Data for History 2021
Modelling Time, Places, Agents

Ontology-based Modeling of Time, Places, Agents in the Project DigiKAR (Digitale Kartenwerkstatt Altes Reich / Digital Map Lab Holy Roman Empire)

Ingo FRANK [a] Monika BARGET [b]

[a] *Library and Electronic Research Infrastructure Division, Leibniz Institute for East and Southeast European Studies, Regensburg, Germany*

[b] *Digital Historical Research Unit / DH Lab, Leibniz Institute of European History, Mainz, Germany*

Project Context The project DigiKAR (Digitale Kartenwerktstatt Altes Reich / Digital Lab Map Holy Roman Empire) develops and tests approaches for the collection, modeling and visualization of early modern spatial data from the Holy Roman Empire (especially 17th and 18th century). In contrast to previous approaches to historical cartography, the project takes the incompleteness and ambiguity of analog and digitized sources ('messy data') into account and opens up alternative perspectives on the analysis of spatial practices in the early modern period.

Objectives There are various problems with traditional modeling of geospatial data which limit the possibilities to integrate, distribute, retrieve, and reuse the data [see detailed list of limitations in 15]. The Linked Data paradigm enables new ways to tackle these issues [cf. 15]. Thus, the poster presents our Linked Data approach towards modeling geospatial information extracted from different historical sources. Instead of coercing historians to apply conventional (H)GIS technology, we intend to "apply GIS to historical research at their own terms, rather than what GIScience and geography proscribe" [16, p. 236]. In order to achieve this kind of paradigm change, we apply requirements engineering guided by ontology-based modeling. In doing so, we consider 'ontology-based' not only as data modeling by means of an *information system ontology*, but also designing such an ontology informed by *philosophical ontology*—i. e. *applied ontology* [18].

Case Studies The interdisciplinary research group (consisting of historians, geographers and information scientists) will pursue two case studies from different geographical regions and political entities of the Holy Roman Empire: the Electorate of Mainz

and the Electorate of Saxony. The aim of the case studies is to model place-based spatial constructions as well as phenomena of historical mobility and networking in order to develop data models for similar projects. By prototypically visualizing human, material, and ideational border-crossings in competing spaces of the Holy Roman Empire, the project addresses central challenges of both traditional imperial historiography and digital historical cartography. The manifold borders of the Holy Roman Empire and its territories—that were by no means exclusively political and often contested—are investigated as integral parts of early modern spaces of action and presented as flexible, ambiguous connections of points.

Methodology The poster focuses on our data modeling approach towards the creation of Linked Data by means of ontology-based modeling. First of all, we need to build an ontology and corresponding ontology design patterns [20, 13] according the requirements of the interdisciplinary project team. We adapt a method from ontology engineering to satisfy the needs of historians, geographers, cartographers and information visualization specialists: The eXtreme Design methodology [2] is an iterative procedure to design ontology design patterns which will be included in the basic information system ontology. The design process starts with the collection of user stories, which describe requirements in a short, structured form. In the next step, so called competency questions are derived from each user story. On the basis of the competency questions, ontology design patterns are selected, extended, or where necessary developed from scratch.

Research Data Life Cycle Seen from a historical information science perspective [3], ontologies are mostly used in the *enrichment* stage and *editing* stage of the *historical information life cycle* [cf. 17, p. 10]. We argue that ontology as a philosophical discipline—i. e. as *applied ontology*—should also be applied in the *analysis* stage. The method of *ontological analysis* ought to support and guide the "modeling for [historical] understanding" as well as the "modeling for production [of maps]" [7]. Using CRM [5] as a top-level ontology is challenging point of view [cf. 25, 1]. However, for pragmatic reasons we use CRM and the CRMgeo extension [12] to conduct our first experiments in ontology-based modeling. Individual principalities can be modeled as an instance of the CRM class *E92 Spacetime Volume* (superclass of *SP1 Phenomenal Spacetime Volume* in CRMgeo) [see 10, fig. 2]. Schneider et al. [26] provide a survey of classes and properties from CRM, CRMgeo, Wikidata, etc. appropriate to represent enclaves and exclaves. Moreover, they propose the use of topological relations where coordinates and polygons are not needed for analysis or not even available from sources. Such elements could be used to model the complex 'fractality' [4] of a fragmented early modern entity like the Electorate of Mainz [see 6, fig. "Das Kurfürstentum Mainz nach 1648"]. An interesting use case of CRMgeo is to model divergent territorial extents or spheres of influence (political, religious, etc.) recorded in different historical sources by combining the CRMgeo class *SP1 Phenomenal Spacetime Volume* with instances of the class *SP7 Declarative Spacetime Volume* to represent the contradictory assumptions about a past phenomenon. Based on our first modeling experiments we will develop ontology design patterns following approaches such as the CRM extension MIDM [24] or the Descriptions and Sitations pattern [9] in order to model spaces of the past according to different interpretations of historical sources [see 8].

Conclusions An essential feature of historical GIS databases is that they integrate data from different types of sources [cf. 11, p. 639]. We use Semantic Web and Linked Data technology as central building blocks to create a geospatial database including not only spatiotemporal data but also provenance information and—where applicable—questionable statements. Based on that technological groundwork, we apply ontological analysis as a method informed by the philosophical discipline of ontology in order to clarify and analyze concepts of political and social entities in the domain of early modern history [see examples for an ontological analysis of the modern concept of 'state' in 22, 23]. With our twofold (technological and philosophical) ontology-based modeling of integrated data from different historical sources, we gain representation systems [19, CP 4.418] suitable for diagrammatic reasoning in the sense of "'gistory"' [16, p. 237].

Outlook "Rather than a visualisation tool, GIS should be used as a painting tool: a tool to creatively engage with one's sources" [16, p. 237]. The use and reuse of the integrated spatiotemporal data within our project's research data life cycle will not be limited to the creation of digital maps (supported by a LOD4WFS [14] implementation), but include the database-supported analysis and non-map visualization of data with spatial relevance. Understanding the Holy Roman Empire as *Personenverbandstaat* [21, p. 448 f.], this includes dynamic network analyis based on serial sources). The project *Digital Lab Map* questions polygon-centered and line-oriented 'patchwork maps' of the Holy Roman Empire [see also 27] and suggests multimodal and multi-perspective visualizations. Last but not least, the DigiKAR team engage in a mutual transfer of knowledge with memory institutions, contribute to historical education, and communicate their research results to the cultural sector as well as society at large.

References

[1] Francesco Beretta. "A challenge for historical research: Making data FAIR using a collaborative ontology management environment (OntoME)". In: *Semantic Web* 12.2 (2021): *Semantic Web for Cultural Heritage*, pp. 279–294. DOI: 10.3233/SW-200416.

[2] Eva Blomqvist, Karl Hammar, and Valentina Presutti. "Engineering Ontologies with Patterns – The eXtreme Design Methodology". In: *Ontology Engineering with Ontology Design Patterns*. Ed. by Pascal Hitzler et al. Vol. 25. Studies on the Semantic Web. IOS Press, 2016. Chap. 2, pp. 23–50.

[3] Onno Boonstra, Leen Breure, and Peter Doorn. *Past, present and future of historical information science*. 2nd ed. DANS, 2006. DOI: 10.26530/OAPEN_353255.

[4] Falk Bretschneider and Christophe Duhamelle. "FRAKTALITÄT: Raumgeschichte und soziales Handeln im Alten Reich". In: *Zeitschrift für Historische Forschung* 43.4 (2016), pp. 703–746.

[5] Martin Doerr. "The CIDOC CRM: An Ontological Approach to Semantic Interoperability of Metadata". In: *AI Magazine* 24.3 (2003), pp. 75–92.

[6] Christophe Duhamelle. "Drinnen und draußen. Raum und Identität der Exklave im Alten Reich nach dem Westfälischen Frieden". In: *Trivium* 14 (2013). DOI: 10.4000/trivium.4630.

[7] Øyvind Eide. "Ontologies, Data Modeling, and TEI". In: *Journal of the Text Encoding Initiative* 8 (2015). URL: http://journals.openedition.org/jtei/1191.

[8] Ingo Frank. “Multi-Perspectival Representation of Historical Reality: Ontology-Based Modeling of Non-Common Conceptualizations”. In: *Proceedings of the Joint Ontology Workshops 2019*. Vol. 2518. CEUR Workshop Proceedings. First International Workshop on Ontologies for Digital Humanities and their Social Analysis. 2019. URL: http://ceur-ws.org/Vol-2518/paper-WODHSA3.pdf.

[9] Aldo Gangemi and Peter Mika. “Understanding the Semantic Web through Descriptions and Situations”. In: *On The Move to Meaningful Internet Systems 2003: CoopIS, DOA, and ODBASE*. Ed. by Robert Meersman, Zahir Tari, and Douglas C. Schmidt. Springer Berlin Heidelberg, 2003, pp. 689–706.

[10] Günther Görz and Laura Albers. “Representing Place in Space and Time – Methodological Aspects in Modelling the Provenance of Cultural Heritage Knowledge”. In: *Provenance of Knowledge. Proceedings CIDOC Conference 2018*. Heraklion: ICOM-CIDOC, 2018.

[11] Ian N. Gregory and Richard G. Healey. “Historical GIS: Structuring, mapping and analysing geographies of the past”. In: *Progress in Human Geography* 31.5 (2007), pp. 638–653.

[12] Gerald Hiebel, Martin Doerr, and Øyvind Eide. “CRMgeo: A Spatiotemporal Extension of CIDOC-CRM”. In: *International Journal on Digital Libraries* 18.4 (Nov. 2017), pp. 271–279. DOI: 10.1007/s00799-016-0192-4.

[13] Pascal Hitzler et al., eds. *Ontology Engineering with Ontology Design Patterns: Foundations and Application*. Vol. 25. Studies on the Semantic Web. IOS Press, 2016.

[14] Jim Jones et al. “Making the Web of Data Available Via Web Feature Services”. In: *Connecting a Digital Europe Through Location and Place*. Ed. by Joaquín Huerta, Sven Schade, and Carlos Granell. Lecture Notes in Geoinformation and Cartography. Springer, 2014, pp. 341–361. DOI: 10.1007/978-3-319-03611-3_20.

[15] Werner Kuhn, Tomi Kauppinen, and Krzysztof Janowicz. “Linked Data – A Paradigm Shift for Geographic Information Science”. In: *Geographic Information Science*. Ed. by Matt Duckham et al. Vol. 8728. Lecture Notes in Computer Science. Springer International Publishing, 2014, pp. 173–186.

[16] Alexander von Lünen. “Tracking in a New Territory: Re-imaging GIS for History”. In: *History and GIS: Epistemologies, Considerations and Reflections*. Ed. by Alexander von Lünen and Charles Travis. Dordrecht: Springer Netherlands, 2013, pp. 211–239.

[17] Albert Meroño-Peñuela et al. “Semantic Technologies for Historical Research: A Survey”. In: *Semantic Web* 6 (2014), pp. 539–564. DOI: 10.3233/SW-140158.

[18] Katherine Munn and Barry Smith, eds. *Applied Ontology: An Introduction*. Vol. 9. Metaphysical Research. ontos verlag, 2008.

[19] Charles Sanders Peirce. *Collected Papers of Charles Sanders Peirce*. Vol. 1–8. cited by CP volume.paragraph. Cambridge: Harvard University Press, 1931–58.

[20] Valentina Presutti et al. “Pattern-Based Ontology Design”. In: *Ontology Engineering in a Networked World*. Ed. by Mari Carmen Suárez-Figueroa et al. Springer, 2012, pp. 35–64. DOI: 10.1007/978-3-642-24794-1_3.

[21] Timothy Reuter. *Medieval Polities and Modern Mentalities*. Ed. by Janet L. Nelson. Cambridge: Cambridge University Press, 2006.

[22] Edward Heath Robinson. “An ontological analysis of states: Organizations vs. legal persons”. In: *Applied Ontology* 5.2 (2010), pp. 109–125.

[23] Edward Heath Robinson. “Reexamining fiat, bona fide and force dynamic boundaries for geopolitical entities and their placement in DOLCE”. In: *Applied Ontology* 7.1 (2012), pp. 93–108.

[24] Muriel Van Ruymbeke et al. “Implementation of multiple interpretation data model concepts in CIDOC CRM and compatible models”. In: *Virtual Archaeology Review* 9.19 (2018), pp. 50–65. DOI: 10.4995/var.2018.8884.

[25] Emilio M. Sanfilippo, Béatrice Markhoff, and Perrine Pittet. “Ontological Analysis and Modularization of CIDOC-CRM”. In: *Formal Ontology in Information Systems*. Ed. by Boyan Brodaric and Fabian Neuhaus. Vol. 330. Frontiers in Artificial Intelligence and Applications. 2020, pp. 107–121. DOI: 10.3233/FAIA200664.

[26] Philipp Schneider et al. “Challenge-derived design practices for a semantic gazetteer for medieval and early modern places”. In: *Semantic Web* 12.3 (2021): *Open Science Data and the Semantic Web Journal*, pp. 493–515. DOI: 10.3233/SW-200394.

[27] Luca Scholz. “Deceptive Contiguity: The Polygon in Spatial History”. In: *Cartographica: The International Journal for Geographic Information and Geovisualization* 54.3 (2019), pp. 206–216. DOI: 10.3138/cart.54.3.2018-0018.