century. During this time, debates were held about the (un)suitability of using mechanical restraints such as straitjackets and iron cuffs on patients.[29] Laying bare the

27 Julia Damerow and Dirk Wintergrün, "The Hitchhiker's Guide to Data in the History of Science," *Isis* 110, no. 3 (2019): 513–21.

28 Laurence Anthony, "AntConc Homepage," accessed September 19, 2020, https://www.laurenceanthony.net/software/antconc/.

29 Some were of the opinion that this formed a necessary part of therapy, as well as a practical element necessary to keep control over a large number of patients. Others were of the opinion that this had no therapeutic value at all and that patients did not have to be confined in this manner, but instead should be able to walk around freely and allowed to enjoy the outside air, games, or working in the kitchen or gardens of the asylum.

non-restraint debate across time and space by manually combing through all the journals to search for relevant articles would have been an immensely time-consuming task. However, by using AntConc as a search tool, in combination with close reading, this became more feasible.

5.1.1 Concordance plots and the vitality of keyword lists

The main feature of AntConc that I used to search through my corpus was the concordance plot.[30] This component shows concordance results plotted in what Laurence Anthony calls a "barcode" format (Fig. 2).[31] This allows you to see the position of one or multiple search terms in different documents in an abstract representation. Each line in the barcode visualization (distant reading) is clickable and brings forward the uploaded text file for close reading, highlighting the selected keyword(s). In the case of my research about non-restraint I always worked with multiple keyword lists, as this search tactic made tracing relevant spots within the corpus (keyword clusters) easier and more consistent. Below I explain why this was the case and why it can be a useful search strategy.

The building of keyword lists proved essential with this form of text mining. As a point of departure, I used the terms "non-restraint" and "mechanical restraint," two phrases that typified the core of the debate. However, this did not capture all places where the debate was mentioned. It is important that the researcher already has some understanding of the subject at hand in order to make decisions about the terms that will be included (e.g. knowing which terms were customary). In a second stage I added other keywords that represented these restraint systems, such as "padded room" and "straitjacket."

Due to the use of corpora in multiple languages, I compiled a list of terms associated with restraint and non-restraint for each language. This was accomplished by, on the one hand, translating already-known terms to other languages, but also by alternating between distant and close reading: examination of specific sections within a source revealed variations of word use within each language. This is a strategy that has also been highlighted by Berridge et al.[32]

30 Different features are explored in more detail by my colleague Jolien Gijbels and I in the following blogpost: Jolien Gijbels and Eva Andersen, "AntConc, Historians and Their Diverging Research Methods," Digital History & Hermeneutics blog, August 11, 2020, accessed April 13, 2021, https://dhh.uni.lu/2020/08/11/antconc-historians-and-their-diverging-research-methods/.
31 See AntConc Help file at Anthony, "AntConc Homepage."
32 Alex Mold and Virginia Berridge, "Using Digitised Medical Journals in a Cross European Project on Addiction History," *Media History* 25, no. 1 (2019): 85–99.

Furthermore, I took the different spelling variations of keywords, some due to OCR mistakes, into account where possible (e.g. no restraint, no-restraint, non-restraint, non^restraint).

Compiling these keyword lists needs to be done thoroughly, as the creation of too limited or too generic or broad a list can create its own problems. Not considering one or multiple keywords can have an impact on the output results of search queries, potentially misleading the researcher. This became tangible while analyzing the German psychiatric journal. I had started out with a limited set of keywords for this particular language, due to my limited knowledge of German. But by translating some of the terms found in the other corpora while combining this with close and distant reading, relevant sections within the corpus were highlighted more distinctly and gave a more concrete image of relevant starting points for further corpus exploration (Fig. 2).

While sparse keyword lists can miss relevant spots in a corpus, the use of words that are too generic can clutter the results and create a mass of data that is not easily processed, as other research has also shown.[33] To give an example: the French word "*cellule*" could either refer to an isolation cell or human cells. The word "restraint" could refer to non-restraint, mechanical restraint, or emotional/behavioral restraint, hence why I opted to use specific words that would not be ambiguous in their use (e.g. isolation cell and *restraint absolu*). I used the same search tactic for zooming in, gathering and extracting information about the editors and editorial decisions, or references to international conferences, from the journals.

A key drawback of AntConc was that, although relevant sections became easier to spot, reading these sections was less straightforward due to its use of text files only: a representation of the source that does not correspond to the original from an aesthetic or visual point of view. Unstructured text files are not always efficiently readable for the human eye. In order to make close reading possible I was obliged to switch between AntConc's visualization, the text files, and the original PDF documents of the sources – the latter to stay as close to

33 Hinke Piersma and Kees Ribbens, "Digital Historical Research: Context, Concepts and the Need for Reflection," *BMGN – Low Countries Historical Review* 128, no. 4 (2013): 78–102; Hieke Huistra, "Experts by Experience. Lay Users as Authorities in Slimming Remedy Advertisements, 1918–1939," *BMGN – Low Countries Historical Review* 132, no. 1 (2017): 126–148; Virginia Berridge, Jennifer Walke, and Alex Mold, "From Inebriety to Addiction: Terminology and Concepts in the UK, 1860–1930," *The Social History of Alcohol and Drugs* 28, no. 1 (2014): 88–105; and Virginia Berridge et al., "Addiction in Europe, 1860s–1960s Concepts and Responses in Italy, Poland, Austria, and the United Kingdom," *Contemporary Drug Problems* 41, no. 4 (2014): 551–66.

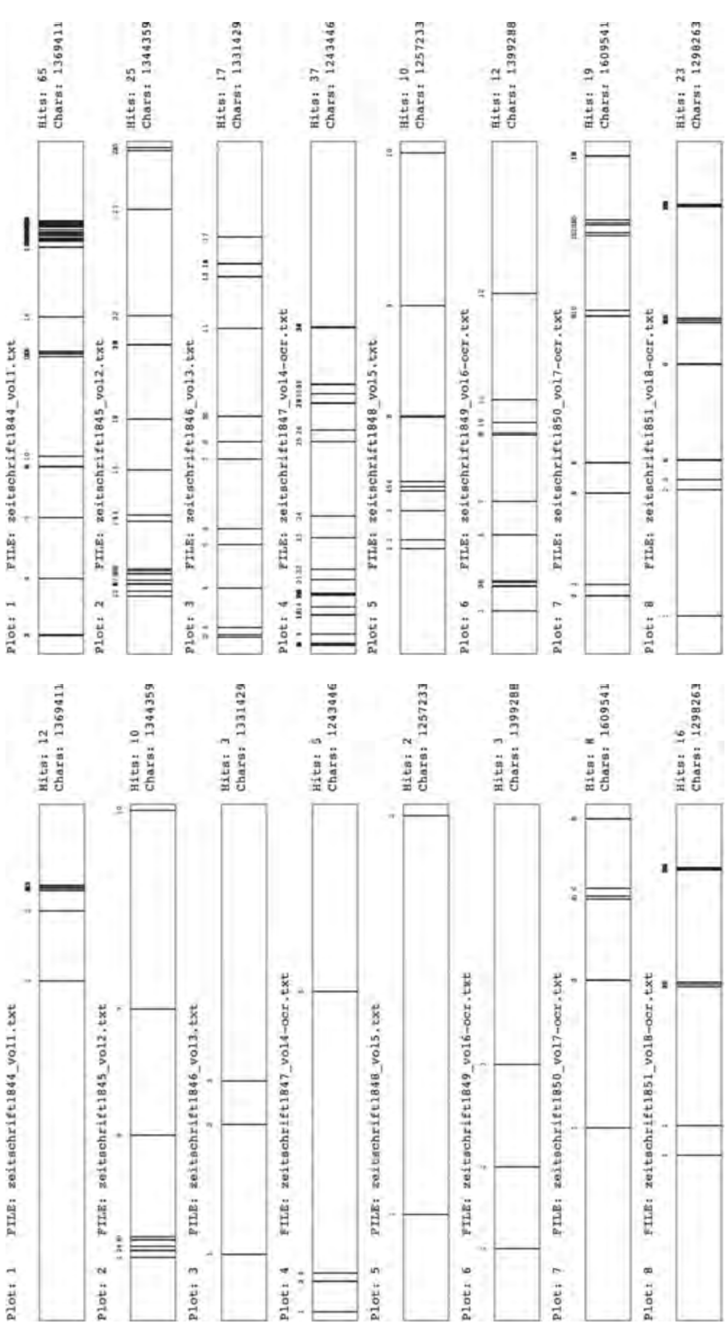

Fig. 2: Frequency distribution of words in AntConc related to non-restraint in the German *Zeitschrift für Psychiatrie*. On the left, my corpus of terms was not yet complete (e.g. it omits words related to *Zwangsmittel* and *Beschrankung*), as opposed to the image on the right with a more extended list of keywords. Notice how the number of hits and relevant places within the corpus changes. See, for example, plot 1: on the left, 12 hits; and the same plot on the right, 65 hits. 2022. © Eva Andersen.

reading the original source as possible. This was a time-consuming workflow which would be improved by using the histograph web app.

The search tactics with keyword lists used in AntConc require substantial background knowledge of a subject in order to thoroughly study it via the barcode visualization. This therefore omits many other topics that stay hidden from the researcher. Via other search tactics (e.g. topic modeling), this can be overcome to a certain extent.

5.2 Histograph

Although the use of AntConc solved some problems, the sheer volume and diversity of the corpus still posed challenges: How can a historian find and trace relevant information to analyze the evolution of specific ideas throughout large corpora? The use of off-the-shelf applications could only go so far. This stimulated a collaboration between me and my colleagues at the C^{2}DH.[34] This cooperation, which included major brainstorming sessions about data quality and inconsistently digitized corpora, as well as the nature of the research project, made sure that the search workflow could stay as close as possible to my own research process.

As a result of this collaboration I did not have to adapt to the constraints of a specific tool, as is often the case, but rather vice versa. This approach simultaneously provided me with a better understanding of the technical processes operating in the background, avoiding the black box effect. The result was a tool for corpus exploration modeled on an earlier version of histograph. Initially developed to provide "graph-based exploration and crowd-based indexation for multimedia collections," through which related documents could be discovered via filtering entities, date ranges, and document types, histograph also reveals relationships between people and keeps track of relevant documents.[35] My

34 For a more detailed excursion into the necessity of collaboration between historians and computer scientists, as well as for all technical details about the processes and algorithms used, see: Eva Andersen et al., "How to Read the 52.000 Pages of the British Journal of Psychiatry? A Collaborative Approach to Source Exploration," *Journal of Data Mining and Digital Humanities (HistoInformatics)*, 2020.

35 "Histograph," accessed January 5, 2021, http://histograph.eu/; Jasminko Novak et al., "HistoGraph: A Visualization Tool for Collaborative Analysis of Networks from Historical Social Multimedia Collections" (18th International Conference on Information Visualisation, Paris, 2014), 241–50; Lars Wieneke et al., "Building the Social Graph of the History of European Integration," in *Social Informatics*, ed. Akiyo Nadamoto et al. (Berlin, Heidelberg: Springer, 2014), 86–99; and Marten Düring, Lars Wieneke, and Vincenzo Croce, "Interactive Networks for colleagues adapted the first version of histograph to fit my particular research and sources – e.g. adding topic modeling and visualizations to maximize the search functionalities.

5.2.1 Establishing an optimal way to search content

As seen earlier, historical corpora are often unstructured and irregular due to poor OCR quality and textual errors, as well as the lack of a regular volume structure which, for example, makes the detection of individual articles within a corpus extremely difficult. Some preprocessing steps were required to make our exploration tool useful. Firstly, this included choosing a logical boundary unit – in this case, at the page level (one page = one document). Choosing this boundary also meant that the structure of the documents would be the same across the multiple corpora. A second preprocessing step involved removing stop words and maximizing the use of content-bearing pages.

Instead of relying on concordance plots, collocations or n-grams, we used topic modeling to enable more control over the corpora and the search functionality. This enabled me to discover which topics were covered in the journal, where, and to what extent – which was important for being able to select relevant parts of the corpora for close reading.

We used non-negative matrix factorization (NMF)[36] instead of the latent Dirichlet allocation (LDA)[37] that is more often used within humanities research. This approach was chosen because instead of specifying three parameters, as is the case with LDA, only two needed to be specified (the number of topics and the number of words in a list). Furthermore, when applying LDA the words per topic will change every time the program runs over a set of documents. With NMF this is not the case and thus provides better topic stability from a historical point of view, making my (re)search more consistent.

Digital Cultural Heritage Collections – Scoping the Future of HistoGraph," in *Engineering the Web in the Big Data Era*, ed. Philipp Cimiano et al. (Cham: Springer International Publishing, 2015), 613–6.

36 Daniel D. Lee and H. Sebastian Seung, "Learning the Parts of Objects by Non-Negative Matrix Factorization," *Nature* 401 (October 1999): 788–91.

37 Topic modeling (TM) was made popular in machine learning by Blei et al. via the use of LDA, one of the many different approaches to TM. Blei and others have published frequently on the use of TM and LDA. David M. Blei, Andrew Y. Ng, and Michael I. Jordan, "Latent Dirichlet Allocation," *Journal of Machine Learning Research* 3 (2003): 993–1022; David M. Blei, "Probabilistic Topic Models," *Communications of the ACM* 55, no. 4 (2012): 77–84; and David M. Blei, "Topic Modeling and Digital Humanities," *Journal of Digital Humanities* 2, no. 1 (2012).

To study psychiatric phenomena across a wide timespan my colleagues generated two kinds of topic: “window topics” – the standard calculation of X topics (where X = 10 to 20 in my case) for each year of a corpus (Fig. 3) – and “dynamic topics” – less standardized, but allowing better spotting of the development of psychiatric topics and their (vocabulary) variations through time.[38] A good example is the development of general paralysis (GP) as a psychiatric disease in the nineteenth century and its connection with syphilis, as well as with the technical developments that took place within medicine. GP was a mental disease in which patients slowly lost all mental and motor functions – including total loss of speech, writing abilities, and movement – often paired with hallucinations and dementia. No cure existed throughout the nineteenth century and for some time into the early twentieth century, until penicillin was discovered and mass produced from the 1940s. During the time period under consideration, a discussion surfaced regarding syphilis as a possible cause of GP.

Rank	1876_01	1876_02	1876_03
1	asylum	case	morphia
2	insane	brain	dose
3	patient	left	mania
4	medical	cell	injection
5	report	side	sleep
6	hospital	nerve	excitement
7	case	vessel	sedative
8	lunatic	paralysis	vomit
9	attendant	frontal	patient
10	superintendent	centre	hypodermic
11	association	general	case
12	number	part	hour
13	treatment	muscle	night
14	appoint	motor	acute
15	class	disease	effect
16	officer	convolution	subcutaneously
17	county	blood	action
18	committee	layer	drug
19	bethlem	eye	hypnotic
20	great	corpus	administer

Fig. 3: Window topic word assignment. This figure displays three topics that are present in the *British Journal of Psychiatry*, 1876. Via the words associated with each topic, a tag could easily be assigned for each subject: the first topic is about asylum management, the second is broadly related to neurology, and the third is about drugs. 2019. © Eva Andersen.

38 These dynamic topics are no longer based on the original page content but on the window topics that were created earlier. Derek Greene, “Derekgreene/Dynamic-Nmf,” September 16, 2020, accessed June 23, 2021, https://github.com/derekgreene/dynamic-nmf.

When reviewing the keywords in the dynamic topic, a couple of interesting points can be observed. First of all, the British corpus I used begins in the 1850s, while the dynamic topic indicates that the word "syphilis" in connection with GP only appears from the 1880s onwards. This tells us at a glance when the connection between GP and syphilis became more central. Secondly, the vocabulary used became more technical around the turn of the century. This is for example noticeable in the use of the words "spinal" and "wassermann." Both these terms refer to August Paul von Wassermann and his Wassermann test, which was developed to discover the presence of syphilis via the extraction of blood and/or spinal fluid.

5.2.2 Multiple ways of searching and exploring via an interface

While I found this raw topic modeling output understandable and usable, it also required my repeatedly switching between the given output and the digitized sources in order to read the content of the psychiatric journals. As with AntConc, this slowed the exploration process down considerably. This was improved by importing the topic modeling pipeline into histograph, thus creating a direct link between the topic modeling output, the digitized sources, and the textual transcription of the sources.

Making use of histograph enabled me to integrate multiple ways of searching – a necessary search strategy to explore the corpus to its fullest. As Coles et al. have said, "[. . .] distant reading visualizations cannot replace close reading, but they can direct the reader to sections that may deserve further investigation."[39] One of the many advantages that these search tactics brought to the fore was that this kind of tool can be a valuable addition to the use of more conventional methods (such as finding information only via tables of contents or indexes). Below I highlight some of the different search mechanisms that I used.

A first way to explore the corpus was via the visualization of the generated topics (Fig. 4). Based on the tone and size of the dots shown in the visualization I could observe how often a certain topic appeared over time. This was especially useful in searching for and selecting subjects (such as general paralysis) that could function as case studies for my PhD dissertation. In addition, there is the possibility to zoom in and out of this dot-visualization in order to view the pages related to a specifically selected year.

39 After Coles et al. in: Stefan Jänicke et al., "On Close and Distant Reading in Digital Humanities: A Survey and Future Challenges," in *Eurographics Conference on Visualization (EuroVis) – STARs*, ed. Rita Borgo, Fabio Ganovelli, and Ivan Viola (The Eurographics Association, 2015), 9.

Fig. 4: Dot-visualization of the different topics and their occurrence over the *British Journal of Psychiatry* corpus via color-coding and circle size in histograph. Topic labels were assigned based on my knowledge of the history of psychiatry. 2019. © University of Luxembourg, http://histograph.eu/, developed by Lars Wieneke, Marten Düring, and Daniele Guido.

Using these search approaches within histograph helped me extract relevant content, and especially to discover otherwise hidden content and "weak signals" around very distinct topics, which would not have been made visible by a manual search approach. Sometimes there were considerable discrepancies between what could be found within a table of contents and the relevant locations suggested by the system. Furthermore, histograph allowed me to find the proverbial "needle in a haystack" while I investigated a particular theme.

To come back to the example of GP: within historical research there has been quite some emphasis on physicians, alienists, and syphilographers developing a cure for this disease. However, their interest in GP entailed more than a race for a cure. Their research would take many directions and become quite diverse. Medical practitioners, for example, conducted research on the sense of smell in GP patients, the presence of peptone in urine and changes in body temperature – all of which were examined as possible indicators of the disease.[40] Although these instances are rather infrequent, they do help paint a broader picture of physicians' and alienists' interest in GP. Without the use of digital search, and more specifically the use of the above-described search tactics in histograph, these instances would have been almost impossible to trace.

A second way of searching within histograph was configured by clicking on a specific topic, for which all related pages were then displayed. Via additional keyword search these results could then be fine-tuned to my specific interests. Aside from a connection between GP and syphilis, many other potential causal links to GP were generated. To get a better grasp on these I was able to, for example, study GP and its relation to alcoholism. In this case, histograph displayed only those pages on which the words "general paralysis" and "alcoholism" appear together within the selected GP topic (Fig. 5). This facilitated the search for only relevant content within the psychiatric journals, reducing the number of pages that I needed to close read.

A third method of searching involved using "keyword mentions." One or multiple keywords were specified by me and were displayed via a bar chart at the same time, also making it possible to directly access the pages with these particular words. This proved to be a useful search tactic to study for example the presence of specific psychiatrists. One of them was the internationally renowned Belgian alienist Jules Morel. By implementing keywords with different variations of the spelling of his name (jules morel, jul. morel and j. morel) a

40 Jules Morel, "Un Nouveau Signe Diagnostiqué de la Paralysie Générale Progressive, par le Dr Marro," *Bulletin de la Société de Médecine Mentale*, no. 48 (1888): 196, http://hdl.handle.net/2027/mdp.39015070250769; and, "De la Température dans la Paralysie Générale, par F. Peterson," *Bulletin de la Société de Médecine Mentale*, no. 71 (1893): 468.

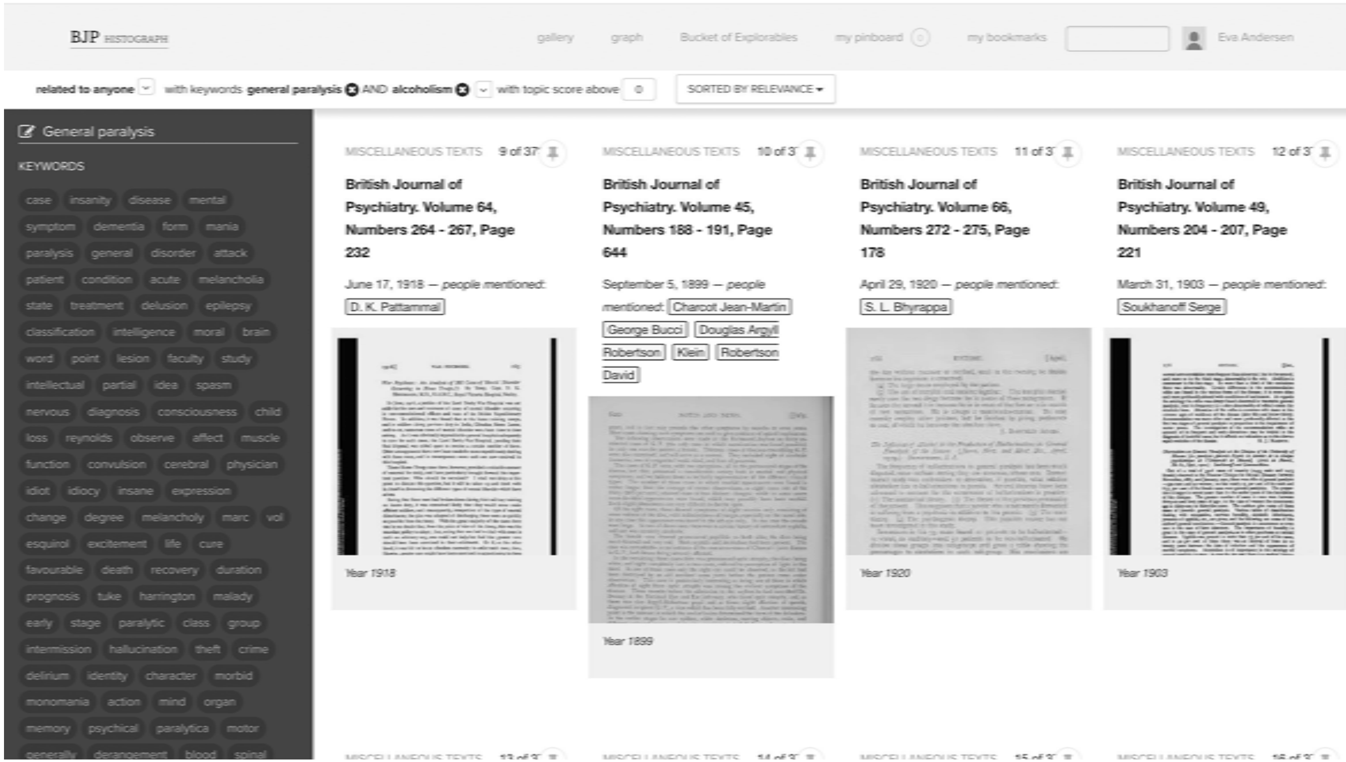

Fig. 5: A histograph results page showing, within the topic “General paralysis,” the additional keywords “general paralysis” and “alcoholism” (top left), and their corresponding pages (center). 2019. © University of Luxembourg, http://histograph.eu/, developed by Lars Wieneke, Marten Düring, and Daniele Guido.

straightforward overview of his name's occurrence within the British psychiatric journal was generated, which created a basis for more in-depth exploration.

Via the use of these different layers and its accompanying search tactics, I had the opportunity to be more precise, as well as flexible about what I wanted to investigate. During my research process I have used these layers for different purposes, ranging from the discovery of relevant study subjects via topic modeling, to the discovery and fine-tuning of my already-selected case studies via "keyword mentions." These examples are of course also traceable in a similar fashion through tools such as AntConc or Voyant Tools which, to a certain extent, use similar mechanisms. However, with histograph, due to the incorporation of different search strategies as well as its more "natural" visualization of the sources, the research process was improved and accelerated.

6 Conclusion: Digital search as an extension of the historian's workflow

One of the first tasks in the historian's research workflow is "search." This is where all historical research begins and it is one of many skills that historians are proficient in. However, within the scope of my PhD project researching the dissemination of psychiatric knowledge across the nineteenth and early twentieth centuries, it became apparent that using only an analog search approach, either for finding my sources (psychiatric journals) or gathering all relevant text fragments within my sources, would not be sufficient as a tactic. This is where digital search became a central aspect of my research workflow.

An implied question that runs throughout this chapter is in how far the historian's skill in analog or traditional search is (dis)similar to that of digital search, and whether the latter undermines the former. This cannot be answered with a simple yes or no answer. Firstly, in essence, analog search and digital search are not that different: their common factor being keywords. Furthermore, analog search often remains present – whether consciously or unconsciously – within the boundaries of digital search. With digital search we are directed to potentially relevant sections within a source. But as historians we will always investigate these specific pages in more detail. It is within this process of close reading specific sections that we (un)consciously apply traditional search. If we, for example, were being directed to a section about non-restraint via a digital keywords search, our eye might be caught (just as in analog search) by certain other words or phrases that may be relevant and which could help to fine-tune our search tactics.

However, this does not mean that we do not need to be aware of some aspects that make digital search disparate from analog search. This awareness starts with the realization that the ways in which one can digitally search (including keyword search, fuzzy search, topic modeling, time range selection, etc.) are far more extensive than when we talk about analog search. In addition, not every project or research question benefits from the same search tactics – and refining our search approach is a process that often involves trial and error.

Secondly, digitization, including the multiple functionalities of the search box, "[. . .] opens shortcuts that enable ignorance as well as knowledge."[41] We need to be aware of the pitfalls that can await the historian when applying digital search. The impact on search possibilities and strategies can be quite tremendous and starts with the digitization of sources. From the scanning machines and scan settings used, through the choice of OCR software and its accuracy, to the source's document format – all have an impact on which search tools the historian can ultimately use.

Thirdly, after locating our digital sources and deciding on our search tools, there comes the problem of developing one or multiple search tactics. Because the information that the historian is looking for is often complex it is better to make use of multiple search tactics. Diverse search functionalities can help us reassess our existing knowledge of particular topoi within history more easily, and can also lead us to discover new or forgotten subjects of interest. Of course, each search function comes with its own opportunities and drawbacks. However, I think that as long as we try to fully understand these functions and be transparent about how we use them – not forgetting to combine distant and close reading – using multiple approaches to digital search can contribute to many realms of historical research, including my own fields of transnational and psychiatric history.

The question now is whether the many technologies available to assist us in searching and gathering information can also enable us to absorb information faster (e.g. speeding up information processing).[42] The effort needed to interpret and close read texts on past events takes time. While the action of interpreting has not sped up as rapidly as technological innovations – we are just human after all – I do think that using digital search tools can speed up certain parts of the search process, as well as the further exploration and analysis of

41 Putnam, "The Transnational and the Text-Searchable," 379.

42 Lara Putnam, "Daily Life and Digital Reach: Place-Based Research and History's Transnational Turn," in *Theorizing Fieldwork in the Humanities: Methods, Reflections, and Approaches to the Global South*, ed. Shalini Puri and Debra A. Castillo (New York: Palgrave Macmillan, 2016), 174.

sources. This is especially true when either looking for specific information in a large volume of data (that elusive needle in a haystack) or wanting to investigate large amounts of data over multiple years and corpora.

With this in mind, I also want to briefly highlight a couple of interesting avenues that still need to be explored in relation to overcoming some of the limitations that digital search currently experiences. Further research efforts need to be invested in topic modeling across languages, making dynamic and cross-lingual explorations possible. When it comes to transnational knowledge exchange, cross-lingual exploration might be one of the most significant approaches that could help researchers discover patterns of exchange over a wide geographical region. Another area that merits further exploration relates to aspects such as the expansion of keyword lists, the use of word embeddings for historical corpora and the use of word co-occurrences – since a researcher never can be aware of all historical variations of certain terms or all their misspellings.

One of the key reasons that we need to continue developing digital search techniques and interfaces is precisely because search is such an essential element within a historian's research practices. Digital search stands closer to, and is more of a continuity of, analog historical scholarship than many often think. Historians do not need to give up on their ways of practicing history via close reading – rather, the option of digital search can function as an extension of already-existing practices.

References

Andersen, Eva. "De Société de Médecine Mentale de Belgique in Transnationaal Perspectief (1869–1900)." *Belgisch Tijdschrift Voor Nieuwste Geschiedenis* XLVII, 4 (2017): 50–82.

Andersen, Eva et al., "How to Read the 52.000 Pages of the British Journal of Psychiatry? A Collaborative Approach to Source Exploration." *Journal of Data Mining and Digital Humanities (HistoInformatics)*, 2020. Accessed June 17, 2021. https://hal.archives-ouvertes.fr/hal-02463141v4.

Anthony, Laurence. "AntConc Homepage." Accessed June 17, 2021. https://www.laurenceanthony.net/software/antconc/.

Berridge, Virginia et al. "Addiction in Europe, 1860s–1960s Concepts and Responses in Italy, Poland, Austria, and the United Kingdom." *Contemporary Drug Problems* 41, 4 (2014): 551–66.

Berridge, Virginia, Jennifer Walke, and Alex Mold. "From Inebriety to Addiction: Terminology and Concepts in the UK, 1860–1930." *The Social History of Alcohol and Drugs* 28, 1 (2014): 88–105.

Bingham, Adrian. “The Digitization of Newspaper Archives: Opportunities and Challenges for Historians.” *Twentieth Century British History* 21, 2 (2010): 225–31.

Blei, David M. “Probabilistic Topic Models.” *Communications of the ACM* 55, 4 (2012): 77–84.

Blei, David M. “Topic Modeling and Digital Humanities.” *Journal of Digital Humanities* 2, 1 (2012). Accessed June 17, 2021. http://journalofdigitalhumanities.org/2-1/topic-modeling-anddigitalhumanitiesby-david-m-blei/.

Blei, David M., Andrew Y. Ng, and Michael I. Jordan. “Latent Dirichlet Allocation.” *Journal of Machine Learning Research* 3 (2003): 993–1022.

Chaudhuri, Arindam et al. “Optical Character Recognition Systems.” In *Optical Character Recognition Systems for Different Languages with Soft Computing*, edited by Arindam Chaudhuri, Krupa Mandaviya, Pratixa Badelia, and Soumya K Ghosh, 352: 9–41. Studies in Fuzziness and Soft Computing. Cham: Springer International Publishing, 2017.

Damerow, Julia, and Dirk Wintergrün. “The Hitchhiker’s Guide to Data in the History of Science.” *Isis* 110, 3 (2019): 513–21.

Düring, Marten, Lars Wieneke, and Vincenzo Croce. “Interactive Networks for Digital Cultural Heritage Collections – Scoping the Future of HistoGraph.” In *Engineering the Web in the Big Data Era*, edited by Philipp Cimiano, Flavius Frasincar, Geert-Jan Houben, and Daniel Schwabe, 613–16. Cham: Springer International Publishing, 2015.

Ehrmann, Maud, Estelle Bunout, and Marten Düring. “Historical Newspaper User Interfaces: A Review.” Athens, 2019. Accessed June 17, 2021. http://library.ifla.org/2578/1/085-ehrmann-en.pdf.

Enderle, Jonathan Scott. “Senderle/Topic-Modeling-Tool,” 2020. Accessed June 23, 2021. https://github.com/senderle/topic-modeling-tool.

Gijbels, Jolien, and Eva Andersen. “AntConc, Historians and Their Diverging Research Methods.” Digital History & Hermeneutics blog, 2020. Accessed June 23, 2021. https://dhh.uni.lu/2020/08/11/antconc-historians-and-their-diverging-research-methods/.

Graham, Shawn, Ian Milligan, and Scott Weingart. *Exploring Big Historical Data: The Historian’s Macroscope*. London: Imperial College Press, 2016.

Greene, Derek. “Derekgreene/Dynamic-Nmf,” September 16, 2020. Accessed June 23, 2021. https://github.com/derekgreene/dynamic-nmf.

Gupta, Maya R., Nathaniel P. Jacobson, and Eric K. Garcia. “OCR Binarization and Image Pre-Processing for Searching Historical Documents.” *Pattern Recognition* 40, 2 (2007): 389–97.

Histograph. “Histograph”. By University of Luxembourg. Accessed January 5, 2021. http://histograph.eu/.

Hitchcock, Tim. “Beyond Close and Distant Reading: Recording and Interview”, June 18, 2019. Accessed June 17, 2021. https://www.c2dh.uni.lu/data/lecture-tim-hitchcock-beyond-close-and-distant-reading-recording-and-interview.

Holley, Rose. “How Good Can It Get?: Analysing and Improving OCR Accuracy in Large Scale Historic Newspaper Digitisation Programs.” *D-Lib Magazine* 15, 3/4 (2009). Accessed June 17, 2021. http://www.dlib.org/dlib/march09/holley/03holley.html.

Huistra, Hieke. “Experts by Experience. Lay Users as Authorities in Slimming Remedy Advertisements, 1918–1939.” *BMGN – Low Countries Historical Review* 132, 1 (2017): 126–48.

Huistra, Hieke, and Bram Mellink. “Phrasing History: Selecting Sources in Digital Repositories.” *Historical Methods: A Journal of Quantitative and Interdisciplinary History* 49, 4 (2016): 220–29.

Iriye, Akira, and Pierre-Yves Saunier. *The Palgrave Dictionary of Transnational History*. Basingstoke: Palgrave Macmillan, 2009.
Jänicke, Stefan et al. "On Close and Distant Reading in Digital Humanities: A Survey and Future Challenges." In *Eurographics Conference on Visualization (EuroVis) – STARs*, edited by Rita Borgo, Fabio Ganovelli, and Ivan Viola. The Eurographics Association, 2015. Accessed June 17, 2021. https://diglib.eg.org/handle/10.2312/eurovisstar.20151113.083-103.
Lee, Daniel D., and H. Sebastian Seung. "Learning the Parts of Objects by Non-Negative Matrix Factorization." *Nature* 401 (October 1999): 788–91.
MALLET. Open source software platform. "*MALLET*." Accessed September 19, 2020. http://mallet.cs.umass.edu/.
Merriam Webster. "Definition of Research." Accessed September 19, 2020. https://www.merriam-webster.com/dictionary/research.
Mold, Alex, and Virginia Berridge. "Using Digitised Medical Journals in a Cross European Project on Addiction History." *Media History* 25, 1 (2019): 85–99.
Morel, Jules. "Un Nouveau Signe Diagnostiqué de la Paralysie Générale Progressive, par le Dr Marro," *Bulletin de la Société de Médecine Mentale*, 48 (1888): 196. Accessed June 17, 2021. http://hdl.handle.net/2027/mdp.39015070250769.
Nicholson, Bob. "The Digital Turn." *Media History* 19, 1 (2013): 59–73.
Novak, Jasminko et al., "HistoGraph: A Visualization Tool for Collaborative Analysis of Networks from Historical Social Multimedia Collections," 241–50. Paper presented at the 18th International Conference on Information Visualisation, Paris, July 16–18, 2014.
Owens, Trevor. "Digital Sources & Digital Archives: The Evidentiary Basis of Digital History". User centered digital memory blog, December 5, 2021. Accessed June 17, 2021. http://www.trevorowens.org/2015/12/digital-sources-digital-archives-the-evidentiary-basis-of-digital-history-draft/.
Piersma, Hinke, and Kees Ribbens. "Digital Historical Research: Context, Concepts and the Need for Reflection." *BMGN – Low Countries Historical Review* 128, 4 (2013): 78–102.
Putnam, Lara. "Daily Life and Digital Reach: Place-Based Research and History's Transnational Turn." In *Theorizing Fieldwork in the Humanities: Methods, Reflections, and Approaches to the Global South*, edited by Shalini Puri and Debra A. Castillo. New York: Palgrave Macmillan, 2016.
Putnam, Lara. "The Transnational and the Text-Searchable: Digitized Sources and the Shadows They Cast." *The American Historical Review* 121, 2 (2016): 377–402.
Romanello, Matteo, and Maud Ehrmann. "What's in Our Corpus?" impresso blog, January 23, 2020. Accessed June 17, 2021. https://impresso-project.ch/news/2020/01/23/state-corpus-january2020.html.
S.N. "De la Température dans la Paralysie Générale, par F. Peterson," *Bulletin de la Société de Médecine Mentale*, 71 (1893): 468. Accessed June 17, 2021. https://books.google.be/books?id=sd4vAQAAMAAJ&pg=PP5#v=onepage&q&f=false.
Scull, Andrew. *Madness in Civilization: A Cultural History of Insanity, from the Bible to Freud, from the Madhouse to Modern Medicine*. London: Thames & Hudson, 2015.
Sinclair, Stéfan, and Geoffrey Rockwell. "About – Voyant Tools Help." Accessed September 19, 2020. https://voyant-tools.org/docs/#/guide/about.
Sinclair, Stéfan. "Voyant Tools." Accessed September 19, 2020. https://voyant-tools.org/.

Tanner, Simon, Trevor Muñoz, and Pich Hemy Ros. "Measuring Mass Text Digitization Quality and Usefulness: Lessons Learned from Assessing the OCR Accuracy of the British Library's 19th Century Online Newspaper Archive." *D-Lib Magazine* 15, 7/8 (2009). Accessed June 17, 2021. http://www.dlib.org/dlib/july09/munoz/07munoz.html.

Wieneke, Lars et al., "Building the Social Graph of the History of European Integration." In *Social Informatics*, edited by Akiyo Nadamoto, Adam Jatowt, Adam Wierzbicki, and Jochen L. Leidner, 86–99. Berlin, Heidelberg: Springer, 2014.

Sam Mersch

The hybridity of living sources

Hermeneutics and source criticism in modern place name studies

1 Introduction

> Learning to know the neighbourhood requires the identification of significant localities, such as street corners and architectural landmarks, within the neighbourhood space. Objects and places are centers of value.[1]

Space is a central element in human cognition as it envelops all our being, actions, and conceptions. From real and lived space to invented and metaphorical space, it is a constant in human cognition.[2] As space constantly surrounds any human civilization, its perception and classification are key elements of navigating that space, either in reality, or cognitively.[3] As language in its broadest sense needs a certain consensus of common knowledge and reference, so too does language that references space.[4] This can either occur through a lengthy and hard-to-follow description by an interlocutor or, as is much more common for a space coinhabited by a community of people, by place names, also called toponyms. The notion of *place name* conveys exactly the specifics of the object or area being referred to, i.e. names for specific places.[5] Places that can be referred to in names include

1 Yi-fu Tuan, *Space and Place. The Perspective of Experience* (Minneapolis: University of Minnesota Press, 1977), 17–8.

2 William Ittelson et al., *An Introduction to Environmental Psychology* (New York: Holt, Rinehart and Winston, 1974), 98–100; Michael Maurer, *Kulturgeschichte* (Cologne: Böhlau, 2008), 177–83; and Kenny Coventry, "Space," in *Cognitive Linguistics. Key Topics*, ed. Ewa Dabrowska and Dagmar Divjak (Berlin: De Gruyter, 2019), 44–51.

3 Martin Thiering, *Kognitive Semantik und Kognitive Anthropologie* (Berlin: De Gruyter, 2018), 93–101.

4 Maurer, *Kulturgeschichte*, 69–72; Bryan Lawson, *The Language of Space* (Oxford: Architectural Press, 2005), 15–38; Joel Kameron, "Experimental Studies of Environment Perception," in *Environment and Cognition*, ed. William Ittelson (New York: Seminar Press, 1973), 165–7; Coventry, "Space," 44–5; and Thiering, *Kognitive Semantik*, 156–60, 208–10.

5 There is an ongoing discussion of the specificities and demarcation of place names, be they settlement names, rural names, or others, which would exceed the limits of what would be

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geomorphological elevations, specific houses, trees, or agricultural areas, and even crossroads and former settlements. In this chapter I analyze those names as a source in general, without focusing on specific names, apart from a couple of illustrative examples.

The base data are those that I amassed for my PhD research on the toponomastic landscape of Luxembourg and its potential for compiling a linguistic history of the Luxembourgish language. In place name data, the focus ison names of unsettled (or formerly settled) places – so-called *anoikonyms* or rural names.[6] However, for simplicity, the term *place name*, specifically denoting such rural names, will be used in this chapter.

In place name studies, the term *hybridity* is usually used when referring to names whose morphological structure exhibits elements that can be traced to multiple (and different) language varieties.[7] However, this phenomenon is rather specific to settlement names (so-called *oikonyms* or names of currently settled places), rather than rural names. Furthermore, it represents only a very small aspect of the hybrid nature of place names. This chapter does not dwell on this general notion of hybrid names, nor does it really focus on hybrid practices or the need for them in general.[8] The focus lies rather on the hybridity of the source, with a slight nod to such hybrid practices in digital humanities research, while

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pragmatic and productive for this chapter. Hence the discussion can be followed via, for example, Rob Rentenaar, "Mikrotoponymie aus nordwestgermanischer Sicht. Einige Bemerkungen zur Definition und Terminologie," in *Mikrotoponyme. Jenaer Symposion, 1. und 2. Oktober 2009*, ed. Eckhard Meineke and Heinrich Tiefenbach (Heidelberg: Universitätsverlag Winter, 2011), 197–205; Teodolius Witkowski, "Probleme der Terminologie," in *Namenforschung. Ein internationales Handbuch zur Onomastik*, ed. Ernst Eichler et al., vol. 1 (Berlin: Mouton de Gruyter, 1995), 288–294; and Erika Windberger-Heidenkummer, *Mikrotoponyme im sozialen und kommunikativen Kontext. Flurnamen im Gerichtsbezirk Neumarkt in der Steiermark* (Frankfurt am Main: Peter Lang, 2001), 102–5.

6 See Friedhelm Debus, *Namenkunde und Namengeschichte. Eine Einführung* (Berlin: Erich Schmidt Verlag, 2012), 138; and Julia Kuhn, "Rural Names," in *The Oxford Handbook of Names and Naming*, ed. Carole Hough (Oxford: Oxford University Press, 2018), 135–6.

7 See Gillian Fellows-Jensen, "Names and History," in *The Oxford Handbook of Names and Naming*, ed. Carole Hough (Oxford: Oxford University Press, 2018), 516–7, 523; and Berit Sandnes, "Names and Language Contact," in *The Oxford Handbook of Names and Naming*, ed. Carole Hough (Oxford: Oxford University Press, 2018), 542, 548–9.

8 For the notion of hybrid practices and the hybrid nature of digital humanities on the examples of digital history see Andreas Fickers, "Hermeneutics of in-betweenness: digital public history as hybrid practice," in *Handbook of Digital Public History*, ed. Serge Noiret, Mark Tebeau, and Gerben Zaagsma (Berlin: De Gruyter, 2022 (forthcoming)) graciously provided by the author as a preprint; and Gerben Zaagsma, "On Digital History," *bmgn – Low Countries Historical Review* 128, no. 4 (2013): 3–29.

concentrating on the similarities of the analog and the digital when concerned with place name studies.

I analyze the types of source that exhibit such place name data on their hermeneutic potential, primarily by an external source criticism that balances the hybridity of the source itself and its provenance or textualization. I compare analog and digital processes to get insights into common problems that both exhibit, and some of the advantages of one over the other, and take internal source criticism into account when demonstrating specific provenance issues of the sources. However, information structure hermeneutics and linguistic hermeneutics are omitted, as are hermeneutics of another nature.

2 The hybridity of the source

2.1 The place name as a source

Rural names as place names do not exist as singular instances. Although every place name is a unique linguistic identifier of a given place, that name only exists in the naming system which is used to reference all relevant space for cultural interaction.[9] The scope of influence of the naming systems can vary but, typically, it is more or less limited to the speaker or user culture that uses the microspace that is named: the latter is roughly equivalent to the people living in a nearby settlement.[10] In the past, when life was rather more bound to locality, place names were more actively in use by the user culture(s), but had less widespread use.

Places can be ranked according to their respective informative values in space, and these rankings also relate directly to the place names and how they are used.[11] The further away a place is that is still referred to in a speaker culture, the more important the place and its name are, in general. This also means that

9 Peter Anreiter, *Zur Methodik der Namendeutung. Mit Beispielen aus dem Tiroler Raum* (Innsbruck: Verlag des Instituts für Sprachwissenschaft der Universität Innsbruck, 1997), 145; David Mills, *Oxford Dictionary of British Place Names* (Oxford: Oxford University Press, 2003), xi; and Vincent Blanár, *Theorie des Eigennamens* (Hildesheim: Olms, 2001), 60–2.

10 Erika Windberger-Heidenkummer, “Kontinuität und Diskontinuität von Flurnamen. Probleme und Beispiele,” in *Mikrotoponyme. Jenaer Symposion, 1. und 2. Oktober 2009*, ed. Eckhard Meineke and Heinrich Tiefenbach (Heidelberg: Universitätsverlag Winter, 2011), 290–1.

11 See Maurer, *Kulturgeschichte*, 165; and Willy Van Langendonck and Mark Van de Velde, “Names and Grammar,” in *The Oxford Handbook of Names and Naming*, ed. Carole Hough (Oxford: Oxford University Press, 2018), 33–4.

individual very important places and their names have a much wider audience. In fact, the closer but less important the place (in a global sense), the smaller the influence on speakers in general. Rural names as place names occupy the least influential slot in this hierarchy, as they are closely bound to very small local spaces, important only to a settlement area and its inhabitants.

These place names have always been used for local narratives, for location in space, when referring to the known space of a settlement.[12] Hence, they are often used for some sort of legal demarcation of the boundaries of larger areas such as settlements, communes, or rural districts.[13] Even though speakers of a language can shape names in a similar fashion, resulting in some onomastic overlap in different geographical areas, the use of a place name while referring to a specific place is always unique.

Rural names are essentially a very informal and oral onomastic category – and they derive their usability through multigenerational tradition. When a name is handed down from generation to generation the human-nature relationship is expressed by the name allotted to a place.[14] This can either be on perceptional grounds, how the community sees and interprets a landscape, or on interactional grounds, how the community has manipulated a landscape in order to make it more profitable to them. Since such uses and perceptions mainly remained unchanged, the names often did, too.[15] It is only when a place does not fulfill its cultural role any more that it is abandoned – however, its

12 For the notion of place names as narratives see Thiering, *Kognitive Semantik*, 321–2; Terhi Ainiala, "Identifying Places and Discussing Names: the Use of Toponyms in a conversation," in *Challenges in Synchronic Toponymy. Défis de la toponymie synchronique: Structure, Context and Use. Structures, contextes et usages*, ed. Jonas Löfström and Betina Schnabel-Le Corre (Tübingen: Francke, 2015), 33–46; and Giovanni Agresti and Silvia Pallini, "Vers une toponymie narrative. Récits auto-biographiques et ancrages géographiques dans deux villages de la Haute Vallée du Vomano (Italie)," in *Challenges in Synchronic Toponymy. Défis de la toponymie synchronique: Structure, Context and Use. Structures, contextes et usages*, ed. Jonas Löfström and Betina Schnabel-Le Corre (Tübingen: Francke, 2015), 21–32.

13 As can be seen from multiple narratives in Luxembourgish deeds, such as the *Weisthum von Besch* from 1541 or the *Weisthum von Beaufort* from 1557. See Mathias Hardt, ed., *Luxemburger Weisthümer. Als Nachlese zu Jacob Grimm's Weisthümern* (Luxembourg: Bück, 1868), 62–5 and 91–100.

14 Maurer, *Kulturgeschichte*, 174–5; Sandnes, "Names and Language Contact," 549; see also Ellen Bramwell, "Personal Names and Anthropology," in *The Oxford Handbook of Names and Naming*, ed. Carole Hough (Oxford: Oxford University Press, 2018), 275–6; and Alison Grant, "Names and Lexicography," in *The Oxford Handbook of Names and Naming*, ed. Carole Hough (Oxford: Oxford University Press, 2018), 575.

15 Blanár, *Theorie*, 20–3.

name, having become part of local tradition, often remains. Hence, such names can still be used to refer to space as a human cultural and cognitive expression.

When a place name no longer reflects its initial setting – when the human relationship with the landscape described is abandoned – the name becomes a source for historical information. Thanks to their close link to the land, place names can offer us a multitude of indications of different strata of information on how human culture has used and shaped a landscape. These strata include environmental interference (such as the creation of agriculturally fertile areas of land through draining wetlands or as in the medieval deforestation), as much as information on agriculture (what crops were grown where), and also on other areas such as legal history (when names refer to legal agricultural districts or frontiers), or language history (offering insight into everyday language beyond evidence from the administrative jargon in historic deeds).

2.2 The living and the petrified

The documentation of place names in general, and in Luxembourg particularly, is quite varied. As these names refer to specific places, they can be mentioned in early property deeds when land plots are concerned. The names are specifically mentioned in such cases because they were legally binding. It was only the place names that made it possible to refer to and identify a place in such documents. Even though the names are no longer legally binding they are still mentioned as a reference point, through tradition. Some of these mentions date back over a millennium, such as that for *heliberc* (meaning "healing mountain") in 902,[16] this being modern-day Helperknapp, located just west of the geographical center of the modern Grand Duchy. It is named as such due to the still recognized legend of a healing well at the top of a hill, that mentions the visits of Charlemagne,[17] and Willibrordus, the Northumbrian missionary saint[18] – but has a

16 Maurits Gysseling, Tom Jozef de Herdt, and Jozef van Loon, *Toponymisch Woor- denboek van België, Nederland, Luxemburg, Noord-Frankrijk en West-Duitsland, (vóór 1226)* (Brussels: Belgisch interuniversitair centrum voor Neerlandistiek, 1960), 471.

17 Nicolas Gredt, *Sagenschatz des Luxemburger Landes. Vollständig durchgesehene und überarbeitete Neuausgabe unter Einbindung des Registerbandes von A. Jacoby, J. Dumont, L. Senninger und H. Rinnen erstellten Registers* (Luxembourg: Institut Grand-Ducal – Section de Linguistique, d'Ethnologie et d'Onomastique, 2005), 66.

18 See Hartmann Melzer and Otto Wimmer, *Lexikon der Namen und Heiligen* (Hamburg: Nikol, 2002), 857–8.

much older history.[19] The narrative regarding Willibrordus is still recognized each Pentecost with a yearly procession to the hilltop. The oral name tradition is still very active, with many place names having been spawned with the linguistic motif of that hill – all relaying the idea of a procession to the mountain. But only the hill itself has been mentioned in historic documents and, apart from two tenth century mentions, only from the fifteenth century onward.[20]

Most place names, however, only experienced solely oral transmission until the nineteenth century, and were only written down when the first land registries emerged.[21] This cataloging was begun in Luxembourg in 1795, by the *Département des forêts*, when Luxembourg was still under French occupation, and was finished in the second half of the nineteenth century.[22] This constituted the first emergence of a quantitatively relevant collection of place names for Luxembourg and later became the basis for the modern place name database of the *Administration du cadastre et de la topographie* (the Luxembourg land registry or cadastral office). The names became binding once they were written down, which means that in any official documentation the name would emerge in the exact form of the land registry entry. This of course creates a few specific problems, the first being the way these names were collected.

When a name is written down in a distorted form and then becomes official, it does not reflect the name and language use at the given place. Technically, this is not an issue when the "unofficial" names are in frequent use, and an official name and its dynamic form can coexist side by side. However, after World War II, with less of the population being employed in the agrarian sector, much of the local landscape knowledge, including place name knowledge, was lost.[23] It was the knowledge about the true local name as it was spoken that was lost,

19 André Schoellen, "Zeugenberg Helperknapp. Neue archäologische Erkenntisse zu dieser herausragenden Fundstelle," *Nos Cahiers* 34, no. 3 (2013): 207–21.

20 Denise Besch, *Vu villa bis Weiler, vu fréier bis haut: Suffixe der Luxemburger Ortsnamen* (Luxembourg: Institut Grand-Ducal – Section de Linguistique, d'Ethnologie et d'Onomastique, 2018), 248; and Joseph Meyers, *Studien zur Siedlungsgeschichte Luxemburgs*, 3rd ed. (Luxembourg: Krippler et cie, 1976), 108.

21 Debus, *Namenkunde*, 141.

22 Alphonse Eyschen, "Das luxemburgische Kataster. Sein Ursprung, seine Entwicklung bis zum heutigen Tag. Vergleich mit den Katasern der beiden Beneluxpartner," *Tijdschrift voor Kadaster en Landmeetkunde* 74, no. 3 (1958): 151–7; and Administration du cadastre et de la topographie, *Dates de l'achèvement des plans-minutes*, copy of a typewritten notice summarizing the dates of the establishment of the first land registries, Administration du cadastre et de la topographie, Luxembourg.

23 See also Damaris Nübling, Fabian Fahlbusch, and Rita Heuser, *Namen. Eine Einführung in die Onomastik* (Tübingen: Narr, 2015), 239.

together with its possible link to the landscape. The form that was written down persists, "petrified" in whichever way it was originally documented. Hence, the potentially distorted forms can also serve as a basis for place name knowledge for a population that does not possess this traditional knowledge any more, and thus the petrified names, written down for economic purposes, also function as a linguistic and cultural marker of place again. There is still a need to reference space in a cultural landscape. In Luxembourg, for example, many of these place names still fulfill their original purpose of referring to space – even though a lot of the knowledge was initially lost – with older place names used when naming bus and tram stops, and also serving in a name-giving function as new industrial and real estate landscapes are created. The petrified forms are thus revived and continue to function as a living source, even though this is a distorted image of the original.

Place names constitute a living and constantly used source. The loss of oral tradition is only problematic when the written documentation distorts the name's identity, with some misinterpretations of a name leading to a distortion of past cultural identity too. An example of this would be for the name originally spelled *Horekaul* – literally a hollow, sometimes flooded, used in linen production. The first word is etymologically connected to the word "hair", as in the threads woven into cloth. However, the agent writing down the name for the land survey seemingly did not know this specific cultural background and wrote the name down as *Hurenkaul*, literally interpreting it as "well of the whores."[24] Such clearly misinterpreted names, however, are not that common. More often, names have been handed down orally for such a long time before they were ever documented, that the original cultural knowledge reflected in a place name has been lost due to cultural changes. An example of this is the place name *Verluerekascht*, which occurs in many places, but is best known in Luxembourg City (in the Bonnevoie district). The name initially hints at the ruins of a derelict castle, its literal meaning being "lost castle." But later on, when the link to the castle was no longer culturally relevant, it was reinterpreted as a place of "lost food," which is also hinted at in the earliest land registry documentation due to its German translation as *Verloren Kost*.[25]

24 See Pierre Anen, *Luxemburgs Flurnamen und Flurgeschichte* (Luxembourg: Sankt Paulus Druckerei, 1945), 23.

25 It is not clear if the reinterpretation had already occurred prior to the documentation in the first land registry or was a result of it. However, the wide dispersal of the name, as well as the regular development of the Latin *castellum* into the Luxembourgish *Kascht*, and the homophony with the Luxembourgish *Kascht* "food," suggests that the reinterpretation occurred prior to the first documentation, as the error seems to be widespread in many German forms of the name.

Place names are difficult to put into historiographical source categories. The oral character of place names shows both of the characteristics of the traditional historiographic division into *tradition* and *remnant*.[26] The oral knowledge of place names served the specific purpose of portraying space, and maintaining and sharing that knowledge within the community, thus making it clearly part of the tradition category, as it was an intentional means of conserving the knowledge, be it only in oral tradition.[27] However, when the name is preserved, but not the cultural link it initially portrayed, it is in fact a remnant, as the initial goal of creating the name was not to archive knowledge in case it got lost or forgotten.[28] The documentation of oral names, however, has the clear goal of preserving information – making it part of the tradition branch of source categorization – even though the documentation was not originally intended to preserve the initial knowledge, which was the reference in space itself. This reference was only documented in order to link to the cultural conception of place, so as to be able to link ownership with space and hence tax revenues. The documents then inadvertently become remnants because they convey information about past cultural events, linguistic history, identity, and other cultural influences, without that having been intention.

In the end, the only seriously detrimental outcome of the loss of the oral tradition is when no documentation exists at all, resulting in absolute loss of knowledge, which of course cannot be documented or scientifically evaluated in any form.

3 External source criticism of Luxembourgish place names

3.1 Hybrid provenances

The initially oral character of place names has already been mentioned above but, when it comes to provenance, there is not really much that can be said. As discussed, the names do not exist by themselves, but only in collections of all place names as a reference for the cognitive impression of space in a specific community. And as names themselves are a linguistic expression, they also

26 As in the German coining of *Tradition* and *Überrest* by Ahasver von Brandt, *Werkzeug des Historikers. Eine Einführung in die historischen Hilfswissenschaften* (Stuttgart: Kohlhammer, 1966), 58–75.
27 Von Brandt, *Werkzeug des Historikers*, 71–4.
28 Von Brandt, *Werkzeug des Historikers*, 66–71.

adhere to linguistic rules. While a person can try to coin a word or a name for a specific purpose, the usefulness of that linguistic instance is only proven if somebody else can interpret it and put it into linguistic relation. Language is a communication system and hence is the common reference of place names. Thus, it is not really possible to pinpoint a specific inventor or author of a name, as the existence of the name is strictly linked to its broad acceptance. Technically, that means that authorship of a name lies with the wider speaker (or user) culture, even when a single specific person invented it first. The name is only valid when it is accepted as a semiotic entity in multiuser communication. Given this situation and the oral tradition, it is rarely possible to narrow the authorship down further than to a specific speaker group, possibly a dialectal subvariety. However, this narrowing down is already part of internal source criticism, as is the relative chronology of the names, which often has to be constructed via linguistic methodology, specifically the historical comparative method – thus it will not be discussed further here.[29]

Even though place names are essentially an oral (and living) source, they are mostly only tangible for science purposes when documented in writing. Retracing their provenance (and transmission history) can broadly be split into two categories: textual and digital.

In place name research, textual provenances exhibit the same problems as any other material or textual sources. Apart from the first land registries, or possibly an early rural map, older instances of place names can only be found in legal deeds. As such, the place name has to be considered using the same criteria of source criticism as the deed – i.e. What material was the deed written on? Who wrote it? For what purpose? and When? However, there is one key element that needs to be distinguished. Regarding the deed itself, the parties involved have rather to be looked upon within the scope of internal source criticism, i.e. by considering the textual evidence. For the name, that evidence would be the exact graphematic transcription of the name (an aspect not discussed in this chapter). However, there are a few other key data that need to be evaluated as part of the *external* source criticism. First comes the issue of where the places are to be located. Place names are used to refer to space, so the narrative of the space is very much part of the external criteria for the precise allocation of the

29 I am preparing a full overview of hermeneutical aspects and source criticism concerning Luxembourgish place names, including internal source criticism, especially linguistic hermeneutics, as part of my PhD thesis.

names. A place name can only be truly analyzed if its whereabouts are known.[30] More important is the *why*. This is not the same as for the deed itself, as in why the contents of this document were written down, but rather why these names in particular were used. When a specific plot of land is mentioned by name as the object of a transaction, this makes answering that question relatively easy. When, however, place names are used to refer in space – meaning to give a pathway, as for example regarding where a legal frontier is to be located – the correspondence is different. Why were these names chosen and not others? Were they more important or better known? Were there only that many names or is this just a selection of a few? Who chose the names to be used as reference markers? The general scope of external source criticism is the same as for internal criticism, but the details differ.

There is one general map for Luxembourg from the eighteenth century that covers all of the modern Grand Duchy's rural terrain. It is the so-called Ferraris map that covered, among other areas, the old duchies of Luxembourg and Limburg.[31] It is the oldest map of Luxembourg that covers all rural areas and it also exhibits a few hundred place names. The who, what, and where are generally well known. It is a military map[32] covering the Austrian Netherlands, which was started circa 1770 and finished by 1778, under the supervision of Count Joseph de

30 The occurrence of a place name in a deed does not guarantee its exact location, which is sometimes needed to discern the meaning of the name. When looking at the *Weisthum von Beaufort (1557)*, we can identify a place name *Weigerwiesz*, which at first glance seems to denote a possessive relation of a pasture plot – see Matias Hardt, ed. *Luxemburger Weisthümer. Als Nachlese zu Jacob Grimm's Weisthümern*, 64. The place cannot be located as such today. However, the modern land registry files offer a place called *Weiherwies* in the village of Beaufort, which is located in the vicinity of a river. This leaves the conclusion that the "g" of the name from the deed was in fact not pronounced (or only very slightly) and that there is no personal name to be identified with it (and hence no possessive relation), but rather the lexeme *Weier*, which denotes a pond. See Ministère de la Culture, ed., "LOD," 2007, s.v. *Weier*, accessed August 31, 2020, http://lod.lu (hereafter cited as LOD). Hence, the identification of an exact place through the digitally available modern data helps in discerning the etymology of a place. See also geoportail.lu, "Zoom in on place name *Weiherwies* in Beaufort," accessed August 31, 2020, https://map.geoportail.lu/theme/main?lang=fr&version=3&zoom=18&X=698408&Y=6415761&layers=320&opacities=1&bgLayer=basemap_2015_global.

31 For more information, see geopunt.be, "Metadata – Ferraris kaart – Kabinetskaart der Oostenrijkse Nederlanden en het Prinsbisdom Luik, 1771–1778," accessed May 6, 2020, https://metadata.geopunt.be/zoekdienst/apps/tabsearch/.?uuid=2d7382ea-d25c-4fe5-9196-b7ebf2dbe352. A digital edition of limited resolution can also be accessed – see Bibliothèque royale, Koninklijke Bibliotheek en. "Ferraris map," accessed August 31, 2020, https://www.kbr.be/en/the-ferraris-map/.

32 This is a map consisting of 275 separate sheets.

Ferraris.[33] It is important to note the fact that, as a military map, it was supposed to highlight the military potential of the landscape – and, as with all maps used in onomastic research, needs the right kind of scrutiny.[34] The latter also reflects the choice of the place names that were selected for the map.[35]

Most place names, however, are to be found in place name collections, including land surveys by cadastral offices and private collections. For the study of Luxembourgish toponymy, there are two major collections that exhibit different characteristics in how they were collected.

The most important collection for Luxembourg is that of the national cadastral office. The way in which the names in this collection were documented has been described above. However, a key feature that needs to be highlighted here is that, in the case of the Luxembourg's early land registries, both the names of the surveyors and the years of their surveys are known.[36] The original (textual) land registries also sometimes give an indication of the people who provided information for specific surveys. What they do not record is the name of the persons collating the surveys over time; neither is there detailed documentation of copies or the variations in these copies, some of which may be errors, some perhaps legitimate changes. The most important hermeneutical insight regarding this source is linked with the digitization of the cadastral offices that occurred in Luxembourg in the 1980s.[37] Here the source underwent a technical transformation of the media that it used. The handwritten registries still exist as archival material but the land registry database itself was converted into a digital format, which is mostly concerned with geographical and geomorphological data, but also records place names. As far as is known, however, there is no

33 See Malte Helfer, "Ferraris-Karte (1771–1777)," 2008, accessed 6 May 2020, https://gr-atlas.uni.lu/index.php/de/articles/ge57/fe102. Little is known about the original surveyors who delivered the handwritten surveys containing the geomorphological data for the map.

34 Anreiter, *Zur Methodik der Namendeutung. Mit Beispielen aus dem Tiroler Raum*, 57.

35 Most names refer to natural resources useful for a traveling battalion, such as forests. Others refer to favorable geomorphology, as in names of mountains to navigate or hide in, as well as hiding places like valleys that were easy to defend. A few also render the usefulness of the land, mentioning land plots used annually for specific staple crops.

36 See Administration du cadastre et de la topographie, ed., *Administration du cadastre et de la topographie, Grand-Duché de Luxembourg. Cinquantenaire 1945–1995*, (Luxembourg: Service information et presse du gouvernement, 1996), 13–6; and Administration du cadastre et de la topographie, *Dates*. The names of the surveyors were always mentioned on the cadastral maps drawn up, most of which are accessible via geoportail.lu, "Urplang JPG 400," accessed May 6, 2020, https://map.geoportail.lu/urplang/JPG_400/.

37 Administration du cadastre et de la topographie, *Cinquantenaire*, 61.

documentation on what transitions were made, except for the institution of the initial systems and some broad administrative choices.[38] Nor is there information on the identity of the specific users who maintained and changed the data. As a land registry is a living source, with plots being changed from time to time, this also leads to the loss or creation of some names – but, as far as is known, there is no equivalent of the "Wayback Machine" that has tracked all the changes made within the different systems and software versions used since digitization.[39] No need seemed to have arisen to establish a detailed documentation of the technical exploits and renderings of the data, nor to publish it in an open setting, which is quite indicative, given that the cadastral office is the most prolific data contributor on Luxembourg's national open data portal.[40] A methodological description of the technical aspects and changes seems either not to have been deemed necessary or, perhaps, feasible – with too many changes having occurred in the last four decades when it comes to technical innovation in computing. However, land registries are not an exception per se, as such transitions and subsequent changes have been successfully documented in many sectors, both public and private.

Another very important collection of place names for Luxembourg is that of the Institut Grand-Ducal – Section de linguistique, d'onomastique et d'ethnologie, which offers initial oral fieldwork data, together with official land registry correspondences. The collection itself has mostly been lost, with just a few pages having been rediscovered in 2019. From these originals, it was possible to discern that the oral survey was undertaken via official channels, with local district commissioners gathering both cadastral and oral names from the mayors of all communes in the year 1935. There is no indication as to why and on whose orders this collection took place, with the original directive being untraceable for now. A complete version of the collection does exist in the form of a copy though – this is the printout of a database file created by a former member of the institute. The source database file has, unfortunately, been lost. The creator of the file, now a nonagenarian, has not been able to give a detailed account of its documentation and can only remember some of the processes involved – although he maintains that the print-

38 Administration du cadastre et de la topographie, *Cinquantenaire*, 61–2.

39 However, ArcGIS, one of the most widespread software implementations of geographical information systems, is (or at least was in 2018) apparently also used by the Luxembourg cadastral office.

40 See Data.public.lu. Luxembourg data platform, "Data Sets." By the Government of the Grand Duchy of Luxembourg, accessed May 6, 2020, https://data.public.lu/fr/datasets/.

out was not generated by him and exhibits some false data entry.[41] Upon comparison to certain originals, it can be established that about a third of the printout contains duplicate entries that are not found in the original manuscripts. Although the database creator asserts that he transmitted every place name instance into the database, after close scrutiny of the remaining originals, it can be estimated that about 5% of the original entries were not transferred. This data source lacks complete documentation with many discrepancies of provenance, textual changes, and redundant entries and the loss of most of the original data. Even though the data represented in this source are highly interesting – and though they represent the only dataset that contains a quantitatively relevant amount of place names in local vernacular – the source still needs to be closely scrutinized due to its problematic provenance.

3.2 Misspelled and wrongly encoded

Despite the hybrid provenance of Luxembourgish place name sources, there are still quite a few areas that are common to both analog and digital sources, specifically regarding textual mistakes occurring due to external factors.

When a scribe misspelled a name in historic deeds, the information that was supposed to be contained in the document was accidently distorted.[42] When that name was then copied in this distorted form, the misspelling became tradition and changed the perception and reference of that name.[43] When there is no oral evidence to veto this minute distortion it becomes strengthened and generalized, and the identity of the place name is permanently changed.

The same is the case with non-analog approaches. As seen above, the cadastral office in Luxembourg switched to digital systems in the 1980s. This meant that all place names were digitized by typing them in manually. Human error always occurs, whether data is handwritten or typed into a computer, but the potential problem lies in the level of trust placed in the veracity of the

41 It is unclear what implications this assertion has for the veracity of the data and its provenance, as the creator did not specify further even after repeated enquiries.

42 Karin Schneider, *Paläographie und Handschriftenkunde für Germanisten. Eine Einführung* (Berlin: de Gruyter, 2014), 149–51.

43 A good example is found in the official, non-Luxembourgish forms for the name *Luxembourg*, where the "x" is actually the result of a phonemic misinterpretation from the seventeenth century, and it should be read as an /s/ not /ks/, as in the name *Brussels*, French *Bruxelles*. See Christian Kollmann, "Woher kommt das x in Luxemburg?," *Beiträge zur Namenforschung* 46, no. 2 (2011): 165–210.

computer data. An important issue here relates to the boundaries of text formatting at the time. The first Unicode character chart was only devised in the late 1980s, while the earlier American Standard Code for Information Interchange (ASCII) was originally developed in the 1960s and was widely dispersed even in countries that used a very different writing system or typography, than did American English. For the study of Luxembourgish place names specifically, this means that certain characters in the Luxembourgish alphabet could not be displayed, out of sheer technical impossibility. This has a lot of repercussions, as for example with the lack of diacritics or any non-ASCII characters. Taking the Luxembourgish word for forest, i.e. *Bësch*, this was often transcribed in the first land registry as *Büsch*. When the land registry was digitized, something had to be done about the diacritic shown as ‹ü›. So, on occasion, forest was spelled *Buesch* – the ‹ue› being a common way to represent the vowel ‹ü› in German[44] – or the graphematic difference was simply omitted, making it *Busch*. This may not seem hugely significant but, from a linguistic standpoint, the origin of the form changes depending on whether the name is written with a ‹ü/ue› or a ‹u›. The effect was that the name became distorted. In many cases, the distortion was kept, making it the official form of that name.[45]

A similar issue can be seen in the copy of the Institut Grand-Ducal's collection. The problems of this source's provenance have already been discussed, but less so the presentation of the names in this copy. The names are shown here in capital letters only, except for the diacritic forms. The full capitalization is of course already a form of distortion, not relaying the true graphematic image of the original – but it is one that can generally be ignored, as it does not produce distortions per se. However, in some cases, diacritics from the originals seem to have been ignored and not rendered in any form, resulting in the same distortion as discussed for the cadastral data. It has to be kept in mind that this file was created in 1990 (at least according to the title allotted to the collection) and that Unicode compatibility was not yet widespread then. The author of the lost digital file that preceded the printed collection was able to code some diacritic characters which, incidentally, were never capitalized. The diacritics do not seem to mirror the originals though, as can be seen from the few remnants that still exist in the archive of the Institut Grand-Ducal. The author had therefore used an unknown, undocumented encoding system, while ignoring some

44 See Schneider, *Paläographie*, 94–5.

45 This discrepancy could only be revealed due to an official data file, established separately by former cadastral officials, now residing at the cadastral office and generously made available to me.

graphematic features and changing others. These discrepancies can only be identified where there are corresponding originals in existence.

The analog and the digital are also comparable as regards mistakes made by interpretation. A scribe might have transcribed a name accurately, but the reader or copyist might have misinterpreted a sign or character and copied it wrongly. This can, of course, also occur when copying from analog to digital but, in the end, it constitutes the same kind of human error. However, it is different when encoding systems come into play. As has already been hinted at, such systems changed during the advancement of computing. The transfer from one such system to another could result in misalignments, creating different forms, as can be seen in the place name *GonneschwÅnkel*, for example.[46] The character ‹Å› does not exist in Luxembourgish or any language varieties in its vicinity and is supposed to mark a diacriticized ‹e›, possibly ‹é›. Misinterpretations can thus occur due to human error or, in this case, computer error.

3.3 Analog vs. digital – the lack of documentation

Lack of documentation is a serious issue for both analog and digital sources, as seen above. With analog documents, the older they are, the less problematic this often seems, as they generally contain far less data – especially when compared to the vast quantity of digital data that exists, be that digitized, born digital or, as in the case of the cadastral office, a hybrid form that is part digitized, part born digital. The fast-growing and ever-changing digital landscape makes the need for documentation even more pressing for any historian or linguist, or indeed for any researcher using data that can be used in an historical analysis.

This fast pace of change enabled by digital methods and tools also exhibits a higher risk of, or potential for, data loss. Permanent changes that are not documented can lead to irreversible loss of information, which could be catastrophic. The loss or absence of data, however, is something inherent to historiographical work, but it is the quantity of data handled and possibly lost that is the key difference of modern day born digital and traditional sources.

Version control will be the most important heuristic feature to the onomastician (historian and linguist alike) using born digital or hybrid digital sources, if their analysis is to be able to extend beyond just the final product. There is a tendency in modern historiography to write not only a historical narrative of the facts, but also of the intermediate steps, as well as the motivations exerted

46 This place is located in Bissen, a village in the middle of the Grand Duchy.

and decisions taken by any agents involved in the process. By doing so, a kind of cultural and workflow history can be established, something that has not yet been attempted on a global scale.

4 For the future (synthesis)

In discussing specific sources for place name studies in Luxembourg, it can be maintained that key issues subsist in both analog and (born) digital sources, as well as those sources that started out as analog, were digitized and then enhanced digitally. I have made a case for the hybridity of place name sources, starting from the initial oral character of place names as a source and their function in a cultural environment. I highlighted the issues and methodological problems that arise when writing down and preserving these names, as well as the living nature of some of these sources.

Provenance studies of sources, whether those sources analog or digital, always suffer from the same key issues regarding lack of information. When the documentation of a source is not complete – or is totally lacking – the ability to assess the provenance of a source, along with all the intermediate steps that might have changed that source, is severely hindered.

Although the key aspects are the same for the external criticism of both analog and digital sources, the pace of possible and actual changes effected in the digital realm makes these source types more complicated, or at least more laborious, to deal with. When external source criticism comes to a standstill because of a lack of documentation the use of internal source criticism might be the only way to further examine the origin of a source, be it analog or digital.

When archival practices remain focused solely on the preservation of a final document – failing to record the intermediate steps and changes the document has experienced, nor to archive the software tools previously used with it – the study of provenance will always be unsatisfying. Even though it may be argued that the software itself that is, or was, used by an institution is not their property to archive, at the very least the recording of a coherent and consistent software version history should be considered a must for the future historian. After all, the end result or product is only one facet of the source, a facet that cannot by itself convey all the changes, decisions, or problems that that document has encountered over its lifetime.

References

Administration du cadastre et de la topographie, ed. *Administration du cadastre et de la topographie, Grand-Duché de Luxembourg. Cinquantenaire 1945–1995*. Luxembourg: Service information et presse du gouvernement, 1996.

Agresti, Giovanni, and Silvia Pallini. "Vers une toponymie narrative. Récits auto-biographiques et ancrages géographiques dans deux villages de la Haute Vallée du Vomano (Italie)." In *Challenges in Synchronic Toponymy. Défis de la toponymie synchronique: Structure, Context and Use. Structures, contextes et usages*, edited by Jonas Löfström and Betina Schnabel-Le Corre, 21–32. Tübingen: Francke, 2015.

Ainiala, Terhi. "Identifying Places and Discussing Names: the Use of Toponyms in a conversation." In *Challenges in Synchronic Toponymy. Défis de la toponymie synchronique: Structure, Context and Use. Structures, contextes et usages*, edited by Jonas Löfström and Betina Schnabel-Le Corre, 33–46. Tübingen: Francke, 2015.

Anen, Pierre. *Luxemburgs Flurnamen und Flurgeschichte*. Luxembourg: Sankt Paulus Druckerei, 1945.

Anreiter, Peter. *Zur Methodik der Namendeutung. Mit Beispielen aus dem Tiroler Raum*. Innsbruck: Verlag des Instituts für Sprachwissenschaft der Universität Innsbruck, 1997.

Besch, Denise. *Vu villa bis Weiler, vu fréier bis haut: Suffixe der Luxemburger Ortsnamen*. Luxembourg: Institut Grand-Ducal – Section de Linguistique, d'Ethnologie et d'Onomastique, 2018.

Bibliothèque royale, Koninklijke Bibliotheek en. "Ferraris map." Accessed August 31, 2020. https://www.kbr.be/en/the-ferraris-map/.

Blanár, Vincent. *Theorie des Eigennamens*. Hildesheim: Olms, 2001.

Bramwell, Ellen. "Personal Names and Anthropology." In *The Oxford Handbook of Names and Naming*, edited by Carole Hough, 263–278. Oxford: Oxford University Press, 2018.

Brandt, Ahasver von. *Werkzeug des Historikers. Eine Einführung in die historischen Hilfswissenschaften*. Stuttgart: Kohlhammer, 1966.

Coventry, Kenny. "Space." In *Cognitive Linguistics. Key Topics*, edited by Ewa Dabrowska and Dagmar Divjak, 44–65. Berlin: De Gruyter, 2019.

Dates de l'achèvement des plans-minutes. Copy of a typewritten notice summarising the dates of the establishment of the first land registries. Administration du cadastre et de la topographie, Luxembourg.

Data.public.lu. Luxembourg data platform. "Data Sets." By the Government of the Grand Duchy of Luxembourg. Accessed May 6, 2020. https://data.public.lu/fr/datasets/.

Debus, Friedhelm. *Namenkunde und Namengeschichte. Eine Einführung*. Berlin: Erich Schmidt Verlag, 2012.

Eyschen, Alphonse. "Das luxemburgische Kataster. Sein Ursprung, seine Entwicklung bis zum heutigen Tag. Vergleich mit den Katasern der beiden Beneluxpartner." *Tijdschrift voor Kadaster en Landmeetkunde* 74, 3 (1958): 151–81.

Fellows-Jensen, Gillian. "Names and History." In *The Oxford Handbook of Names and Naming*, edited by Carole Hough, 513–24. Oxford: Oxford University Press, 2018.

Fickers, Andreas. "Hermeneutics of in-betweenness: digital public history as hybrid practice." In *Handbook of Digital Public History*, edited by Serge Noiret, Mark Tebeau, and Gerben Zaagsma. Berlin: De Gruyter, (forthcoming).

geoportail.lu. “Urplang JPG 400.” Accessed May 6, 2020. https://map.geoportail.lu/urplang/JPG_400/.
geoportail.lu. “Zoom in on place name *Weiherwies* in Beaufort.” Accessed August 31, 2020. https://map.geoportail.lu/theme/main?lang=fr&version=3&zoom=18&X=698408&Y=6415761&layers=320&opacities=1&bgLayer=basemap_2015_global.
geopunt.be. “Metadata – Ferraris kaart – Kabinetskaart der Oostenrijkse Nederlanden en het Prinsbisdom Luik, 1771–1778.” Accessed May 6, 2020. https://metadata.geopunt.be/.
Grant, Alison. “Names and Lexicography.” In *The Oxford Handbook of Names and Naming*, edited by Carole Hough, 572–84. Oxford: Oxford University Press, 2018.
Gredt, Nicolas. *Sagenschatz des Luxemburger Landes. Vollständig durchgesehene und überarbeitete Neuausgabe unter Einbindung des von A. Jacoby, J. Dumont, L. Senninger und H. Rinnen erstellten Registers*. Luxembourg: Institut Grand-Ducal – Section de Linguistique, d’Ethnologie et d’Onomastique, 2005.
Gysseling, Maurits, Tom Jozef de Herdt, and Jozef van Loon. “*Toponymisch Woordenboek van België, Nederland, Luxemburg, Noord-Frankrijk en West-Duitsland, (vóór 1226)*.” Brussel: Belgisch interuniversitair centrum voor Neerlandistiek, 1960. Accessed June 17, 2021. https://bouwstoffen.kantl.be/tw/.
Hardt, Mathias, ed. *Luxemburger Weisthümer. Als Nachlese zu Jacob Grimm’s Weisthümern*. Luxembourg: Bück, 1868.
Helfer, Malte. “Ferraris-Karte (1771–1777).” 2008. Accessed May 6, 2020. https://gr-atlas.uni.lu/index.php/de/articles/ge57/fe102.
Ittelson, William et al., *An Introduction to Environmental Psychology*. New York: Holt, Rinehart and Winston, 1974.
Kameron, Joel. “Experimental Studies of Environment Perception.” In *Environment and Cognition*, edited by William Ittelson, 157–80. New York: Seminar Press, 1973.
Kollmann, Christian. “Woher kommt das x in Luxemburg?” *Beiträge zur Namenforschung* 46, 2 (2011): 165–210.
Kuhn, Julia. “Rural Names.” In *The Oxford Handbook of Names and Naming*, edited by Carole Hough, 135–43. Oxford: Oxford University Press, 2018.
Lawson, Bryan. *The Language of Space*. Oxford: Architectural Press, 2005.
Maurer, Michael. *Kulturgeschichte*. Cologne: Böhlau, 2008.
Melzer, Hartmann, and Otto Wimmer. *Lexikon der Namen und Heiligen*. Hamburg: Nikol, 2002.
Meyers, Joseph. *Studien zur Siedlungsgeschichte Luxemburgs*. 3rd edition. Luxembourg: Krippler et Cie, 1976.
Mills, David. *Oxford Dictionary of British Place Names*. Oxford: Oxford University Press, 2003.
Ministère de la Culture, ed. “LOD – Lëtzebuerger Online Dictionnaire.” 2007. Accessed August 31, 2020. http://lod.lu.
Nübling, Damaris, Fabian Fahlbusch, and Rita Heuser. *Namen. Eine Einführung in die Onomastik*. Tübingen: Narr, 2015.
Rentenaar, Rob. “Mikrotoponymie aus nordwestgermanischer Sicht. Einige Bemerkungen zur Definition und Terminologie.” In *Mikrotoponyme. Jenaer Symposion, 1. und 2. Oktober 2009*, edited by Eckhard Meineke and Heinrich Tiefenbach, 197–205. Heidelberg: Universitätsverlag Winter, 2011.
Sandnes, Berit. “Names and Language Contact.” In *The Oxford Handbook of Names and Naming*, edited by Carole Hough, 540–53. Oxford: Oxford University Press, 2018.
Schneider, Karin. *Paläographie und Handschriftenkunde für Germanisten. Eine Einführung*. Berlin: Walter de Gruyter, 2014.

Schoellen, André. “ Zeugenberg Helperknapp. Neue archäologische Erkenntisse zu dieser herausragenden Fundstelle.” *Nos Cahiers* 34, 3 (2013): 207–21.

Thiering, Martin. *Kognitive Semantik und Kognitive Anthropologie*. Berlin: De Gruyter, 2018.

Tuan, Yi-fu. *Space and Place. The Perspective of Experience*. Minneapolis: University of Minnesota Press, 1977.

Van Langendonck, Willy, and Mark Van de Velde. “Names and Grammar.” In *The Oxford Handbook of Names and Naming*, edited by Carole Hough, 17–38. Oxford: Oxford University Press, 2018.

Windberger-Heidenkummer, Erika. “Kontinuität und Diskontinuität von Flurnamen. Probleme und Beispiele.” In *Mikrotoponyme. Jenaer Symposion, 1. und 2. Oktober 2009*, edited by Eckhard Meineke and Heinrich Tiefenbach, 289–306. Heidelberg: Universitätsverlag Winter, 2011.

Windberger-Heidenkummer, Erika. *Mikrotoponyme im sozialen und kommunikativen Kontext. Flurnamen im Gerichtsbezirk Neumarkt in der Steiermark*. Frankfurt am Main: Peter Lang, 2001.

Witkowski, Teodolius. “Probleme der Terminologie.” In *Namenforschung. Ein internationales Handbuch zur Onomastik*, edited by Ernst Eichler et al., 1: 288–94. Berlin: Mouton de Gruyter, 1995.

Zaagsma, Gerben. “On Digital History.” *BMGN – Low Countries Historical Review* 128, 4 (2013): 3–29.

Jan Lotz

Reconstructing Roman trade networks

An experiment in approaching fragmented sources with network analysis

This paper focuses on my study on trade and transport networks in the Gaulish and German provinces during the Roman Empire and the challenges that came with using network analysis with fragmented or uncertain sources, and is based on my perspective on and experiences during this study. First I give a brief glimpse of digital and ancient history, followed by an introduction to the sources, then some remarks on epigraphy in the digital age, as well as the application of network analysis and its difficulties, and finally some concluding thoughts.

No matter how spectacular, innovative, or promising new digital tools, methods, and ways of conducting research may seem, the most important thing is to have a critical mindset, especially regarding the digital, the sources, and the way the digital is applied to those sources.[1] This leads to an urgently needed combination of source criticism and tool and method criticism. While there is no point in denying the opportunities the digital turn offers, and that it will change today's academia landscape, it is not the panacea for historiography and should not be treated as such.[2]

1 Sybille Krämer adds the research question as a crucial criterion regarding the applicability of digital humanities in Sybille Krämer, "Der 'Stachel des Digitalen' – ein Anreiz zur Selbstreflexion in den Geisteswissenschaften? Ein philosophischer Kommentar zu den Digital Humanities in neun Thesen," *Digital Classics Online* 4, no. 1 (2018): 8.

2 Michel de Certeau, *Histoire et psychanalyse entre science et fiction* (Paris: Gallimard, 1987), 66–96; Erez Aiden and Jean-Baptiste Michel, *Uncharted. Big Data as a Lens on Human Culture* (New York: Riverhead Books, 2013); and Stylianos Chronopoulos, Felix Maier, and Anna Novokhatko, *Digitale Altertumswissenschaften. Thesen und Debatten zu Methoden und Anwendungen* (Heidelberg: Propylaeum, 2020), 10.

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1 Digital approaches in ancient history

Charlotte Schubert and Corina Willkommen ascribe an "internationally very visible pioneering role in the development of the e-humanities or digital humanities" (international sehr sichtbare Pionierrolle in der Entwicklung der eHumanities bzw. Digital Humanities) to classical studies and consider them well advanced in terms of digitization.[3] But there is also skepticism and rejection regarding the hype around digital humanities. The development is seen as the replacement of "interpretation as a key competency in the humanities" (*Interpretation als geisteswissenschaftliche Schlüsselkompetenz*) by mathematical methods.[4] Sybille Krämer reminds us that the digital humanities are still humanities and thus a "humanities subdiscipline" (*geisteswissenschaftliche Teildisziplin*).[5] There is also criticism that barely any cooperation exists between digital humanities and classical studies. Furthermore, some historians see the digital humanities as "a renewal possibility" (*Möglichkeit der Erneuerung*) and "the humanities' only chance of survival" (*einzige Überlebenschance [. . .] der Geisteswissenschaften*), while others are critical of these developments and warn against the uncritical projection of the epistemic principles of the natural sciences onto the humanities.[6] In ancient history studies, many digital projects focus on the creation of digital editions of ancient texts.[7] A famous digital project on ancient economic history is ORBIS, which has been heavily criticized.[8] Regarding network analysis, which will be discussed in detail in Section 4 as the approach in my research, Christian Rollinger considers ancient historians to be "(fashionably) late to the party."[9] It was not until the early 1990s

3 Charlotte Schubert and Corina Willkommen, "Alte Geschichte," in *Clio Guide – Ein Handbuch zu digitalen Ressourcen für die Geschichtswissenschaften*, ed. Laura Busse et al. (Berlin: Humboldt-Universität zu Berlin, 2018), C.1–5.

4 Krämer, "Der 'Stachel des Digitalen,'" 7.

5 Krämer, "Der 'Stachel des Digitalen,'" 6.

6 Chronopoulos, Maier, and Novokhatko, *Digitale Altertumswissenschaften*, 10.

7 For example, the Perseus Digital Library, accessed September 8, 2021, https://www.perseus.tufts.edu/hopper/ and papyri.info, accessed September 8, 2021, http://papyri.info/, as well as several epigraphic databases.

8 "ORBIS: The Stanford Geospatial Network Model of the Roman World," https://orbis.stanford.edu/; Pascal Warnking, *Der römische Seehandel in seiner Blütezeit. Rahmenbedingungen, Seerouten, Wirtschaftlichkeit* (Rahden: Marie Leidorf, 2015), 178–83; Leif Scheuermann, "Geschichte der Simulation / Simulation der Geschichte. Eine Einführung," *Digital Classics Online* 6, no. 1 (2020): 16–9; and Ullrich Fellmeth, "Möglichkeiten und Grenzen der Quantifizierung und Modellierung von antiken Handels-Transportbedingungen – aus ökonomischer Sicht," *Digital Classics Online* 6, no. 1 (2020): 137–9.

9 Christian Rollinger, "Prolegomena. Problems and Perspectives of Historical Network Research and Ancient History," *Journal of Historical Network Research* 4 (2020): 2.

that network analysis was applied to studies in ancient history, for example by Michael Alexander and James Danowski who analyzed Roman society based on letters written by Cicero.[10] At the beginning of the twenty-first century, network analysis was still rarely used in historiography, but its use has increased significantly in recent years.[11] Rollinger, who analyzes the phenomenon of friendship and connections among the Roman upper class using social network analysis during the late Roman Republic, criticizes the often metaphorical use of the term "network" in (ancient) historiography, but also notes a turn toward the actual methodology of network analysis.[12] An example of the metaphorical use of "network" without deeper analysis comes from Wim Broekaert who uses it to describe connections between individuals or families, but refrains from further investigation.[13] Network analysis performed on fragmented sources, however, is hardly discussed in the literature on historical network research.[14]

When I studied ancient history and archaeology there was no mention of anything related to digital history, nor indeed network analysis. I had never heard of either of these terms before embarking on my dissertation and was quite skeptical about what computer science could do for historiography and that there could be any advantages to combining the two. They seemed worlds

10 Michael Alexander and James Danowski, "Analysis of an ancient network. Personal communication and the study of social structure in a past society," *Social Networks* 12 (1990), 313–35.

11 For an overview of ancient history and network analysis see Christian Rollinger, *Amicitia sanctissime colenda. Freundschaft und soziale Netzwerke in der Späten Republik* (Heidelberg: Vandenhoeck & Ruprecht, 2014), 367–81. For a more general view see Linton C. Freeman, *The development of social network analysis. A study in the sociology of science* (Vancouver: Booksurge Publishing, 2004). More recently, see Christian Nitschke, "Die Geschichte der Netzwerkanalyse," in *Handbuch Historische Netzwerkforschung. Grundlagen und Anwendungen*, ed. Marten Düring et al. (Berlin: Lit Verlag, 2016), 11–29; and Matthias Bixler, "Die Wurzeln der Historischen Netzwerkforschung," in *Handbuch Historische Netzwerkforschung*, ed. Düring et al., 45–61. For a regularly updated bibliography regarding network analysis in ancient history see "HNR Bibliography: Ancient History," accessed November 3, 2020, https://historicalnetworkresearch.org/bibliography/#Ancient%20History.

12 Rollinger, *Amicitia sanctissime colenda*, 353–54; and Christian Nitschke and Christian Rollinger, "'Network Analysis is performed.' Die Analyse sozialer Netzwerke in den Altertumswissenschaften: Rückschau und aktuelle Forschungen," in *Knoten und Kanten III. Soziale Netzwerkanalyse in der Geschichts- und Politikforschung*, ed. Markus Gamper, Linda Reschke, and Marten Düring (Bielefeld: transcript, 2015), 229–30.

13 For example, Wim Broekaert, *Navicularii et negotiantes. A prosopographical study of Roman merchants and shippers* (Rahden: Marie Leidorf, 2013).

14 For example, Eva Jullien, "Netzwerkanalyse in der Mediävistik. Probleme und Perspektiven im Umgang mit mittelalterlichen Quellen", *Vierteljahrschrift für Sozial- und Wirtschaftsgeschichte* 100, no. 2 (2013), 135–53.

apart and without connection: one digs into and wants to understand the past, while the other focuses on modern and future technologies.

2 Inscriptions as sources

Due to the lack of ancient literary texts, the main sources for my study were inscriptions. The source material consisted of over 250 inscriptions,[15] mostly found in important cities like Lyon, Narbonne, and Trier, or along important roads and rivers.[16]

In the field of ancient economic history, especially regarding trade, inscriptions play an important role. They are one of the few sources created by merchants themselves or by people in their surroundings. They therefore offer a more direct access to researching trade and transport in antiquity. Nevertheless, there are several challenges and obstacles in using inscriptions as sources.

The main such problem or challenge is the state of preservation of the inscriptions, which can result in uncertain readings and different interpretations. Following are four inscriptions that document trade or transport, and their texts according to the Corpus Inscriptionum Latinarum (CIL), which is the most important collection of Latin inscriptions.[17] The reading of the texts is based inter alia on the meaning of the abbreviations (e.g. *NEG* = *negotiator*) and comparisons with other inscriptions, but also on assumptions.[18]

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15 Admission criteria are professions (e.g. *negotiator*, *mercator*, *nauta*, *navicularius)*, organizations connected to trade/transport (e.g. *Collegium negotiatorum Cisalpinorum et Transalpinorum*), or other connections to trade and transport (e.g. by the symbology of the inscription). Some inscriptions require further investigation (e.g. *mercator* can also appear as a cognomina). Many other inscriptions that might indicate trade or transport were not included because the connection was uncertain.

16 These rivers were major transport routes, especially the Rhône and Saône. *Nautae* (shippers) of these rivers: Rhône: AE 1982, 703; 1997, 1130; CIL XII, 1667, 1797, 3317; XIII, 1716, 1967, 1996, 2002, 2494; Saône: AE 1975, 613; CIL VI, 29722; XII, 1005; XIII, 1709, 1911, 1954, 1972, 2009, 2020, 2028, 2041, 5096, 5489, 11179; Rhône/Saône: CIL XII, 3316; CIL XIII, 1688, 1695, 1918, 1960, 1966, 11480. See also Thomas Schmidts, *Akteure und Organisation der Handelsschifffahrt in den nordwestlichen Provinzen des Römischen Reiches* (Mainz: Schnell & Steiner, 2011).

17 The work began in 1853; today, there are 17 volumes with over 180,000 inscriptions, with new supplements and editions added on a regular basis.

18 For a list of publications see the Epigraphik-Datenbank Clauss/Slaby (EDCS, http://db.edcs.eu/epigr/epi.php?s_sprache=en) and the Epigraphic Database Heidelberg (EDH, https://edh-www.adw.uni-heidelberg.de/home?&lang=en). Symbols according to Leiden Conventions. For an introduction to epigraphy see, for example Christer Bruun and Jonathan Edmondson, *The Oxford Handbook of Roman Epigraphy* (New York: Oxford University Press, 2015).

Fig. 1: Roman trade inscription CIL XIII, 1911, EDCS, EDCS-10500866, Location: Lyon, Date: 75–125,[19] Text: *C APRONIO APRONI //BLANDI FIL//RAPTORI//TREVERO//DEC EIVSD CIVITATIS//N ARARICO PATRON//EIVSDEM CORPORIS//NEGOTIATORES// VINARI// LVGVD CON[SIST]ENTES BENE DE SE M[ere]NTI //PATRO[n]O// CVIVS STATVA[E D]EDICA// TIONE SPORTVLAS// DED NEGOT SING CORP XV* ©Manfred Clauss. EDCS, Epigraphik-Datenbank Clauss/Slaby. https://db.edcs.eu/epigr/bilder.php?s_language=de&bild=$CIL_13_01911.jpg;$CIL_13_01911_1.jpg&nr=2, accessed February 4, 2022.

19 Broekaert, *Navicularii et negotiantes*, 31. See also Amable Audin and Yves Burnand, “Chronologie des épitaphes romaines de Lyon,” *Revue des Études Anciennes* 61 (1959): 324–5; Peter Kneißl, *Die Berufsangaben auf den Inschriften der gallischen und germanischen Provinzen. Beiträge zur Wirtschafts- und Sozialgeschichte der römischen Kaiserzeit* vol. 2 (Marburg, 1977), 138–9; Jean Krier, *Die Treverer außerhalb ihrer Civitas. Mobilität und Aufstieg* (Trier: Rheinisches

The first inscription is easy to read (Fig. 1). It was erected by the wine merchants of Lyon in honor of Caius Apronius Raptor, a patron of Lyon's wine merchants and of the *nautae* of the Saône. Caius Apronius? originated from Trier, or rather the Treveri, where he was a *decurio*.

The second inscription is not as well preserved, but still quite readable (Fig. 2):[20] Murranius Verus from the Treveri is described as a merchant for wine and ceramics. The third inscription is a small fragment found in Augst, with nine letters, two of which are barely recognizable (Fig. 3).

It has been suggested to be part of an inscription of the *Collegium negotiatorum Cisalpinorum et Transalpinorum*, an association of merchants who traded across the Alps. This interpretation is likely but still speculative.[21] The last inscription was erected by the Helvetii in honor of their patron Quintus Otacilius Pollinus, who also was the patron of the association of cisalpine and transalpine slave traders and the association of the *nautae* of the Rhône and Saône. It is preserved in numerous fragments but most of the inscription is missing (Fig. 4).[22]

There are also other difficulties. The dating is not always clear:[23] some inscriptions can be dated to a year, or even an exact date with day, month, and year, but most of the time the dating is rather vague and inscriptions can only be dated to a range of decades or centuries.[24] Furthermore, only a small part of the entire corpus

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Landesmuseum Trier, 1981), 31–5; Lothar Wierschowski, *Fremde in Gallien – "Gallier" in der Fremde. Die epigraphisch bezeugte Mobilität in, von und nach Gallien vom 1. bis 3. Jh. n. Chr.* (Stuttgart: Franz Steiner Verlag, 2001), 318–9; and Schmidts, *Akteure und Organisation*, 135–6.

20 Different readings are possible, e.g. EDCS 10500989; Broekaert, *Navicularii et negotiantes*, no. 127; Krier, *Die Treverer,* no. 17; and Wierschowski, *Fremde in Gallien,* no. 494.

21 Theophil Burckhardt-Biedermann, *Die Kolonie Augusta Raurica. Ihre Verfassung und ihr Territorium* (Basel: Helbing & Lichtenhahn, 1910), 5; Kolb and Ott, "Ein 'Collegium negotiatorum Cisalpinorum et Transalpinorum' "; Gerold Walser, "Corpus mercatorum cisalpinorum et transalpinorum," *Museum Helveticum. Schweizerische Zeitschrift für klassische Altertumswissenschaft* 48 (1991): 169–75; Hans Sütterlin, "Altes und Neues zur Augster Curia. Zwei neue Inschriftenfunde aus dem Forumsbereich von Augusta Raurica (Grabung Curia-Schutzdach 1998.51)," *Jahresberichte aus Augst und Kaiseraugst* 20 (1999): 159–80; and Ludwig Berger, *Führer durch Augusta Raurica* (Basel: Schwabe Verlag, 2012), 35–6.

22 Joyce Reynolds, "Q. Otacilius Pollinus of Aventicum," *Bulletin de l'Association Pro Aventico* 20 (1969): 53–7; Regula Stolba-Frei, "Q. Otacilius Pollinus. Inquisitor III Galliarum," in *Alte Geschichte und Wissenschaftsgeschichte,* ed. Peter Kneißl and Volker Losemann (Darmstadt: Wissenschaftliche Buchgesellschaft, 1988), 186–201; and Oelschig, "Methode und Geschichte."

23 Inscriptions can be dated in different ways – for example, by the text and content (e.g. reference to a known person like an emperor or consul, a dated event or location, certain abbreviations, expressions, symbology), the appearance of the letters, or the archaeological context.

24 For example, John Bodel, "Epigraphy and the ancient historian," in *Epigraphic Evidence. Ancient History From Inscriptions*, ed. John Bodel (London: Taylor & Francis Ltd, 2001), 49–52; Alison E. Cooley, *The Cambridge manual of Latin epigraphy* (Cambridge: Cambridge University

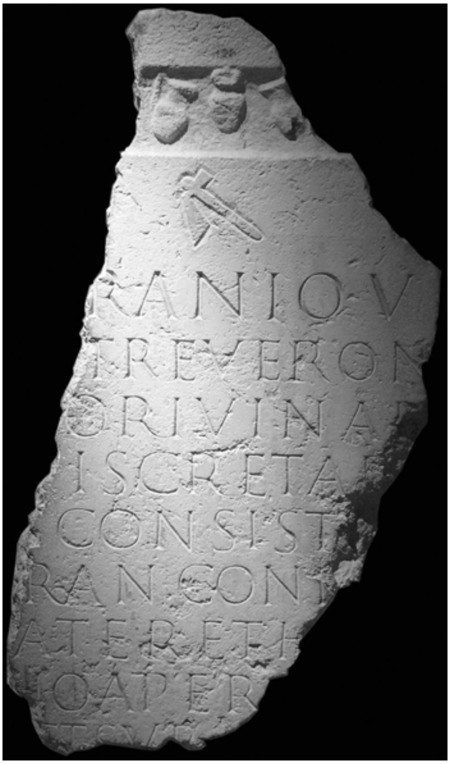

Fig. 2: Roman trade inscription CIL XIII, 2033, EDCS, EDCS-10500989, Location: Lyon, Date: 125–150,[25] Text: *?[tur]RANIO V[ero]//[civi] TREVERO N[ego]//[tiat]ORI VINAR[io //[et (?) art]IS CRETAR[iae] //[lug] CONSIST[enti]//[Mur]RAN(ius?) CONI[stans]// [fr]ATER ET H[eres] //?[agat] HO APTER[us lib]//[p c] ET SVB [asc ded]* © Manfred Clauss and Véronique Krier. EDCS, Epigraphik-Datenbank Clauss/Slaby. https:////db.edcs.eu/epigr/bilder.php?s_language=de&bild=$CIL_13_02033.jpg;$CIL_13_02033_1.jpg;$VK_CIL_13_02033_2.jpg&nr=2,https://db.edcs.eu/epigr/bilder.php?s_language=de&bild=$CIL_13_02033.jpg;$CIL_13_02033_1.jpg;$VK_CIL_13_02033_2.jpg&nr=2, accessed February 4, 2022.

of inscriptions is preserved and known today: most inscriptions have been lost. Géza Alföldy estimates the overall number of inscriptions that existed during the Roman Empire at between 20 and 40 million and notes that even this number

Press; 2012), 398–434; and Christer Bruun and Jonathan Edmondson, "The Epigrapher at Work," in *Oxford Handbook*, ed. Bruun and Edmondson, 14–7.

25 Broekaert, *Navicularii et negotiantes*, 84–6. See also Audin and Burnand, *Chronologie des épitaphes*, 325–6; Kneißl, *Die Berufsangaben* 2, 199–200; Krier, *Die Treverer*, 54–6; and Wierschowski, *Fremde in Gallien*, 357–8.

Fig. 3: Roman trade inscription CIL XIII, 5303, EDH, F027244, EDCS-ID: EDCS-10800707, EDH ID: HD009215, Location: Augst, Date: Early Roman Empire,[26] Text: *COL//CISAL* ©Krešimir Matijević, Phototek CIL XIII/2 Flensburg/Trier. heidICON, Heidelberger Objekt- und Multimediadatenbank, https://heidicon.ub.uni-heidelberg.de/iiif/2/1439557%3A788001, accessed February 2022.

might still be too small.[27] Today, approximately 500,000 Latin inscriptions are known,[28] which is between 1.3 and 2.6 percent of Alföldy's estimate. Consequently, inscriptions are not necessarily representative.[29] Related to this is the concept of

26 Kolb and Ott, "Ein "Collegium negotiatorum Cisalpinorum et Transalpinorum" in Augusta Rauricorum?" *Zeitschrift für Papyrologie und Epigraphik* 73 (1988): 107–10.

27 Géza Alföldy, "Römische Inschriftenkultur von Hispanien bis zum vorderen Orient. Die Erfolgsgeschichte eines antiken Kommunikationsmediums," in *Die epigraphische Kultur der Römer. Studien zu ihrer Bedeutung, Entwicklung und Erforschung*, ed. Angelos Chaniotis and Christian Witschel (Stuttgart: Franz Steiner Verlag, 2018), 37; and Géza Alföldy, "Die epigraphische Kultur der Römer. Die Ausbreitung eines Kommunikationsmediums und seine Rolle bei der kulturellen Integration," in *Epigraphische Kultur*, ed. Angelos Chaniotis and Christian Witschel, 70.

28 Tommaso Beggio, "Epigraphy," trans. Laurence Hooper, in *The Oxford Handbook of Roman Law and Society*, ed. Paul J. du Plessis, Clifford Ando, and Kaius Tuori (New York: Oxford University Press, 2016), 43. Over 400,000 Latin inscriptions without *instrumentum domesticum*: Alföldy, *Die epigraphische Kultur der Römer*, 64; Géza Alföldy, "Tausend Jahre epigraphische Kultur im römischen Hispanien. Inschriften, Selbstdarstellung und Sozialordnung," in *Epigraphische Kultur*, 244; and Manfred Schmidt, "*Carmina Latina Epigraphica*, translated by Orla Mulholland," in *Oxford Handbook*, ed. Bruun and Edmondson, 764. More than 300,000 preserved inscriptions: Francisco Beltrán Lloris, "The 'Epigraphic Habit' in the Roman World," in *Oxford Handbook*, ed. Bruun and Edmondson, 132, 136.

29 Werner Eck, "Befund und Realität. Zur Repräsentativität unserer epigraphischen Quellen in der römischen Kaiserzeit," *Chiron* 37 (2007): 49–64.

Fig. 4: Roman trade inscription CIL XIII, 11480, EDCS, EDCS-12200144, EDH ID: HD009430,[30] Location: Avenches, Date: after 138,[31] Text:[32] *Q OTACIL[ ]O QVIR POLLINO //Q OTACIL[ ]//CERIALI[ ] FILIO OMNIBVS HONOR[ ]BV[ ] //APVD SVO[ ] FVNCTO T[ ]R IMMVNIT[ ] //A DIVO [ ] ADR[ ] DON[ ]O INQVIS[ ] //II[ ]IAR PA[ ]NO VENAL [ ] //CISAL[ ]INO[ ] ET TRANSALPINORVM // ITEM [ ]AVT[ ]R AR[ ]ICOR [ ]DANICOR //OB [ ]G[ ]A EIVS ERGA RE[ ]L ERGAQ //SIN[ ] VN[ ]VERSO[ ] R[ ]A // HELV[ ]ATRONO [ ]S ET // [ ]IBTI[ ] [ ]B QV[ ]E SV[ ]* © Krešimir Matijević, Phototek CIL XIII/2 Flensburg/Trier. heidICON, Heidelberger Objekt- und Multimediadatenbank, https://heidicon.ub.uni-heidelberg.de/detail/1440435, accessed February 2022.

the "epigraphic habit", that goes back to Ramsay MacMullen[33] and implies that the tradition of erecting stone inscriptions was not equally distributed across the different parts of the Roman Empire, but changed over time, and was also dependent on social status. Another example of an important aspect for the preservation of inscriptions was their material. Lastly, inscriptions only represent snapshots of the time in which they were erected.

Studies based only on inscriptions should not be regarded as generalizable or generally valid, as they are based on only a very small fraction of the total

30 Slightly different text: *Helv[etii publ(ice) p]atrono [—]s et / [inscr?]ibti[on(es)?](!) [a]b qu [— d]e su[o].*

31 Date based on the mention of *Divus Hadrianus*.

32 Stefan Oelschig, "Methode und Geschichte. Variationen zur Inschrift CIL XIII 11480," in *Arculiana. Recueil d'hommages offerts à Hans Bögli*, ed. Franz E. König and Serge Rebetez (Avenches: LAOTT, 1995), 47–60.

33 Ramsay MacMullen, "The epigraphic habit in the Roman Empire," *The American Journal of Philology* 103, no. 3 (1982): 233–46.

number of inscriptions. Besides this, new discoveries or reinterpretations of already-known inscriptions can change the state of our knowledge. Regarding ancient economic history, important epigraphic documents that are now mostly missing include, for example, freight lists and purchase or delivery contracts. Nevertheless, this should not lead to the rejection of results based on epigraphy.

3 Epigraphy in the digital age: Epigraphic databases

Digital resources have become essential in many aspects of the study of history. This also applies to epigraphy, with epigraphic databases like the Epigraphik-Datenbank Clauss/Slaby (EDCS) or the Epigraphic Database Heidelberg (EDH).[34] The EDCS was created in the 1980s to collect all known Latin inscriptions. It offers various search options, such as for the unique identity number (ID) of an inscription within the database, publication, finding place and province, text, date, material, and type of inscription, as well as the personal status of the people mentioned in the inscription.[35] According to those responsible, the inclusion of Latin inscriptions is almost complete and the database now includes 99.5 percent of all published Latin inscriptions.[36] The EDH was founded in 1986 and has been online since 1997, offering multiple search options. It offers some additional information such as the year of discovery, storage location, properties of the inscription carrier and the inscription, and a list of the people mentioned in the inscription. These different search options in particular make working with inscriptions much easier compared to working with the printed collections of inscriptions.

A big difference between the databases, however, is their size. The EDCS consists of around 520,000 inscriptions and is currently the most extensive digital collection of Latin inscriptions, while the EDH has around 81,000 inscriptions.[37]

34 Tom Elliot, “Epigraphy and Digital Resources,” in *The Oxford Handbook of Roman Epigraphy*, ed. Bruun and Edmondson, 78–85.

35 For an explanation of these different options and guidelines for using the EDCS see http://db.edcs.eu/epigr/hinweise/hinweis-en.html and for more detail in the German version see http://db.edcs.eu/epigr/hinweise/hinweis-de.html, accessed August 30, 2020.

36 http://db.edcs.eu/epigr/hinweise/hinweis-de.html, accessed August 30, 2020.

37 As at August 2020. Considering the research area of the dissertation, the numbers are as follows: EDCS: ca. 110,000 inscriptions; EDH: ca. 13,500 inscriptions. Another sign of the higher information density of the EDH (which was already shown by the listed categories of every entry) is seen in the totals of dated inscriptions (Gaul and Germania, EDCS: 9,698; EDH: 10,012).

Hence the EDCS was used as the main resource for this study, with the EDH serving as a complementary collection.

While using the EDCS during the study, several problems arose – for example, some inscriptions were found to be included more than once, while others did not belong to the Roman Era.[38] Another issue became clear when searching for inscriptions from Gaul and Germania: running a search across the Gaulish and German provinces combined, the database showed 109,421 inscriptions,[39] but searching for inscriptions in the two provinces individually resulted in almost 4,000 additional inscriptions being shown. Some locations in the database, such as Dijon or Langres, are assigned to multiple provinces (e.g. "Belgica | Germania inferior" and "Belgica | Germania superior") and so appeared more than once in the second search. Furthermore, some places are matched with the wrong province. The EDCS classifies Colijnsplaat as part of Gallia Belgica, although the course of the border between Gallia Belgica and Germania inferior is not clear.[40] Another problem concerns the text of the inscriptions in the EDCS. Although there is a list of references for various editions or publications of the inscription, it is not clear which reading the database follows. Deviating readings are not mentioned, and critical or unclear points in the text are not marked. Sometimes the EDCS can be proven wrong by consulting the drawing in the CIL or the linked image in the database itself.

Lastly, a description of the symbological features of the inscription and the option to search for inscriptions based on these are not possible. The symbology is an important part of the inscription and often adds crucial information. The inscription on the famous Igel Column (Trier, Germany) gives no information on the owners except for their names, but the large reliefs on its sides reveal that the owners had a role in the textile industry (CIL XIII 4206).[41]

38 An example for both is EDCS-44100009/EDCS-54900666. These two IDs refer to the same inscription. The inscription is included twice in the EDCS. It also dates from the Middle Ages (Matthieu Michler, *Les Vosges* (Paris: Académie des Inscriptions et Belles-Lettres, 2005), no. 415 with further literature). See also Beltrán Lloris, "The 'Epigraphic Habit' in the Roman World," 136–41.

39 As at February 2020.

40 Inter alia Wolfgang Spickermann, *Religion in den germanischen Provinzen Roms* (Tübingen: Mohr Siebeck, 2001), 8–13; Broekaert, *Navicularii et negotiantes*, no. 14, 35, 37, 48, 50, 65, 74, 91, 94, 154, 157, 163, 168, 191, 203, 353, 1229, 1237, 1246, 1248, 1257, 1267, 1285, 1291, 1304, 1317; and Andreas Kakoschke, *Ortsfremde in den römischen Provinzen Germania inferior und Germania superior. Eine Untersuchung zur Mobilität in den germanischen Provinzen anhand der Inschriften des 1. bis 3. Jahrhunderts n. Chr.* (Möhnesee: Bibliopolis, 2002), 6: both treat Colijnsplaat as part of Germania inferior.

41 For the similar CIL XIII, 264: the text provides no information on the profession of the deceased, but the relief shows the transport of wine barrels. He was probably active in wine transport and perhaps a wine merchant.

Despite these problems, the EDCS is an important and valuable research tool and most of its disadvantages can be avoided by using a critical approach.

Having discussed the inscriptions as sources, I would like to discuss what the gaps and uncertainties in the epigraphic sources mean for the application of (social) network analysis.

4 The challenges of approaching fragmented sources using network analysis

It was the goal of identifying networks and other long-term collaborations between merchants that led me to consider using social network analysis in my study. CIL XIII, 8338 and 8568 were important for that decision as they mention two merchants, Tertinius Secundus and Priminius Ingenuus. Secundus was married to Priminia Sabina who may have been related to Ingenuus, thus providing the possibility of a social network and collaboration between the Tertinii and Priminii.

The value of using network analysis always depends on the quality and quantity of the sources, and the research question. As shown earlier, in ancient history in particular, historians often have to rely on fragmentary sources that contain uncertainties or do not contain all the information needed. Gaps in sources result in incomplete and unfinished networks that can change and have to be treated critically. Nonetheless, epigraphic materials that contain all the necessary information on potential relationships seem to beg a network analytical approach.[42]

Several issues arose during my study. First, the dating of the sources was problematic. Second, only a fraction of the people in the networks created were actually merchants; most of the rest were probably family members, with no information on their professions available. Third, even the previous classification as "probably family members" is often questionable, as is the collaboration between them. The network of the Priminii, Sentii, and Tertinii shown in Fig. 5 demonstrates these problems.

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42 Shawn Graham and Giovanni Ruffini, "Network Analysis and Greco-Roman Prosopography," in *Prosopography Approaches and Applications. A Handbook*, ed. Katharine S. B. Keats-Rohan (Oxford: University of Oxford Unit for Prosopographical Research Linacre College, 2007), 325–36; and Shawn Graham, "On Connecting Stamps. Network Analysis and Epigraphy," *Les Nouvelles de l'Archéologie* 135 (2014): 39–44.

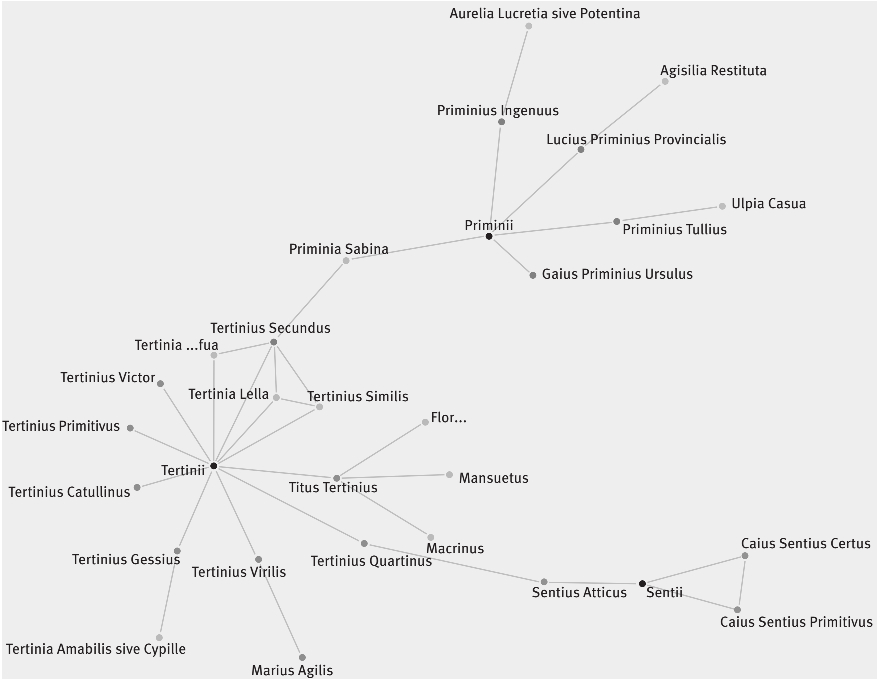

Fig. 5: Priminii-Sentii-Tertinii network: Tertinius Secundus and Priminius Ingenuus are merchants with evidence; Tertinii, Sentii, Priminii are families. 2020. © Jan Lotz.

This network is based on 17 inscriptions, mentioning 27 people.[43] According to Broekaert, CIL XIII, 8338 is dated between AD 100 and 220 and CIL XIII, 8568 between AD 175 and 250, which adds up to a range of 150 years.[44] It is possible that Tertinius Secundus and Priminius Ingenuus lived at the same time, but also that they did not, which makes the attempt to create a network between them highly questionable. The same applies to the other inscriptions.[45] The longevity of the network is also debatable, as a single inscription only represents a snapshot in time. In Colijnsplaat, two inscriptions were found:

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43 AE 1926, 128, 130, 131; 1975, 643; 2001, 1457, 1461, 1472, 1476, 1492; CIL XIII, 1897, 5482, 7394, 7899, 8338, 8545, 8568, 8601; Finke 307.

44 Broekaert, *Navicularii et negotiantes*, no. 144, 175; Kneißl, *Die Berufsangaben* 2, 191–3, 195; Wierschowski, *Fremde in Gallien*, no. 575; Kakoschke, *Ortsfremde in den römischen Provinzen*, no. 1.37, 9.4; Andreas Kakoschke, *Die Personennamen in den zwei germanischen Provinzen* vol. 1 (Rahden: Marie Leidorf, 2006), GN 989, 1281; and Brigitte Galsterer and Hartmut Galsterer, *Die römischen Steininschriften aus Köln* (Mainz: Verlag Philipp von Zabern, 2010), no. 430.

45 Kakoschke, *Die Personennamen 1*, GN 989, 1150, 1281.

one that had been erected by Sentius Atticus and Tertinius Quartinus and the other by Tertinius Virilis and Marius Agilis (AE 2001, 1461, 1476). If they were collaborating merchants, the question that arises is whether this was a singular occurrence or whether they collaborated on a regular basis. It is not possible to answer this question,[46] but it remains important for the creation and credibility of networks, since singular events or collaborations do not result in (trading) networks.

Commercial activities are confirmed for Tertinius Secundus and Lucius Priminius Ingenuus via the mention of their profession. But the inscriptions give no information on the profession of any of the others, although the Tertinii are considered to have been active in the cross-Channel trade between Britannia and the Gallic and Germanic provinces; the same might apply to Sentius Atticus and Marius Agilis.

Furthermore, the other Sentii and two Priminii (AE 2001, 1457, 1461, 1476; CIL XIII, 5482, 8545) might also have been merchants.[47] Some of the actors in the network were *decuriones* or veterans, who could have been involved in trade (AE 1926, 128, 130, 131; Finke 307; CIL XIII, 1897, 7394, 8601).[48] A cooperation between a textile dealer and someone dealing in bread might have been based on supplying soldiers near the Roman-Germanic border or the area around Cologne. Potentially, Priminius Ingenuus, as a *negotiator vestiarius importator*, imported textiles to the Cologne area, and the Nervi Tertinius Secundus sold bread and similar goods from the hinterland of the Belgica at the border. Regarding the Tertinii and Sentii from Colijnsplaat, it is possible that they were merchants – e.g. *negotiatores allecarii* (of fish sauces) or *negotiatores salarii* (of salt)[49] – or sailors (*moritex*), thus providing a connection to Britain for the export of grain products and the import of clothes. Perhaps the purpose of this network was the expansion of trading opportunities and goods, in order to achieve an advantageous or predominant position in supplying the border

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46 Another inscription from Colijnsplaat mentions a second Tertinius Virilis (AE 1975, 643) who can probably be considered to be the same person as the first one. He erected this inscription by himself which might indicate that the hypothetical collaboration with Marius Agilis was a singular occurrence.

47 Broekaert, *Navicularii et negotiantes*, no. 175; and Kakoschke, *Die Personennamen*, GN 989, 1150, 1281.

48 Multiple decuriones and veterans from Gaul and Germania were active in trade or transport – decuriones: AE 1975, 630, 646; CIL XIII, 1688, 1695 1911, 5116, 11179; veterans: CIL XIII, 1906, 6677, probably CIL 8267a and 11812.

49 These were the most common types of merchant in Colijnsplaat. Petrus J. Stuart and Julianus E. Bogaers, *Nehalennia. Römische Steindenkmäler aus der Oosterschelde bei Colijnsplaat* 1 (Leiden: Rijksmuseum van Oudheden, 2001), 34–7.

region, or the organization of joint – and thus simpler – business trips to Britain. Most members of this network are confirmed? to have been located in the northeastern part of the research area, with the exception of Tertinius Gessius (Lyon), Priminius Ursulus (Dijon) and Tertinius Catullinus (Friedberg). Maybe they can be interpreted as links to the rest of the Gallic and Germanic business world (especially Lyon).

But, no matter how tempting these ideas seem, there is no evidence that any of these people, except Tertinius Secundus and Priminius Ingenuus, were merchants. A limitation to these two individuals (and the people mentioned on the same inscription) leads to negligible plausible network visualization.

Even this reconstruction is highly speculative since the inscriptions do not confirm that these people definitely collaborated[50] or were related as members of the same families.[51] The network is based on assumptions, with no evidence that it really existed. These problems are not limited to this specific network, but also apply to others found.

However, the application of network analysis is not limited to epochs or subjects. The problems described here were the reason that I shifted my focus from social to spatial networks. Trade and transport are always connected to mobility – and inscriptions can be quite expressive in terms of such information (e.g. information on trading places, route, goods, origin of the goods or merchant). While the sources did not change and some of the problems mentioned earlier still existed, they were no longer as serious and hindering, for example regarding dating. While a relationship between two merchants is possible, it is usually based on at least two inscriptions. For the relationship to be possible in the first place, the two inscriptions have to be dated to a similar period. But for a connection between two cities, one inscription is sufficient, thus the simultaneity of two different sources is no longer necessary. But there are new problems, such as the role of the find spot of the inscription or the place of origin of the merchant.

50 This also applies to people mentioned in the same inscription, for example Tertinius Quartinus and Sentius Atticus. Although it is rather likely that they did cooperate (assuming both of them were merchants), it is also possible that there were other reasons, e.g. to save money, to erect the inscription together.

51 Due to the geographical proximity, it is quite possible that the Tertinii and the Priminii in the northeast were related, but there is no clear evidence for this. For more on collaboration between families see Wim Broekaert, "Welcome to the family! Marriage as business strategy in the Roman economy", *Marburger Beiträge zu antiken Handels-, Sozial- und Wirtschaftsgeschichte* 30 (2012).

Without implying any direction of the trade, edges in the network usually run between the find spot and the location mentioned in the inscription. The find spot serves as the merchant's "base." However, generalizing this approach can lead to mistakes. A bronze plaque that had been reworked into the bottom of a pot (CIL III, 14165,8), and which documents a conflict between the *navicularii* of Arles and the administration in Rome, was found in Beirut. In this case, the find spot should be ignored. Although researchers have repeatedly assumed the existence of a branch of the *navicularii* of Arles in Beirut because of this inscription, there is no further evidence for it and it is possible that the document reached Beirut in a variety of other ways.[52] A person's place of origin is often equated with the trading place. For Murranius Verus (CIL XIII, 2033) from the *civitas Treverorum*, it "[. . .] seems feasible that Verus was mainly shipping Gallic and possibly Mediterranean wine to the northern provinces [. . .]. On the way back from Trier [to Lyon, where his epitaph was found], he then may have been concentrating on ceramics."[53] Similar cases include CIL XIII, 1998[54] and CIL XIII, 1911, 11179.[55] Although the assumption that a merchant had local contacts in his homeland and maintained business connections to this place seems likely, thus justifying the question mentioned, it is not usually verifiable.

Ultimately, there is no procedure that is universally applicable. Only a one-by-one examination of the inscriptions and the locations mentioned, based on the individual assessment of the historian, can help decide on their value and function for network creation.

52 Peter Kneißl, *Die Berufsangaben auf den Inschriften der gallischen und germanischen Provinzen. Beiträge zur Wirtschafts- und Sozialgeschichte der römischen Kaiserzeit* vol. 1 (Marburg 1977), 206–7. For more details see Catherine Virlouvet, "Les naviculaires d'Arles. À propos de l'inscription provenant de Beyrouth," *Mélanges de l'École française de Rome, Antiquité* 116, no. 1 (2004): 327–70; Mireille Corbier, *Donner à voir, donner à lire. Mémoire et communication dans la Rome ancienne* (Paris: CNRS, 2006), 233–42; and Schmidts, *Akteure und Organisation*, 62–7, 146.

53 Broekaert, *Navicularii et negotiantes*, no. 127. See also Wierschowski, *Fremde in Gallien*, no. 494. Against this see Krier, *Die Treverer*, no. 17.

54 Peter Kneißl, "Die utricularii. Ihre Rolle im gallo-römischen Transportwesen und Weinhandel," *Bonner Jahrbücher* 181 (1981): 185; Wierschowski, *Fremde in Gallien*, no. 468; and Broekaert, *Navicularii et negotiantes*, no. 372.

55 Krier, *Die Treverer*, no. 7, 8; Wierschowski, *Fremde in Gallien*, no. 443, 586; and Broekaert, *Navicularii et negotiantes*, no. 13.

5 Conclusion

One of the key problems of network analysis in ancient history, if not the key problem, is the source situation, which is vastly different from modern history. Not only is the number of sources different, but also the information density and quality. In contrast to modern history, the sources in ancient history, if they exist, are often heavily fragmented with uncertain content and meaning. This makes it harder to gather sufficient and reliable data for network analysis. Broekaert warns of the limitation of network analysis and of the use of overly extensive mathematical calculations. Ancient historians "always work with fragmentary networks, isolated glimpses of a wide set of relationships."[56]

To a certain extent, incorporating network analysis as a key part of my thesis set the research focus and questions. Was its use justified? As outlined, some serious problems came with this approach. Social network analysis could not be used to its full potential and the results did not meet my expectations: the sources simply did not support this approach. However, the number of sources was not the main obstacle, but rather the uncertainties, especially in the form of dating.

Should this study therefore be seen as a failure? The University of Luxembourg's doctoral training unit in digital history and hermeneutics aims to "provide an experimental space" with the concept of "'thinkering' [as] the playful experimentation with digital tools and technologies for historical research."[57] And experiments will sometimes lead to a negative result or a dead end. In this case, the sources and data available for my study were too incomplete for its purposes and did not allow coherent social networks to be created – as a result, a meaningful analysis was not possible.

On the other hand, the non-applicability of social network analysis led to my taking a closer look at the sources and to experimenting with them regarding network analysis more generally. Maybe the value should be seen in dealing with the problems, rather than in the actual outcome. Malte Rehbein warns of a "marginalization of criticism" (*Marginalisierung der Kritik*), with the displacement of critical questions in favor of results, as one of the risks of the digital revolution.[58] This applies not only to thematic, but also to methodological

56 Wim Broekaert, "Financial experts in a spider web. A social network analysis of the archives of Caecilius Iucundus and the Sulpicii," *Klio* 95 (2013): 474.
57 Andreas Fickers and Tim van der Heijden, "Inside the Trading Zone. Thinkering in a Digital History Lab," *Digital Humanities Quarterly* 14, no. 3 (2020).
58 Malte Rehbein, "L'historien de demain sera programmeur ou il ne sera pas." (Digitale) Geschichtswissenschaften heute und morgen, *Digital Classics Online* 4, no. 1 (2018): 37.

questions. Leif Scheuermann urges a documentation not only of the results but also of the research process, to make the digital hermeneutic process understandable and communicable.[59] This also includes describing problems and setbacks, and a critical reflection of one's own research process.

What place does network analysis have in an environment of fragmented, uncertain, and scarce sources? First and foremost, it is not the researcher that decides the applicability, use, and type of network analysis – the sources do. The results have to be interpreted based on and in even closer connection to the sources than in the case of "complete" source material. Detailed knowledge of the sources and especially their shortcomings is key. So is their communication. The documentation of the research process is especially important since digital methods can quickly produce impressive-looking results that can be hard to understand and verify for others. Furthermore, not only is methodological knowledge required but, especially and even more importantly, methodological awareness.[60]

In the case of fragmented sources, although criticized by Rollinger, a limitation on network visualizations with or without limited further mathematical analysis – and a metaphorical use of the term "network" or a more descriptive approach – can be more appropriate, as seen in the works of Broekaert. Therefore, network "analysis"[61] in this study is mostly a way of showing connections between people or rather cities. Nonetheless, fragmented or uncertain sources should not discourage analysis, as long as their weaknesses are kept in mind and addressed. "Historical network research into the ancient world will probably never (or only in very exceptional cases) be able to present analyses as detailed or encompassing as much information as network analysis is able to in contemporary sociological research or even in SNA [social network analysis] of the early modern and modern period. Both network researchers and ancient historians should accept this."[62]

59 Leif Scheuermann, "Die Abgrenzung der digitalen Geisteswissenschaften," *Digital Classics Online* 2, no. 1 (2016): 58–67.

60 Regarding the Middle Ages, but with similar conclusions, see Robert Gramsch, "Zerstörte oder verblasste Muster? Anwendungsfelder mediävistischer Netzwerkforschung und das Quellenproblem," in *Handbuch Historische Netzwerkforschung*, ed. Düring et al., 85–99.

61 Network visualization would be a more fitting description.

62 Rollinger, "Prolegomena," 26.

References

Aiden, Erez, and Jean-Baptiste Michel. *Uncharted: Big Data as a Lens on Human Culture*. New York: Riverhead Books, 2013.

Alexander, Michael, and James Danowski. "Analysis of an ancient network. Personal communication and the study of social structure in a past society." Social Networks 12 (1990): 313–35.

Alföldy, Géza. "Die epigraphische Kultur der Römer. Die Ausbreitung eines Kommunikationsmediums und seine Rolle bei der kulturellen Integration." *Die epigraphische Kultur der Römer. Studien zu ihrer Bedeutung*, Entwicklung und Erforschung, edited by Angelos Chaniotis and Christian Witschel, 53–72. Stuttgart: Franz Steiner Verlag, 2018.

Alföldy, Géza. "Römische Inschriftenkultur von Hispanien bis zum vorderen Orient. Die Erfolgsgeschichte eines antiken Kommunikationsmediums." *Die epigraphische Kultur der Römer*. Studien zu ihrer Bedeutung, Entwicklung und Erforschung, edited by Angelos Chaniotis and Christian Witschel, 35–51. Stuttgart: Franz Steiner Verlag, 2018.

Alföldy, Géza. "Tausend Jahre epigraphische Kultur im römischen Hispanien. Inschriften, Selbstdarstellung und Sozialordnung." *Die epigraphische Kultur der Römer. Studien zu ihrer Bedeutung*, Entwicklung und Erforschung, edited by Angelos Chaniotis and Christian Witschel, 243–77. Stuttgart: Franz Steiner Verlag, 2018.

Audin, Amable, and Yves Burnand. "Chronologie des épitaphes romaines de Lyon." *Revue des Études Anciennes* 61 (1959): 320–52.

Beggio, Tommaso. "Epigraphy". Translated by Laurence Hooper. In *The Oxford Handbook of Roman Law and Society*, edited by Paul J. du Plessis, Clifford Ando and Kaius Tuori, 43–55. New York: Oxford University Press, 2016.

Beltrán Lloris, Francisco, "The „Epigraphic Habit" in the Roman World." In *The Oxford Handbook of Roman Epigraphy*, edited by Christer Bruun and Jonathan Edmondson, 131–48. New York: Oxford University Press, 2015.

Berger, Ludwig. *Führer durch Augusta Raurica*. 7th edition. Basel: Schwabe Verlag, 2012.

Bixler, Matthias. "Die Wurzeln der Historischen Netzwerkforschung." In *Handbuch Historische Netzwerkforschung. Grundlagen und Anwendungen*, edited by Marten Düring et al., 45–61. Berlin: Lit Verlag, 2016.

Bodel, John. "Epigraphy and the ancient historian." In *Epigraphic Evidence. Ancient History from Inscriptions*, edited by John Bodel, 1–56. London: Taylor & Francis Ltd, 2001.

Broekaert, Wim. "Financial experts in a spider web. A social network analysis of the archives of Caecilius Iucundus and the Sulpicii." *Klio* 95 (2013): 471–510.

Broekaert, Wim. *Navicularii et negotiantes. A prosopographical study of Roman merchants and shippers*. Rahden: Marie Leidorf, 2013.

Broekaert, Wim. "Welcome to the family! Marriage as business strategy in the Roman economy." *Marburger Beiträge zu antiken Handels-, Sozial- und Wirtschaftsgeschichte* 30 (2012): 41–66.

Bruun, Christer, and Jonathan Edmondson. ed. *The Oxford Handbook of Roman Epigraphy*. New York: Oxford University Press, 2015.

Bruun, Christer, and Jonathan Edmondson. "The Epigrapher at Work." *In The Oxford Handbook of Roman Epigraphy*, edited by Christer Bruun and Jonathan Edmondson, 3–20. New York: Oxford University Press, 2015.

Burckhardt-Biedermann, Theophil. *Die Kolonie Augusta Raurica. Ihre Verfassung und ihr Territorium*. Basel: Helbing & Lichtenhahn, 1910.

Chronopoulos, Stylianos, Felix Maier, and Anna Novokhatko. *Digitale Altertumswissenschaften. Thesen und Debatten zu Methoden und Anwendungen*. Heidelberg: Propylaeum, 2020.

Cooley, Alison E. *The Cambridge manual of Latin epigraphy*. Cambridge: Cambridge University Press, 2012.

Corbier, Mireille. *Donner à voir, donner à lire. Mémoire et communication dans la Rome ancienne*. Paris: CNRS, 2006.

De Certeau, Michel. *Histoire et psychanalyse entre science et fiction*. Paris: Gallimard, 1987.

Eck, Werner. "Befund und Realität. Zur Repräsentativität unserer epigraphischen Quellen in der römischen Kaiserzeit. " *Chiron* 37 (2007): 49–64.

Elliot, Tom. "Epigraphy and Digital Resources." In *The Oxford Handbook of Roman Epigraphy*, edited by Christer Bruun and Jonathan Edmondson, 78–85. New York: Oxford University Press, 2015.

Fellmeth, Ullrich. "Möglichkeiten und Grenzen der Quantifizierung und Modellierung von antiken Handels-Transportbedingungen – aus ökonomischer Sicht." *Digital Classics Online* 6, 1 (2020): 137–54. https://doi.org/10.11588/dco.0.0.73389.

Fickers, Andreas, and Tim van der Heijden. "Inside the Trading Zone. Thinkering in a Digital History Lab." *Digital History Quartely* 14, 3 (2020). Accessed October 2, 2020. http://www.digitalhumanities.org/dhq/vol/14/3/000472/000472.html.

Freeman, Linton C., *The development of social network analysis. A study in the sociology of science*. Vancouver: Booksurge Publishing, 2004.

Galsterer, Brigitte, and Hartmut Galsterer. *Die römischen Steininschriften aus Köln*. Mainz: Verlag Philipp von Zabern, 2010.

Gaubatz-Sattler, Anita. "Intra Limites. Zur zivilen Besiedlung zwischen den Limites im Neckar-Odenwald-Kreis." *Fundberichte aus Baden-Württemberg* 31 (2010): 561–606.

Graham, Shawn. "On Connecting Stamps. Network Analysis and Epigraphy." *Les Nouvelles de l'Archéologie* 135 (2014): 39–44.

Graham, Shawn, and Giovanni Ruffini. "Network Analysis and Greco-Roman Prosopography." In *Prosopography Approaches and Applications. A Handbook*, edited by Katharine S. B. Keats-Rohan, 325–66, Oxford: University of Oxford Linacre College Unit for Prosopographical Research, 2007.

Gramsch, Robert. "Zerstörte oder verblasste Muster? Anwendungsfelder mediävistischer Netzwerkforschung und das Quellenproblem." In *Handbuch Historische Netzwerkforschung. Grundlagen und Anwendungen*, edited by Marten Düring et al., 85–99. Berlin: Lit Verlag, 2016.

Jullien, Eva. "Netzwerkanalyse in der Mediävistik. Probleme und Perspektiven im Umgang mit mittelalterlichen Quellen." In *Vierteljahrschrift für Sozial- und Wirtschaftsgeschichte* 100, 2 (2013): 135–53.

Kakoschke, Andreas. *Ortsfremde in den römischen Provinzen Germania inferior und Germania superior. Eine Untersuchung zur Mobilität in den germanischen Provinzen anhand der Inschriften des 1. bis 3. Jahrhunderts n. Chr*. Möhnesee: Bibliopolis, 2002.

Kakoschke, Andreas. *Die Personennamen in den zwei germanischen Provinzen* 1. Rahden: Marie Leidorf, 2006.

Kneißl, Peter. *Die Berufsangaben auf den Inschriften der gallischen und germanischen Provinzen: Beiträge zur Wirtschafts- und Sozialgeschichte der römischen Kaiserzeit*, vol. 1. Marburg, 1977.

Kneißl, Peter. *Die Berufsangaben auf den Inschriften der gallischen und germanischen Provinzen. Beiträge zur Wirtschafts- und Sozialgeschichte der römischen Kaiserzeit*, vol. 2. Marburg, 1977.

Kneißl, Peter. "Die utriclarii. Ihre Rolle im gallo-römischen Transportwesen und Weinhandel." *Bonner Jahrbücher* 181 (1981): 185.

Kolb, Anne, and Joachim Ott. "Ein "Collegium negotiatorum Cisalpinorum et Transalpinorum" in Augusta Rauricorum?" *Zeitschrift für Papyrologie und Epigraphik* 73 (1988): 107–10.

Krämer, Sybille. "Der ‚Stachel des Digitalen' – ein Anreiz zur Selbstreflexion in den Geisteswissenschaften? Ein philosophischer Kommentar zu den Digital Humanities in neun Thesen." *Digital Classics Online* 4, 1 (2018): 5–11. https://doi.org/10.11588/dco.2017.0.48490.

Krier, Jean. *Die Treverer außerhalb ihrer Civitas. Mobilität und Aufstieg*. Trier: Rheinisches Landesmuseum Trier, 1981.

MacMullen, Ramsay. "The epigraphic habit in the Roman Empire." *The American Journal of Philology* 103, 3 (1982): 233–46.

Michler, Matthieu. *Les Vosges*. Paris: Académie des Inscriptions et Belles-Lettres, 2005.

Nitschke, Christian. "Die Geschichte der Netzwerkanalyse." In *Handbuch Historische Netzwerkforschung*. Grundlagen und Anwendungen, edited by Marten Düring et al., 11–29. Berlin: Lit Verlag, 2016.

Nitschke, Christian, and Christian Rollinger. "'Network Analysis is performed.' Die Analyse sozialer Netzwerke in den Altertumswissenschaften. Rückschau und aktuelle Forschungen." In *Knoten und Kanten III. Soziale Netzwerkanalyse in der Geschichts- und Politikforschung*, edited by Markus Gamper, Linda Reschke and Marten Düring, 214–60. Bielefeld: transcript, 2015.

Oelschig, Stefan. "Methode und Geschichte. Variationen zur Inschrift CIL XIII 11480." In *Arculiana. Recueil d'hommages offerts à Hans Bög*li, edited by Franz E. König and Serge Rebetez, 47–60. Avenches: LAOTT, 1995.

Rehbein, Malte. "„L'historien de demain sera programmeur ou il ne sera pas." (Digitale) Geschichtswissenschaften heute und morgen." *Digital Classics Online* 4, 1 (2018): 23–43. https://doi.org/10.11588/dco.2017.0.48491.

Reynolds, Joyce. "Q. Otacilius Pollinus of Aventicum." In *Bulletin de l'Association Pro Aventico* 20 (1969): 53–7.

Rollinger, Christian. *Amicitia sanctissime colenda. Freundschaft und soziale Netzwerke in der Späten Republik*. Heidelberg: Vandenhoeck & Ruprecht, 2014.

Rollinger, Christian. "Prolegomena. Problems and Perspectives of Historical Network Research and Ancient History," *Journal of Historical Network Research* 4 (2020): 2. https://doi.org/10.25517/jhnr.v4i0.72.

Scheuermann, Leif. "Die Abgrenzung der digitalen Geisteswissenschaften." *Digital Classics Online* 2, (2016): 58–67. https://doi.org/10.11588/dco.2016.1.22746.

Scheuermann, Leif. "Geschichte der Simulation/Simulation der Geschichte. Eine Einführung." *Digital Classics Online* 6, 1 (2020): 4–32. https://doi.org/10.11588/dco.0.0.73396.

Schmidt, Manfred. "Carmina Latina Epigraphica." Translated by Orla Mulholland. In *The Oxford Handbook of Roman Epigraphy*, edited by Christer Bruun and Jonathan Edmondson, 764–82. New York: Oxford University Press, 2015.

Schmidts, Thomas. *Akteure und Organisation der Handelsschifffahrt in den nordwestlichen Provinzen des Römischen Reiches*. Mainz: Schnell & Steiner, 2011.
Schubert, Charlotte, and Corina Willkommen. “Alte Geschichte.” In *Clio Guide – Ein Handbuch zu digitalen Ressourcen für die Geschichtswissenschaften*, 2nd edition, edited by Laura Busse, Wilfried Enderle, Rüdiger Hohls, Thomas Meyer, Jens Prellwitz and Annette Schuhmann, C.1-1–C.1-29. Berlin: Humboldt-Universität zu Berlin, 2018. https://doi.org/10.18452/19244.
Spickermann, Wolfgang. *Religion in den germanischen Provinzen Roms*. Tübingen: Mohr Siebeck, 2001.
Stolba-Frei, Regula. “Q. Otacilius Pollinus. Inquisitor III Galliarum.” In *Alte Geschichte und Wissenschaftsgeschichte*, edited by Peter Kneißl and Volker Losemann, 186–201. Darmstadt: Wissenschaftliche Buchgesellschaft, 1988.
Stuart, Petrus J., and Julianus E. Bogaers. *Nehalennia. Römische Steindenkmäler aus der Oosterschelde bei Colijnsplaat*, vol. 1. Leiden: Rijksmuseum van Oudheden, 2001.
Sütterlin, Hans. “Altes und Neues zur Augster Curia. Zwei neue Inschriftenfunde aus dem Forumsbereich von Augusta Raurica (Grabung Curia-Schutzdach 1998.51).” *Jahresberichte aus Augst und Kaiseraugst* 20 (1999): 159–80.
Virlouvet, Catherine. “Les naviculaires d’Arles. À propos de l’inscription provenant de Beyrouth.” *Mélanges de l’École française de Rome, Antiquité* 116, 1 (2004): 327–70.
Walser, Gerold. “Corpus mercatorum cisalpinorum et transalpinorum.” *Museum Helveticum. Schweizerische Zeitschrift für klassische Altertumswissenschaft* 48 (1991): 169–75.
Warnking, Pascal. *Der römische Seehandel in seiner Blütezeit. Rahmenbedingungen, Seerouten, Wirtschaftlichkeit*. Rahden: Marie Leidorf, 2015.
Wierschowski, Lothar. *Fremde in Gallien – “Gallier” in der Fremde. Die epigraphisch bezeugte Mobilität in, von und nach Gallien vom 1. bis 3. Jh. n. Chr*. Stuttgart: Franz Steiner Verlag, 2001.

Floor Koeleman

Re-viewing the *constcamer*

A digital approach to seventeenth-century pictures of collections

1 Introduction

In 2019, 100 selected masterpieces of Dutch and Flemish art (ca. 1350–1750) were presented to the public and the art world as the CODART Canon. The final list had been compiled by members of the CODART international network of curators of Dutch and Flemish art, after a public vote.[1] No less than two *constcamer* paintings were included in the final selection: *The Five Senses* (1617–1619) by Jan Brueghel I and Peter Paul Rubens, which is actually a series of five paintings, and the *The Picture Gallery of Cornelis van der Geest* (1628) by Willem van Haecht II.[2] This demonstrates how popular *constcamer* paintings are among the public and art professionals.

A *constcamer* is a specific type of painting created mainly for the Antwerp art markets in the seventeenth century. It depicts a room with a rich collection of paintings, musical and scientific instruments, animals, plants, people, and many other interesting elements that were of significant cultural relevance for the period. Despite its popularity, the genre is not well researched, and no complete overview exists to this day.[3] My PhD project aims not only to create a corpus of the *constcamer* paintings that have been preserved, but also to study their rich and complex content. This chapter explains the rationale behind the use of digital tools and methodologies to collect, archive, and analyze a dataset of over 160 *constcamer* paintings and the information relating to them.

1 "The CODART Foundation, "About the CODART Canon," accessed September 28, 2020. https://canon.codart.nl/about/.

2 "The CODART Foundation, "100 Masterpieces," accessed September 28, 2020. https://canon.codart.nl/.

3 The main reference work on the genre remains Simone Speth-Holterhoff, *Les Peintres Flamands de Cabinets d'Amateurs au XVIIe Siècle* (Brussels: Elsevier, 1957). For the historiography of the genre see Alexander Marr, "The Flemish 'Pictures of Collections' Genre: An Overview," *Intellectual History Review* 20, no. 1 (2010): 5–25.

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2 Digital art history

In 2017, the lack of availability of datasets was characterized in the report on the symposium Art History in Digital Dimensions as "the primary obstacle for many art historians and students."[4] Creating datasets is currently the main work being done in the field of digital art history and, at the same time, an ongoing trend to digitize museum collections is contributing to the accessibility of artworks. "Yet even with these available resources," the 2017 report continues, "the majority of researchers will have to develop their own dataset. For many, compiling this dataset has the potential to be more challenging than mastering new software."[5] It requires a way of working in which art historians are not usually trained.

Digital art history "has become a shorthand reference to the potentially transformative effect that digital technologies hold for the discipline of art history."[6] In the 2013 special issue of *Visual Resources* dedicated to digital art history, Drucker posed the controversial question, "Is There a 'Digital' Art History?" She proposed a distinction between *digitized* art history, characterized as making use of online repositories and images, and *digital* art history, where computational technology allows the use of analytic techniques.[7] Computational analysis alone, however, cannot replace argumentation and interpretation.[8] Subsequent research has shown that Drucker's distinction no longer holds.[9]

4 Stephen Bury et al., "Art History in Digital Dimensions: The White Paper" (Washington DC: Frick Art Reference Library, 2017), 11, accessed June 17, 2021, http://dah-dimensions.org/report/.

5 Bury et al., "Art History in Digital Dimensions," 11.

6 The Getty Foundation, "Digital Art History", accessed September 28, 2020, https://www.getty.edu/foundation/initiatives/current/dah/.

7 Johanna Drucker, "Is There a 'Digital' Art History?," *Visual Resources* 29, nos. 1–2 (2013): 7; Benjamin Zweig, "Forgotten Genealogies: Brief Reflections on the History of Digital Art History," *International Journal for Digital Art History* 1 (2015): 37–49; and Anna Bentkowska-Kafel, "Debating Digital Art History," *International Journal for Digital Art History* 1 (2015): 51–64.

8 Claire Bishop, "Against Digital Art History", Humanities Futures, Franklin Humanities Institute, 2017, accessed September 20, 2020, https://humanitiesfutures.org/papers/digital-art-history/. According to Hans Brandhorst the "real question is whether in documenting our sources the field will ever be able to keep one step ahead of researchers, providing them with ready-made answers when they are asking new questions." Hans Brandhorst, "Aby Warburg's Wildest Dreams Come True?," *Visual Resources* 29, nos. 1–2 (2013): 76.

9 Georg Schelbert, "Digital Art History – Digitale Kunstgeschichte, Überlegungen zum Aktuellen Stand," in *Computing Art Reader: Einführung in die Digitale Kunstgeschichte*, ed. Piotr Kuroczyński, Peter Bell, and Lisa Dieckmann, Computing in Art and Architecture, vol. 1 (Heidelberg: arthistoricum.net, 2018), 54. In her latest publication, Drucker fully acknowledges the importance of interpretation for the humanities. See Johanna Drucker, *Visualization and Interpretation: Humanistic Approaches to Display* (Cambridge, MA: The MIT Press, 2020).

It remains to be seen if computational analysis will ever gain the same importance in art history as in disciplines within the humanities that are primarily text-based.[10] In art history, material artifacts without inherent digital representation are traditionally the starting point of study. As Schelbert pointed out, the interpretation of art and its historical context is an intellectual and theoretical process. But the ways in which information is structured and links between data are made influence the interpretation of that data.[11] The latest digital art history special edition of *Visual Resources* (2019) similarly highlights that "creating a database is anything but straightforward and that its complications cannot be separated from disciplinary, socio-historical, and ideological contexts."[12]

The reassessment of the current state of research in the field of digital art history mainly reveals that "data sets are not 'interpretations' or 'conclusions' in and of themselves; all hypotheses and interpretations must be made by examining data in conjunction with historical knowledge and taking into consideration the contexts in which the works and artists exist."[13] However, the focus on databases within digital art history seems to come at a cost.

In 2012 Schelbert identified "image analysis and image annotation" (*Bildanalyse und Bild-Annotation*) as one of the six areas of work in digital art history. This aspect had disappeared from his list of 2018.[14] A similar trend can be discerned in the contributions to *The Routledge Companion to Digital Humanities and Art History* of 2020.[15] None of the thirty-four chapters deals explicitly with the analysis and annotation of images. Whenever images are referenced in this book, the focus is limited to the formal analysis of artworks rather than offering interpretations of what is depicted and its associated meanings. Traditionally the latter has been at the heart of art historical research.

10 Schelbert, "Digital Art History," 48; and Lev Manovich, "Data Science and Digital Art History," *International Journal for Digital Art History* 1 (2015): 13–35.

11 Schelbert, "Digital Art History," 54–5.

12 Murtha Baca, Anne Helmreich, and Melissa Gill, "Digital Art History," *Visual Resources* 35, nos. 1–2 (2019): 2.

13 Baca, Helmreich, and Gill, "Digital Art History," 3.

14 Schelbert, "Digital Art History," 45. The 2018 list consists of: innovative search strategies and tools; cross-media semantic linking and enrichment of information units; social media; reception research; digital visualizations and diagrams; and digital communication of art historical knowledge.

15 Kathryn Brown, ed., *The Routledge Companion to Digital Humanities and Art History*, Routledge Art History and Visual Studies Companions (New York: Routledge, 2020).

3 Looking, seeing, understanding

The discipline of art history revolves around objects (e.g. paintings) and images (e.g. that which is represented in paint). Stories on the origins of art in general, and painting in particular, can already be found in Pliny the Elder's *Naturalis Historia* (77–79 AD), for example.[16] They all have in common that the outlines of a person's shadow are traced. By the seventeenth century the art of painting had definitely become more sophisticated and a wide variety of materials was being used to create and support the image. The study of *constcamer* paintings within this project is primarily concerned with the analysis and interpretation of the image, regardless of its materiality.[17]

For example, it is certainly impressive to experience the grandeur of Rembrandt's *The Night Watch* (1642) physically and aesthetically in the Rijksmuseum.[18] But in order to examine and understand the iconographic meaning embedded in the image – a meaning which is both sociohistorically and culturally determined – the artwork can equally be studied from a screen, print, or any other form of reproduction.[19]

To study *constcamer* paintings, this project does not focus on applying one single method or theory. In line with the recommendations of Lorenz, I am using a "multilateral, multi-method approach" combining formalized methods such as iconology, semiotics, and image studies in order to study and interpret these images.[20] This means that, first of all, the pictorial properties of the artworks are looked at. The content of the images informs analysis and dictates the subsequent research necessary for interpretation. This is a process of looking, seeing or cognitively identifying what it is we are looking at, and determin-

16 Pliny, *The Natural History of Pliny*, trans. John Bostock and Henry T. Riley (London: H. G. Bohn, 1855), 35.5.

17 The branch of art history that deals with the materiality of artworks is called technical art history.

18 See Christopher Morse's contribution to this volume, Chapter 13.

19 See for example the highly detailed photograph of *The Night Watch* available via Rijksmusum, "Operation Night Watch", accessed October 15, 2020, https://www.rijksmuseum.nl/en/nightwatch.

20 Katharina Lorenz, *Ancient Mythological Images and Their Interpretation: An Introduction to Iconology, Semiotics and Image Studies in Classical Art History* (Cambridge: Cambridge University Press, 2016), 245. This book is an excellent resource for those who are not yet familiar with the study of images and their interpretation.

ing meaning.[21] In addition I document part of this process textually by means of annotations.

Annotating or adding information about what is represented in *constcamer* paintings poses a great challenge, mainly because there are no complementary sources that go with these pictures. Consequently, it can be very difficult to establish what you "see" when you do not know exactly what you are looking at. This difference between looking and seeing has already been discussed by Fleck (1896–1961) in his 1947 paper on the philosophy of science entitled "To Look, to See, to Know."[22] "Fleck distinguishes between 'looking' and 'seeing' – the former referring to the physiological process of visual perception, the latter to the cognitive aspect of identifying what someone is looking at."[23] Contextual knowledge, as Fleck argued, is often necessary in order to be able to see – "To see, one has first to know."[24]

Fleck's view is not that different from the theories of knowledge that prevailed in previous centuries, which can be traced all the way back to classical antiquity. Interestingly, he illustrates the problem of seeing shapes or forms with the example of letters of the alphabet.[25] The understanding of the visual experience was also given much thought in the Renaissance. Written text is something to be seen, just like a picture, and both text and image were conceived as part of visual culture. Moreover, according to Leonardo da Vinci (1452–1519), paintings give "unmediated access to nature that words cannot give," and painting thus constitutes a kind of universal language that can replace the written word.[26] The

21 This roughly corresponds to the three steps of iconology (i.e. phenomenal meaning, meaning dependent on content, and documentary meaning), or semiotic triangulation (of object, sign, and connotation). See Erwin Panofsky, "On the Problem of Describing and Interpreting Works of the Visual Arts," trans. Jaś Elsner and Katharina Lorenz, *Critical Inquiry* 38, no. 3 (2012): 482; and Lorenz, *Ancient Mythological Images*, 105.

22 Ludwik Fleck, "To Look, to See, to Know [1947]," in *Cognition and Fact: Materials on Ludwik Fleck*, ed. Robert S. Cohen and Thomas Schnelle, Boston Studies in the Philosophy of Science, vol. 87 (Dordrecht: D. Reidel Publishing Company, 1986), 129–51.

23 Tim Boon et al., "A Symposium on Histories of Use and Tacit Skills," *Science Museum Group Journal* 8, no. 8 (2020).

24 Fleck, "To Look," 134.

25 Fleck, "To Look," 131.

26 Pamela H. Smith, *The Body of the Artisan: Art and Experience in the Scientific Revolution* (Chicago: University of Chicago Press, 2004), 92; and David Summers, *The Judgment of Sense: Renaissance Naturalism and the Rise of Aesthetics*, Ideas in Context (Cambridge: Cambridge University Press, 1987), 137–9.

concern with "how to adjust words to things, or *verba* to *res*" remained prominent well into the seventeenth century.[27]

One of the reasons for the fascination with words and things (including images) at that time was the exploration of the New World and the discoveries this led to. Since there were no antique sources describing the novelties that were being found, there were no textual authorities to verify such findings.[28] Another reason was the "rise of the vernaculars" in an age of "inventorying and categorizing" the visible world, which often meant that words did not yet exist and had to be invented.[29] The complexity of the pictorial sign, however, is that the meaning it signifies is not fixed and depends on historical and sociocultural factors.[30]

As a result, the meaning of the *constcamer* with its many representations has been largely lost, while the image has survived. This demonstrates that the transfer of images as a universal language without contextual information does not stand the test of time. In concrete terms this means that only part of the iconographic significance of the *constcamer* can be deduced from its images. The remainder requires the study of various contemporary sources in order to penetrate into the intellectual mindset of the period in which they were made. The findings based on looking and seeing can be documented in a dataset, but not the processes of determining meaning.[31] Interpretation is inextricably linked to additional art historical research.

4 Classification and identification

The Order of Things by Michel Foucault (1926–1984) has been studied extensively in relation to museums and collections, but less so in connection with *constcamer* paintings or pictures of collections.[32] Foucault's form of historical

27 Thijs Weststeijn, "From Hieroglyphs to Universal Characters: Pictography in the Early Modern Netherlands," in *Netherlands Yearbook for History of Art – Nederlands Kunsthistorisch Jaarboek* 61, ed. Eric Jorink and Bartholomeus A. M. Ramakers (Zwolle: WBooks, 2011), 239.
28 Smith, *The Body of the Artisan*, 42.
29 Weststeijn, "From Hieroglyphs," 269.
30 Robert S. Cohen and Thomas Schnelle, eds., *Cognition and Fact: Materials on Ludwik Fleck*, Boston Studies in the Philosophy of Science, vol. 87 (Dordrecht: D. Reidel Publishing Company, 1986), xi–xii.
31 This corresponds to what in iconology is called documentary meaning, or connotation in semiotics (see above).
32 Most notably in Eilean Hooper-Greenhill, *Museums and the Shaping of Knowledge* (London: Routledge, 1992).

awareness is useful when dealing with such images. On systems of classification, he famously quotes

> a "certain Chinese encyclopedia" in which it is written that "animals are divided into: (a) belonging to the Emperor, (b) embalmed, (c) tame, (d) suckling pigs, (e) sirens, (f) fabulous, (g) stray dogs, (h) included in the present classification, (i) frenzied, (j) innumerable, (k) drawn with a very fine camel-hair brush, (l) *et cetera,* (m) having just broken the water pitcher, (n) that from a long way off look like flies." In the wonderment of this taxonomy, the thing that we apprehend in one great leap, the thing that, by means of this fable, is demonstrated as the charm of another system of thought, is the limitation of our own, the stark impossibility of thinking *that*.[33]

By replacing the example of a "Chinese encyclopedia" with a "*constcamer* painting," we realize that here too we are dealing with another system of thought.

For example, fossilized shark teeth (see orange frame in Fig. 1) were found on beaches and thought, in the seventeenth century, to be fish tongues or "tongue stones." They were categorized and depicted between other "stony" objects such as seashells and coral that were the subject of contemporary debates on petrifaction.[34] Another example is the display of musical instruments together with clocks – the latter being considered today purely as mechanical devices for timekeeping, but which were then treated like trumpets and violas, associated with the greater theory of universal harmony.[35] The writing of history, however, does require the "translation of past concepts and terms into ones that can be comprehended by modern-day audiences."[36] The same applies to the transformation of *constcamer*s and other images into data.

33 Michel Foucault, *The Order of Things; An Archaeology of the Human Sciences* (New York, 1971), xv; and Hooper-Greenhill, *Museums*, 4.

34 Marlise Rijks, "Catalysts of Knowledge; Artists' and Artisans' Collections in Early Modern Antwerp" (Ghent: Ghent University, 2016), 179 and 222–30. According to Rijks, it seemed impossible to classify coral at the time, because it was not known how it came into existence. Several classification suggestions were circulated (such as plant, stone, or animal), but no consensus was reached. See Marlise Rijks, "'Unusual Excrescences of Nature': Collected Coral and the Study of Petrified Luxury in Early Modern Antwerp," *Dutch Crossing* 43, no. 2 (2019): 140.

35 See for example the *Allegory of Hearing*, part of *The Five Senses* mentioned in the introduction.

36 Adam Mosley, "'Sundials and Other Cosmographical Instruments': Historical Categories and Historians' Categories in the Study of Mathematical Instruments and Disciplines," in *The Whipple Museum of the History of Science*, ed. Joshua Nall, Liba Taub, and Frances Willmoth (Cambridge: Cambridge University Press, 2019), 80.

Fig. 1: Frans Francken II, *Cabinet of Art and Curiosities*, ca. 1620–1625. Oil on panel, 74 x 78 cm. Vienna, Kunsthistorisches Museum of Vienna, Gemäldegalerie, Inv. no. 1048. © Wikimedia Commons, accessed September 28, 2020, https://commons.wikimedia.org/wiki/File:Frans_Francken_(II),_Kunst-_und_Rarit%C3%A4tenkammer_(1636).jpg; painting © Kunsthistorisches Museum Vienna, CC BY-NC-SA 4.0, www.khm.at/de/object/912d2b1c7b. The shark tooth has been highlighted with the orange box by the author.

5 Paintings as data

The question of how art historical objects and images can be converted into concepts and terms that can be understood by today's audience and, moreover, can be processed digitally, is one that was already being asked over fifty years ago.

> One way to bring an ideal system down to reality is to ask ourselves three questions. Once the program for the system is outlined, who will make it, who will use it, and who

> will maintain it? [. . .] The second question, “Who will use the archive?,” is prompted by a slogan found on the walls of many computer centers. It reads, “Your formula for failure is to try to please everybody.”[37]

Taking this advice to heart, I opted to cater mainly to my own needs. My dataset is set up so that it can easily be shared and used by others but, when making technical choices regarding the structure and format, for example, this was never a primary concern. And other potential users of this dataset will have their own equally specific needs, so it is not up to me to dictate their process. However, there are examples and best practices we can learn from.

As we have seen, present-day digital art history projects often focus on the contextual information that surrounds works of art, for example when conducting art market studies and provenance research.[38] This is understandable from a data point of view, since context usually deals with text and numbers rather than images.[39] Projects that, on the other hand, include the iconographic meaning of artworks to a greater or lesser degree are often related to museums. Online museum catalogs such as those of the Rijksmuseum and the Walters Art Museum sometimes indicate what is depicted in the online images of works from their collections.[40] In this way, users are given additional ways to search and explore the data, but this is nowhere near the level of detail required for art historical research.[41]

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37 Kenneth Lindsay, “Computer Input Form for Art Works: Problems and Possibilities,” in *Computers and Their Potential Applications in Museums : A Conference Sponsored by the Metropolitan Museum of Art, 1968* (New York: Arno Press, 1968), 21–2. For more recent approaches, see especially Ross Parry, ed., “(Part One) Information: data, structure and meaning,” in *Museums in a Digital Age*, Leicester Readers in Museum Studies (London: Routledge, 2010), 10–115.

38 Examples of such projects are the *London Gallery Project* and *Mapping Titian*, respectively, accessed September 28, 2020, http://learn.bowdoin.edu/fletcher/london-gallery/; and http://www.mappingtitian.org/.

39 Furthermore, “the lack of trained individuals to describe visual content is a continuing impediment to providing access to photographic and other visual collections,” as noted in Joan E. Beaudoin, “Describing Images: A Case Study of Visual Literacy among Library and Information Science Students,” *College & Research Libraries* 77, no. 3 (2016): 389.

40 Getty Foundation, *Museum Catalogues in the Digital Age: A Final Report on the Getty Foundation’s Online Scholarly Catalogue Initiative (OSCI)* (Los Angeles: Getty Foundation, 2017); and Claire Quimby, *Digital Catalogues Study: A Cross-Institutional User Study of Online Museum Collection Catalogues* (Chicago: Art Institute of Chicago, 2019), https://digpublishing.github.io/catalogues-study/. See for example http://hdl.handle.net/10934/RM0001.collect.96871; and https://art.thewalters.org/detail/14623/the-archdukes-albert-and-isabella-visiting-a-collectors-cabinet/, all accessed October 16, 2020.

41 This statement is based on my extensive research in 2017 into the usability of datasets, such as those of the Rijksmuseum and Metropolitan Museum of Art, for answering art historical

One of the online projects that bring together and present art historical data from numerous museum and other collections is the website janbrueghel.net. This website offers a complete catalog of the works of Jan Brueghel I and includes two companion sites dedicated to Pieter Bruegel I (Jan I's father) and the Brueghel family.[42] Together they are "meant to provide ways of furthering our understanding of how the Brueg(h)el family produced a complex body of interconnected work."[43] The catalog entries are sometimes accompanied by a discussion section that offers valuable insights into past and present scholarly debates. While tags are a means of roughly indicating what the artworks represent, image annotation is not the main concern of this particular website.

The Wikimedia Commons website, on the other hand, has implemented a different solution to annotating and referring to other Wikimedia image entries. Its online image of the *constcamer* painting *Cabinet of Art and Curiosities* (ca. 1620–1625) (Fig. 1), for example, is supplemented with several annotations that become visible when moving the mouse pointer over the image.[44] These mouse-overs show either a text or an image, notably of the paintings represented in the *constcamer*, and clicking on one of these takes the user to the Wikimedia entry for that specific artwork.[45]

Wikimedia's annotations are an elegant solution, but the inclusion of text that can be entered freely results in descriptions such as "? *Mitra cardinalis*" and "probably some *Amphidromus*" regarding the seashells on display in Fig. 1. From a computational point of view it would be desirable to structure such data by using controlled vocabularies, so that all depictions annotated with *Mitra cardinalis* are understood as the same type of seashell. When in doubt about what kind of seashell is represented, it would be more reasonable to simply annotate "seashell" instead of including a question mark in the annotation.

questions. Some of the results can be found on "Visualizing Visions", accessed October 18, 2020, http://visualizingvisions.com/.

42 Elizabeth Honig, "Jan Brueghel," University of Maryland, Baltimore, accessed September 28, 2020, http://www.janbrueghel.net/.

43 Elizabeth Honig, "Pieter Bruegel" and "Brueghel Family," University of Maryland, Baltimore, http://pieterbruegel.net/; and http://brueghelfamily.net/, both accessed September 28, 2020.

44 Wikimedia Commons, "Chamber of Art and Curiosities," accessed September 28, 2020, https://commons.wikimedia.org/wiki/File:Frans_Francken_(II),_Kunst-_und_Raritätenkammer_(1636).jpg.

45 One of the small portraits on the left, for example, links to Peter Paul Rubens' *Abraham Ortelius*, available at https://commons.wikimedia.org/wiki/File:Abraham_Ortelius_by_Peter_Paul_Rubens.jpg, accessed January 7, 2021.

The Getty Vocabularies are usually at the basis of digital art history projects dealing with datasets.[46] These controlled vocabularies are reference works that contain structured terminology for categorizing works of art and architecture (in the Art & Architecture Thesaurus, or AAT), their creators and current owners (in the Union List of Artist Names, or ULAN), and associated geographic names (in the Getty Thesaurus of Geographic Names, or TGN). These vocabularies have been in development since the late 1960s for museum cataloging and information retrieval.[47] It is important to keep in mind, however, that historical terms and concepts are not necessarily part of the vocabularies. For example, "fish tongues" or

Fig. 2: Jan Brueghel II, *Allegory of Sight (Venus and Cupid in a Picture Gallery)*, ca. 1660. Oil on copper, 58.1 x 89.7 cm. Philadelphia, Philadelphia Museum of Art, Inv. no. 656. © Wikimedia Commons, accessed September 28, 2020, https://commons.wikimedia.org/wiki/File:Jan_Breughel_II_-_Allegory_of_Sight_-_gallery_painting_Cat656.jpg; painting © Philadelphia Museum of Art, accessed September 28, 2020, https://www.philamuseum.org/collection/object/102459. The sector has been highlighted with the rectangular box by the author.

46 Diane M. Zorich, *Transitioning to a Digital World: Art History, Its Research Centers, and Digital Scholarship* (The Samuel H. Kress Foundation & The Roy Rosenzweig Center for History and New Media, George Mason University, 2012); and Patricia Harpring, *Introduction to Controlled Vocabularies: Terminology for Art, Architecture, and Other Cultural Works*, 1st ed. (Los Angeles, CA: Getty Research Institute, 2010).

47 Brown, *The Routledge Companion*, 440.

"tongue stones" are not included in the Getty's AAT, but "shark teeth" are, yet without reference to earlier interpretations.[48]

6 *Constcamer* paintings as data

Annotating paintings can be a complex task and involves collecting metadata, then breaking down the content of the images into thematic and iconographic elements. Conceptually, my dataset consists of "entities" and "links": an entity can be connected to another entity through such a link. For example, the *constcamer* painting entitled *Allegory of Sight (Venus and Cupid in a Picture Gallery)* (Fig. 2) is an entity. Another entity is the painting's artist, the person Jan Brueghel II (Jan I's son). These two entities are connected to each other by means of the link type "creator." In this way it is documented that the *Allegory of Sight* was created by Jan Brueghel II, the Flemish painter and draftsman who lived from 1601 to 1678.[49] It is useful to refer to Jan Brueghel II's record in the Getty's ULAN because his name can be written in many ways but, with the ULAN, we know exactly which artist is meant.[50]

The same method is used to annotate what is depicted in a *constcamer* painting, only this time with the link type "depicts." The entity *Allegory of Sight* depicts among other things the entity "sector." This term can mean different things, and therefore reference is made to a specific Getty AAT record that describes sectors, in this context, as "proportional measuring gauges consisting of two straight, metal bars hinged at one end and graduated for measuring; used in clockmaking" (see Fig. 2).[51] By the end of the sixteenth century, the period of its invention, the main use of the sector was to solve mathematical problems, and the design of the instrument was continuously improved upon – but this aspect is not captured by the Getty Vocabularies.

48 Getty Research Institute, "Shark Teeth" (AAT), accessed October 16, 2020, http://vocab.getty.edu/page/aat/300379302.
49 Getty Research Institute, "Brueghel, Jan, the younger" (ULAN) accessed September 28, 2020, http://vocab.getty.edu/page/ulan/500013747.
50 Whenever an artist is missing from the Getty's ULAN, the Netherlands Institute for Art History's online resource "RKD Explore" is used as the authority instead. See for example, The Netherlands Institute for Art History (RKD), "Jan Breughel (II)," accessed September 28, 2020, https://rkd.nl/explore/artists/13289.
51 Getty Research Institute, "Sectors" (AAT), accessed September 28, 2020, http://vocab.getty.edu/page/aat/300201680.

Additionally, the list of terms in other languages provided by Getty's AAT is far from comprehensive. The sector is referred to in French as the *compas de proportion*, in German as the *Proporzionalzirkel*, in Dutch as the *proportionaalpasser*, and in Italian as the *compasso di proporzione*. The proportional compass, however, is known in French as the *compas de réduction*, in German as the *Reduktionszirkel*, in Dutch as the *reductiepasser*, and in Italian as the *compasso di riduzione*.[52] To complicate matters even further, each inventor who developed a variation on the sector, around the year 1600 that is, also gave their invention a new name. Thomas Hood (ca. 1556–1620) was the first to call his instrument a sector, inspired by Euclid's *Elements*, while Michiel Coignet (1549–1623) speaks of his *pantomètre*, and Muzio Oddi (1569–1639) of his *compasso polimetro*.[53]

Nevertheless, the entity "sector" provides a basis for mapping and comparing all instances of representations of this type in *constcamer* paintings. Such annotations are the result of looking and seeing understood as the cognitive identification of what we are looking at. In order to determine meaning we need to broaden our view and take into account not only the realistic, but also the allegorical qualities of a *constcamer* painting such as the *Allegory of Sight*. Its overall theme is the sense of sight, the most important of the five classical senses (i.e. sight, hearing, taste, touch, and smell).[54] The inclusion of a mathematical instrument such as the sector in this painting suggests a symbolic significance of the instrument as an aid to vision or a tool to improve sight.

7 The *constcamer* dataset: Possibilities and limitations

The sector is just one small representation – of about 3.8 by 3.6 centimeters – amid many others in the *Allegory of Sight*. Each of the represented objects,

52 Ad Meskens, "Michiel Coignet's Contribution to the Development of the Sector," *Annals of Science* 54 (1997): 143. See also, Getty Research Institute, "Proportional Compasses" (AAT), accessed September 28, 2020, http://vocab.getty.edu/page/aat/300022492; and https://catalogo.museogalileo.it/approfondimento/Compasso.html.

53 Robert Bud and Deborah Jean Warner, eds., *Instruments of Science: An Historical Encyclopedia*, Garland Encyclopedias in the History of Science, vol. 2 (New York: Garland Publishing, 1998), 527; and Filippo Camerota, *The Geometric and Military Compass of Galileo Galilei*, ed. Filippo Camerota and Giorgio Strano, Scientific Instruments: History, Exploration, Use 1 (Florence: Scatolificio Isolotto, 2004), 62.

54 Charles M. Peterson, "The Five Senses in Willem II van Haecht's *Cabinet of Cornelis van der Geest*," *Intellectual History Review* 20, no. 1 (2010): 105–9.

animals, plants, people, and interior and exterior elements have stories of their own. This abundance of data can be effectively collected and archived in a relational database management system. My project makes use of a no-code development platform (NCDP), which is database management software with a graphical user interface.[55] Currently, my dataset holds 161 *constcamer* paintings in the form of images and associated information. These give rise to approximately 3,400 entities that are connected to each other via 13 link types. In total I have recorded about 12,700 such connections between these entities.

The *constcamer* dataset describes the contents of pictures of collections. These paintings provide insight into contemporary thoughts on the organization of items included in collections and the associated meanings they represented.[56] Having to be precise when naming the individual entities depicted in *constcamer* paintings actually leads to improved vision. A shark tooth or sector can easily be overlooked, but this is less likely when applying a label to each representation in a painting. In this way annotation promotes accuracy, which generates a more extensive overview of what is displayed in the seventeenth-century pictures of collections. Moreover, by looking at *constcamer* paintings collectively, repetitions of subject matter and certain entities can readily be observed.

At the same time, there are the issues of transformation and translation. As we have seen, the dataset requires a transformation of *constcamer* paintings into data. These data are a modern interpretation of the pictorial content and require additional translation to expose historical and ideological meanings. The *constcamer* dataset is therefore not an interpretation or conclusion in itself, but rather a starting point for further analysis.

8 Conclusion

Constcamer paintings are rich and varied images whose content can be "reviewed" via a dataset. While the dataset is an integral part of digital art history, the analysis and annotation of images is currently an underrepresented area of work in this field. One of the main reasons for this is that a transformation is needed to turn artworks into representative digital equivalents. A

55 For a brief overview of NCDPs, see, https://www.g2.com/categories/no-codedevelopment-platforms, accessed September 28, 2020.

56 See especially "Vorrede – Das Objeckt als Symbol" in Andreas Grote, ed., *Macrocosmos in Microcosmo: Die Welt in der Stube: Zur Geschichte des Sammelns, 1450 bis 1800*, Berliner Schriften zur Museumskunde, vol. 10 (Opladen: Leske + Budrich, 1994), 11–9.

further difficulty is that images from bygone eras reflect systems of thought that are different from our own. The ensuing process of translation results in a mediated access to the content of the images, the meaning of which can only be determined on the basis of knowledge of the contexts in which artworks and their creators existed.

The annotation of *constcamer* paintings by means of controlled vocabularies enables the retrieval of information by expert and non-expert users alike. This information is collected by looking, and by identifying what we see. A dataset makes it possible to archive a large number of identifications and the relations between these identifications, as well as to share them with the scholarly community and an interested audience. The *constcamer* dataset is thus a tool that allows for better vision. The act of interpretation, or understanding what a certain representation means, is not recorded digitally because – as is wisely inscribed on a piece of paper depicted in *The Interior of a Picture Gallery with Personifications of Pictura and Disegno* (ca. 1630) of which the Flemish painter is not known – "*aly et alia vident*" or, "others see it yet otherwise."[57]

References

Baca, Murtha, Anne Helmreich, and Melissa Gill. "Digital Art History." *Visual Resources* 35, 1–2 (2019): 1–5. https://doi.org/10.1080/01973762.2019.1556887.

Beaudoin, Joan E. "Describing Images: A Case Study of Visual Literacy among Library and Information Science Students." *College & Research Libraries* 77, 3 (2016): 376–92. https://doi.org/10.5860/crl.77.3.376.

Bentkowska-Kafel, Anna. "Debating Digital Art History." *International Journal for Digital Art History* 1 (2015): 51–64.

Bishop, Claire. "Against Digital Art History." Humanities Futures, Franklin Humanities Institute, 2017. Accessed September 20, 2020. https://humanitiesfutures.org/papers/digital-art-history/.

Boon, Tim et al. "A Symposium on Histories of Use and Tacit Skills." *Science Museum Group Journal* 8 (2020). https://doi.org/10.15180/170808.

Brandhorst, Hans. "Aby Warburg's Wildest Dreams Come True?" *Visual Resources* 29, 1–2 (2013): 72–88. https://doi.org/10.1080/01973762.2013.761129.

Brown, Kathryn, ed. *The Routledge Companion to Digital Humanities and Art History*. Routledge Art History and Visual Studies Companions. New York: Routledge, 2020.

Bud, Robert, and Deborah Jean Warner, eds. *Instruments of Science: An Historical Encyclopedia*. Garland Encyclopedias in the History of Science, vol. 2. New York: Science

57 Michael John Gorman and Alexander Marr, "'Others See It Yet Otherwise': Disegno and Pictura in a Flemish Gallery Interior," *The Burlington Magazine* 149 (2007): 88.

Museum, London, and National Museum of American History, Smithsonian Institution, in association with Garland Pub, 1998.
Bury, Stephen et al. “Art History in Digital Dimensions: The White Paper.” Washington D.C.: Frick Art Reference Library, February 2017. Accessed June 17, 2021. http://dah-dimensions.org/report/.
Camerota, Filippo. *The Geometric and Military Compass of Galileo Galilei*. In S*cientific Instruments: History, Exploration, Use 1*, edited by Filippo Camerota and Giorgio Strano, 62. Florence: Scatolificio Isolotto, 2004.
“CODART Foundation”, Accessed September 28, 2020. https://canon.codart.nl.
Cohen, Robert S., and Thomas Schnelle, eds. *Cognition and Fact: Materials on Ludwik Fleck. Boston Studies in the Philosophy of Science*, vol. 87. Dordrecht: D. Reidel Publishing Company, 1986: xi–xii.
Drucker, Johanna. *Visualization and Interpretation: Humanistic Approaches to Display*. Cambridge, Massachusetts: The MIT Press, 2020.
Drucker, Johanna. “Is There a ‘Digital’ Art History?” *Visual Resources* 29, 1–2 (June 2013): 5–13. https://doi.org/10.1080/01973762.2013.761106.
Fleck, Ludwik. “To Look, to See, to Know [1947].” In *Cognition and Fact: Materials on Ludwik Fleck*, edited by Robert S. Cohen and Thomas Schnelle, Boston Studies in the Philosophy of Science, vol. 87, 129–51. Dordrecht: D. Reidel Publishing Company, 1986.
Foucault, Michel. *The Order of Things; An Archaeology of the Human Sciences*. New York: Pantheon Books, 1971.
Getty Foundation. “Museum Catalogues in the Digital Age: A Final Report on the Getty Foundation’s Online Scholarly Catalogue Initiative (OSCI).” Los Angeles: Getty Foundation, 2017.
Getty Research Institute. “Art & Architecture Thesaurus Online” (AAT) Accessed September 28, 2020. http://www.getty.edu/research/tools/vocabularies/aat/.
Getty Research Institute. “Union List of Artist Names Online” (ULAN) Accessed September 28, 2020. http://www.getty.edu/research/tools/vocabularies/ulan/.
Gorman, Michael John, and Alexander Marr. “‘Others See It Yet Otherwise’: Disegno and Pictura in a Flemish Gallery Interior.” *The Burlington Magazine* 149 (2007): 85–91.
Grote, Andreas, ed. *Macrocosmos in Microcosmo: Die Welt in der Stube: Zur Geschichte des Sammelns, 1450 bis 1800*. Berliner Schriften zur Museumskunde, vol. 10. Opladen: Leske + Budrich, 1994.
Harpring, Patricia. *Introduction to Controlled Vocabularies: Terminology for Art, Architecture, and Other Cultural Works*. 1st ed. Los Angeles, CA: Getty Research Institute, 2010.
Honig, Elizabeth, “Jan Brueghel,” “Pieter Bruegel” and “Brueghel Family,” University of Maryland, Baltimore. Accessed September 28, 2020, http://www.janbrueghel.net/; http://pieterbruegel.net/; http://brueghelfamily.net/.
Hooper-Greenhill, Eilean. *Museums and the Shaping of Knowledge*. London: Routledge, 1992.
Lindsay, Kenneth. “Computer Input Form for Art Works: Problems and Possibilities.” *Computers and Their Potential Applications in Museum: A Conference Sponsored by the Metropolitan Museum of Art*, 19–37. New York: Arno Press, April 15–17, 1968.
Lorenz, Katharina. *Ancient Mythological Images and Their Interpretation: An Introduction to Iconology, Semiotics and Image Studies in Classical Art History*. Cambridge: Cambridge University Press, 2016.
Manovich, Lev. “Data Science and Digital Art History.” *International Journal for Digital Art History* 1 (2015): 13–35.

Marr, Alexander. "The Flemish 'Pictures of Collections' Genre: An Overview." *Intellectual History Review* 20, 1 (2010): 5–25. https://doi.org/10.1080/17496971003638233.

Meskens, Ad. "Michiel Coignet's Contribution to the Development of the Sector." *Annals of Science* 54 (1997): 143–60.

Mosley, Adam. "'Sundials and Other Cosmographical Instruments': Historical Categories and Historians' Categories in the Study of Mathematical Instruments and Disciplines." In *The Whipple Museum of the History of Science*, edited by Joshua Nall, Liba Taub, and Frances Willmoth, 1st ed., (2019): 55–82. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781108633628.004.

Panofsky, Erwin. "On the Problem of Describing and Interpreting Works of the Visual Arts." Translated by Jaś Elsner and Katharina Lorenz. *Critical Inquiry* 38, 3 (2012): 467–82. https://doi.org/10.1086/664547.

Parry, Ross, ed. *Museums in a Digital Age*. Leicester Readers in Museum Studies. London: Routledge, 2010.

Peterson, Charles M. "The Five Senses in Willem II van Haecht's *Cabinet of Cornelis van der Geest*." *Intellectual History Review* 20, 1 (2010): 103–21. https://doi.org/10.1080/17496971003638274.

Pliny. *The Natural History of Pliny*. Translated by John Bostock and Henry T. Riley. London: H. G. Bohn, 1855. https://doi.org/10.5962/bhl.title.32866.

Quimby, Claire. "Digital Catalogues Study: A Cross-Institutional User Study of Online Museum Collection Catalogues." Chicago: Art Institute of Chicago, 2019. Accessed June 17, 2021. https://digpublishing.github.io/catalogues-study/

Rijks, Marlise. "Catalysts of Knowledge: Artists' and Artisans' Collections in Early Modern Antwerp." Ghent University, 2016.

Rijks, Marlise. "'Unusual Excrescences of Nature': Collected Coral and the Study of Petrified Luxury in Early Modern Antwerp." *Dutch Crossing* 43, 2 (2019): 127–56. https://doi.org/10.1080/03096564.2017.1299931.

Schelbert, Georg. "Digital Art History – Digitale Kunstgeschichte, Überlegungen zum Aktuellen Stand." In *Computing Art Reader: Einführung in die Digitale Kunstgeschichte*, edited by Piotr Kuroczyński, Peter Bell, and Lisa Dieckmann, 41–57. Computing in Art and Architecture, vol. 1. Heidelberg: arthistoricum.net, 2018.

Smith, Pamela H. *The Body of the Artisan: Art and Experience in the Scientific Revolution*. Chicago: University of Chicago Press, 2004.

Speth-Holterhoff, Simone. *Les Peintres Flamands de Cabinets d'Amateurs au XVIIe Siècle*. Brussels: Elsevier, 1957.

Summers, David. *The Judgment of Sense: Renaissance Naturalism and the Rise of Aesthestics*. Ideas in Context. Cambridge: Cambridge University Press, 1987.

The Netherlands Institute for Art History (RKD), "Jan Breughel (II)." Accessed September 28, 2020. https://rkd.nl/explore/artists/13289.

Weststeijn, Thijs. "From Hieroglyphs to Universal Characters: Pictography in the Early Modern Netherlands." In *Netherlands Yearbook for History of Art – Nederlands Kunsthistorisch Jaarboek* 61, edited by Eric Jorink and Bartholomeus A. M. Ramakers, 239–80. Zwolle: WBooks, 2011.

Wikimedia Commons. The free media repository. Accessed September 28, 2020. https://commons.wikimedia.org/wiki/Main_Page.
Zorich, Diane M. "Transitioning to a Digital World: Art History, Its Research Centers, and Digital Scholarship." The Samuel H. Kress Foundation & The Roy Rosenzweig Center for History and New Media George Mason University, 2012.
Zweig, Benjamin. "Forgotten Genealogies: Brief Reflections on the History of Digital Art History." *International Journal for Digital Art History* 1 (2015): 37–49.

Sytze Van Herck

Historians as computer users

Organizing sources with digital asset management for a history of computing

Mass digitization and born-digital sources have changed the work of historians, archivists, and museologists. Many historians spend less time in the archives, instead photographing or scanning sources on short research visits. In other cases archivists and museologists create online repositories to make sources more accessible. But what happens to all the photographs and scans researchers collect? This chapter studies how data management and curation influence historical research with textual, (audio)visual, and material sources regarding the history of the design and use of computing devices.

Placing computers into a broader context, my research focuses on the societal, business, and labor developments that are at the basis of computing devices. My PhD dissertation deals with the emergence of new occupations and changes in existing labor structures in relation to different computer models. Computers have also had an impact on both the workspace and the workflow of the user. Lastly, marketing has created an image of the idealized and archetypal user and has influenced gender stereotypes. To illustrate the evolution of the design and use of computer devices, my dissertation is based on objects and their representation in images, audiovisual sources, texts, and other sources such as drawings.

Since my primary sources were located across Europe and the United States, the time I could spend in museums and archives was limited. Rather than combining source collection and analysis during my research visits, I instead used these visits to briefly look at the objects on display, or sources in the archive catalog, to decide whether or not to digitize. Section 1 therefore looks into the different approaches for selecting sources before, during, and after museum and archive visits. Additionally, each section of this chapter discusses one or more of

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the FAIR *Guiding Principles for scientific data management*.[1] FAIR stands for findable, accessible, interoperable, and reusable, and these principles can be used to evaluate existing research datasets such as museum and archive catalogs, or as selection criteria for research data management tools. Section 1 places a particular focus on the first FAIR principles of findable and accessible data.

After spending a day in the museum or archive, I usually amassed between 200 and 700 photographs, depending on the number of objects and archival sources I selected and photographed. Seven museum and seven archive visits have resulted in a total of over 18,000 photographs. In order to remember when, where, and what was digitized, the structure and organization of notes, photographs, and/or scans was essential. The metadata needed to be rigid enough to relocate a source, yet flexible enough to reorganize and recombine sources to facilitate analysis.

Section 2 discusses the digitization process and is followed in Section 3 by an analysis of (meta)data structure and documentation practice using the Tropy data asset management tool. Section 4 focuses on the influence of the interface and algorithms on the analysis stage of research, as well as on the final FAIR principles of data being interoperable and reusable. The chapter concludes with a reflection on the notion of the "original," the consequences of curating or selecting sources, the value of digital asset management, and the human factors that influence digital historical research.

1 Selecting sources

Since my research covers an array of machines, users, and applications, my dissertation is composed of several historical case studies. In the first stage I selected different types of computing devices – such as punch card equipment, a mainframe, a minicomputer, a microcomputer, and a personal computer – which differed in medium, size, price, and application. After exploratory visits to several computer history museums in the United Kingdom, Germany, and the United States, I limited the selection to specific computer manufacturers and models.

The first case study centers around Remington Rand and Powers-Samas equipment for punch cards used in accounting in the 1950s. The second case study shifts to the 1960s with IBM's System/360 mainframe, aimed at small and medium-sized companies, while the third study focuses on a computer model

1 Mark D. Wilkinson et al., "The FAIR Guiding Principles for Scientific Data Management and Stewardship," *Scientific Data* 3, no. 1 (2016): 1–9.

from the 1970s: the PDP-11 minicomputer developed by the Digital Equipment Company (DEC) and used in the aerospace industry. The final two case studies compare a microcomputer from the United Kingdom, the BBC Micro, with the Apple *II*e personal computer from the United States, both of which were popular in schools in the 1980s.[2]

The framework of life cycle studies from material culture allows a comparison of different computing devices based on Henry Glassie's three main contexts of objects, namely "creation, communication and consumption."[3]These contexts translate to the following life cycle stages for computers: design and manufacturing (creation), sales and marketing (communication), and installation and use (consumption). The refined selection of case studies above formed the basis of my preparation for archive visits.

Reviewing the policies of the archive or museum in detail before a visit is paramount, in order to check whether scans or photographs are allowed, what has already been digitized, and how the collection is organized.[4] Limiting the research question to a small number of case studies helped me select only relevant objects and sources. Ideally, a museum or archive's online catalog allowed browsing, filtering, and search. Finding aids were especially helpful to get an idea of the material an archive offered. In large collections, even specific searches sometimes generated too many results, so filtering could refine results further.[5] Reviewing the temporary and permanent exhibitions in advance also made for a more efficient museum visit.

For both museum objects and archival records, most items are not on display but located in storage, either on-site or further away. Furthermore, archives have not usually cataloged their entire holdings and certain (sensitive) information might even be withheld from the publicly available online catalog. The internal catalog of the institution often contains more extensive metadata. Metadata is "data about (digital) data or any physical or conceptual object."[6] As Leonie Hannan and Sarah Longair remind researchers in their research guide, "the composition of collections is shaped by a variety of factors including the

2 Sytze Van Herck, "Re/constructing Computing Experiences. From 'punch girls' in the 1940s to 'computer boys' in the 1980s." (PhD diss., University of Luxembourg), xxxi.

3 Henry Glassie, *Material Culture* (Bloomington: Indiana University Press, 1999), 48.

4 For further guidance on preparing research visits to museums see Leonie Hannan and Sarah Longair, *History through Material Culture*, IHR Research Guides (Manchester: Manchester University Press, 2017), 95–120.

5 See chapter 6 of Eva Andersen in this volume.

6 Julia Damerow and Dirk Wintergrün, "The Hitchhiker's Guide to Data in the History of Science," *Isis* 110, no. 3 (2019): 514.

purpose for its foundation and the original contents; decisions made by collectors, donors, and curators; the institution's changing priorities and locality; and its resources and size."[7]

As Gerben Zaagsma puts it, "digitisation is about selection" based on a variety of criteria which are rarely made explicit and certainly influenced by costs or funding.[8] At some of the museums, the enthusiasm of volunteers and staff – and their preference for certain computer models – together with the availability of sources that provided a glimpse of users from the past, certainly influenced my selection of case studies. Additionally, my time in archives across the world was limited as I had a generous but not unlimited amount of funding – and this too impacted my selection.[9]

Unlike library catalogs, which often use the same metadata format (MARC, or machine-readable cataloging) to develop online public access catalogs (OPACs) – and for which global catalogs such as Worldcat allow researchers to search beyond a single institution – museum and archive catalogs are rarely searchable through a single global catalog due to the diverse nature of items in the collections. Many initiatives such as the Conceptual Reference Model of the International Council for Documentation (CIDOC-CRM), which is a Linked Open Data ontology to describe metadata, in combination with overarching collections like Europeana, attempt to standardize metadata across cultural heritage institutions and thus create search portals beyond single institutions.[10] However, each institution I visited used a different portal. As Fotis Lazarinis concludes after listing the advantages of OPACs over card catalogs, "encoding data using the same format promotes interoperability among digital library tools."[11]

Some catalogs accommodated browsing, whereas the interface of others was only meant for search. Browsing allows researchers to discover sources they were not necessarily looking for and provides an overview of the institution's collections and structure. Searching, however, is only useful if you know what you are looking for. The Computer History Museum in Mountain View, California made archival finding aids available as PDFs describing each collection donated to the museum and listing nearly all individual items, thus allowing me to explore its

7 Hannan and Longair, *History through Material Culture*, 98.

8 Gerben Zaagsma, "On Digital History," *BMGN – Low Countries Historical Review* 128, no. 4 (2013): 20–1.

9 Supported by the Luxembourg National Research Fund (FNR) (10929115).

10 "What is the CIDOC CRM?," accessed October 1, 2020, http://www.cidoc-crm.org/; and "About Us," Europeana, accessed October 1, 2020, https://www.europeana.eu/en/about-us.

11 Fotis Lazarinis, "Introduction to Cataloguing Classification," in *Cataloguing and Classification*, ed. Fotis Lazarinis (Boston: Chandos Publishing, 2015), 1–17.

content before my visit.[12] Another unexpected find occurred while I was browsing the Centre for Computing History's website, where I discovered a single box filled with documents from a former Helena Rubinstein employee which provided the foundation for an entire case study.[13]

Helena Rubinstein was one of three influential female business owners in the cosmetics industry and was described by Life Magazine in 1941 as belonging to the "matriarchy of the beauty industry."[14] The company's billing departments in the United States and United Kingdom used punch card equipment and Madame Helena Rubinstein helped to promote this technology in the 1940s and 1950s. Since both advertisements and company documents have survived, comparing the changing gender composition of the beauty industry and the punch card industry brought to light some interesting parallels.

Other catalogs, such as the OPAC catalog of the Living Computers Museum + Labs, were difficult to locate on the museums' website and had been designed for searching rather than browsing.[15] Browsing through finding aids respects the original order of a collection and is thus particularly useful in the exploratory phase of a study, whereas search functionality facilitates making connections across collections, which can aid not only the selection of sources but also the analysis of the material. In any case, "the ability to formulate meaningful queries and an awareness of how these queries might influence the search results and thus the analytical outcome is essential."[16]

Before each archive or museum visit I created a spreadsheet listing the collection, box, call number, date, and short title of each item of interest to my research. Depending on the institution's policy I either contacted the archivist beforehand or when I arrived. The policy of the Computer History Museum, for instance, only allowed researchers to consult a maximum of ten boxes per day, meaning I had to pare down my original selection. Choosing only those boxes with either very important or many items per box, I managed to shorten my list. Adding simple tick boxes to my spreadsheet also helped me keep track of the

12 "Archival Finding Aids," accessed October 1, 2020, https://www.computerhistory.org/collections/findingaids/.

13 "Powers-Samas & ICT Documentation," accessed October 1, 2020, http:// www.computinghistory.org.uk/det/28274/Powers-Samas-ICT-Documentation/.

14 Elaine Brown Keiffer, "Madame Rubinstein. The Little Lady from Krakow Has Made a Fabulous Success of Selling Beauty," *Life* 11, no. 3 (1941): 40.

15 The catalog has, at the time of writing, been suspended indefinitely due to the closure of the museum during the COVID-19 pandemic. "Living Computers: Museum+Labs is Closing for Now," accessed October 5, 2020, http://livingcomputers.org/Closure.aspx.

16 Zaagsma, "On Digital History," 25.

items I selected and photographed, meaning I could just take very short notes for each item while I was on-site.

As for any historical research, the selection of sources depends on the research question and scope of the project. The sources available in turn influence the delimitation of the research question in terms of temporal and geographical boundaries and thus refine the topic. For instance, I originally intended to cover the entire twentieth century but noticed that the case studies differed substantially after the 1980s and required more context regarding networks and the advent of the World Wide Web. Furthermore, computing devices in the first half of the twentieth century revolved around improvements in punch card machines or single-purpose installations for defense or research projects, which have already been extensively researched and had fewer users. Therefore, the temporal delimitation of my research question was reduced from the entire twentieth century to the period between the 1940s and the 1980s.

2 Digitizing sources

Many historians rarely mention the technical setup and equipment they use during archive visits. In this section I intend to make my process more explicit, given my interest in the use of technology both as a subject of study and as a user myself. I digitized most sources on-site. Due to the large variety of material objects, textual, and visual sources, a camera was more appropriate than a portable scanner. Although our media center provides compact digital cameras, I preferred my own camera for its SR+ setting which "automatically optimizes settings to suit the scene" and its TEXT setting that ensures clear images of text or drawings in print.[17] The lighting in archive and museum settings and the limited time frame of research visits, as well as a lack of professional photography training, resulted in acceptable rather than professional digitization. Aside from a camera, I took along an SD memory card reader and an external hard drive to back up the photographs, a ReMarkable tablet to take notes, a laptop to go over my list of items and quickly look up additional information, and chargers for each device, just in case. In museums I also used my smartphone to record short videos of functioning computers.[18]

17 "FujiFilm Digital Camera X20 Owner's Manual," 32, 34, 38, accessed September 28, 2020, https://dl.fujifilm-x.com/support/manual/x/fujifilm_x20_manual_en.pdf.
18 An iPhone SE from 2016.

At the Centre for Computing History in Cambridge in the United Kingdom I established a useful workflow for documenting a single machine. First, an overview photograph showed the setup of a computer, then I photographed each component or peripheral such as the screen, keyboard, or mouse, followed by the object description. In some cases, exceptional inscriptions or signs of wear were also interesting, such as the names of schools printed on some of the BBC Micro computers. Perspective was also important, to convey the dimensions of the object.

Including the folder or item number where possible, at least for the first and/or last photograph of the same source helps to distinguish photographs of archival sources later on. In addition, respecting the order of a source by photographing one page, folder, or object after another saves time in comparing notes to photographs. At the end of each day, I copied all the images including metadata into the correct folder (one for each museum or archive) on my laptop and immediately created a backup on an external hard drive. At first I made the mistake of renaming files according to the model of the computer being photographed, but quickly realized that this disrupted the order of the photographs. Adding tags to files directly, without a clear ontology or structure in place to ensure consistency was disorganized – plus the document tags were difficult to export. Because of these difficulties I switched to dedicated software to organize the photographs.

Among some especially challenging sources to digitize were slides from the 1970s in the DEC collection of the Computer History Museum.[19] Using a light box was useful for capturing the image of the slides but obscured the handwritten text on the frame. In the worst instances this meant I had trouble identifying the subject, location, or date of the slide later on. Digitizing the museum objects was challenging for two reasons. Firstly, in crowded museums, visitors were sometimes accidentally included in the photographs and needed to be cropped out later. Secondly, images of reflective surfaces such glass display cases or computer screens could not be included if they showed visitors or the photographer/researcher. Finally, when the battery of the camera ran low or my muscles became sore and the images were not sharp, some text was no longer legible and some sources became unusable.

19 Bo Doub, Kim Hayden, and Sara Chabino Lott, "Guide to the Digital Equipment Corporation Records," Computer History Museum, 2017, accessed November 12, 2020, https://www.computerhistory.org/collections/catalog/102733963.

3 Documenting collections

Choosing a tool or method always depends on what works for the project. Collaborative projects need software that allows each team member to interact with documents on a shared server or in a cloud infrastructure, whereas an individual researcher dealing with sensitive or copyrighted material certainly cannot share files and needs sufficient storage on a single device. For some researchers, combining images into a single PDF and adding each to a bibliography management tool such as Zotero is the easiest and most efficient solution. Others choose to build their own dataset or turn to other digital asset management software.[20]

When selecting a tool or method it is essential to first determine the requirements, keeping in mind the budget, digital literacy, and time investment. Since annotating images is just one step in the research project, it is important to consider whether the tool fits the research ecosystem. Criteria for evaluating the suitability of a tool include, for example, the workflow, compatibility with other research tools, or integration into a website.

Tropy is one of the first research photo management tools specifically designed for historians. Digital asset management software helps researchers to annotate, structure, and recombine not only text, or photographs, but also audio, video, and even 3D renditions of objects. For now, files are stored locally which means that neither synchronization between different machines nor collaboration with others is possible. Fortunately, an expansion of the range of media that Tropy can import, and the addition of remote access and cloud storage, are currently under development. The strength of digital asset management tools lies in navigating large photo collections with powerful searching, tagging, and annotation features. Although organizing sources, adding metadata, tagging, and transcribing is time consuming, data asset management tools definitely save time in the crucial final writing phase.

In the end, Tropy suited the project best, mostly because the photographs remain in their original folders, and only a small tile of the image is uploaded. Therefore the software does not duplicate the files, thus saving precious storage space. The tool was developed by the Roy Rosenzweig Center for History and New Media, which also developed Zotero. A collection in Tropy contains items that in turn consist of one or several images.

I chose to separate photographs into projects based on the subject of each of my dissertation chapters. For the first collection in which I tested the tool I

20 See chapter 9 of Floor Koeleman in this volume.

browsed all images from the archives and museums I visited and wrote down the file names of the images from the original folder that were selected for the collection. Because the file path needs to remain the same to display the original image in the item view, I created a designated folder that I used only for copies of the selected photographs from the external solid-state drive (SSD) while still continuing the file structure according to the name of the institution.

I changed one crucial step in this selection process for all other collections after the first trial. Rather than repeatedly browsing all photographs whenever starting a new collection, it proved more efficient to browse everything only once and to take note of the file name, the designated collection, and a short title, including the date where possible. For this selection process to be ergonomic I used a larger monitor and on one side of the 24-inch display I browsed the images, while on the other side I checked archive notes via my MacBook using the monitor's Picture in Picture (PIP) option.

After this selection process, there were two potential approaches to uploading the images to Tropy. Photographs can be added all at once through the import feature or simply dragging and dropping, and separated or grouped into items later on. Alternatively, an item and its metadata can be created first, before any photographs are added to a single item. The first method is more efficient for a large number of items containing only a small number of images, such as letters consisting of one or two images, whereas the second method is useful for a small number of items with a large number of images attached to each item – in particular for user manuals consisting of up to 300 images for a single item.

I created metadata templates using existing ontologies. Metadata are data describing data or, in the case of digital sources, data generated by the camera such as date and time, as well as a file name, accompanied by data added by the researcher including the archive or museum, the identifier, the collection number or call number, a title, the folder and box or location, the language, the manufacturer or author, the copyright holder, etcetera. Each of the optional metadata fields for an item can be selected based on different ontologies. I created a separate metadata template for each institution based on the information available in the catalog and any additional research needs. Indicating the correct institution (i.e., the museum or archive) and the rights (e.g., educational non-commercial use only) determined by the institution's policy was partially automated.

When datasets adhere to the FAIR principles, they should also be interoperable. Tim Berners-Lee introduced the idea of a Semantic Web containing Linked Open Data in 2008 as "the idea of having data on the Web defined and linked in a way that it can be used by machines not just for display purposes, but also for automation, integration, and reuse of data across various applications."[21] The Semantic Web is based on the Resource Description Framework (RDF) built up of triples that contain a subject (e.g., the image DSCF7180), a predicate or property (e.g., has the title) and an object or value (e.g., Apple *II*e).

Each element of a triple can be a Uniform Resource Identifier (URI) which, similarly to a file path, identifies a resource on a computer network. For instance, http://purl.org/dc/elements/1.1/title is the URI referring to the property called "title" according to the Dublin Core Metadata Initiative (DCMI).[22] Thus, by searching the DCMI's website for this URI, other researchers or algorithms can find the description of the title property. The most common form of URI is a URL, such as https://www.dublincore.org/specifications/dublin-core/dcmi-terms/#http://purl.org/dc/elements/1.1/title, which links to a web page that describes the aforementioned URI.

An RDF can be expressed in different languages: Tropy uses JSON-LD.[23] The URI is defined by an ontology which describes concepts that can be used to build semantic models adding meaning to data which can be reused by others. In other words, by adhering to established standards or URIs both future researchers and search algorithms can understand the meaning of metadata. In Tropy's metadata template builder I could select concepts from an ontology such as the DCMI metadata terms mentioned earlier, as well as RDF Schema.[24] In theory I could also incorporate a cultural heritage ontology such as CIDOC-CRM but the concepts were often too detailed or complex for my research dataset.[25]

Aside from the metadata based on the catalog and the content of the source, I added tags such as *image*, *mainframe*, or *manual* to allow filtering. Filtering in turn made it easier to relocate certain types of items or compare items with the same tag. The "notes" function was very useful for transcribing any text on the image but can also be used to formulate ideas or thoughts and will show up in search results. Besides transcribing sources, Tropy makes comparisons between

21 Vipul Kashyap, Christoph Bussler, and Matthew Moran, *The Semantic Web: Semantics for Data and Services on the Web*, Data-Centric Systems and Applications (Berlin: Springer-Verlag, 2008).

22 "DCMI Metadata Terms," Dublin Core, accessed October 5, 2020, https://www.dublincore.org/specifications/dublin-core/dcmi-terms/.

23 Other examples are RDF/XML and Turtle.

24 "RDF Schema 1.1," World Wide Web Consortium, accessed October 5, 2020, https://www.w3.org/TR/rdf-schema/.

25 This paragraph is based on Sytze Van Herck, "DHOxSS 2017 – Linked Open Data, July 2017," Centre for Contemporary Digital History, accessed October 5, 2020, https://www.c2dh.uni.lu/thinkering/dhoxss-2017-linked-open-data.

sources from different institutions easier, since tags help users discover links between sources. Nevertheless, tags also further decontextualize sources from their original order in the archive and from the collection to which the original source belonged. Tagging is always a trade-off between few but broad terms, and many but narrow terms.

An advertisement for Remington Rand's SYNCHRO-MATIC bookkeeping machine featuring Helena Rubinstein as a person, a brand, and a user of the punch card machinery illustrates the documentation process described above.[26] First I noted the file name of my photographs of the first and last pages of the 12-page advertising leaflet. I selected the photographs in the relevant folder and dragged them into Tropy. After merging them into a single item, I applied the Computer History Museum Archive metadata template from the drop-down menu. The template mimics the online catalog and includes additional information. The first photograph included the catalog number, so finding the record online was straightforward.[27]

Since the title in the catalog referenced the contents of an entire folder rather than this particular advertisement, the Tropy item title was taken from the front cover of the leaflet. I determined the date based on an example of an invoice dated 1940 inside the advertisement. The metadata for the publisher, collection, URL, catalog number, dimension, and provenance came from the Computer History Museum catalog. The description was based on the content of the advertisement and the box number came from my research visit preparation notes which were based on the finding aid.[28] Tropy automatically inserted technical metadata and I added four tags to this particular item: *applications and use*, *equipment*, *marketing*, and *punch card*. After a comparison of all items tagged *marketing*, this advertisement became the focus of my Helena Rubinstein punch card case study.[29]

26 Computer History Museum, "Madame Helena Rubinstein: Pioneer in Beauty, Research Scientist, Astute Businesswoman," *Remington Rand*, 1940, 102683284.

27 "Remington Rand Promotional and Sales Materials," 1940, accessed November 12, 2020, https://www.computerhistory.org/collections/catalog/102683284.

28 Dale Jenne, "Guide to the David C. Faloon papers," 2007, Computer History Museum, accessed November 12, 2020, https://www.computerhistory.org/collections/catalog/102634421.

29 "Powers-Samas & ICT Documentation."

4 Analyzing sources through the interface

The key advantage of digital asset management during the analysis phase of research lies in the easy navigation between an overview of all sources in the project view that can be filtered through tags or sorted based on metadata, and the detailed item view where each image or page can be annotated separately using notes. When describing the workflow of punch operators and the wholesale department at Helena Rubinstein's company in London in the second half of the 1950s, for example, the software allowed me to quickly switch between a transcription of a policy document, an image of several invoices, the corresponding punch cards, an order form, and personal notes of the manager of the machine room. Another example of how the interface facilitates the analysis is through the zoom function in the item view. For a visual discourse analysis of the Apple *II*e advertisement, zooming into and panning over the image of the advertisement and the corresponding text allowed me to capture small details that would be overlooked without this function.

However, one issue I mentioned earlier remains unresolved. Greater flexibility in navigating the collection results in a loss of the original order of archival sources or a violation of the core principles of the *respect de l'ordre* and the *respect des fonds* in archival science and the historical method.[30] Gerben Zaagsma states that the key issue facing digital history is the loss of context both on "the level of collections, the use of digital archives or when dealing with information retrieval strategies," and in engaging with and experiencing historical materials.[31]

Although switching between items is easy, comparing images by placing them next to each other on the screen is not possible in Tropy itself. Within the program, users cannot open two images from the same item or two items next to each other. As a temporary solution the original files can be opened from the folder via the file path and placed next to each other outside of the program window. An interesting feature for in-depth discourse analysis is the possibility to select a specific part of the photograph which is added underneath and can be combined with additional metadata about the selection. This selection feature can be useful for separating images from text in the analysis.

Finally, the last FAIR principle – stating that data should be reusable – is certainly supported by Tropy since the metadata adheres to existing ontology. Unfortunately, sharing photographs and metadata is limited because of archival

30 Andreas Fickers, "Update für die Hermeneutik. Geschichtswissenschaft auf dem Weg zur Digitalen Forensik?," *Zeithistorische Forschungen*, author preprint (2020): 10.
31 Zaagsma, "On Digital History," 27.

and museum policies, and heavily impeded by copyright laws and the European Union's General Data Protection Regulation (GDPR). Or, in the words of Julia Damerow and Dirk Wintergrün, "copyright practices often prohibit sharing acquired data, which significantly hampers attempts to reproduce or build on the results of a project."[32] These legal restrictions had never hindered my previous research as a medievalist, but they prevent me from sharing sources and metadata concerning contemporary history. Due to these restrictions the dataset for my project will remain internal to the institution and reusable only when permission is granted by the archive or museum and the original copyright holder.

5 Dissemination

A final discrepancy to acknowledge is that the published images will differ substantially from the photographs taken at the archive. The preparation of photographs in photo editing software depends on the medium of publication. For online publications the resolution of an image file is usually set to 72 dpi or the standard monitor resolution, whereas publishers of printed publications generally require a higher resolution of 300 dpi. As DiMarco explains, print requires high resolution "because it is a high-fidelity media looked at closely by the viewer," whereas "Web images are viewed on a screen, and at a distance."[33] Aside from the resolution, photo editing software can improve the lighting, straighten crooked photographs, and cut out the part of the image that is relevant. After editing an image I usually indicate the archive, call number, original image file name, and whether the reworked version is an edit or cutout of the original.

As Andreas Fickers mentions in "Update für die Hermeneutik," the notion of the original becomes problematic in any case because data is, as Lisa Gitelman and Virginia Jackson pointed out, never raw but rather the result of a process, as I have illustrated here.[34] The provenance of a digital source is influenced by the format, display, storage, and compatibility of a file. In other words, both the software and the hardware used to store, open, and display the file, influence the representation of a digital or digitized source.[35]

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32 Damerow and Wintergrün, "The Hitchhiker's Guide," 520.

33 John DiMarco, *Digital Design for Print and Web: An Introduction to Theory, Principles, and Techniques*, (Hoboken, NJ: Wiley, 2010), 135.

34 Lisa Gitelman and Virginia Jackson, "Introduction," *"Raw Data" Is an Oxymoron*, ed. Lisa Gitelman, Infrastructures series (Cambridge, MA: MIT Press, 2013), 2.

35 Andreas Fickers, "Update für die Hermeneutik," 7.

As Matthew Kirschenbaum explains "One can, in a very literal sense, *never* access the 'same' electronic file twice, since each and every access constitutes a distinct instance of the file that will be addressed and stored in a unique location in computer memory. [. . .] Access is thus duplication, duplication is *preservation*, and preservation is creation – and recreation."[36] To further complicate matters, Jacob Gaboury explains how "the computer is not a visual medium," but rather "our engagement with computing technology is increasingly mediated through the interface of the screen."[37] Although we perceive an image on the screen as a representation of an original source, the file is saved on an SSD in the form of zeros and ones, bits and bytes, or colored pixels.

To illustrate the discrepancy between what is stored and what is shown, without wrecking a hard drive, I opened a PNG file with the text editor. The first few letters made some sense (*àPNG*), but the rest of the file can only be described as a gibberish of letters, numbers, and symbols. What the PNG file contains when opened with image software is an edited cutout of a Powers-Samas tabulator which processed punch cards to produce reports and was taken from a user manual.[38]

To avoid a mismatch between the gray background of the image and the white pages of my printed dissertation, I deleted the background of the image using the magic eraser feature, in combination with the lasso and pencil cutout features of PhotoScape X. I also adjusted the perspective to correct the strange angle of a picture taken from a book. Finally, the file name of the edited image (CCHa_CH28274_DSCF3374_edit-cutout.png) references the archive where the image was made (Centre for Computing History archive), the call number of the source (CH28274), the file name of the original as assigned by the camera (DSCF3374), and the transformations made in PhotoScape X (edit and cut out). The name thus ensures that, even if the document is taken out of context when uploaded to Overleaf for insertion into my dissertation, I can easily relocate the source and remember which changes were made in the photo editing software.

36 Matthew Kirschenbaum, "The .txtual Condition: Digital Humanities, Born-Digital Archives, and the Future Literary," *Digital Humanities Quarterly* 7, no. 1 (2013).
37 Jacob Gaboury, "Hidden Surface Problems: On the Digital Image as Material Object," *Journal of Visual Culture* 14, no. 1 (2015): 540.
38 Centre for Computing History, "The Tabulator for 36 and 40-Column Cards. Operator's Manual," accessed November 12, 2020, http://www.computinghistory.org.uk/det/28274/Powers-Samas-ICT-Documentation/.

6 Conclusion

Historians increasingly rely on digitized and born-digital sources. But digitizing collections is often an expensive undertaking and nearly always a political choice which can bias historians' gravitation toward certain sources over others that are not digitized and yet form a much larger part of the overall collection. The problems of access to sources and a bias toward particular topics at the expense of others also depend on which sources survive both in analog and digital form, or how much of a museum's collection is cataloged, accessible, and can be searched, versus what remains hidden. However, for geographically dispersed archival research, "quick and dirty" digitization of sources through photography has an impact on the kinds of questions historians can ask. I argue that although digital history is primarily concerned with digital tools and methods for analysis, data entry – much like archival research – requires careful reflection and should not be taken for granted.

Aside from selecting relevant sources and accompanying metadata for the researcher's collection, categorization, and the use of established existing ontologies ensure consistency, and assigning metadata in bulk can improve the accuracy of the data. As the FAIR Guiding Principles state, "beyond proper collection, annotation, and archival, data stewardship includes the notion of 'long-term care' of valuable digital assets, with the goal that they should be discovered and reused for downstream investigations, either alone, or in combination with newly generated data."[39]

The notion of the *digital dark age* in which potentially valuable digital sources rapidly disappear into a "digital black hole" reveals several tensions that worry historians and archivists. In a constantly expanding mass of digital records, and despite the common notion that what appears online "sticks," data and files are easily deleted, or can become damaged, or incompatible with ever-changing hardware and software. What is often overlooked is the fact that behind most of the data there are people, organizations, and events that impact the sustainability of datasets. This holds true for museums and archives as well as their dynamic catalogs, and for the data management of individual researchers' projects and their affiliations with an institution.

In other words, institutions are never permanent and both collections and institutions are subject to change. As soon as stakeholders disappear, so too might data after the termination of a project. As researchers or employees of institutions move on and lose interest, a lack of transparency can result in the

39 Wilkinson et al., "The FAIR Guiding Principles," 1.

loss of the most valuable asset of research, its sources and data. The loss of data becomes even more problematic in research funded by public institutions.

References

Brown Keiffer, Elaine. "Madame Rubinstein. The Little Lady from Krakow Has Made a Fabulous Success of Selling Beauty." *Life* 11, 3 (1941): 37–45.
Centre for Computing History. "Powers-Samas & ICT Documentation." Accessed October 1, 2020. http://www.computinghistory.org.uk/det/28274/Powers-Samas-ICT-Documentation/.
CIDOC-CRM. "What is the CIDOC CRM?" Accessed October 1, 2020. http://www.cidoc-crm.org/.
Computer History Museum. "Archival Finding Aids." Accessed October 1, 2020. https://www.computerhistory.org/collections/findingaids/.
Computer History Museum. "Guide to the David C. Faloon papers." Dale Jenne, 2007. Accessed November 12, 2020. https://www.computerhistory.org/collections/catalog/102634421.
Computer History Museum. "Remington Rand Promotional and Sales Materials," 1940. Accessed November 12, 2020. https://www.computerhistory.org/collections/catalog/102683284.
Computer History Museum. "The Tabulator for 36 and 40-column cards. Operator's Manual." Accessed November 12, 2020. http://www.computinghistory.org.uk/det/28274/Powers-Samas-ICT-Documentation/.
Computer History Museum. "Madame Helena Rubinstein: Pioneer in Beauty, Research Scientist, Astute Businesswoman." Remington Rand, 1940, 102683284.
Damerow, Julia, and Dirk Wintergrün. "The Hitchhiker's Guide to Data in the History of Science." *Isis* 110, 3 (2019): 513–21. https://doi.org/10.1086/705497.
Dublin Core™ Metadata Initiative. "DCMI Metadata Terms." Accessed October 5, 2020. https://www.dublincore.org/specifications/dublin-core/dcmi-terms/.
DiMarco, John. *Digital Design for Print and Web: An Introduction to Theory, Principles, and Techniques*. Hoboken, NJ: Wiley, 2010.
Doub, Bo, Kim Hayden, and Sara Chabino Lott. Computer History Museum. "Guide to the Digital Equipment Corporation records." 2017. Accessed November 12, 2020. https://www.computerhistory.org/collections/catalog/102733963.
Europeana. "About Us." Accessed October 1, 2020. https://www.europeana.eu/en/about-us.
Fickers, Andreas. " Update für die Hermeneutik. Geschichtswissenschaft auf dem Weg zur Digitalen Forensik?" *Zeithistorische Forschungen*, Author preprint (2020): 12.
Fujifilm. "FujiFilm Digital Camera X20 Owner's Manual." Accessed September 28, 2020. https://dl.fujifilm-x.com/support/manual/x/fujifilm_x20_manual_en.pdf.
Gaboury, Jacob. "Hidden Surface Problems: On the Digital Image as Material Object." *Journal of Visual Culture* 14, 1 (2015): 40–60. https://doi.org/10.1177/1470412914562270.
Gitelman, Lisa, and Virginia Jackson. "Introduction." In *"Raw data" is an Oxymoron*, edited by Lisa Gitelman, Infrastructures series, 2. Cambridge, MA: MIT Press, 2013.
Glassie, Henry. *Material Culture*. Bloomington: Indiana University Press, 1999.

Hannan, Leonie, and Sarah Longair. *History through Material Culture*. IHR Research Guides. Manchester: Manchester University Press, 2017. Accessed April 24, 2020. https://manchesteruniversitypress.co.uk/9781784991265.

Kashyap, Vipul, Christoph Bussler, and Matthew Moran. *The Semantic Web: Semantics for Data and Services on the Web*. Data-Centric Systems and Applications. Berlin: Springer-Verlag, 2008. https://doi.org/10.1007/978-3-540-76452-6.

Kirschenbaum, Matthew. "The .txtual Condition: Digital Humanities, Born-Digital Archives, and the Future Literary." *Digital Humanities Quarterly* 7, 1 (2013). Accessed June 18, 2021. http://www.digitalhumanities.org/dhq/vol/7/1/000151/000151.html

Lazarinis, Fotis. "Introduction to cataloguing classification." In *Cataloguing and Classification*, edited by Fotis Lazarinis, 1–17. Boston: Chandos Publishing, 2015. https://doi.org/10.1016/B978-0-08-100161-5.00001-4.

Living Computers Museum+Labs. "Living Computers: Museum + Labs is Closing for Now." Accessed October 5, 2020. http://livingcomputers.org/Closure.aspx.

Van Herck, Sytze. "Annotating Sources: Digital Asset Management for Historians," 2019. Accessed June 10, 2020. https://dhh.uni.lu/2019/05/23/annotating-sources-digital-asset-management-for-historians/.

Van Herck, Sytze. "DHOxSS 2017 – Linked Open Data," 2017. Accessed October 5, 2020. https://www.c2dh.uni.lu/thinkering/dhoxss-2017-linked-open-data.

Van Herck, Sytze. "Re/constructing Computing Experiences. From 'punch girls' in the 1940s to 'computer boys' in the 1980s." PhD diss., University of Luxembourg.

Wilkinson, Mark D. et al., "The FAIR Guiding Principles for Scientific Data Management and Stewardship." *Scientific Data* 3, 1 (2016): 1–9. https://doi.org/10.1038/sdata.2016.18.

World Wide Web Consortium. "RDF Schema 1.1." Accessed October 5, 2020. https://www.w3.org/TR/rdf-schema/.

Zaagsma, Gerben. " On Digital History." *BMGN – Low Countries Historical Review* 128, 4 (2013): 3–29. https://doi.org/10.18352/bmgn-lchr.9344.

III Digital experiences and imaginations of the past

Marleen de Kramer

3D models are easy. Good 3D models are not

What's the difference between a reconstruction and an artist's impression? Merely that the latter does not imply scientific accuracy. The term "artist's impression" – or the equally vague "visualization" – is often used in an attempt to bypass the issues of explaining how a reconstruction was validated, how and by whom design decisions were made, and how conflicting theories were reconciled. These processes are time-consuming to document – but very much necessary if the finished model is to be a scientific document in its own right,[1] as well as one in which "the foundations of evidence for the reconstructed elements, and the reasoning around them, are made not only explicit and interrogable but also can be updated, extended, and reused by other researchers in future work."[2]

Furthermore, for many virtual reconstructions, other researchers are not the only – or even the primary – users. Rather, reconstructions are often aimed at communicating theories about the past to lay users such as museum visitors, readers of magazines, users of websites, and school pupils. This means that, to be truly useful, a finished model must not only appeal to the viewer and show the theory the creator intended, but must also engender a healthy skepticism in its viewers, to encourage them to interrogate it and learn about the data that went into its creation – and to show that, for all the hyperrealism a model can achieve, it remains a theory rather than the truth.

This paper seeks to give an overview of how I approached this challenge in my case study, experimenting with ways to document the reconstruction process, ways to communicate to the user that there are underlying decisions that rely on very different types and qualities of data, and a way to test that users understand the principles involved.

1 Erik Champion and Hafizur Rahaman, "3D Digital Heritage Models as Sustainable Scholarly Resources," *Sustainability* 11, no. 8 (2019), 2425.

2 George Bruseker, Anais Guillem, and Nicola Carboni, "Semantically Documenting Virtual Reconstruction: Building a Path to Knowledge Provenance." *ISPRS Annals Volume* II-5/W3, no. 5 (2015).

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1 Documenting decisions

Initially, it seemed that the problem of documenting knowledge provenance and decisions would be trivial. An interdisciplinary approach suggested that I could simply co-opt and reuse a tool from industry, perhaps something used by industrial designers, engineers, or in forensics – a tool made to document dependencies, decision processes, and levels of confidence in those decisions, along with a database to store supporting documentation.

Unfortunately, it turns out that such a tool does not exist. Over the past three years, I have approached visiting lecturers and conference speakers, friends working in different disciplines, and even written directly to representatives of various industries, and always received the same answer: that if projects are documented at all, this is done in a non-standardized text format. Furthermore, the documentation process tends to fall by the wayside relatively early on in project timelines, one of the first tasks to be cut if time or finances are tight, and often seen as an onerous administrative burden rather than an integral part of a project.

This, of course, fundamentally changed my research question. Developing such a tool would have been a PhD thesis in itself – or, more likely, a cross-disciplinary project for multiple researchers. Incidentally, the same was true of my originally proposed database structure, which the experts I consulted deemed "more of a hypercube than a table."

Therefore, having to rely primarily on my own knowledge across different disciplines, my question shifted from: How can I apply an industry documentation method to a humanities project? to: How can the decision-making processes and the underlying data involved in a 3D reconstruction be communicated to end users, so that the reconstruction is a robust historical resource?

This stage taught me two important lessons: to never assume that a task from another discipline is trivial; and to establish what is feasible, to determine scope before defining the question.

2 The state of the art – documentation

Many researchers are currently working toward the documentation of cultural heritage knowledge. What makes this field especially challenging is its multidimensionality and the fact that many related data are not text-based and are therefore more difficult to annotate, browse, and catalog – requiring semantic enrichment to be searchable or machine readable.

Two significant initiatives, the CIDOC CRM[3] and Arches,[4] were created specifically to address these challenges. They go beyond the recording of sources, to show the connections between historic events, objects, people, and places.

CIDOC is the international documentation standards committee of the International Council of Museums (ICOM), and its object-oriented conceptual reference model (CRM) "represents an 'ontology' for cultural heritage information i.e. it describes in a formal language the explicit and implicit concepts and relations relevant to the documentation of cultural heritage." This framework allows disparate data and sources to be mapped to a common frame of reference.

Arches – an open-source software platform for cultural heritage data management – is a practical implementation of CIDOC CRM, aimed at helping cultural heritage institutions and organizations collect and manage their data in a common format. It was developed jointly by the Getty Conservation Institute and World Monuments Fund and includes an app to make it easy for end users to gather data.

Unfortunately, the latter is not suitable for individual projects unless it is supported at the host institution. As the project's fact sheet cautions, "Arches is a powerful enterprise-level platform designed to be used at an organization or project level and not as an individual desktop application. As a result, adopters will need to identify a server to host the Arches platform and as with any enterprise-level system, should expect to engage the services of an appropriate IT professional to set up and maintain it."[5] Though it is tempting to suggest this could be solved by working together with a computer science researcher, this would not be research for them, but a simple implementation issue, making it a problem of infrastructure.

Additionally, while Arches is designed to work with geographic information systems (GISs) or maps, it does not include a way to view and browse 3D models. This is a task more appropriate to building information modeling (BIM) systems, such as Heritage BIM (H-BIM) software for cultural heritage.

H-BIM is an interesting and challenging field because it inverts the typical BIM process. In modern construction planning, architects and engineers can draft structures using BIM systems such as Archicad, which break a building's composition down into discrete parametric objects whose qualitative and quantitative

3 Martin Doerr, "The CIDOC CRM – An Ontological Approach to Semantic Interoperability of Metadata," *AI Magazine*, 24 (2003).

4 Arches Project, Cultural Heritage Inventory and Management, accessed May 14, 2021. https://www.archesproject.org/.

5 Arches Project, "What is Arches Software for Cultural Heritage Inventory and Management?," accessed June 10, 2020, https://www.archesproject.org/what-is-arches/.

metadata are fed directly into a database, allowing the building's costs, structure, building time, etc. to be quickly computed and analyzed.

A heritage building, however, is "the result of modification and stratification processes carried out over time,"[6] meaning that its existing or past elements must be surveyed, analyzed, and then reproduced as-built in a BIM environment in order to enrich the resulting model with data, and that the intangible history of the building must be taken into account.

While H-BIMs are specific to cultural heritage and are helping to address the specific intricacies of modeling existing historic buildings, even an H-BIM system combined with a heritage ontology such as CIDOC CRM is insufficient for documenting 3D reconstructions. Although relationships between data points are tracked, their dependencies are not. It is not possible to specify that a conclusion is true, or that an element exists only *if* a previous assumption is true, nor to compare different theories, nor to assign probabilities or degrees of accuracy to those theories. Furthermore, H-BIMs are not designed to allow for conflicting theories, or multiple versions of an element, to be contrasted. This means that while they are a good choice for tracking metadata, H-BIMs do not yet have capabilities that extend to paradata.

3 The state of the art – communication

To date, there has been no convention for communicating the data behind a model, in the way that bibliographical references are used to convey sources for text. While most 3D reconstructions are captioned for dissemination, as 2D images would be, their captions usually only extend to basic data such as what they represent and who their creators were, but give no information on the creation process, or the metadata or paradata, nor an indication of which part of the model they apply to.

Interactive 3D models are closing this information gap, as they allow different types of data to be displayed on the same model – for example, through the use of different textures, or by annotating certain elements. End users are becoming more familiar with this mechanism through the increasing ubiquity and accessibility of 3D content, especially in gaming.

6 Stefano Brusaporci, Pamela Maiezza, and Alessandra Tata, "Introduction: Heritage Building Information Modeling (HBIM)," in *Special Issue,* ed. Stefano Brusaporci et al., accessed June 10, 2020, https://www.mdpi.com/journal/heritage/special_issues/heritage_BIM#info.

Furthermore, virtual tours of museums and heritage sites are springing up across the internet, many no longer even requiring specialist apps. In some cases, they communicate their metadata through an audio track, much like a museum guide, while others use text, either embedded or as accompanying popups. These digital offerings sometimes include virtual reconstructions, allowing users to switch between a view of the current physical site and a historical visualization, or show different types of content on different parts of the website.

One notable example of this is the MayaArch3D project,[7] which documents historic Copán, Honduras, in a way that is scientifically rigorous yet accessible to the general public. Unfortunately, like many such initiatives, it does not deliver the smooth, polished graphics that users have come to expect from video games. As many heritage sites and institutions do not have the budget to deliver this technological state of the art, less ambitious solutions that do not attempt photo-realism are a reasonable compromise.

4 Visualizing certainty

Creating a new system entirely from scratch as an interdisciplinary but still solo researcher, without technical support or outside expertise for its implementation, was clearly outside the scope of PhD work. I therefore decided to focus on creating a 3D reconstruction as a case study, to show the feasibility of visualizing uncertainty in architectural reconstructions, using the existing tools of text and tables to document the process.

To this end, I designed a two-dimensional matrix (Fig. 1).[8] The horizontal axis has four categories, in decreasing order of certainty or estimated accuracy: relict, interpolated, extrapolated, and speculative. These categories are intentionally broad and were chosen to be reasonably self-explanatory.

“Relict” covers elements for which evidence survives from the time of their creation. “Interpolated” refers to consulting several nearby data points, e.g. filling a gap in a wall along an existing foundation. Whereas this interpolated result is a line between two points, an “extrapolated” result is a vector, using a solid

7 Maya Arch 3D, “3D Visualisation and Analysis of Maya Archeology,” accessed May 15, 2021, https://mayaarch3d.org/en/.

8 Marleen de Kramer, “Relict–Interpolated–Extrapolated–Speculative: An Approach to Degrees of Accuracy in Virtual Heritage Reconstruction,” in *Visual Computing for Cultural Heritage*, Springer Series on Cultural Computing, ed. Fotis Liarokapis et al. (Cham: Springer, 2020).

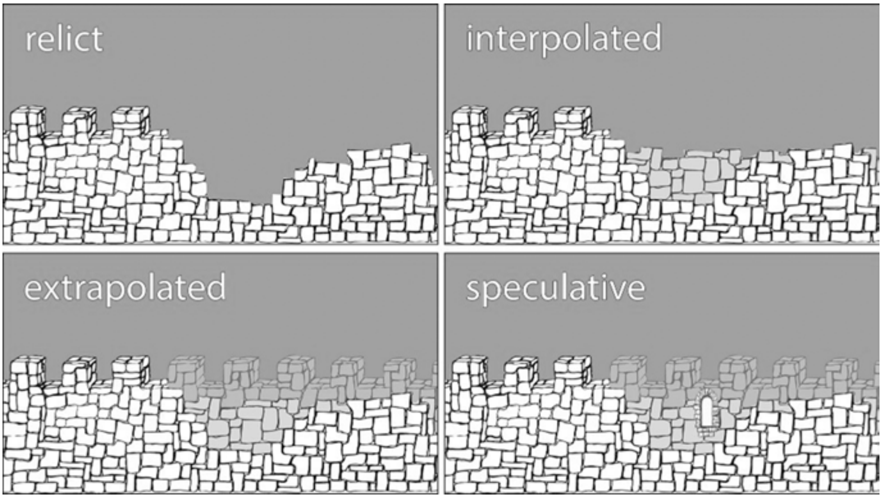

Fig. 1: A visualization of the four degrees of accuracy. 2020. © Marleen de Kramer.

point of reference augmented with secondary and tertiary sources. "Speculative" results are obtained using only secondary and tertiary sources, e.g. making comparisons with similar sites or using engineering knowledge to estimate heights of walls.

The second dimension in the matrix is level of detail (LoD) (Fig. 2). At a low LoD, the degree of accuracy may, conversely, be very high – with the location and dimensions of a building already being known based on ruins, historic maps, etc.[9] – while at a very high LoD, accuracy may be low and all conclusions speculative, with elements such as details of individual rooms having no evidential basis, such as when there is no trace remaining of the original wall coverings.

This system of classifying accuracy relies on a segmented model whose granularity increases with its LoD, so visual differentiation between levels of accuracy can be achieved through parameters like texture, transparency, or line weight, controlled by attribute tables attached to the segments. They can be adapted dynamically, e.g. displaying anything with an accuracy of "interpolated" or better at a medium LoD. As new data are discovered or new conclusions reached, individual segments can be updated or their classification changed without invalidating the model entirely.

9 LiDAR data, ground-penetrating radar, historic photographs, or other depictions or descriptions.

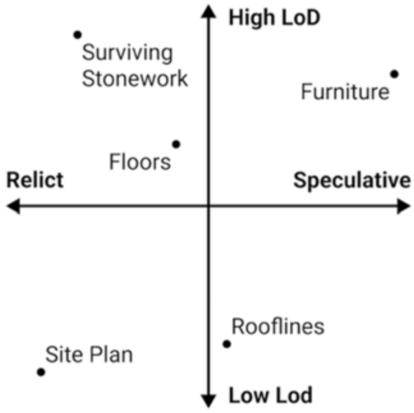

Fig. 2: Accuracy relative to level of detail. 2020. © Marleen de Kramer.

5 Finding sources

The first step in creating a reconstruction was to pick a case study site, with the caveat that it should be a medieval castle in Luxembourg. Vianden Castle is the best-known, best-researched and one of the best-preserved such castles, so seemed the obvious choice – but a digital reconstruction was recently produced by a commercial archaeology consultant, so another reconstruction that replicated previous work would add little new knowledge to the history of Luxembourg's castles and little value to the site. Instead, I settled on Larochette Castle, which is only partially rebuilt, but is reasonably well documented, and has some primary sources available in the form of written documents.

The next step was to gather and investigate various primary and secondary sources, from John Zimmer's seminal work on the castles of Luxembourg, "Die Burgen des Luxemburger Landes,"[10] along with contemporary documents and contracts, to historic maps and images that, while not contemporary, show a pre-industrial view of the town. I quickly decided to reconstruct not just the castle but the surrounding town, as the economic and defensive structures of both work together, and so they cannot be viewed in isolation.

There were several barriers to overcome in this step. First, certain documents were not available – documents of whose existence I knew, but which were contained in archives I could not access, like the archaeological records of

10 John Zimmer, *Die Burgen des Luxemburger Landes*, vol. 1 (Luxembourg: Imprimerie Saint-Paul, 1996).

the castle excavation. Second, Luxembourg's multilingual nature meant that searching for "Larochette" was not enough: the castle and town are referred to in German and Luxembourgish as "Fels" and "Fiels," respectively, and there are also historical variants like "Veltz." Third, the name Larochette, meaning "the rock" in French, is far from unique, and simply adding "Luxembourg" to a search string does not achieve the desired results, as the region's complex history means that the town and castle belonged variously to other countries or now-defunct kingdoms. Finally, the search had to cover not just text sources, most of which are now machine readable and can be found via the usual search tools, but, more importantly, images.

Finding, analyzing, and using images is inherently more difficult than working with text. Unlike text, which only loses a small amount of metadata when digitized, images are very sensitive to scanning and reproduction methods, losing resolution, experiencing color skewing, and with excerpts being difficult to trace back to their original contexts. There is also no single established way to cite them, and usage rights for publications are more difficult to obtain.

6 Interdisciplinary warm-up exercises

While the format of our individual PhD projects left little time for joint projects, I was able to team up with two researchers from other disciplines within C^{2}DH for a small exercise designed to benefit each of our research projects, and which resulted in joint conference submissions. Sam Mersch is a linguist working on microtoponyms in the Luxembourgish language, while Christopher Morse is studying virtual reality for cultural heritage institutions from a human-computer interaction perspective.

Together, we reconstructed the landscape around Larochette Castle, using microtoponyms found in historical maps and other sources to pinpoint the location of landmarks such as churches and mills, and to determine which areas were under cultivation historically.[11] We then translated our hypothetical map into a terrain model, as well as a reconstruction of one of the castle's rooms, in

11 Marleen de Kramer, Sam Mersch, and Christopher Morse, "Reconstructing the Historic Landscape of Larochette, Luxembourg," in *Digital Heritage. Progress in Cultural Heritage: Documentation, Preservation, and Protection*, EuroMed 2018, Lecture Notes in Computer Science, vol. 11197, ed. Marinos Ioannides et al. (Cham: Springer, 2018).

order to create an environment for an educational game in virtual reality.[12] In this game, users combine elements from toponyms and place them on a map to unlock landscape elements in the terrain below the castle.

While an alpha prototype was tested at both a conference and a public-facing event, the game could not be fully developed in the limited time we had. Nevertheless, it was a valuable insight into interdisciplinary work, demonstrating how each of our different disciplines approaches research, which tools we use, and, particularly, which steps were not obvious to the other researchers as being time-consuming. It also involved some negotiating between us of a joint vocabulary, which became an important tool when communicating with the public, as we identified and defined some terms that would otherwise have been ambiguous to them.

7 Reconstruction: Buildings in the town

After this exercise had provided a solid hypothesis for the historical landscape surrounding the town, the next step was to reconstruct the town itself. The structures of buildings themselves can be fairly changeable over the centuries and indeed, the town of Larochette suffered several devastating fires after which dozens of houses had to be rebuilt. However, other elements, including building footprints, roads, and property boundaries, are much more resistant to change and can serve as the basis for a reasonable attempt to depict the town's historical structure. The most significant of these changes occurred in the late nineteenth and early twentieth centuries, in the course of industrialization, so any earlier descriptions and depictions are likely to contain relicts of the town as it was circa 1550, the time period chosen for the reconstruction because the castle was then at its full extent and had not yet burned down.

The town's basic structure is determined by its geography. Situated at the junction of two valleys, the town is bounded by high cliffs to the northeast and southwest, with the castle on the rocky promontory to the southeast that gives the town its name. Historically, these two natural 'walls' were supplemented by two high, man-made walls – one of which closed off the southern end of the valley and the other which ran straight across it to the north. The other valley, running almost perpendicular to the first, contains a wide, flat floodplain

12 Christopher Morse and Marleen de Kramer, "What's in a Name: Gamifying the Intangible History of Larochette, Luxembourg", 23rd International Conference on Cultural Heritage and New Technologies, Vienna, Austria, 2018.

around the White Ernz River. This river was straightened and largely buried, and the two roads in the valley were merged into one, in the late nineteenth century to make room for a narrow-gauge railway that terminated in Larochette; but an approximation of its historical course can be found on the cadastral map that depicts the area before these changes.

In his book, John Zimmer had already speculated on the general layout of the town when the walls were still in place, based on historical maps (though the book introduced some errors through oversimplification), so this formed the basis of my town reconstruction. The footprints of the main buildings were kept and extruded into simple houses that maintained the historical and, largely, contemporary character of the town: two-story buildings with pitched roofs and single-story annexes. The infill of outbuildings was reduced in a speculative but logical progression and these structures were kept relatively low in profile. Contrary to my first assumption that many of these would have single-pitched roofs, research revealed that double-pitched roofs were more likely, as shown in contemporary paintings from the Greater Region – largely nativity scenes, which often show the shapes of barns and stables that were familiar to the artists. Major civic buildings, such as the church, were modeled somewhat more precisely, and negative spaces were broken up by larger empty spaces surrounded by low garden walls, which can still be seen today.

These models were deliberately kept purely volumetric and with a low LoD. Where buildings were textured, simple textures with low detail were chosen – cream-colored rendered walls, red sandstone foundation walls and lintels, tiled roofs – to reflect the typical character of the region. The town wall and its towers were partially extrapolated from their remains, and partially guided by John Zimmer's drawings and other historical views of the town.

The area outside the town walls to the south housed what was (and still is) the commercial area of the town – presumably the floodplain accommodated a green where larger markets were held. This area is speculatively surrounded by smaller buildings, including some early industrial ones – the town had multiple mills and tanneries at this time, as indicated by historical tax records and other reports, and located using microtoponyms and the eighteenth-century Ferraris Atlas.

8 Reconstruction: Reconstructing the castle

While the castle and the town function together, they are distinct entities, with different sources available. The major primary source here is, of course, the castle itself. The ruins are run as a tourist attraction today; they have been excavated, secured against further decay and supplemented with modern utility buildings, but otherwise remain largely unaltered, apart from Créhange Manor, the castle's best-preserved residential building, which has been physically reconstructed.

Fortunately, there is an excellent source for determining which building parts are authentic: when the Luxembourg state acquired this and other castles for the nation in the late 1970s, John Zimmer, a building surveyor specializing in heritage, was tasked with documenting these acquisitions. He produced stone-by-stone drawings that showed the extent and condition of the buildings before any interventions took place and which were reprinted in his books on the castle. This data was supplemented by nineteenth and early twentieth century views of the town collected from archives and from the local history magazine, *Les Cahiers Luxembourgeois*, which dedicated a double issue to Larochette in 1938. While these views are largely artists' renditions whose goal was not objectivity, they are similar enough to give an impression of the state of the castle between its destruction and its restoration, especially the view of the southeastern façade from the hill opposite – this perspective was popular with painters.

Leaving aside the physical reconstruction of Créhange, there have been three known attempts to visually reconstruct the castle. The first was a series of illustrations dating from around 1900, by Jean-Pierre Koenig, an architect and a member of the "Friends of the Castle" society. These drawings are quite fanciful, and reflect the contemporary historicized fashion of the day much more than any serious scientific work. Most notable among its inaccuracies are a tall tower above what should be a chapel in the Homburg Manor and the castle's baffling indefensibility: while the walls, as drawn, have loopholes, they lack battlements – and the postern gate has external hinges that would be very easy to breach. This reconstruction also sprouts fanciful turrets and stepped gables for which there is no evidence in the castle ruins.

The second reconstruction took a more scientific approach, being a drawing by John Zimmer based on his precise castle survey. Unlike the town map that he proposed, this reconstruction seems to account for all known castle parts and to incorporate some of the archaeological evidence. However, Zimmer failed to explain his reasoning or expound on his theories, so while the reconstruction may be sound, it is not supported by data.

Finally, there is a model of the castle in the attic of Créhange Manor, recognizable as such only by association. Strangely, this model includes no metadata whatsoever, not even as to which castle it is supposed to represent – we do not learn who built it, when, or which era it presumes to show, so it cannot function as a scientific document in any sense.

As my self-imposed task was not “a complete and accurate reconstruction of Larochette Castle,” but rather “enriching a model with paradata to allow future researchers to refine it,” my model as drawn is largely based, again, on John Zimmer’s reconstruction, though validated where possible by using other available data.

9 3D model

My volumetric model was drawn largely in Autodesk 3ds Max, which is a modeling and animation tool rather than a computer-aided design (CAD) or BIM system. This means that it lacks the accuracy of CAD – although this is not needed given the inaccuracies of the data underlying it – and does not have the native link to a database that would be provided by a BIM system. To create links to data more easily, the individual elements could, in theory, have been exported from Autodesk to a BIM system and assembled there. However, they would need to be transformed back to Autodesk anyway to be used in the web-viewable 3D environment that was my goal, and this step was not necessary.

Instead, similar objects were transformed into *instances*, so that changes to one would propagate throughout the model easily, grouped by type. Each class of object was given a distinct name and then numbered to provide unique identifiers. This was slightly complicated by the fact that the segmentation of the objects could vary by attribute; for example, the town wall might have pieces with different *accuracies* along its length whose extent did not match up with the different *sources*, so objects had to be broken down into sub-objects to allow this distinction.

Finally, as the model was primarily designed to give a visual impression, the objects had to be adjusted to sit in the terrain without any floating, so they were extended under ground level to achieve this – therefore, the heights of the building objects were no longer the same as the heights of the buildings when viewed in isolation. The details of the terrain itself were taken from the cadastral office’s 5 m digital terrain model and first interpolated using Terragen[13] to smooth the hard edges, then simplified so that the polygon count was reduced outside the immediate town area. While this introduced some fuzziness regarding the accuracy of the terrain, it made for a more realistic visual statement, as it resulted in shapes that were more organic.

13 A program by Planetside Software for creating photo-realistic scenery and terrain models.

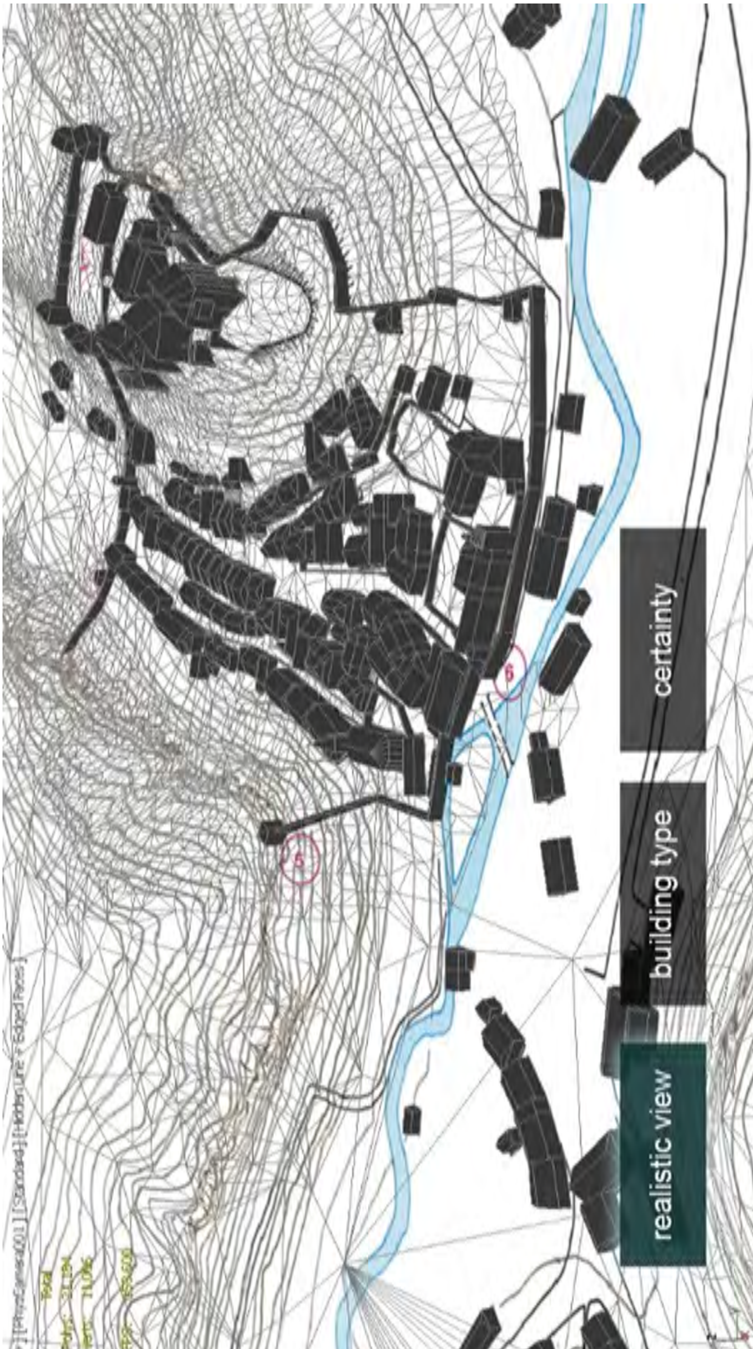

Fig. 3: The neutral view as a volumetric model. 2020. © Marleen de Kramer.

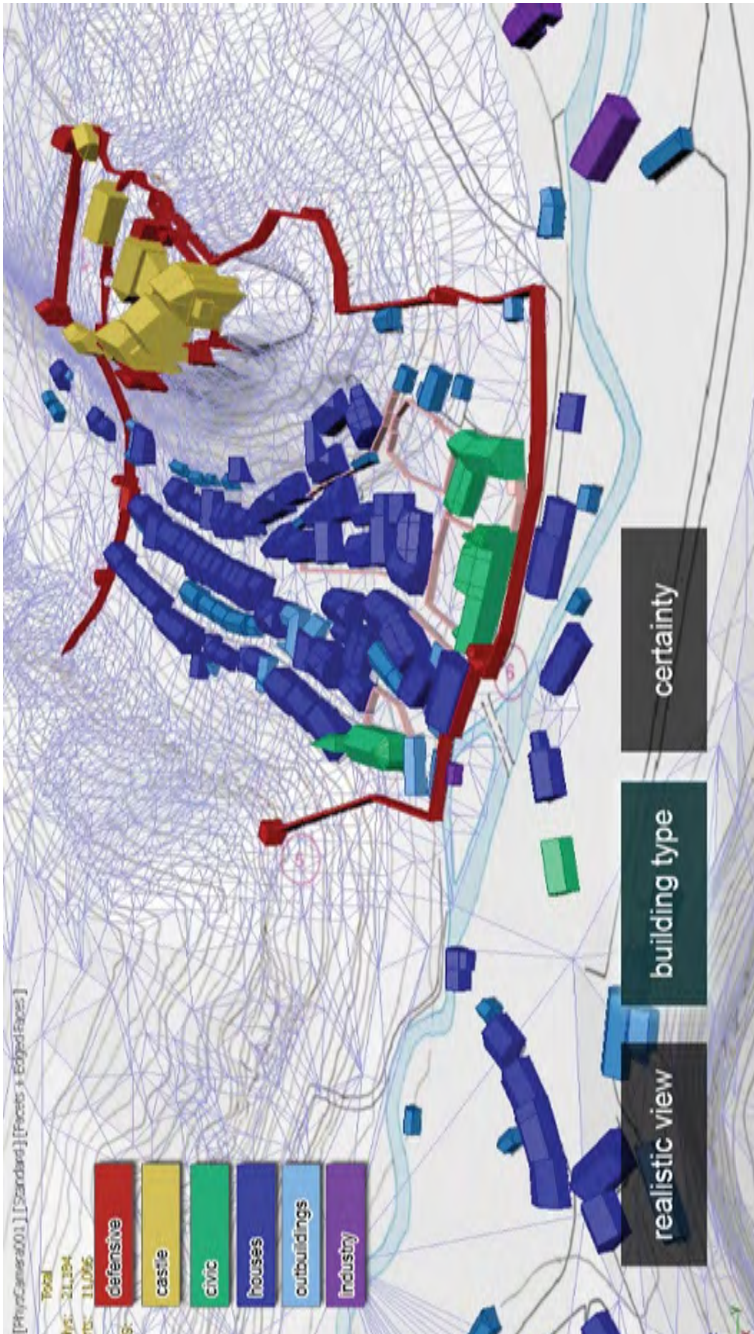

Fig. 4: The building-type view, color-coded by function. 2020. © Marleen de Kramer.

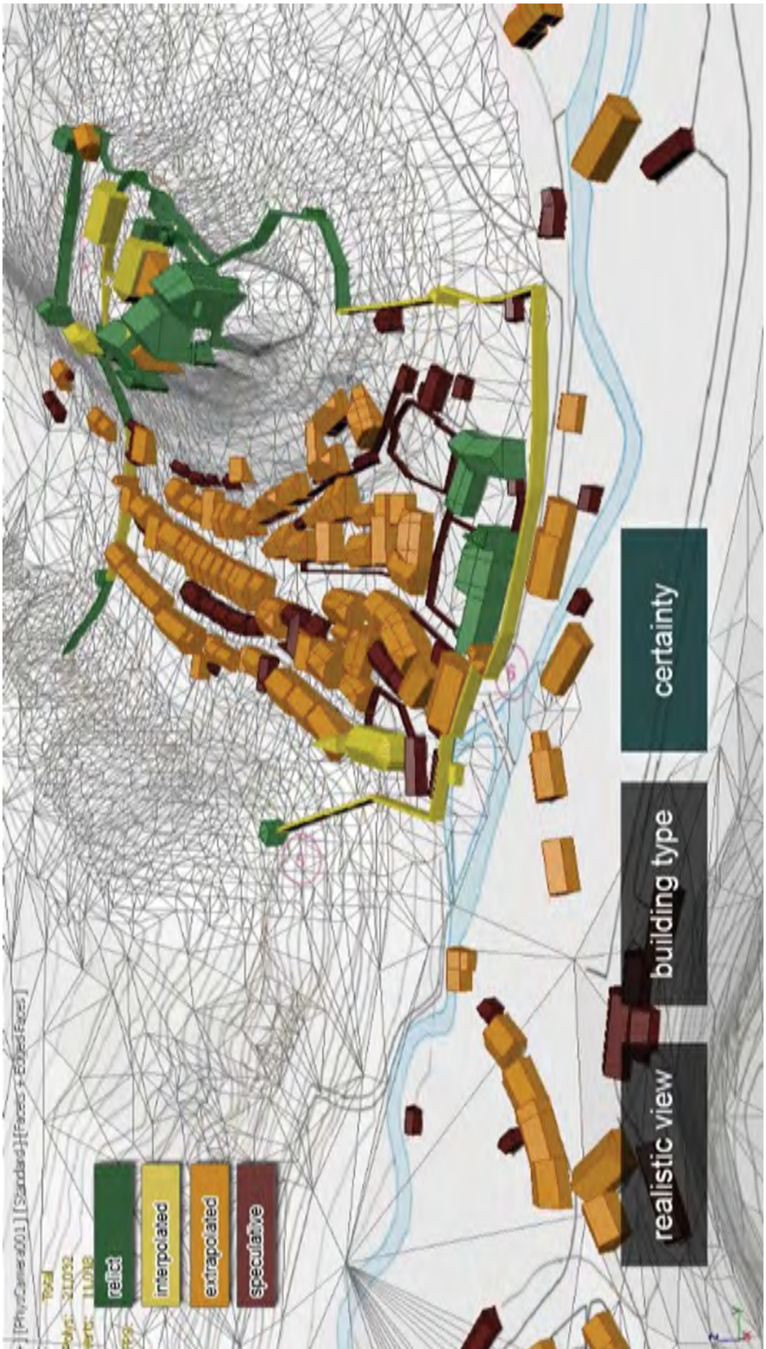

Fig. 5: The certainty view, color-coded by degrees of confidence. 2020. © Marleen de Kramer.

In dealing with the difficulty of documenting metadataintegrity and paradata without access to a database system, the unique identifiers allowed me to use an attribute table that contained, for each object, its classes and types, degree of accuracy, scale/level of detail, and so forth: a simple but structured way to store data. To avoid long texts in a table – and much error-prone copying and pasting – the argumentation, sources, etc. can be provided in documents for groups of objects, rather than individually. A true database would have simplified this process, but was outside the scope of the project.

As presented to the user, the model has three modes. The first, a neutral mode, allows the user to explore the model as a whole, i.e. a realistic view of the whole reconstruction (Fig. 3). The second mode color-codes the buildings by function and type and, when an object (such as a building feature or part) is selected, provides short texts about its purpose and history (Fig. 4). The third mode switches to a different color ramp that reveals the certainty according to my previously described four-step system of degrees of confidence (Fig. 5). Selecting buildings in this third mode gives the user a brief description of the sources underlying their reconstruction, as well as any particularly relevant argumentation.

10 Going public

Documenting the model was not enough, though – it also needed to communicate to users that there are decision-making processes behind the 3D reconstructions, and that these models are not "the truth" but a fairly accurate theory. This stage of the project moved beyond architectural history and 3D modeling into the realms of digital storytelling, educational psychology, and website design. It could be implemented in various ways, from creating a special exhibit at the site itself to implementing a fully digital display.

Initially, my intention was to run special group projects with local school pupils aged around 12–14 years old – the age at which they are learning about castles and the Middle Ages. Source criticism, especially of digital resources, is an increasingly important skill for students to learn, and one that can be taught in many disciplinary contexts – in this case, as part of a history lesson.

For this approach, the students would explore a 3D model of the castle that showed both metadata and paradata, then engage in a group activity to test their understanding of the data types and whether they could distinguish between the metadata (what we know) and the paradata (how we know it) by producing their own.

Unfortunately, the necessary response to the Covid-19 pandemic prevented this approach from being implemented, with pupils needing to be taught remotely and then with no time for special projects in the new school year as the children caught up on material from the core curriculum. Instead, the focus shifted to using a questionnaire. Originally intended as a minor part of a history lesson, to see whether understanding how reconstructions work influenced pupils' ability to understand the model and its data, the original questionnaire was extended, refined (in the context of the user experience design course offered by the University of Luxembourg's psychology department) and translated into versions for adults and school pupils, in German as well as English, then disseminated both via social media and directly through schools and institutions.

The questionnaire takes users through a reconstruction process, then seeks to gauge their critical understanding of existing reconstructions. Initially, users are shown a view of the modern-day town of Larochette and a 3D model of the same view in the sixteenth century. One building, the gatehouse, has been omitted. Users are tasked with choosing one of six possible versions of it to fit the gap shown in the model – and to indicate how they made their choice and how confident they are that it is correct.

They are then shown a series of historical images of a building and asked to make a choice between two options for each image set – each of which pertains to a different aspect of the building in question – in order to guide them through reconstructing the building from original sources. They are then again asked about their confidence in the result.

Next, users look at historical images for another building and are asked to make choices about those, but are presented with more options and allowed to suggest their own solutions. And finally, they evaluate existing reconstructions, answering questions that are carefully phrased to avoid indicating which aspects are considered most important.

With over 400 participants at the time of writing, this survey[14] will yield interesting results on its own, but also serve to improve the model itself, and the website on which it is to be presented. Preliminary analysis shows fascinating differences in users' confidence in their own choices – from "I don't have enough information to say anything definite" to "The historical sources must be wrong because they don't match my initial theory" – as well as in their willingness to trust authority figures even without being given evidence, and in their ability to deal with uncertainty, which some think is fascinating but many find frustrating.

14 The distribution page for the survey is temporarily hosted at https://wordpress-111824-1160269.cloudwaysapps.com/index.php/larochette-quiz-en/, accessed September 3, 2021.

11 Conclusions

The inclusion of metadata and paradata in 3D reconstructions involves two separate problem areas: gathering and recording the data, and displaying and communicating them. While standard data formats for metadata are already being used and developed, they are still highly complex and require specialized work environments – and no such standards yet exist for paradata.

While most end users understand footnotes and image captions, 3D models do not yet have any such established conventions. Therefore, the problem is not just which format of model display to use, but how to communicate to users that there is something they should be looking for: that there is further information to be found within the model and why it is important.

This is also true in an interdisciplinary environment, where two of the main difficulties in working together are establishing a common vocabulary and deciding on ways to communicate.

Perhaps some problems have not yet been solved not because they are not interesting, but because they are more difficult than expected.

References

Arches, Open source software platform. "Arches Project, Cultural Heritage Inventory and Management." By Getty Conservation Institute and World Monuments Fund for cultural heritage data management. Accessed May 14, 2021. https://www.archesproject.org/.

Brusaporci, Stefano, Pamela Maiezza, and Alessandra Tata. "Introduction: Heritage Building Information Modeling (HBIM)." In *Special Issue*, edited by Stefano Brusaporci, Pamela Maiezza and Alessandra Tata. Accessed June 10, 2020. https://www.mdpi.com/journal/heritage/special_issues/heritage_BIM#info.

Bruseker et al. "Semantically Documenting Virtual Reconstruction: Building A Path To Knowledge Provenance," *ISPRS Annals Volume II-5/W3*, 2015.

Champion, Erik and Hafizur Rahaman. "3D Digital Heritage Models as Sustainable Scholarly Resources." *Sustainability* 11, 8 (2019): 2425. https://doi.org/10.3390/su11082425.

Doerr, Martin. "The CIDOC CRM – An Ontological Approach to Semantic Interoperability of Metadata," *AI Magazine*, 24 (2003).

De Kramer, Marleen, Sam Mersch, and Christopher Morse. "Reconstructing the Historic Landscape of Larochette, Luxembourg." In *Digital Heritage. Progress in Cultural Heritage: Documentation, Preservation, and Protection*, EuroMed 2018, Lecture Notes in Computer Science, vol.11197, edited by Marinos Ioannides, Eleanor Fink, Raffaella Brumana, Petros PatiasAnastasios Doulamis, João Martins and Manolis Wallace. Cham: Springer International Publishing, 2018.

De Kramer, Marleen. "Relict–Interpolated–Extrapolated–Speculative: An Approach to Degrees of Accuracy in Virtual Heritage Reconstruction." In *Visual Computing for Cultural*

Heritage, Springer Series on Cultural Computing, edited by Fotis Liarokapis, Athanasios Voulodimos, Nikolaos Doulamis, and Anastasios Doulamis. Cham: Springer International Publishing, 2020.

De Kramer, Marleen. Open source software platform. Historic Larochette. "Reconstructing the Historic Landscape of Larochette, Reconstruction Quiz". Accessed May 14, 2021. https://wordpress-111824-1160269.cloudwaysapps.com/index.php/larochette-quiz-en/.

Maya Arch 3D. Open source software platform. "3D Visualisation and Analysis of Maya Archeology." By the German Federal Ministry of Education and Research. Start-up funding was provided by the National Endowment of the Humanities (USA). Accessed May 15, 2021. https://mayaarch3d.org/en/.

Morse, Christopher, and Marleen de Kramer. "What's in a Name: Gamifying the Intangible History of Larochette, Luxembourg." Paper presented at the 23rd International Conference on Cultural Heritage and New Technologies, Vienna, Austria, November, 2018.

Zimmer, John. *Die Burgen des Luxemburger Landes*. Luxembourg: Imprimerie Saint-Paul, 1996.

Jakub Bronec

Walking through the process

Teaching Jewish history in Luxembourg with the help of digital tools

1 Introduction

Continually improving technology, and the expansion of virtual educational options worldwide, mean that tutors need to develop their understanding of new pedagogical approaches that are effective for teaching in a digital environment. As McBride et al. have put it, in the context of teaching controversial topics such as the Holocaust: “This [digital teaching] phenomenon has ushered in a new era of education thus bringing forth a myriad of new questions and issues that must be addressed.”[1]

This chapter looks into new challenges that have arisen in the teaching of Jewish post-Holocaust history in the past decade, especially in the fields of digital storytelling and oral history. Angelyn Balodimas-Bartolomei judged that students of all ages need to experience new educational methods and a new level of involvement as regards the teaching of modern Jewish history.[2] It is generally accepted that teachers can no longer satisfy students’ desire to learn by using frontal teaching alone; they have to actively involve their students in the teaching activities.[3]

1 Holly McBride, Brandon Haas, and Michael Berson, “Teaching the Holocaust at a Distance: Reflections from the Field,” *Ohio Social Studies Review* 51, no. 1 (2014): 18.

2 Angelyn Balodimas-Bartolomei, “Political and Pedagogical Dimensions in Holocaust Education: Teacher Seminars and Staff Development in Greece,” *Diaspora, Indigenous, and Minority Education* 10, no. 4 (2016): 242–54. See also Alina Bothe, *Die Geschichte der Shoah im virtuellen Raum* (Berlin: De Gruyter, 2018).

3 Frontal teaching (teacher-centered instruction, typically led from the front of a classroom) is still predominant, even though this traditional form of teaching is not adequate and does not promote the intellectual and emotional involvement of students. See: Snježana Nevia Močinić, “Active Teaching Strategies in Higher Education,” *Metodički Obzori/Methodological Horizons* 7, no. 2 (2012): 97–105.

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One of various possibilities for motivating students is to use real-time educational applications that stimulate the imagination and involve not just memory but also other aspects of the mind such as empathy and critical thinking. Keith Barton and Alan McCully found in their study that students prefer courses that emphasize interactive and cooperative projects – and that the history classroom seems a natural venue for such projects.[4] It is also important for the teacher to create awareness among students regarding historical debates, since current policy debates are invariably rooted in history.

This chapter will introduce two different applications: the IWalk interactive educational app, and MAXQDA, a tool for qualitative data analysis. I used them both during the video content analysis course that I ran for bachelor students at the University of Luxembourg. MAXQDA served as a gatekeeping tool to help shortlist video testimonies for the real-time IWalk application, from the large number now available. I organized this course as part of the research within my PhD project based on the cultural and educational history of the Jewish postwar populations in Luxembourg and Czechoslovakia. I intend to elaborate on the outcome of the course, via students' reflections, in my PhD chapter entitled "Teaching of Holocaust and public Jewish history in the postwar states of Czechoslovakia and Luxembourg," in which I will critically analyze a practical output of this course, together with the collected data used in both the aforementioned applications. The aim of that chapter is to evaluate and compare development of teaching Jewish public history in Luxembourg and Czechoslovakia.

2 The concept of IWalk

The IWalk application was developed by USC Shoah Foundation – The Institute for Visual History and Education. This interactive educational app connects specific physical locations with memories of historical events that took place in those locations. It is currently focused on locations in Europe and the US. The USC Shoah Foundation is not a standard scientific institution or cultural foundation. It oscillates between different poles and it is difficult to grasp its institutional form. Nowadays, it has a large number of branch offices and contract holders (associated cultural and historical associations) scattered all over the world.

After months of beta-testing with educators around the globe, USC Shoah Foundation launched a brand new version of the IWalk app in 2019, offering 29

4 Keith Barton and Alan McCully, "Teaching Controversial Issues . . . Where Controversial Issues Really Matter," *Teaching History* 1, no. 127 (2007): 13.

IWalks in seven countries and eight languages. Visitors and students can discover curated multimedia tours that connect specific historical sites, and locations of memory and memorialization, with testimonies from survivors and witnesses of genocides, violence, and mass atrocities. The application no longer contains only testimonies from Holocaust victims – users can now work with genocide stories from all over the world.[5] IWalk contextualizes and humanizes the history of sites of memory by using testimonies, photographs, and maps, thus enabling users to experience the past for themselves.[6] The result is a unique multimedia experience that provides users with a personalized learning experience at sites of memory around the world, in multiple languages.

People walking through the locations of the different tours can use smartphones, tablets or computers to watch video clips of survivors and witnesses telling personal stories about the role of these locations in their experiences. Students create these clips on an online educational platform called IWitness using a free and intuitive video editor. As I've explained previously in a blogpost, in order to make meaningful video tracks for IWalk tours, these clips are usually extracted from full-length video testimonies that are in USC Shoah Foundation's Visual History Archive. And the testimonies, along with photos, documents, maps, and other primary sources that can be displayed on users' devices, tell a story that connects past events to present locations in a way that underlines the gravity and reality of what occurred there.[7]

3 The course: Empowering the students to engage with local history

Ian Davies judges that "[p]erhaps the most difficult of the pedagogical issues relates to the choice that teachers have to make in deciding how to present the Holocaust and what sort of educational aims are valid,"[8] and Totten and Feinberg

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5 IWalk testimonies now include genocide stories from multiple countries, including Rwanda, Armenia, and Sudan.

6 Regarding the humanization of history, see James K. Bidwell, "Humanize your Classroom with the History of Mathematics," *Mathematics Teacher* 86, no. 6 (1993): 461–4.

7 Jakub Bronec, "IWalk: Mapping Jewish Life with your Mobile – New Ways of Teaching Jewish History in Luxembourg," Digital History & Hermeneutics blog, March 9, 2020, accessed July 16, 2020, https://dhh.uni.lu/2020/03/09/iwalk-mapping-jewish-life-with-your-mobile-new-ways-of-teaching-jewish-history-in-luxembourg/.

8 Ian Davies, *Teaching the Holocaust: Educational Dimensions, Principles and Practice* (London: Continuum, 2000), 5.

argue that teachers should avoid overusing visual material and trying to explain the Holocaust too simply.[9] Barton and McCully found that "there is empirical evidence that [engaging students in controversial issues discussion] can succeed and that classroom discussions, in which several sides of an issue are explored and in which students feel comfortable expressing their views, are associated with a range of positive outcomes."[10] Based on their research, it appears important to motivate students to analyze problems from the past, such as the Holocaust, as well as to critically evaluate different opinions in classroom discussion.[11] These ideas were later supplemented by Huei-Tse Hou and Sheng-Yi Wu, in whose opinion "teachers can lead discussions in two formats: synchronous or asynchronous. Typically, asynchronous forums are the most widely utilized format because students have more time to respond to discussion topics, which leads to deeper levels of thinking."[12]

Working in the academic sphere, I have actively participated in a large number of courses addressing the issue of perceived conflict in society, covering issues such as anti-Semitism, xenophobia, or homophobia. Timothy Peace demonstrated from sociological statistics that hatred and animosity toward all kinds of minorities had increased significantly in France, for example, especially among young people.[13] Regarding these data, the question is: How can we foster awareness of history among young people? The purpose of the IWalk project in Luxembourg is to create interactive and educational online historical tours and provide rich content for online applications – primarily involving university students, but also secondary school pupils – based on the principles of open science. It aims to motivate students to become active content producers and not mere consumers. I organized a semester-long course for university students that set out to create an experimental working environment that would provide them with the freedom to be creative. The idea was that the tutor would assume the role of mediator by helping the students to interact with the materials and derive their own conclusions.

9 Samuel Totten and Stephen Feinberg, "Teaching about the Holocaust: Issues of Rationale, Content, Methodology, and Resources," *Social Education* 59, no. 6 (1995): 323–33.

10 Barton and McCully, "Teaching Controversial Issues," 13.

11 Barton and McCully, "Teaching Controversial Issues," 13–9.

12 Huei-Tse Hou and Sheng-Yi Wu, "Analyzing the Social Knowledge Construction Behavioral Patterns of an Online Synchronous Collaborative Discussion Instructional Activity Using an Instant Messaging Tool: A Case Study," *Computers & Education* 57, no. 2 (2011): 1459–68.

13 Timothy Peace, "Un antisémitisme nouveau? The Debate about a 'New Antisemitism' in France," *Patterns of Prejudice* 43, no. 2 (2009): 103–21.

When it comes to controversial topics, there are several advantages to having students engage in collaborative projects, but it is important to create deep and meaningful instructional structures and to foster abilities, skills, and approaches based on content-specific critical enquiry. How can a teacher create this environment? According to David Pace, teachers should begin a project with sufficient objective background information on the controversial issue or topic, offer multiple perspectives, model how to address controversial issues, contextualize the issue to ensure student comprehension, allow students to practice discussing similar controversial issues prior to the planned topic, and provide ground rules for the class discussion.[14]

4 Methodology of the video content analysis course and digital source criticism

The aim of my video content analysis course was to help students apply new educational methods in order to facilitate learning about Jewish society in Luxembourg. In the winter 2019/2020 semester, I taught bachelor students at the University of Luxembourg to use the IWalk app as an example of using archival sources in the digital era. During the individual sessions, participants used the intuitive video editing software on the online IWitness/IWalk platforms. The course also provided students with an overview of how to use and edit historical photos, maps and personal documents as archival sources.[15]

There was an emphasis on remembering local history and, as part of this effort, the course featured a tour of sites in Esch-sur-Alzette and Luxembourg City which were relevant to the German occupation of Luxembourg and the atrocities committed by the Nazi regime toward local communities. The Jewish community was strongly antagonized by Nazi propagandists and, along with Roma people, homosexuals, and political detractors of the occupying regime, faced heavy persecution.[16] Based on the training I received at the Zachor Institute of Social Remembrance in Budapest, I guided the students in following an

14 David Pace, "Controlled Fission: Teaching Supercharged Subjects," *College Teaching* 51, no. 2 (2003): 42–5.

15 Bronec, "IWalk: Mapping Jewish Life."

16 For further reading see Vincent Artuso, *La Question Juive au Luxembourg | L'état luxembourgeois face aux persécutions antisémites nazies* (Luxembourg: Editions forum Luxembourg, 2015); and Laurent Moyse, *Du rejet à l'intégration: histoire des Juifs du Luxembourg des origines à nos jours* (Luxembourg: Editions Saint-Paul, 2011).

educational methodology based on the four Cs of consider, collect, construct, and communicate.[17]

The students were divided into two working groups, with one group tasked with designing a virtual tour of Luxembourg City and the other group designing one for Esch-sur-Alzette. The participants took pictures of current buildings and locations associated with Jewish war history and compared them with original historical photos taken before and during the war. The students were encouraged to reflect on how the appearance and function of certain buildings had changed over time.[18]

The theme of an IWalk should be specific enough to meet a learning outcome, but the content of the IWalks in Luxembourg and Esch-sur-Alzette is rather varied. The students could choose from a wide range of themes such as civil resistance (a topical theme), historical events (chronological), memorials (spatial) and Jewish traditions (historical). To maintain a clear focus, the video testimonies associated with the theme of each IWalk were limited to three minutes. The students were advised to choose different interviewees in order to highlight different personal perspectives, and they created a short biography for each clip, giving details of the interviewee's life before, during, and after the Second World War.[19]

To successfully complete the course, the students had to consider different examples of perceived conflict throughout history,[20] different definitions of intolerance, and selected clips of testimonies related to a specific type of resentment (e.g. religious, political, etc.), and construct a video essay about a specific incident. Last but not least, the students communicated their reflections to their peers via video essays. They were then given an opportunity to use technology to

17 The four Cs in more detail are: consider background information that draws on previous knowledge; collect information from testimonies, biographies, and physical locations; construct – analyze and evaluate information and one's own reflection; communicate – discuss that reflection. For further reading see Andrea Szonyi and Kori Street, "Videotaped Testimonies of Victims of National Socialism in Educational Programs: The Example of USC Shoah Foundation's Online Platform IWitness," in *Interactions: Explorations Of Good Practice in Educational Work with Video Testimonies of Victims of National Socialism*, ed. Werner Dreier, Angelika Laumer, and Moritz Wein (Berlin: Stiftung EVZ, 2018), 266–80; and Dagi Knellessen and Ralf Bachmann, *From Testimony to Story. Video Interviews about Nazi Crimes. Perspectives and Experiences in four Countries* (Berlin: Stiftung EVZ, 2015).

18 Bronec, "IWalk: Mapping Jewish Life."

19 See also Nigel King, Christine Horrocks and Joanna Brooks, *Interviews in Qualitative Research*, 2nd ed. (London: SAGE Publications, 2018).

20 These not only related to anti-Semitism: the students had to reflect on and compare other forms of hate against stigmatized minorities in history.

become more active learners, while encountering eyewitnesses talking about their experiences in different historical periods.[21] The work was published in December 2020 on USC Shoah Foundation's IWitness website – an educational platform that responds to the demand to build multiliteracy skills and responsible digital citizenship among educators and students.[22]

4.1 Nature of the clips used and the selection process

My role as tutor was to identify testimony clips that would support students' learning of the topic under study, whilst ensuring that these clips were not too graphic, emotional, or lengthy and that they were appropriate for the desired learning outcomes and the diverse audience. I was also responsible for providing a broader historical context for the testimonies, considering the contexts in which the interviews were conducted. I did, however, take into account that there is a part of the academic community that is very critical of the methods of testimony conducting and maintenance.[23]

Some scholars particularly decry the use of a vague system of questions given to interviewees. They often favorably cite the interviews undertaken by David P. Boder as examples of strictly and precisely led conversation.[24] The fact is that many witnesses felt a time pressure to pass on their testimonies to others, but they had already gone through a phase of biographical stabilization (getting married, starting a family, emigrating, building a new livelihood) by that point. It is clear that their memories cannot be viewed without critical reconsideration, but it is arguable whether or not parts of video clips that illustrate Jewish daily life should be used in order to provide another historical dimension for those interested in history. Video recordings, or even audio recordings, have also given those who found themselves unable to write down their memories the opportunity to pass them on in other ways.

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21 Barton and McCully, "Teaching Controversial Issues," 13–9.

22 "IWitness USC Shoah Foundation, One Voice at a Time," accessed July 20, 2020, https://iwitness.usc.edu/sfi/.

23 See, for example, Bothe, *Die Geschichte der Shoah*, 103.

24 Frank Mehring, "The 1946 Holocaust Interviews: David Boder's Intermedia Project in the Digital Age," *Amerikastudien* 58, no. 1 (2013): 139–50. "In the summer of 1946, Chicago-based psychologist David P. Boder undertook a remarkable interview project. [. . .] Boder went to shelter houses in and around Paris, Geneva, Munich, Wiesbaden, and Tradate [Italy] to conduct 130 interviews. [His archive] has been excavated and remediated [. . .] by the Illinois Institute of Technology."

Visual history archives (VHAs) such as those of USC Shoah Foundation and the Fortunoff Archive reveal important views, visual codes, and cultural patterns. However, users have to take into account a few critical aspects that are associated with VHAs, as some sources of oral history do not give a well-balanced depiction of historical events. Collecting memories and testimonies is a good example of how difficult it is to create coherent archives for academic and educational use. Administrators have to contend with multilingualism, divergent memories of interviewees depending on their country of origin, and the subjective narratives of those interviewees. The potential for errors and misunderstandings in translations and transcriptions can also be significant. Moreover, there are the technical challenges of digital archival indexing. According to Alina Bothe, the Fortunoff Archive at Yale is regarded as a professional benchmark for conducting interviews – and academic scholars use it as an alternative to the USC Shoah Foundation database.[25] However, based on my experience, the Fortunoff Archive has been struggling with its indexing of testimony metadata and contains several shortcomings in terms of its methodology for conducting interviews.[26] We can conclude that testimonies deposited in a VHA are grounded in the memories of survivors (changing though they may be), but that scholars can benefit from putting them into historical context. A platform itself does not provide broad historical context, but the USC Shoah Foundation has recently organized several workshops on providing historical context and ethical editing, in which questions of digital source criticism and responsible practices for editing authentic historical testimonies were discussed with teachers and researchers.[27]

IWitness, an educational website for teachers and their students, could prove to be a turning point as it now provides a broader historical context for the database of testimonies, through the workshops it organizes for teachers. This interactive online platform gives students access to more than 1,600 testimonies for guided exploration, and more than 39,000 educators around the world have been trained to incorporate its testimonies into classroom lessons. The medium itself can provide opportunities for students to engage their media literacy skills, by challenging them to critically consider the sources: Who is this person? Why are they telling their story? To whom? Under what circumstances?[28] My students

25 Bothe, *Die Geschichte der Shoah*, 108.
26 Jakub Bronec, "Malach Visual History Center Conference and Workshop on the New Procedure and the Use of the Fortunoff Video Database,"*Marginalia Historica: Časopis pro dějiny vzdělanosti a kultury* 7, no. 1 (2020): 164–7.
27 Andreas Fickers, "Digital hermeneutics: the reflexive turn in digital public history?," unpublished document: 6.
28 "USCF Teaching guidelines," last modified May 11, 2015, www.facinghistory.org.

and I also selected clips that would support the use of the KWL (Know, Want [to know], Learned) teaching methodology[29] – ones that correspond to the same methodological conducting of interviews. These clips are of similar lengths, were recorded in the same year, and in the same country – and we only picked excerpts associated with the same questions, such as, Did you ever experience anti-Semitism before the war?

Future users of the IWalk app are likely to come from different backgrounds and not to have a thorough knowledge of citizen history – the students developing the Luxembourg app content therefore adapted the wording relating to the individual stops on the virtual tour to make the content more comprehensible to the general public. To identify relevant locations for thematic perspective, students chose the clips first. It was important to make a connection between the chosen stops and the clip – and it was considered advisable, although not essential, to have a clip at each stop. Each stop in the tour also had to be within easy walking distance of the previous stop. After long discussions, students eventually created six stops dealing with issues of pre-war anti-Semitism, forced emigration, restitutions, active resistance, and Jewish traditions in Luxembourg.

4.2 Participants: Students and tutors

Three experts from the Zachor Foundation for Social Remembrance in Budapest and the Malach Centre for Visual History in Prague came to Luxembourg to help me implement IWalk and MAXQDA, in order for me to run my video content analysis course. To improve my own expertise in this field, I completed a number of in-depth training sessions on how to effectively use IWalk with other historical resources, such as archival materials. Because of the detailed nature of qualitative research, small sample sizes are recommended, with a focus on "selecting information-rich cases for study in depth. Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the inquiry."[30] I also attended several workshops at the Malach Centre and the Zachor Institute on maintaining ethical standards when conducting interviews. These mainly familiarized workshop participants with the pre-interview questionnaire completed by narrators (interviewees) which enables us to discover, among other things, a narrator's biography, political

29 Students identify what they already know about the time period the testimony references, what they want to know about that time period, and what they learned from the testimony.
30 Michael Quinn Patton, *Qualitative Research & Evaluation Methods: Integrating Theory and Practice*, 4th ed. (Thousand Oaks, California: SAGE Publications, 2015), 230.

thinking, and religious classification, as well as relevant metadata related to key locations in their narrative.

As for USC Shoah Foundation, its first goal is to "overcome prejudice, intolerance, bigotry – and the suffering they cause – through the educational use of the Foundation's visual history testimonies."[31] Secondly, it is dedicated to making "audio-visual interviews with survivors and witnesses of the Holocaust and other genocides a compelling voice for education and action."[32] Alina Bothe eventually admitted in her critical 2018 publication that the Foundation had shifted toward being more of an educational and scientific institution under its then director.[33] Despite criticism from scholars (albeit open and often meaningful), the Foundation remained a trustworthy institution for narrators themselves. When IWitness was launched in its alpha version in 2010, the thousand narrators whose testimonies were to be included on the platform were asked whether they were comfortable with their testimonies being published online. Of 1,000 notices issued, less than 1 percent of the interviewees requested that their testimony be withdrawn from Internet-based distribution.[34]

5 MAXQDA as an analytical digital tool: Creating a new experimental space for IWalk projects

While working on the IWalk tours in Luxembourg, students had to analyze the selected testimonies by applying the MAXQDA analytical tool. From a methodological perspective, this enabled them to judge the relevance of interviews for the tours. Students also learned to link different text passages to each other, as well as to other documents, geographical locations, diaries, educational websites, and historical images. To establish a methodological basis we analyzed the interviews using hermeneutical case analysis[35] and comparative case analysis. The codes for qualitative textual analysis that were developed in these two

31 "Shoah Foundation embarks on new mission," *PastForward* 2 (2001): 2.

32 "About us: Our mission Is to develop empathy, understanding, and respect through testimony," USC Shoah Foundation, accessed July 20, 2020, https://sfi.usc.edu/about.

33 Bothe, *Die Geschichte der Shoah*, 141.

34 Claudio Fogu, Wulf Kansteiner, and Todd Presner, *Probing the Ethics of Holocaust Culture* (Cambridge, Massachusetts: Harvard University Press, 2016), 134–5.

35 Udo Kuckartz and Stefan Rädiker, *Analyzing Qualitative Data with MAXQDA: Text, Audio, Video* (Cham: Springer, 2019), 72.

methodological phases were allocated to the text segments to determine different thematic categories in the transcribed interviews.

To find patterns in the testimonies we used both inductive[36] and deductive coding.[37] Using multiple coding methods to analyze the same dataset and comparing the findings reduces certain biases.[38] Deductive coding can help students understand the structure of individual testimonies. It also improves their understanding of narrators of different ages talking about the same historical event from different perspectives. The students mainly used two of MAXQDA's basic analysis functions: "hierarchical category system" and "thematic summaries." They summarized text passages to which the same code had been assigned on a case-by-case basis.

Why did I decide to use MAXQDA for qualitative analysis working with a team? First, it facilitated teamwork management. When several students are working with one dataset, it is important to create a clear system of memos, codes and intercoder agreements[39] that they can apply to that dataset.[40] Since it is essential to code data in a similar manner, I opted for MAXQDA because it has one of the best memo retrieval systems, making it particularly useful for teamwork.

MAXQDA allows users to use their own favorite codes and code sets as a compilation of codes. Optionally, weighting of coded segments and the addition of comments are also possible.[41] For a comparative analysis, students used a unified thematic coding tree they had created themselves. The use of a common code tree enabled them to find thematic intersections in their work. We also developed an intercoder agreement demonstrating how different analysts coded the same data and we used this to identify differences in coding practices.

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36 "Inductive coding method is used when you know little about the research subject and conducting heuristic or exploratory research. In this case, you don't have a codebook, you're building on from scratch based on your data." Erika Yi, "Themes Don't Just Emerge – Coding The Qualitative Data," accessed 18 July, 2020. https://medium.com/@projectux/themes-dont-just-emerge-coding-the-qualitative-data-95aff874fdce.

37 "Deductive coding is the coding method wherein you have developed a codebook as a reference to guide you through the coding process. The codebook will be developed before your data collection starts, usually in the process of researching the existing field." Yi, "Themes Don't Just Emerge," accessed 18 July, 2020.

38 Michael Quinn Patton, "Enhancing the Quality and Credibility of Qualitative Analysis," *Health Services Research* 34, no. 5 part 2 (1999): 1189–208.

39 To create intercoder agreements, several coders process the same document independently and code it according to mutually agreed code definitions.

40 Kuckartz and Rädiker, *Analyzing Qualitative Data*, 254.

41 Kuckartz and Rädiker, *Analyzing Qualitative Data*, 5.

To give a specific example of an intercoder agreement, we assigned the subcode "Open antisemitism" to the text passage: *"Kids were really aggressive shouting at me 'dirty Jew.' Fortunately, I was not there alone, but together with my brother. We were always able to defend ourselves. We also made good friends who always stood by us."* In an effort to explore and describe the social roles and interactions of interviewees we involved all the students in discussing our intercoder agreements. We decided that the subcode "Open antisemitism," for example, could only be applied to specific cases where there was a clear social interaction between individuals and the interviewee spoke about a clear anti-Semitic offense. By contrast, we defined the subcode "Hidden antisemitism" as relating to anti-Semitic texts and speeches in the media, or ambiguous remarks on Jewish origin.[42] The students focused primarily on the different social interactions described by witnesses. We defined social interaction as "a form of human behavior to which the actors involved attach subjective meaning and which is related to the behavior of others. The term 'meaning' is related to the subject and is not, according to Weber's definition, 'any kind of objectively correct or metaphysically explored *true* meaning.'"[43]

Our understanding of human behavior was facilitated by "methodological triangulation," a term used in the social sciences to describe the combined use of more than two research methods to achieve more reliable results.[44] One such method, thematic content analysis, consists of the three stages of methodological triangulation: pre-analysis, exploration, and interpretation.[45] MAXQDA can include all three phases and assign them to codes, summaries of texts, files, notes and results in the form of tables and graphs. All of these functions offered my students a wide range of analytical approaches. In addition, the tool obliged them to observe several ethical regulations. Once the data was analyzed and coded, we used investigator triangulation (the use of multiple researchers in an empirical study – here, coding by more than one student) in order to further establish reliability in the coding of our data, and employed peer review to assess the analysis and coding in terms of inter-rater reliability (the extent to which two or more coders agreed).[46]

42 Based on the "MAXQDA 2018 Manual," accessed July 15, 2020, https://www.maxqda.com/help-max18/welcome.

43 Quoting Max Weber, *Wirtschaft und Gesellschaft: Grundriss der Verstehenden Soziologie: Grundriss der Verstehenden Soziologie*, 5th ed. (Heidelberg: Mohr Siebeck, 2002), 4.

44 See, for example, Patton, *Qualitative Research*.

45 Wendy Gordon, "Behavioral Economics and Qualitative Research – A Marriage Made in Heaven?," *International Journal of Market Research* 53, no. 2 (2011): 171–85.

46 Sharan B. Merriam and Elizabeth J. Tisdell, *Qualitative Research: A Guide to Design and Implementation*, 4th ed. (San Francisco, CA: John Wiley, 2015): 77.

Afterward, the students analyzed measurements of the frequency of variables and their mutual correlations. In terms of building the theoretical concepts of our IWalk tours, we found MAXQDA's memoing tools to be well-suited to our requirements. The tool helped to harmonize coding approaches among the student analysts and I could easily check that they were not digressing from the approved coding tree.

However, as the pattern grows, it becomes increasingly difficult to identify complex patterns. We only analyzed around 20 interviews in our qualitative study but, even with this population size,[47] it became increasingly difficult to recognize thematic and social intersections. We had to refrain from using labels with quasi-statistical terms (typical, mainly, pattern, etc.).

The visual tool that we used the most in MAXQDA was the Document Portrait, which displays any text as a "painting" of either all or selected codes assigned throughout the text. The students could choose colors for their code – e.g. a special color for Holocaust (black) or Jewish traditions (green) – or select some emoticons to stress positive and negative aspects. Factors that played an important role are therefore immediately visible and therefore easier to locate in the interviews or any other text. The tool "takes the size of the text segments into account and 'weights' the color according to the segment's size. The color attributes of the codes associated with the document are displayed in a matrix with little squares arranged in rows, each one with 40 squares."[48] In my opinion, this is a valuable feature that gives viewers an uncluttered visual impression of the text's content.

Students also appreciated the Code Relations Browser (CRB) visualization tool, which shows how codes overlap in a given document and allows quick identification of possible connections between codes, thus enabling students to identify all clusters with particular codes. The tool is also a good way to test the quality of a code system. If there are no intersections in your corpus, it may be indicative of problems with the way you set up your coding system. The CRB maps the chosen documents on the x-axis, while the y-axis contains the whole code system. If larger or smaller squares are located between the axes, then the codes overlap. You can decide whether you want to analyze a particular segment or the whole corpus. With this visualization, the students were able to reflect on and analyze incidents relating to the Holocaust[49] and gain more detailed insights.

47 This is small compared to the sample size in mainstream social research.

48 "MAXQDA 2018 Manual," accessed July 15, 2020, https://www.maxqda.com/help-max18/visual-tools/document-portrait-visualizing-a-document.

49 Including, for example, postwar restitutions.

6 Conclusion: IWalk and a digital hermeneutical approach

Digital educational tools seem to be omnipresent these days and the digital hermeneutics of history is no exception. “Digital hermeneutics can be defined as a set of skills and competences that allow historians to critically reflect on the various interventions of digital research infrastructures, tools, databases and dissemination platforms in the process of thinking, doing and narrating history.”[50]

To critically analyze the role of IWalk in terms of Jewish public history we also have to consider the ethical dimension of the whole project.

When using digital tools to investigate the lives of Holocaust survivors, scholars must be aware of the ethical issue of treating “Holocaust victims as quantifiable entries in a database and [visualizing] their lives as data points using colored pixels on a bitmap,” such as with the Digital Monument of the Jewish Community in the Netherlands website.[51] Sociologist Zygmunt Bauman criticized this approach as an act of dehumanization in his seminal work *Modernity and the Holocaust*. According to Bauman, scholars should refrain from codifying and instrumentalizing human morality and experience, and from technifying the subjective individuality of human experience.[52] The content of IWalk, however, does not turn narrators into unknown intangible persons, since the different war incidents, crimes, events[53] and deeds[54] that they relate in the video clips enable the narrators to live on the screens of our devices.

According to Andreas Fickers, we need to define digital hermeneutics as a hermeneutics of in-betweenness to give space to problematizing tensions between the analog and digital interpretation of history.[55] He argues that we cannot totally abandon strongly embedded analog practices and traditions. In fact, it would be counterproductive to lose the current model of historical hybridity based on the current duality of parallelism of analog and digital practices. Using a great variety of data, the IWalk represents a compromise – the tool that

50 Fickers, “Digital Hermeneutics,” 2.

51 Fogu, *Probing the Ethics*, 175; and “Joods Monument,” accessed July 16, 2020, https://www.joodsmonument.nl/. For further information see Laurie M. C. Faro, “The Digital Monument to the Jewish Community in the Netherlands: a meaningful, ritual place for commemoration,” *New Review Of Hypermedia And Multimedia* 21, no. 1–2 (2015): 165–84.

52 Zygmunt Bauman, *Modernity and the Holocaust*, 3rd reprinted ed. (New York: Cornell University Press, 2000), 235–269 and 222.

53 Such as forced emigration and exploitation.

54 Such as resistance fighting, smuggling, and collaborating.

55 Fickers, “Digital Hermeneutics,” 3.

does not reprobate either analog or digital practice. It represents a platform where you can comprehensively customize your data to make them comprehensible to both students and the general public.

Based on a kitchen metaphor elaborated by Anita Lucchesi,[56] the raw historical datasets used in creating IWalk tours in Luxembourg had passed through the digital kitchen and then in turn been "cooked" by the students into an interactive educational tool grounded in the practice of doing Jewish public history in the digital age. Walter Benjamin argues in his "The Storyteller" essay that we have "lost the ability to share experiences" or, as Todd Presner summarized it, "The experiences of the war event and mass death could no longer be observed, described, and communicated using the structures and meaning-making strategies reserved for historical realism, which was part and parcel of the tradition of storytelling with clear agents, a coherent plot, and narrative strategies characterized by the unities of time, place, and action[. . .]."[57] This argument should not be interpreted as an act of resignation to historical facticity, but as a necessity for finding a new epistemological balance. Presner admits that, although USC Shoah Foundation's VHA "assures factuality and facilitates access and preservation, it has the side effect of flattening differences between the testimonies and rendering listening one-directional."[58] Based on these facts, I assert that testimonies should be used as a relevant historical source in education, but with the proviso that they have to remain in the hands of professionals (teachers or academics).

56 See Anita Lucchesi, "For a New Hermeneutics of Practice in Digital Public History. Thinkering with memorecord.uni.lu," (unpublished PhD diss., University of Luxembourg, 2020). Lucchesi describes the mediated memories as *tira-gostos* (appetizers), the historical context as the "menu," and the digital platforms such as Memorecord (similar to IWalk) as the "digital kitchen" she used for producing the digital public history product.

57 Walter Benjamin, "The Storyteller: Reflections of the Works of Nikolai Leskov," in *Illuminations*, ed. Hannah Arendt, trans. Harry Zohn (New York: Schocken Books, 1968), 83; and Todd Presner, "The Ethics of the Algorithm," in *Probing the Ethics of Holocaust Culture*, ed. Claudio Fogu, Wulf Kansteiner, and Todd Presner (Cambridge, Massachusetts: Harvard University Press, 2016), 181.

58 Presner, "The Ethics of the Algorithm," 182.

References

Andreas Fickers, “Hermeneutics of in-betweenness: digital public history as hybrid practice,” in Handbook of Digital Public History, ed. Serge Noiret, Mark Tebeau, and Gerben Zaagsma (Berlin: De Gruyter, 2022 (forthcoming))

Artuso, Vincent. *La Question Juive au Luxembourg | L’état Luxembourgeois face aux persécutions antisémites nazies*, Luxembourg: Editions forum Luxembourg, 2015.

Balodimas-Bartolomei, Angelyn. “Political and Pedagogical Dimensions in Holocaust Education: Teacher Seminars and Staff Development in Greece.” Online. *Diaspora, Indigenous, and Minority Education* 10, 4 (2016): 242–54.

Barton, Keith, and Alan McCully. “Teaching Controversial Issues . . . Where Controversial Issues Really Matter.” *Teaching History* 1, 127 (2007): 13–9.

Bauman, Zygmunt. *Modernity and the Holocaust*, 3rd reprinted ed. New York: Cornell University Press, 2000.

Benjamin, Walter. “The Storyteller: Reflections of the Works of Nikolai Leskov.” In *Illuminations*. New York: Schocken Books, 1968.

Bidwell, James K. “Humanize your Classroom with the History of Mathematics.” *Mathematics Teacher* 86, 6 (1993): 461–64.

Bothe, Alina. *Die Geschichte der Shoah im Virtuellen Raum*. Berlin, Boston: De Gruyter, 2018.

Bronec, Jakub. “IWalk: Mapping Jewish Life with your Mobile – New ways of teaching Jewish history in Luxembourg.” Accessed July 10, 2020. https://dhh.uni.lu/2020/03/09/iwalk-mapping-jewish-life-with-your-mobile-new-ways-of-teaching-jewish-history-in-luxembourg/.

Bronec, Jakub. “Malach Visual History Center Conference and Workshop on the new Procedure and the Use of the Fortunoff Video Database.” *Marginalia Historica: Časopis pro dějiny vzdělanosti a kultury* 7, 1 (2020): 164–67.

Davies, Ian. *Teaching the Holocaust: Educational Dimensions, Principles and Practice*. 1st ed., UK: Continuum, 2000.

Faro, Laurie M. C. “The Digital Monument to the Jewish Community in the Netherlands: a meaningful, ritual place for commemoration,” *New Review Of Hypermedia And Multimedia* 21, 1–2 (2015): 165–84.

Fogu, Claudio, Wulf Kansteiner, and Todd Presner. *Probing the Ethics of Holocaust Culture*, Cambridge, Massachusetts: Harvard University Press, 2016.

Gordon, Wendy. “Behavioral Economics and Qualitative Research – A Marriage Made in Heaven?” *International Journal of Market Research* 53, 2 (2011): 171–85. https://doi.org/10.2501/IJMR-53-2-171-186.

Holocaust Education Resource Council. “Holocaust Education: Why Simulation Activities Should Not Be Used,” ADL Fighting Hate for Good. UK: Anti-Defamation League, 2018. Accessed June 18, 2021. holocaustresources.org.

Hou, Huei-Tse, and Sheng-Yi Wu. “Analyzing the Social Knowledge Construction Behavioral Patterns of an Online Synchronous Collaborative Discussion Instructional Activity Using an Instant Messaging Tool: A Case Study.” *Computers & Education* 57, 2 (2011): 1459–68. Accessed July 15, 2020.

King, Nigel, and Christine Horrocks. *Interviews in Qualitative Research*. Los Angeles: SAGE Publications, 2010.

Knellessen, Dagi, and Ralf Bachmann. *From Testimony to Story. Video Interviews about Nazi Crimes. Perspectives and Experiences in four Countries*. Berlin: Stiftung EVZ, 2015.

Kuckartz, Udo, and Stefan Rädiker. *Analyzing Qualitative Data with MAXQDA: Text, Audio, Video*. 1st ed. Cham: Springer, 2019.
Lehrmann, Charles. *La communauté juive du Luxembourg dans le passé et dans le présent: Histoire illustrée*. Esch-sur-Alzette: Impr. Coopérative Luxembourgeoise, 1953.
Lucchesi, Anita. *For a New Hermeneutics of Practice in Digital Public* History. *Thinkering with memorecord.uni.lu*. Unpublished PhD thesis at the University of Luxembourg 2020.
McBride, Holly, Brandon Haas, and Michael Berson, "Teaching the Holocaust at a Distance: Reflections from the Field," *Ohio Social Studies Review* 51, 1 (2014): 18.
Mehring, Frank. "The 1946 Holocaust Interviews: David Boder's Intermedia Project in the Digital Age." *Amerikastudien* 58, 1 (2013): 139–50.
Merriam, Sharan B, and Elizabeth J. Tisdell. *Qualitative Research: A Guide to Design and Implementation*, 4th edition. San Francisco, CA: John Wiley, 2015.
Močinić, Snježana Nevia. "Active Teaching Strategies in Higher Education," *Metodički Obzori/ Methodological Horizons* 7, 2 (2012): 97–105.
Moyse, Laurent. *Du rejet à l'intégration: Histoire des Juifs du Luxembourg des origines à nos jours*. Luxembourg: Éditions Saint-Paul, 2011.
Pace, David. "Controlled Fission: Teaching Supercharged Subjects." *College Teaching* 51, 2 (2003): 42–5.
Patton, Michael Quinn. *Qualitative Research & Evaluation Methods: Integrating Theory and Practice*, 4th edition. Thousand Oaks, California: SAGE Publications, 2015.
Patton, Michael Quinn. "Enhancing the Quality and Credibility of Qualitative Analysis." *Health Services Research* 34, 5 Pt 2 (1999): 1189.
Peace, Timothy. "Un antisémitisme nouveau? The Debate about a 'New Antisemitism' in France." *Patterns of Prejudice* 43, 2 (2009): 103–21. https://doi.org/10.1080/00313220902793773.
Pearcy, Mark. "A Year of Reflection: The More Things Change." Online. *Contemporary Issues in Technology and Teacher Education* 13, 4 (2013). Accessed July 15, 2020. https://citejournal.org/volume-13/issue-4-13/social-studies/a-year-of-reflection-the-more-things-change.
Szonyi, Andrea and Kori Street. "Videotaped Testimonies of Victims of National Socialism in Educational Programs: The Example of USC Shoah Foundation's Online Platform IWitness," in *Interactions: Explorations Of Good Practice in Educational Work with Video Testimonies of Victims of National Socialism*, edited by Werner Dreier, Angelika Laumer, and Moritz Wein, 266–280. Berlin: Stiftung EVZ, 2018.
Totten, Samuel, and Stephen Feinberg. "Teaching about the Holocaust: Issues of Rationale, Content, Methodology, and Resources." *Social Education* 59, 6 (1995), 323–33.
USC Shoah Foundation: Shoah Foundation embarks on new mission. *Past Forward 2* (2001).
USC Shoah Foundation, "Our Mission is to develop empathy, understanding, and respect through testimony," online, USC Shoah Foundation, (USA), Accessed July 15, 2020. https://sfi.usc.edu/about.
USC Shoah Foundation. "IWitness: One Voice at a Time,". Accessed July 20, 2020. https://iwitness.usc.edu/sfi/.
Weber, Max. *Wirtschaft Und Gesellschaft: Grundriss Der Verstehenden Soziologie: Grundriss Der Verstehenden Soziologie*, Mohr Siebeck, 2002.
Yi, Erika. "Themes Don't Just Emerge-Coding The Qualitative Data." Medium Data Science, ProjectUX, 2018. Accessed July 15, 2020. https://medium.com/@projectux/themes-dont-just-emerge-coding-the-qualitative-data-95aff874fdce.

Christopher Morse

Meaning-making in the digital museum

Reflections on a hermeneutics of the user

1 Introduction

In the inaugural post for the Digital Tool Criticism blog of the University of Luxembourg's Digital History & Hermeneutics (DHH) unit, Koenig et al. assert that the field of human-computer interaction (HCI) has much to offer humanities computing.[1] Indeed, while the adoption of digital tools is no longer novel to the humanities, the increasing sophistication and interdisciplinarity of those tools present challenges that have long been the subject of HCI research. Recent advances in HCI have, for example, moved us away from tool-centric design and toward a more nuanced and deeply reflective human-centric model. This new approach necessitates a rethinking of our relationship to user interface design for the arts and humanities, which is the subject of this chapter.

It is through this evolving human-centric model for technology design, also known as user experience (UX), that I have conducted my doctoral research on user interfaces for digital museum collections. Central to this work is understanding how interfaces mediate the experience of browsing and discovery within digital cultural heritage environments, such as a fine arts collection on a museum website. As Drucker argues, *interface* is what we read, and how we read, combined through engagement – a provocation to cognitive experience and to meaning-making itself.[2] This conception of interface underlies my own critical analysis, which attempts to reconcile two approaches to interface design and development: the UX method (Fig. 1) and the digital hermeneutical tradition. As conceptually adjacent interpretive frameworks for the design and use of technologies, each system carefully considers the subjective nature of

1 Vincent Koenig, Juliane Tatarinov, and Christopher Morse, "Tool Criticism Meets Human-Computer Interaction (HCI)," Digital History & Hermeneutics blog, November 25, 2019, accessed June 15, 2020, https://dhh.uni.lu/2019/11/25/tool-criticism-meets-human-computer-interaction-hci/.

2 Johanna Drucker, "Humanities Approaches to Graphical Display," *Digital Humanities Quarterly* 5, no. 1 (2011).

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knowledge production and consumption involved in digital interaction. My work is therefore a synthesis of these interrelated ideas, a hybrid approach that engages the complexity of designing *meaningful* interactions with cultural data while simultaneously reflecting on the merits of each method.

An important outcome as a result of this research trajectory lies within the relationship between UX and digital hermeneutics. In this chapter I argue that beyond merely reinforcing digital hermeneutics in the context of humanities computing, the UX method also offers something more: a "hermeneutics of the user." This vital perspective encourages design researchers to empathize with the target audience of a particular technology in order to inform the design of meaningful interactions therein. Digital hermeneutics conceives of the historian-as-user who is constantly mindful of methodological concerns throughout the digital research process,[3] but UX extends this critical apparatus beyond the pragmatic, task-oriented mode of knowledge production and into its *hedonic* and *eudaimonic* elements. That is to say, UX investigates the emotional qualities (*hedonia*) of digital interaction, and their capacity to trigger moments of personal reflection, empowerment, or meaning-making (*eudaimonia*).[4] Through a discussion of the user research process across a series of different UX studies I conducted, I will demonstrate the ways in which a hermeneutics of the user can support the design of future technologies in the arts and humanities, paying special attention to the role of meaning-making as an important component of interaction and knowledge production.

2 Experience design for digital cultural collections

The overarching research question informing my doctoral work asks how we might design meaningful interactivity for digital museum collections. Just as museum professionals design physical spaces to inspire enjoyable, memorable,

3 Andreas Fickers, "Update für die Hermeneutik. Geschichtswissenschaft auf dem Weg zur Digitalen Forensik?," *Zeithistorische Forschungen/Studies in Contemporary History* 17, no. 1 (2020).
4 Marc Hassenzahl and Noam Tractinsky, "User Experience – A Research Agenda," *Behaviour & Information Technology* 25, no. 2 (2006): 91–7; and Veronika Huta and Alan S. Waterman, "Eudaimonia and Its Distinction from Hedonia: Developing a Classification and Terminology for Understanding Conceptual and Operational Definitions," *Journal of Happiness Studies* 15, no. 6 (2014): 1425–56.

and, ultimately, meaningful experiences for in-person visitors,[5] so too should this same consideration extend into digital spaces where the presence of online museum collections has become the norm.

It is an opportune time to be considering such a question. Decades of digitization initiatives at museums around the world have created a massive influx and staggering complexity of cultural data on the Web.[6] Access to this data and meaningful navigation through it remain a challenge because the user interfaces that mediate cultural collections too often rely on outdated information-seeking behaviors.[7] Consider, for example, our reliance on targeted search to access the wide variety of information we consume on a daily basis. In the context of cultural heritage, Whitelaw describes the search bar in terms of a museum attendant who requires visitors to request specific artworks rather than allowing them to casually browse the gallery floor.[8] In this task-oriented mode of information-seeking there is little room for spontaneity or serendipity. In lieu of exploration and discovery, digital collections become a locus for subject matter experts, often to the detriment of casual users.

However, meaningful interaction as a quality of user experience extends beyond mere browsing and discovery. UX is often misconstrued as usability, that is to say, narrowly concerned with a technology's capacity to assist in the accomplishment of a specific task, or to fulfill a particular information need.[9] This reductionist view fails to account for the cognitive, emotional, and experiential aspects that also inform perceptions of technology use, and which are central to the UX design process. These subjective concerns are themselves the very objects of a hermeneutics of the user and a primary contribution of my thesis, which explores meaningful design as it relates to emerging information-seeking behaviors in cultural heritage. My users are adult museum visitors and, more specifically, the digital visitor. I investigate how their interactions within

5 Linda Norris and Rainey Tisdale, "Developing a Toolkit for Emotion in Museums," *Exhibition*, (2017), 100–8.

6 Florian Windhager et al., "Visualization of Cultural Heritage Collection Data: State of the Art and Future Challenges," *IEEE Transactions on Visualization and Computer Graphics 25*, no. 6 (2019), 2311–30.

7 Max L. Wilson and David Elsweiler, "Casual-Leisure Searching: the Exploratory Search Scenarios that Break Our Current Models," 2010, accessed November 4, 2021, https://epub.uni-regensburg.de/22693/1/wilson_HCIR2010.pdf; and David Walsh and Mark M. Hall, "Just Looking Around: Supporting Casual Users Initial Encounters with Digital Cultural Heritage," (European Conference on Information Retrieval, ECIR, Vienna, 2015), 3.

8 Mitchell Whitelaw, "Generous Interfaces for Digital Cultural Collections," *Digital Humanities Quarterly* 9, no. 1 (2015).

9 Hassenzahl and Tractinsky, "User Experience."

museums can inform their experience of an online visit. Additionally, I consider the role of user-as-creator and the implications of involving the public in the co-creation of museum technologies they will one day use. Together, these individual approaches form a holistic view of museum technologies from the point of view of the user, offering new perspectives on experience design for the practical, but also the aesthetic, emotional, or even sublime.

3 Moving beyond the experience economy

Why do we care about designing experiences around digital cultural collections, and what forms might that take? Pine and Gilmore's essay in the *Harvard Business Review* on the experience economy formalized a growing economic trend that foresaw a limitless commodification potential of the experience.[10] In lieu of goods and services, experience economies specialize in offering sensations, new memories, social connections, and other forms of individualized, meaningful events and encounters. In opposition to this development, some cultural professionals have decried the experiential turn in museums, which they argue has compelled cultural heritage institutions to rebrand themselves as theme parks or cultural complexes that cheapen or trivialize their original missions.[11]

In spite of these very real pitfalls, experience design for cultural heritage has implications that reach far beyond its economic impact. As a comprehensive self-reflexive design thinking approach, it has emerged within HCI's "third wave," where design embraces meaning-making and critiques the notion of efficiency for efficiency's sake.[12] It is the difference between a museum app with a robust search interface and one that employs mindfulness techniques to create calm moments of reflection with a single artwork. By empathizing with users, we come to understand how transformational museum experiences occur, and how they can contribute to meaning-making in digital spaces.

10 Joseph Pine II and James Gilmore, "Welcome to the Experience Economy," *Harvard Business Review*, July–August 1998.
11 Martin Hall, "The Reappearance of the Authentic," in *Museum Frictions: Public Cultures/Global Transformations*, ed. Ivan Karp et al. (Duke University Press, 2006); and Andreas Huyssen, "The Metamorphosis of the Museal: From Exhibitionary to Experiential Complex and Beyond," in *Women Mobilizing Memory*, ed. Ayşe Gül Altýnay et al. (Columbia University Press, 2019).
12 Susanne Bødker, "Third-Wave HCI, 10 Years Later – Participation and Sharing," *Interactions* 22, no. 5 (2015): 24–31.

For Simon, meaning-making in museums comes from creating relevance, in other words, orienting the museum's priorities to reflect the lived realities of the communities they serve.[13] A similar theme appears in the work of Vermeeren et al., who emphasize the notion of a community-centered museum rather than a collection-centered institution.[14] Aware of this trend, museums have begun to solicit the involvement of the public in the curation of exhibits[15] and the development of new interactive technologies.[16] Many of these developments have grown in tandem with developments in museology and public history, where participants are encouraged to take ownership of their own interpretive authority and connect to the past through their own lives and perspectives.[17] By drawing on the expertise of their communities, museums can make themselves essential fixtures within them.

In recent years, similar attempts to flatten the hierarchy of knowledge production and consumption have extended into the design of museum technologies and become an important area of study in HCI research. Generally speaking, however, researchers tend to focus disproportionately on technologies inside of museums. As Petrelli et al. argue, many museum professionals still view the museum and its digital initiatives as separate worlds altogether, and more re- cently this divide has transposed itself into technology on-site versus technology online.[18] In the introduction to their recent monograph, *Human-Computer Interaction in Museums*, Hornecker and Ciolfi acknowledge the growing interest in digital museums and similar platforms, but nevertheless consider the technologies as out of scope

13 Nina Simon, *The Art of Relevance* (Santa Cruz, CA: Museum 2.0, 2016).

14 Arnold P. O. S. Vermeeren et al., "Future Museum Experience Design: Crowds, Ecosystems and Novel Technologies," in *Museum Experience Design*, ed. Arnold Vermeeren, Licia Calvi, and Amalia Sabiescu (Cham: Springer International Publishing, 2018), 1–16.

15 Luigina Ciolfi, Liam J. Bannon, and Mikael Fernström, "Including Visitor Contributions in Cultural Heritage Installations: Designing for Participation," *Museum Management and Curatorship* 23, no. 4 (2008): 353–65; and Amy S. Weisser and Alison Koch, "Talking Through Our Pain: Visitor Responses at the 9/11 Memorial Museum," *Exhibition* vol. 36, no. 1 (2017): 78.

16 Joel Lanir et al., "The Influence of a Location-Aware Mobile Guide on Museum Visitors' Behavior," *Interacting with Computers* 25, no. 6 (2013): 443–60; and Paul F. Marty, "My Lost Museum: User Expectations and Motivations for Creating Personal Digital Collections on Museum Websites," *Library & Information Science Research* 33, no. 3 (2011): 211–9.

17 Benjamin Filene, "History Museums and Identity: Finding 'Them,' 'Me,' and 'Us' in the Gallery," in *The Oxford Handbook of Public History*, ed. James B. Gardner and Paula Hamilton (Oxford: Oxford University Press, 2017).

18 Daniela Petrelli et al., "Tangible Data Souvenirs as a Bridge Between a Physical Museum Visit and Online Digital Experience," *Personal and Ubiquitous Computing* 21, no. 2 (2017): 281–295.

for their study.[19] For museum collections on the Web this overlooks many important and unresolved challenges that warrant closer inspection.

Digital collections struggle to engage users, resulting in platforms that go unused or remain largely underappreciated.[20] The increasing power of Web technologies has not embraced an equally sophisticated translation of modern museological theory and practice into the digital.[21] Many collections default to static libraries of objects, often displayed out of context and accompanied by an authoritative wall of text – a passive recapitulation of the museum's colonial history as the ultimate purveyor of culture. This didactic approach to digital museum learning does not take advantage of the vast potentials afforded by digital spaces, and is instead reminiscent of the nineteenth century museum.[22] Digital collections also face the challenge of authenticity, which is to say the direct and tangible confrontation with artworks.[23] Dematerialized museum objects do not have the same perceived value as their physical counterparts, but nevertheless many museums attempt to recreate their physicality on the Web, often through the creation of virtual gallery walk-throughs that have only limited interactivity.

Meaningful interaction design for digital cultural collections confronts a number of important challenges, as described above. Each of these challenges directly implicates the user. In cases where museum technologies fail to engage, this is arguably due to a kind of user myopia. Interactive systems should not only acknowledge the collections on display, but also the visitors in the gallery, even if the gallery is in cyberspace.

How then should we understand the notion of an experience? In their seminal research agenda on UX design, Hassenzahl and Tractinsky extend the

19 Eva Hornecker and Luigina Ciolfi, *Human-Computer Interactions in Museums*, ed. John M. Carroll, Synthesis Lectures on Human-Centered Informatics (San Rafael, California: Morgan & Claypool, 2019).

20 Craig MacDonald, "Assessing the User Experience (UX) of Online Museum Collections: Perspectives from Design and Museum Professionals," (Museums and the Web, Chicago, USA, 2015), accessed November 4, 2021, https://mw2015.museumsandtheweb.com/paper/assessing-the-user-experience-ux-of-online-museum-collections-perspectives-from-design-and-museum-professionals/.

21 Sara Perry et al., "Moving Beyond the Virtual Museum: Engaging Visitors Emotionally," (23rd International Conference on Virtual System Multimedia, Dublin, 2017), 1–8.

22 Konstantinos Arvanitis, "Museums Outside Walls: Mobile Phones and the Museum in the Everyday," in *Museums in a Digital Age*, ed. Ross Parry (London: Routledge, 2013), 496; and Filene, "History Museums and Identity."

23 Yves Evrard and Anne Krebs, "The Authenticity of the Museum Experience in the Digital Age: The Case of the Louvre," *Journal of Cultural Economics* 42, no. 3 (2018): 353–63.

notion of user experience beyond the instrumental, that is to say, beyond pragmatic or task-oriented behaviors, and into the more complex emotional and dynamic aspects of product use.[24] They describe UX as "a consequence of a user's internal state, the characteristics of the designed system," and "the context within which interaction occurs." In this framework, therefore, we can understand the notion of experience as a complex phenomenon resulting from the coalescing of personal disposition, situational circumstances, and a particular product, service, or technology. Museum experience design, therefore, must take these factors into account.

4 Meaning-making in the museum experience

Museum experience design has emerged within the HCI community as a result of advances in UX research and its application to the cultural heritage domain. A primary objective is to design meaningful technologies. But how can we define meaning, and what makes technology meaningful?

Meaning-making matters, argues Simon, and relevance is the key to unlocking it within museum spaces and communities.[25] Cultural professionals have increasingly adopted this perspective, and with good reason. Seminal work by Falk and Dierking on visitor experiences found that memories of museum visits are persistent, salient, and highly personal.[26] In their later work, they emphasized the cognitive and social aspects of the museum visit that work in tandem with the design of museum spaces and the curation of exhibits to create meaning and inspire learning.[27] For both Simon, and Falk and Dierking, the museum resonates far beyond its front door. More than merely a metaphor, museum outreach is a tangible reality – particularly in the digital, where online galleries and virtual exhibits have become the norm for many museums around the world.

Stepping back for a moment from how we might design for meaningful experiences, we must first consider more critically the question, What is meaning? Mekler and Hornbæk illustrate the inconsistent use of the term "meaningful" in

24 Hassenzahl and Tractinsky, "User Experience."
25 Simon, *The Art of Relevance*.
26 John H. Falk and Lynn D. Dierking, "Recalling the Museum Experience," *Journal of Museum Education* 20, no. 2 (1995): 10–3.
27 John H. Falk and Lynn D. Dierking, *The Museum Experience Revisited* (London: Taylor & Francis, 2013).

HCI literature, noting that it may refer to the user experience of a system, a particular artifact or occurrence, or even a user's interpretation of their own interactions.[28] As the authors describe, in many cases publications make explicit use of the term "meaningful" in their titles, only to completely avoid defining it within the text. The term has been used quite freely, but recent work has sought to more clearly define this concept.

In the case of Simon, meaningfulness results, at least in part, from cultivating relevance.[29] For Falk and Dierking, meaningfulness arrives through the complex interplay of personal, physical, and sociocultural contexts that inform our thoughts, behaviors, and underlying motivations.[30] Falk's typology of museum visitors, a collection of museum-specific identities that represent typical visitor behaviors, carefully considers the role of identity and personal motivation in learning and meaning-making.[31] Take for example the identity of the "recharger," who experiences the museum as a calm respite away from the world, where they connect with objects, artworks, and with themselves through contemplation or spirituality. Falk's attempt to identify the underlying motivations that catalyze museum visitors to construct meaning offers a window into meaning-making that has actionable implications for designers of cultural technologies who are considering how to connect with different kinds of audiences.

Another aspect of meaning appears in the UX research agenda of Hassenzahl and Tractinsky, where the authors contrast pragmatic usability with hedonic pleasure and stimulation, that is to say, the emotional and often subjective reactions that arise during interaction with a product, service, or technology.[32]

Interacting with a useful product may bring satisfaction, but interacting with a *beautiful* and useful product offers something even more. Successfully retrieving a sought-after museum object while navigating through a digital collection might make you feel capable or smart, but watching the object come to life through an engaging digital storytelling experience may trigger interest, curiosity, or excitement.

28 Elisa D. Mekler and Kasper Hornbæk, "A Framework for the Experience of Meaning in Human-Computer Interaction," (CHI Conference on Human Factors in Computing Systems, Glasgow, 2019), 1–15.

29 Simon, *The Art of Relevance*.

30 Falk and Dierking, *The Museum Experience Revisited*.

31 John H. Falk, *Identity and the Museum Visitor Experience* (Walnut Creek, CA: Left Coast Press, 2009).

32 Hassenzahl and Tractinsky, "User Experience."

An additional layer of experience comes in the form of eudaimonia, which Huta and Waterman describe as growth, meaning, authenticity, and excellence.[33] Often contrasted with hedonic experiences, which generally represent short-term pleasures and comforts, eudaimonia comprises those experiences that trigger long-term change, such as personal development or the feeling of well-being. In their analysis of eudaimonia and hedonia, Huta and Waterman emphasize the challenges of discerning between the two, as they are often interrelated – but even amidst this tension researchers have yet another lens through which to consider the notion of meaningfulness in design.[34] This lens draws from an empirically based understanding of subjective experience, sense of self, and personal motivations.

Returning to Mekler and Hornbæk, we see in their work many of the aforementioned ideas aggregated into a framework of meaning that attempts to answer the important question, What makes interaction good?[35] Their framework presents a series of five criteria that underlie the experience of meaning during interaction: connectedness, purpose, coherence, resonance, and significance. Meaning emerges as a result of a personal connection, or in relation to our particular circumstances in the world (connectedness). It aligns with or even challenges our aims, goals, and personal agency in life (purpose). Meaning happens when something makes sense to us – when we are able to understand how an experience fits into our perception or worldview (coherence). It has an intuitive quality insofar as it carries an inherent, unspoken feeling of rightness or wrongness that we feel "clicks" with us or does not (resonance). Finally, it is nontrivial: meaning has lasting impact that matters (significance).

Much like the concepts of experience and experience design, meaning-making is a complex process inextricable from the thoughts, feelings, and personal identities of users. In the development of my own project, "meaningful design" has come to embody this synthesis of ideas as they make themselves relevant throughout the design process. However, from the perspective of museum experience design, it has also become clear that meaning has an important communal aspect that museums must consider, even in digital spaces. As museums increasingly embrace their emerging role as centers for public activities of all kinds, so too should they reconsider their digital spaces in order to accommodate for these activities.

33 Huta and Waterman, "Eudaimonia."
34 Huta and Waterman, "Eudaimonia."
35 Mekler and Hornbæk, "A Framework."

5 Applying a user-centered methodology to the design of digital collections

UX design is still a relative newcomer to cultural heritage and humanities computing. In a recent systematic review of visualization tools in cultural heritage, Windhager et al. reported that more than half of publications surveyed did not include any kind of user study.[36] Therefore, an important objective of my project is to serve as a case study in the design of digital tools for cultural heritage using a UX process. Understanding the triggers behind memorable museum experiences and the ways in which museum visitors interact with arts and culture online are critical steps to inform the design of engaging digital browsing experiences. Grounding the design and implementation of these new features in the UX process ensures a close relationship between user and technology, curator and museumgoer, and an overall improvement in the usability of the interactive system.

Central to the UX method (Fig. 1) is an iterative cycle consisting of five steps: planning, exploration, ideation, generation, and evaluation.[37] This method is applicable to virtually any research project or idea, allowing museum technology designers to empathize with the users for whom they are designing, while also providing methods to empirically measure the opportunities and pain points implicated in the design of the technology.

Here, I contrast the UX method with that of digital hermeneutics as described by Fickers, which identifies algorithm criticism, digital source criticism, tool criticism, and interface criticism throughout the research process.[38] Additionally, other forms of multimodal literacy, such as data criticism and simulation criticism, are described within this framework. As an update to the classical tradition of Schleiermacher, Dilthey, Heidegger, and Habermas, digital hermeneutics seeks to expose and critique the oftentimes invisible layers of meaning-making that happen within automated environments. It posits that tools, interfaces, and encodings have implications for the collection, interpretation, and presentation of data, and in doing so establishes new, critically oriented information behaviors within the digital research process.[39]

36 Windhager et al., "Visualization."

37 Carine Lallemand and Guillaume Gronier, *Methodes de Design UX*, 2nd ed. (Paris: Eyrolles, 2018).

38 Andreas Fickers, "Update für die Hermeneutik. Geschichtswissenschaft auf dem Weg zur digitalen Forensik?", *Zeithistorische Forschungen/Studies in Contemporary History*, Online-Ausgabe, 17, no. 1 (2020).

39 Fickers, "Update."

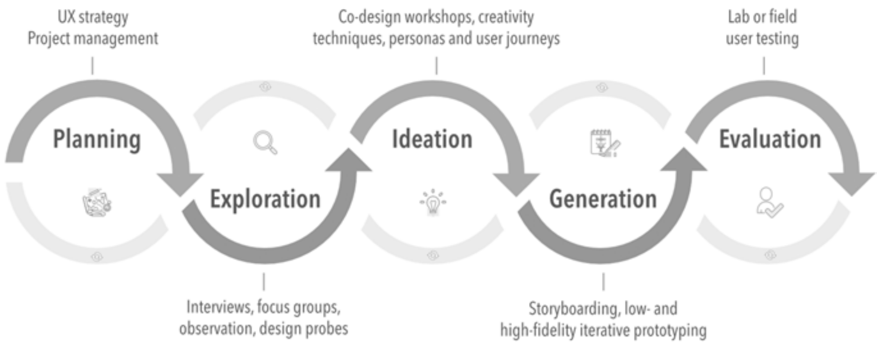

Fig. 1: UX design method scheme. 2018. © Carine Lallemand, University of Luxembourg, first published in French in: Lallemand, Carine, and Guillaume Gronier. Methodes de design UX. 2nd ed. Paris: Eyrolles, 2018.

As iterative frameworks for the design and use of technologies, the UX method and the digital hermeneutical tradition both represent a new critical apparatus for digital research. I suggest, however, that while digital hermeneutics contributes to a deeper understanding of the instrumental and goal-oriented aspects of the research process (e.g. identifying bias in data visualization, critiquing sources, etc.), a hermeneutics of the user that arises from the UX method considers as well the aesthetics of use, its subjective or emotional experience, the personal dispositions of its users (e.g. information-seeking habits, technology preferences, etc.), and its temporality (e.g. before, after, and long after use). To put this more into perspective, following are two of the user studies on museum visitors that I conducted during my research process, and which embody these aspects.

6 Study 1: Experience narratives and the meaningful museum experience

Although the aura of a museum object is not easily translatable into the digital,[40] there are other kinds of experiences that designers in the cultural sector might consider instead. In the first of the two studies discussed here, I sought to uncover how meaning-making occurs for museum visitors during in-person visits. By understanding what happens during physical visits, we can derive new approaches to designing for the digital.

40 Evrard and Krebs, "Authenticity."

Building on the work of Falk and Dierking, and Henry, whose interviews with museum visitors shed light on the complex nature of museum memories, my study endeavored to advance this research in the direction of "experience triggers."[41] Experience triggers represent the various phenomena that coalesce to form a memorable experience. In this case, triggers may be thoughts, feelings, encounters, objects, or any tangible or intangible aspect of the museum visit. In order to identify these triggers, I invited 32 participants to the User Lab at the University of Luxembourg to discuss their most meaningful museum experiences. During semistructured interviews, I asked participants to discuss aloud five to ten memorable museum experiences and then to report on each of them using an "experience narrative template" (Figure 2).

Research has demonstrated that experience narratives contribute to a more holistic understanding of user interaction with digital technologies, and that emotional qualities – both positive and negative – are deeply intertwined with experience.[42] We designed an experience narrative report that contained four sections: object description, keywords, rating, and emotions.

The object description field asked participants for information about the object, artwork, or museum being discussed. This information included the name, location, and date of visit. The keywords section asked participants for three keywords that came to mind when considering their overall experience. These keywords could represent salient aspects of the memories themselves, or even how participants were feeling at the time of the experience. The goal was to give participants autonomy in their keyword choice. In the third section, participants rated the overall museum experience from 0 (very bad) to 10 (very good). Finally, in the emotions section, together with fellow researchers, I employed the Geneva Emotion Wheel (GEW), an empirically tested psychometric tool that allows participants to rate their emotional response and corresponding intensity to objects, events, and situations across an axis of valence and control.[43]

41 Falk and Dierking, "Recalling"; and Carole Henry, "How Visitors Relate to Museum Experiences: An Analysis of Positive and Negative Reactions," *Journal of Aesthetic Education* 34, no. 2 (2000): 99.

42 Marc Hassenzahl, Sarah Diefenbach, and Anja Göritz, "Needs, Affect, and Interactive Products – Facets of User Experience," *Interacting with Computers* 22, no. 5 (2010): 353–62; Timo Partala and Aleksi Kallinen, "Understanding the Most Satisfying and Unsatisfying User Experiences," *Interacting with Computers*, 24, no. 1 (2012); and Alexandre N. Tuch, Rune Trusell, and Kasper Hornbæk, "Analyzing Users' Narratives to Understand Experience with Interactive Products," (SIGCHI Conference on Human Factors in Computing Systems, Paris, 2013), 207–9.

43 Klaus R. Scherer, "What Are Emotions? And How Can They Be Measured?," *Social Science Information* 44, no. 4 (2005): 695–729; and Klaus R. Scherer et al., "The GRID Meets the Wheel: Assessing Emotional Feeling via Self-Report," in *Components of Emotional Meaning: A*

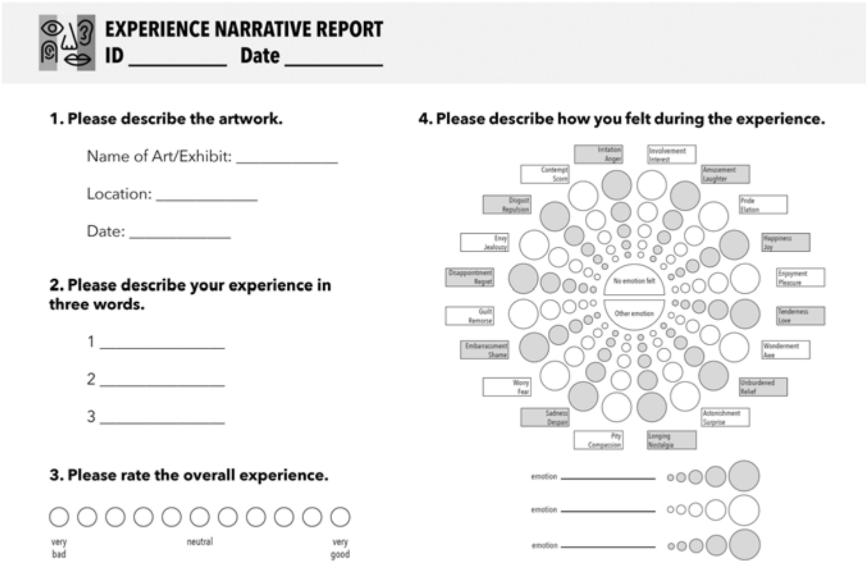

Fig. 2: Experience narrative report template. 2019. © design by Christopher Morse. The wheel of emotions is part of the Geneva Emotion Wheel, published in the works of Klaus R. Scherer et al. (see references) and Swiss Center for affective Sciences https://www.unige.ch/cisa/gew/, accessed February 7, 2022.

In total, we collected almost 200 individual narrative reports on participants' meaningful museum experiences at museums around the world, which we documented both in a database and as verbatim transcriptions from each interview. We then performed an iterative thematic analysis on the transcriptions, paying close attention to the varying aspects of each experience that made it memorable for the participant. This "close reading" of the user through the collected experience narratives helped us to identify 23 unique triggers for memorable museum experiences, which we later incorporated into a framework of museum experience.

Using this framework, I designed the Museum Experience Cards shown in Fig. 3 as an ideation tool and for use in design workshops with museum visitors. The ideation phase, which corresponds to the third step in the UX process of Fig. 1, built on the wisdom gained during my exploratory research and user studies, and included targeted brainstorming sessions, user modeling

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Sourcebook, edited by J. R. J. Fontaine, K. R. Scherer, and C. Soriano. (Oxford: Oxford University Press, 2013): 281–98.

(e.g. personas), creativity workshops, and other activities that can inform the future design of technology prototypes. Ideation cards, such as the Museum Experience Cards, are commonly used during this phase, and studies have established their effectiveness in supporting creativity during design and co-creation activities.[44]

Fig. 3: Sample Museum Experience Card. 2018. © Christopher Morse.

The Museum Experience Cards comprise one card for each experience trigger. The image and text on each card come directly from the experience narrative reports; as such they closely mirror the needs, expectations, and motivations of museum visitors – that is to say, future users. The "expectations" trigger, illustrated on the left of Fig. 3, represents experiences where visitors either excitedly anticipate a particular exhibit or, conversely, feel disappointment when seeing a blockbuster exhibit and thinking to themselves, Oh, is that all? Another important trigger is "VIP" status, such as when a visitor receives some kind of special treatment or privilege (e.g. a private museum tour or unrestricted access to an

44 Joanna Kwiatkowska, Agnieszka Szóstek, and David Lamas, "(Un)structured Sources of Inspiration: Comparing the Effects of Game-Like Cards and Design Cards on Creativity in Co-Design Process," (*13th Participatory Design Conference*, Windhoek, Namibia, 2014), 31–9; and Kim Halskov and Peter Dalsgård, "Inspiration Card Workshops," (*6th ACM Conference on Designing Interactive Systems*, University Park, PA, 2006), 2.

object). It is rare that an experience is memorable due to only a single trigger. Instead, meaningful memories arise as a complex interplay of different triggers simultaneously.

During the ideation phase I hosted a series of "design jam" events at Luxembourg's National Museum of History and Art (MNHA) with the goal of involving members of the public in the design of museum interfaces, and also to test the Museum Experience Cards as a tool for inspiration during the session. Design jam participants broke up into teams, identified a museum digital collections-related design challenge to solve, and created their own low-fidelity prototypes as a part of those solutions. One group selected the "responsibility" trigger as their design case study. Responsibility here relates to the moral and ethical implications of the museum experience, such as notions of spoliation, curation of difficult themes, and even legal copyright. In particular, the group focused on pushing the boundaries of fair use by designing a platform that gave users the ability to remix artwork and re-curate it on their own terms. In this way, the ideation cards served as a springboard to a design thinking solutions approach.

The framework of experience triggers provides technology designers in the cultural sector with a toolkit to better understand the various experiential categories relevant to the museum visit, and in doing so allows them to empathize with members of the public as future users. Rather than merely building tools that showcase the museum's physical holdings, designers can target specific kinds of interaction, such as creating moments of "discovery" or "fondness." Moreover, the resulting museum experience ideation cards can help nonexpert users (e.g. members of the public) participate in design thinking processes with museums, giving them a bridge to share their own experiences and to co-create the technologies they will one day use.

7 Study 2: Rich-prospect browsing

In recent years a number of user interface design frameworks have emerged within the context of visual collections. One such design framework is called "rich-prospect browsing." Described initially by Ruecker et al., rich-prospect interfaces visualize the entirety of a visual collection first, and then allows users to zoom in for more details.[45] Additionally, interfaces of this variety typically have a suite of features that allow users to navigate the collections in different

45 Stan Ruecker, Milena Radzikowska, and Stéfan Sinclair, *Visual Interface Design for Digital Cultural Heritage: A Guide to Rich-Prospect Browsing* (Farnham, England: Ashgate, 2011).

ways, such as by specific metadata, flexible visual layouts, etc. A nice example constitutes the *Coins* interface, which visualizes the entire coin collection of the Münzkabinett Berlin, one of the world's largest numismatic collections.[46]

Advances in Web technologies have resulted in the emergence of new interfaces of this variety, but few studies exist to understand their effectiveness and their implications for user experience. Therefore, the second exploratory study in my project invited 30 participants to the User Lab to test three different rich-prospect browsers: Coins, *Curator Table*, and *Museum of the World*.[47]

The Coins interface represents one type of digital cultural collection, namely numismatics. Curator Table, built by Google Arts & Culture, visualizes the collections of 600+ partnering institutions in the form of a giant landscape. This collection consists primarily of visual art. Finally, the Museum of the World interface of the British Museum (in collaboration with Google) provides visitors with a 3D geographical timeline of a selection of the museum's collections, mainly archaeological in nature.

We asked participants in our study to spend ten minutes with each interface and report on their experiences through interviews and the think-aloud technique (describing the experience of using the interface aloud throughout each session). Additionally, we evaluated the user experience of each collection using a well-established UX scale called the *AttrakDiff*, originally developed by Hassenzahl et al.[48] The AttrakDiff establishes four empirically measurable elements within user experience: pragmatic quality (PQ), hedonic quality – identification (HQ-I), hedonic quality – stimulation (HQ-S), and global attractiveness (ATT).

PQ measures how well a technology allows users to complete a task (e.g. search for artwork, compare objects, learn about an artist, etc.). This component represents notions of task-oriented usability more generally. HQ-I measures how well the user self-identifies with the technology. In other words, this aspect of experience considers the role of self-image and self-expression arising as a result of using the technology. For example, a musician may closely identify with a specific mobile app for tuning their instrument because its functionality corresponds well with how they structure their practice. HQ-S measures the level of stimulation engendered. Is the technology novel and engaging? To

46 Flavio Gortana et al., "COINS – A Journey Through a Rich Cultural Collection," Münzkabinett Berlin, accessed September 16, 2019, https://uclab.fh-potsdam.de/coins.
47 Christopher Morse et al., "Art in Rich-Prospect: Evaluating Next-Generation User Interfaces for Cultural Heritage," (Annual Conference of Museums and the Web, Boston, Massachusetts, 2019).
48 Marc Hassenzahl, Michael Burmester, and Franz Koller, "AttrakDiff: Ein Fragebogen zur Messung Wahrgenommener Hedonischer und Pragmatischer Qualität," in *Mensch & Computer 2003*, ed. Gerd Szwillus and Jürgen Ziegler, vol. 57 (Wiesbaden: Vieweg+Teubner Verlag, 2003), 187–96.

what extent does the technology break conventions? This component considers originality and perceived stimulation during use. Finally, ATT measures the aesthetics of use and the technology's perceived value according to users.

During the interviews and think-aloud sessions we learned that many users struggled to understand the context and underlying structure of the interfaces. In some cases users wanted more explicit access to search bar functionality, which highlighted a lingering reliance on conventional information-seeking behaviors. We also found that users had polarized reactions to the feature that visualized cultural collections in their entirety. As one participant commented, "Everything is there, but nothing is there." In other words, by seeing everything at once you are too overwhelmed to really see anything at all. Another participant described the experience as interesting but impractical.

Rich-prospect browsing purports to have many distinct advantages over other user interface design frameworks. For example, by visualizing a collection in its entirety, no single item will be lost within the depths of the digital repository, as so many objects often are. All objects are accessible right from the start. However, rich-prospect also presents new challenges. Many people have not yet adopted the information seeking behaviors that are necessary to fully engage with a dynamic digital collection of this kind. Moreover, visualizing the entirety of a collection by itself is not enough. Perhaps our most important finding was that rich-prospect browsing suffers from a lack of context. Users struggled to understand why certain visualization patterns were used (e.g. is the Curator Table visualization supposed to be a map, a landscape, something random?), or what the explicit purpose of the interface was in the first place. Understanding the perspective of the user provided us with meaningful insights on the technologies and their future development.

8 A hermeneutics of the user

Digital hermeneutics concerns itself with criticism, whether that be source criticism, tool criticism, algorithmic criticism, or any other reflective apparatus. In my discussion of the hermeneutics of the user I carefully avoid suggesting the term "user criticism." Arguably, the term "user hermeneutics" (or "a hermeneutics of the user") has a different underlying objective. The framework of digital hermeneutics endeavors to expose bias in the data, the algorithm, or the tool, ultimately informing the researcher how to frame their results as objectively as possible. In contrast, a hermeneutics of the user is highly nuanced and deeply subjective. We might say instead that it is an empirically based measurement of bias in a particular target individual or group and that, through those biases, designers can elevate users' interactions with technologies.

We might apply this hermeneutics of the user to more closely understand how to design tools for humanities interpretation rather than uncritically borrowing tools from the natural and social sciences. In Drucker's article on graphical display in the humanities, she argues for an approach to the design of tools that are "rooted in a co-dependent relation between observer and experience."[49] From this perspective, temporal realities may warp based on fleeting or long-standing emotional states, demographic statistics might be dynamic based on how a person self-identifies, or a Cartesian map may display in fish-eye lens mode based on the subjective reactions of a witness to an external event.[50] In human–computer interaction, similar initiatives, such as feminist HCI, theorize about how to construct interactive systems that embody notions of agency, fulfillment, identify and the self, equity, empowerment, diversity, and social justice.[51]

My doctoral research attempts to draw similar conclusions in the context of museum technologies. By understanding different kinds of museum visitors – their needs, expectations, and motivations – my project aims to reveal new avenues for *meaningful* interaction design in digital spaces. The experience must go beyond instrumentality or mere usability, embracing as well the hedonic and eudaimonic qualities that factor into our perceptions of technology use. As such, user experience design and, by proxy, a hermeneutics of the user contribute to the advancement of current trends that are shifting us toward a human-centered, holistic approach to the conceptualization of technologies altogether.

9 Conclusion

At first glance it may appear that the UX method exists on a different timeline than digital hermeneutics. The UX process in its ideal state assumes that a research tool (or museum user interface) has not yet been developed and that the previously discussed five-step iteration will be applied from beginning to end. In contrast, digital hermeneutics often concerns itself with what already exists, whether that be digitized sources in a virtual gallery or network visualization software to make sense of one's data. However, this assertion could not be

49 Drucker, "Humanities Approaches."
50 Drucker, "Humanities Approaches."
51 Shaowen Bardzell, "Feminist HCI: Taking Stock and Outlining an Agenda for Design," (28th International Conference on Human Factors in Computing Systems, Atlanta, GA, 2010), 1301.

further from the truth. First, the UX process is an iterative cycle. Designers can at any point re-engage their target audience in order to learn how to improve a product they have already generated. UX understands that technology is not a static thing but, rather, an evolving experience. And while it is true that digital hermeneutics as a critical apparatus offers an analytical approach to reflect on technologies currently in use, its central commitments of transparency, multimodality, and the non-neutrality of technology are essential to the process of visionary design. Both digital hermeneutics and the UX method have forward-looking and retrospective potentialities.

In my own doctoral research, both approaches shed light on the challenges of designing technologies that have a practical function (e.g. object search and retrieval) as well as a much deeper, experiential quality (e.g. serendipity or wonderment). I am now beginning the final phases of the design process in my research and evaluating the digital prototypes that emerge as a result. I have already witnessed firsthand the importance and relevance of a user hermeneutics, as it has provided my project with valuable insights about meaning-making and information-seeking. As technology increasingly becomes more nuanced – not only to our preferences, but to our words, our gestures, even our moods – understanding the unlimited diversity of the user will be paramount.

References

Arvanitis, Konstantinos. “Museums Outside Walls: Mobile Phones and the Museum in the Everyday.” In *Museums in a Digital Age*, edited by Ross Parry, 496. London: Routledge, 2013.

Bardzell, Shaowen. “Feminist HCI: Taking Stock and Outlining an Agenda for Design.” Paper presented at the 28th International Conference on Human Factors in Computing Systems, 1301–10. Atlanta, Georgia: ACM Press, 2010.

Bødker, Susanne. “Third-wave HCI, 10 Years Later – Participation and Sharing.” *Interactions* 22, no. 5 (2015): 24–31.

Ciolfi, Luigina, Liam J. Bannon, and Mikael Fernström. “Including Visitor Contributions in Cultural Heritage Installations: Designing for Participation.” *Museum Management and Curatorship* 23, 4 (2008): 353–65.

Drucker, Joanna. “Humanities Approaches to Graphical Display.” *DHQ: Digital Humanities Quarterly* 5, no. 1 (2011). Accessed November 4, 2021. http://www.digitalhumanities.org/dhq/vol/5/1/000091/000091.html.

Evrard, Yves, and Anne Krebs. “The Authenticity of the Museum Experience in the Digital Age: The Case of the Louvre.” *Journal of Cultural Economics* 42, 3 (2018): 353–63.

Falk, John H. *Identity and the Museum Visitor Experience*. Walnut Creek, California: Left Coast Press, 2009.

Falk, John H., and Lynn D. Dierking. "Recalling the Museum Experience." *Journal of Museum Education* 20, no. 2 (1995): 10–3.
Falk, John H., and Lynn D. Dierking. *The Museum Experience Revisited*. London: Taylor & Francis, 2013.
Fickers, Andreas. "Update für die Hermeneutik. Geschichtswissenschaft auf dem Weg zur Digitalen Forensik?" *Zeithistorische Forschungen/Studies in Contemporary History* 17, 1 (2020). https://doi.org/10.14765/ZZF.DOK-1765.
Filene, Benjamin. "History Museums and Identity: Finding 'Them,' 'Me,' and 'Us' in the Gallery." In *The Oxford Handbook of Public History*, edited by James B. Gardner and Paula Hamilton. Oxford: Oxford University Press, 2017. Accessed November 4, 2021. https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199766024.001.0001/oxfordhb-9780199766024-e-18.
Gortana, Flavio et al., "COINS – A Journey Through a Rich Cultural Collection." Münzkabinett Berlin. Accessed September 16, 2019. https://uclab.fh-potsdam.de/coins.
Hall, Martin. "The Reappearance of the Authentic." In *Museum Frictions: Public Cultures/ Global Transformations*, edited by Ivan Karp, Corinne A. Kratz, Lynn Szwaja, and Tomás Ybarra-Frausto. Durham, NC: Duke University Press, 2006.
Halskov, Kim, and Peter Dalsgård. "Inspiration card workshops." Paper presented at *the 6th ACM Conference on Designing Interactive Systems*, 2. University Park, PA, 2006. Accessed November 5, 2021. https://dl.acm.org/doi/proceedings/10.1145/1142405.
Hassenzahl, Marc, Michael Burmester, and Franz Koller. "AttrakDiff: Ein Fragebogen zur Messung Wahrgenommener Hedonischer und Pragmatischer Qualität." In *Mensch & Computer 2003*, edited by Gerd Szwillus and Jürgen Ziegler, vol. 57, 187–96. Wiesbaden: Vieweg+Teubner Verlag, 2003.
Hassenzahl, Marc, Sarah Diefenbach, and Anja Göritz. "Needs, Affect, and Interactive Products – Facets of User Experience." *Interacting with Computers* 22, 5 (2010): 353–62.
Hassenzahl, Marc, and Noam Tractinsky. "User Experience – A Research Agenda." *Behaviour & Information Technology* 25, 2 (2006): 91–7.
Henry, Carole. "How Visitors Relate to Museum Experiences: An Analysis of Positive and Negative Reactions." *Journal of Aesthetic Education* 34, no. 2 (2000): 99–106.
Hornecker, Eva, and Luigina Ciolfi. *Human-Computer Interactions in Museums*. Edited by John M. Carroll. Synthesis Lectures on Human-Centered Informatics. San Rafael, California: Morgan & Claypool, 2019.
Huta, Veronika, and Alan S. Waterman. "Eudaimonia and Its Distinction from Hedonia: Developing a Classification and Terminology for Understanding Conceptual and Operational Definitions." *Journal of Happiness Studies* 15, no. 6 (2014): 1425–56.
Huyssen, Andreas. "The Metamorphosis of the Museal: From Exhibitionary to Experiential Complex and Beyond." In *Women Mobilizing Memory*, edited by Ayşe Gül Altýnay et al., New York: Columbia University Press, 2019.
Koenig, Vincent, Juliane Tatarinov, and Christopher Morse. "Tool criticism meets Human–Computer Interaction (HCI) – Doctoral Training Unit 'Digital History & Hermeneutics.'" Digital Tool Criticism, 2019. Accessed June 15, 2020. https://dhh.uni.lu/2019/11/25/tool-criticism-meets-human-computer-interaction-hci/.
Kwiatkowska, Joanna, Agnieszka Szóstek, and David Lamas. "(Un)structured Sources of Inspiration: Comparing the Effects of Game-Like Cards and Design Cards on Creativity in Co-Design Process." Paper presented at the 13th Participatory Design Conference, 31–39. Windhoek, Namibia, 2014. https://doi.org/10.1145/2661435.2661442.

Lallemand, Carine, and Guillaume Gronier. *Méthodes de Design UX*. 2nd ed. Paris: Eyrolles, 2018.
Lanir, Joel et al. “The Influence of a Location-Aware Mobile Guide on Museum Visitors’ Behavior.” *Interacting with Computers* 25, no. 6 (2013): 443–60.
MacDonald, Craig. “Assessing the User Experience (UX) of Online Museum Collections: Perspectives from Design and Museum Professionals.” Paper presented at the annual conference of Museums and the Web, Chicago, Illinois, 2015. Accessed November 4, 2021, https://mw2015.museumsandtheweb.com/paper/assessing-the-user-experience-ux-of-online-museum-collections-perspectives-from-design-and-museum-professionals/.
Marty, Paul F. “My Lost Museum: User Expectations and Motivations for Creating Personal Digital Collections on Museum Websites.” *Library & Information Science Research* 33, no. 3 (2011): 211–9.
Mekler, Elisa D., and Kasper Hornbæk. “A Framework for the Experience of Meaning in Human-Computer Interaction.” Paper presented at the CHI Conference on Human Factors in Computing Systems, 1–15, Glasgow, 2019.
Morse, Christopher et al., “Art in Rich-Prospect: Evaluating Next-Generation User Interfaces for Cultural Heritage.” Paper presented at the annual conference of Museums and the Web, Boston, Massachusetts, 2019.
Norris, Linda, and Rainey Tisdale. “Developing a Toolkit for Emotion in Museums.” *Exhibition* 36, 1 (2017): 100–8.
Partala, Timo, and Aleksi Kallinen. “Understanding the Most Satisfying and Unsatisfying User Experiences.” *Interacting with Computers* 24, no. 1 (2012): 25–34.
Perry, Sara et al., “Moving Beyond the Virtual Museum: Engaging Visitors Emotionally.” Paper presented at the 23rd International Conference on Virtual Systems and Multimedia, Dublin, 2017.
Petrelli, Daniela et al., “Tangible Data Souvenirs as a Bridge Between a Physical Museum Visit and Online Digital Experience.” *Personal and Ubiquitous Computing* 21, no. 2 (2017): 281–95. https://doi.org/10.1007/s00779-016-0993-x
Pine II, Joseph, and James Gilmore. “Welcome to the Experience Economy.” *Harvard Business Review*, 1998. Accessed November 4, 2021. Accessed November 4, 2021, https://hbr.org/1998/07/welcome-to-the-experience-economy.
Ruecker, Stan, Milena Radzikowska, and Stéfan Sinclair. *Visual Interface Design for Digital Cultural Heritage: A Guide to Rich-Prospect Browsing*. Farnham, England: Ashgate, 2011.
Scherer, Klaus R. “What Are Emotions? And How Can They Be Measured?” *Social Science Information* 44, 4 (2005): 695–729.
Scherer, Klaus R. et al., “The GRID Meets the Wheel: Assessing Emotional Feeling Via Self-Report.” In *Components of Emotional Meaning: A Sourcebook*. Edited by J. R. J. Fontaine, K. R. Scherer, and C. Soriano. 281–98. Oxford: Oxford University Press, 2013.
Simon, Nina. *The Art of Relevance*. Santa Cruz, California: Museum 2.0, 2016.
Tuch, Alexandre N., Rune Trusell, and Kasper Hornbæk. “Analyzing Users’ Narratives to Understand Experience With Interactive Products.” Paper presented at the SIGCHI Conference on Human Factors in Computing Systems, 207–9. Paris, 2013.
Vermeeren, Arnold P. O. S. et al., “Future Museum Experience Design: Crowds, Ecosystems and Novel Technologies.” In *Museum Experience Design*, edited by Arnold Vermeeren, Licia Calvi, and Amalia Sabiescu, 1–16. Cham: Springer International Publishing, 2018.

Walsh, David, and Mark M Hall. "Just Looking Around: Supporting Casual Users Initial Encounters with Digital Cultural Heritage." Paper presented at the 37th European Conference on Information Retrieval, Vienna, 2015.

Weisser, Amy S., and Alison Koch. "Talking Through Our Pain: Visitor Responses at the 9/11 Memorial Museum." *Exhibition* 36, 1 (2017): 70–8.

Whitelaw, Mitchell. "Generous Interfaces for Digital Cultural Collections." *Digital Humanities Quarterly* 9, 1 (2015). Accessed November 4, 2021, http://www.digitalhumanities.org/dhq/vol/9/1/000205/000205.html.

Wilson, Max L., and David Elsweiler. "Casual-Leisure Searching: The Exploratory Search Scenarios That Break Our Current Models," 2010. Accessed November 4, 2021, https://epub.uni-regensburg.de/22693/1/wilson_HCIR2010.pdf.

Windhager, Florian, et al., "Visualization of Cultural Heritage Collection Data: State of the Art and Future Challenges." *IEEE Transactions on Visualization and Computer Graphics* 25, no. 6 (2019): 2311–30.

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