Multi-Perspectival Representation of Historical Reality

Ontology-Based Modeling of Non-Common Conceptualizations

Ingo FRANK [a]

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

Abstract. The paper presents work in progress towards an applied ontology for Digital History. The challenge of ontology-based modeling for historical understanding is to make explicit the conceptualizations of historians. As philosophy of history shows, historians build conceptual models of historical events by the method of 'colligation'. Grasping different points of view on one and the same historical event is an essential requirement of historical research. Hence, I focus on the representation of multiple perspectives on historical events. Although being already well-established in the biomedical and legal domain, philosophically informed ontology design principles and patterns are rarely applied in the Digital Humanities. Thus, the paper explores the role of philosophy and the relevance of the widely neglected use of top-level foundational ontologies, ontology design patterns, and Semantic Web technologies for augmenting historical understanding via knowledge modeling.

Keywords. digital history, conceptual models, knowledge representation, ontology design patterns, ontology-based information systems

1. Introduction

The representation of historical reality as seen from the divergent perspectives of different historians, as perceived by historical actors or as reported in historical sources has requirements beyond the straightforward 'reality representation' [49] focused on physical reality [50] in the domain of the natural sciences. The term 'ontology' in computer and information science is defined as "formal, explicit specification of a shared conceptualization" [51] (extending the famous definition by Gruber [22]). However, the divergent, non-common and 'unshared' conceptualizations of different historians demand more than these approaches.

Despite the important role of philosophical ontology for a "coherent conception of historical knowledge" [30], the applied ontology approach is widely neglected in the domain of Digital History and in the Digital Humanities in general. In line with Garbacz and Trypuz [19], who state that, "[i]f neither the standard nor the simple patterns meets your needs, we think you will have to consider a solution that involves some philoso-

phy", I propose an approach towards ontology-based modeling of historical knowledge informed by philosophy of history. The goal is to provide an applied ontology approach to support historians in modeling their expert knowledge about historical events. I suggest a modular architecture reusing and extending Ontology Design Patterns (ODPs) [25] for knowledge modeling tasks in the domain of (Digital) History.

2. Related Work

Work—theoretically very similar to the philosophically informed knowledge modeling approach presented in this paper—was already introduced by Shaw [48]. Despite its theoretical foundation informed by philosophy of history, the modeling outcome[1] of his approach achieves the requirements of semantic web and linked data applications, but remains beyond the theoretical demand for knowledge modeling for historical understanding.[2]

The Spatial History Ontology (SHO) developed by Grossner [21] applies the top-level ontology DOLCE [18] and its Descriptions and Situations (DnS) ODP [17] and thus enables the event-based modeling of multiple interpretations of historical processes including spatial information. An alternative to the DnS pattern is the Multiple Interpretation Data Model (MIDM) [43] extension for CIDOC CRM [12]. MIDM allows to model multiple interpretations of historical events by separating the representation of historical reality and knowledge about it. Another alternative would be SEM (Simple Event Model) [23], but it is too simple[3] for our purposes [see its application in 2]. HERO (Historical Event Representation Ontology) [20] is based on DOLCE and focuses on the representation of thematic and social roles, and considers also perspectival roles—in a more expressive way than SEM. Similar to the SEM approach, the Reporting Event ODP is for modeling divergent representation of events in different news e. g. "to model different opinions of historians" [29]. Finally, the modular Event-Model-F (F) [45] comes very close to our requirements by providing patterns for modeling multiple interpretations of events and their interrelations. Concerning modular ontology design, Trame, Keßler, and Kuhn [52] for instance developed a DnS-based extension for biographies, i. e. to represent the social roles played by (historical) persons.

In summary, regarding the ontologies which explicitly state the feature of representing multiple perspectives, views, or interpretations of historical events, SEM is suited to represent multiple perspectives of different actors involved in historical events (second use case addressed in the introduction) and views according to different historical sources (third use case) via its `sem:accordingTo` property, but not to grasp conceptualizations of whole historical processes as conceived by different historians (first use case). In contrast, MIDM allows the modeling of different conceptualizations of historical processes

[1] See LODE ontology: `http://linkedevents.org/ontology/`

[2] The life cycle of historical information [7] is a good tool to locate the use of Semantic Web technologies in Historical Information Science [33]. Ontologies are typically applied in the enrichment and editing phases [cf. 33, p. 10], but not in the analysis phase of the life cycle. Though, using Eide's distinction between 'modeling for production' and 'modeling for understanding' [13], I focus on the task of knowledge modeling as modeling for (historical) *understanding*, not as modeling for *production* (e. g. the production of digital editions enriched with knowledge graphs to support information retrieval and exploration of the content).

[3] SEM is not aligned with a foundational ontology, has no properties to model relationships between events and has no thematic roles.

(M5 Sequence class), but neglects the modeling of roles. Despite its advanced representation of thematic and social roles, HERO does not yet provide a DOLCE extension to support perspectival role modeling. Regarding the other DOLCE-based ontologies, both SHO and F use the DnS pattern—(F via DUL[4])—and therefore are well prepared for modeling multiple conceptualizations of historical events. However, SHO's emphasis is on the geospatial domain and F was designed with distributed event-based system applications in mind.

3. Knowledge Modeling for Historical Understanding

Historians perform conceptualization in order to understand historical events. Philosophers of history analyzed this activity as *colligation*. Walsh [53, p. 59] defines colligation as "the procedure of explaining an event by tracing its intrinsic relations to other events and locating it in its historical context".

According to Abell [1, p. 39 f.] there are two meanings of colligation: tracing causal connections between events and classifying interconnected events. Though colligation can also be seen as a two-step process or procedure consisting of these two tasks (see UML Use Case diagram in fig. 1).

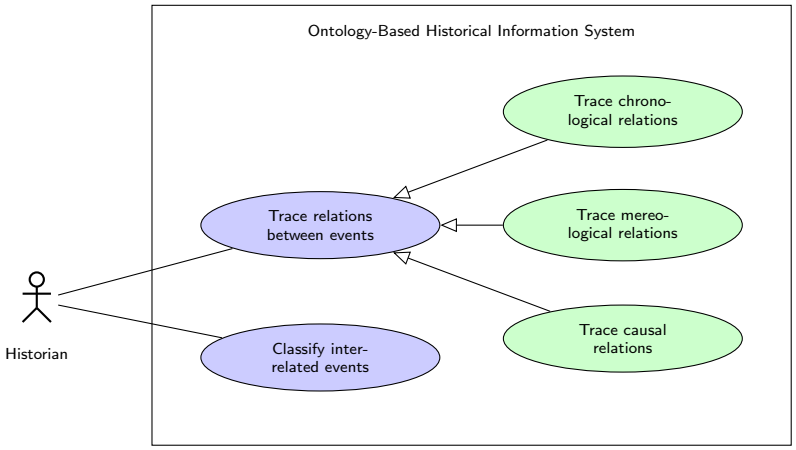

Figure 1. Meeting the requirements of knowledge modeling for historical understanding by supporting the method of *colligation*. Using a computational ontology providing properties for chronological (e. g. `P114 is equal in time to` – `P120 occurs before` in CRM), mereological (e. g. `P9 consists of` in CRM), and causal dependence relationships (e. g. `P15 was influenced by`, `P17 was motivated by`, or `O13 triggers` in CRM) [see also 4, pp. 116–118], the historian connects the pieces of historical facts [see also 36, pp. 1099–1101] and classifies his final interpretation under a colligatory concept.

The Descriptions and Situations ODP (DnS) [17] is applied to support the process of colligation (see fig. 2) by means of ontology-based modeling as sense-making tool [see also 14].[5] A Description represents the colligatory concepts and relations grasped in a

[4] `http://ontologydesignpatterns.org/wiki/Ontology:DOLCE+DnS_Ultralite`

[5] DnS is not limited to DOLCE and can be adjusted to other top-level ontologies with the categorial distinction between endurants and perdurants. CRM has the categories `E77 Persistent Item` for endurants

"synoptic judgment" [34]. In bio-medical ontologies Descriptions are used to represent medical diagnoses [e. g. 16]. There is indeed an interesting analogy between the synoptic judgments of a historian and medical diagnoses of a physician:

> a combination of broad medical knowledge, relevant evidence drawn from various tests, a knowledge of various theoretical possibilities for explanation, and skill in seeing which interpretation of the evidence works best in a particular case—the difference being, of course, that the physician deals primarily with law-bound physiological processes, the historian primarily with human conduct and purposive action. [46, p. 69]

A Situation represents the explanatory relevant historical context, i. e. historical events and their interrelations. The intent of the Situation pattern is to "represent contexts or situations, and the things that are contextualized"[6]. A Description "provides an interpretation to a set of observed entities"[7].

Hence, a Situation is a historical context of related events and entities as interpreted in a synoptic judgement (represented by a Description). Note that an instance of a historical process in our ontology is not a process (as perdurant) [see also 21, p. 169], but a concept conceptualized by a historian (e. g. the colligatory concept 'Russian Revolution'). In this way, it is possible to represent multiple perspectives on one and the same historical phenomenon by modeling Descriptions which define colligatory concepts as expressed in different historical narratives (see `lmm:expresses` in fig. 2).

4. Elements of Historical Knowledge Representation

To summarize the proposed approach towards an applied ontology for knowledge modeling in Digital History, the following paragraphs provide an overview of the required modules or components which cannot be discussed in-depth within this paper.

Event-based Modeling enables the representation of temporal, mereological, and causal or constitutive relations between events.

Role-based Modeling enhances event-based modeling with thematic and social roles played by the agents involved in events.

Levels of Reality to represent entities on different ontological levels (e. g. political and economical in the social sphere) [see 38] can be modeled with DnS in line with the stratification principle and reification principle [cf. 15, with examples from the legal domain]. (See example for epistemological layering in the biomedical domain by Gangemi, Catenacci, and Battaglia [16, diagram in fig. 6].)

Semiotics has to be added to the ontology to further clarify the representation of historical reality. Indeed there is some confusion in the distinction between representation and the *represented* with the distinction between representation and *reality* in the DnS pattern used without explicit modeling of semiotic relations [cf. 26, p. 27]. Different interpreta-

(agents and objects) and `E2 Temporal Entity` for perdurants (events) and therefore can be extended with an ontology module for the DnS pattern.

[6] `http://ontologydesignpatterns.org/wiki/Submissions:Situation`

[7] `http://ontologydesignpatterns.org/wiki/Submissions:Description`

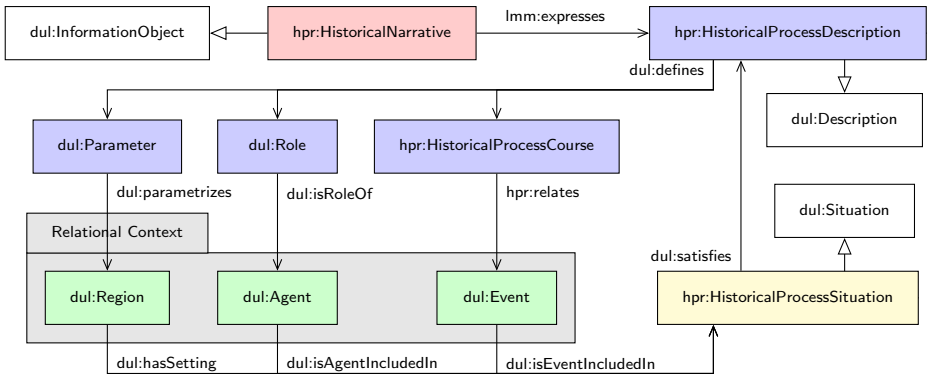

Figure 2. Descriptions and Situations ODP from DUL adapted for the representation of different conceptualizations of historical processes as conceived in divergent historical narratives. The Historical Process Representation ODP sketched here (extensions in namespace prefix `hpr` aligned to DUL) allows to model temporal, mereological, and causal relations between historical events by using appropriate properties to represent direct relationships between events. Thereby, the class `hpr:HistoricalProcessCourse` enables a straightforward representation of the historical course of events as traced by *colligatory relations* according to the historian's selection of historical facts (first use case in fig. 1). Finally, the interrelated events, including the historian's interpretations of the involvement of historical actors, are reified by a Situation which satisfies a Description, representing an individual *colligatory concept* (second use case in fig. 1). (Properties of the class `dul:Region` for representation of temporal and spatial location of entities—alongside further details—have been omitted for clarity in the diagram. The pattern is similar to the `Historical Process` class in the DOLCE-based SHO [see 21, pp. 169–177] and needs more modularization as in F's event interpretation pattern.)

tions of one and the same historical event or historical source can be explicitly modeled with the Semiotic Ontology Design Pattern [5] or the Linguistic Meta-Model (LMM) in addition to DnS. LMM's basic classes `Expression`, `Meaning`, and `Reference` are the building blocks for Peircean semiotic triangles [see diagram in fig. 2 in 37].

Frames are considered as *knowledge patterns* and can be used to validate ODPs [40].[8] Presutti, Draicchio, and Gangemi [39] argue that the *units of meaning* in Semantic Web technologies should be *frames*, not just classes and properties.

5. Conclusion, Future Work and Outlook

I have shown that the classification of historical events by colligatory concepts and the multi-perspectival representation of historical reality as seen from the 'Sehepunckte'[9] of different historians, conceived in their synoptic judgements and presented in historical narratives can be well supported by applying the DnS and LMM ODPs.

Special ODPs have to be created following a modular approach in order to model causal narratives, conflict trajectories, biographies, historical travelogues, etc. for specific case scenarios and use cases (e. g. modeling multiple causal narratives for compara-

[8] Compare for example the `Travel` frame in FrameNet with the Linked Places project's conceptual model of historical geographic movement: `http://commons.pelagios.org/2016/10/linking-linked-places-project-update/`

[9] See Chladenius's [10, p. 100] concept of viewpoint (Sehepunckt) in his theory of multiperspectivity: `http://www.deutschestextarchiv.de/book/view/chladni_geschichtswissenschaft_1752/?p=136`

tive historical analysis or modeling divergent conflict histories as seen from the perspectives of conflict parties or as reported in different historical sources[10]). So, the next steps are the further development and the evaluation of the approach in selected case studies.[11] Furthermore, phenomenological ontology as per Husserl's idea of formal ontology [27] will be applied to analyze and conceptualize the constitution of objects of historical research in different realms and on different layers of reality.[12]

Digital historians *should* be able to formalize their expert knowledge—at least if the high demand of philosophy of history is taken seriously by considering that "the more schematic the conceptualization in a discipline, the more its practitioners are likely to engage with models rather than concepts" [31, p. 25]. Nevertheless, there remains the challenge of the computational requirements of "total explicitness and absolute consistency" [31, p. 5] [see also 36, p. 1099] due to the problem of the 'semantic gap' between narrative descriptions and ontology-based models of historical processes [see also 32]. As Saab and Fonseca [44] assert, "formal ontologies are problematic in that they simultaneously crystallize and decontextualize information, which in order to be meaningful must be adaptive in context". In the end, one has to be careful not to commit "cliocide" [3] by modeling away all the crucial subtleties of historical reality. At the same time, applied ontology as a sense-making tool[13] is capable to help (digital) historians to bridge the gap.

Acknowledgements This work was partially supported by a visiting research fellowship at the Trier Center for Digital Humanities (TCDH) in November and December 2018.

References

[1] Peter Abell. "History, Case Studies, Statistics, and Causal Inference". In: *European Sociological Review* 25.5 (2009), pp. 561–567.

[2] Chiel van den Akker et al. "Digital Hermeneutics: Agora and the Online Understanding of Cultural Heritage". In: *Proceedings of the 3rd International Web Science Conference*. ACM, 2011, 10:1–10:7.

[3] Hayward R. Alker. "Ontological Reflections on Peace and War". In: *Intelligent Complex Adaptive Systems*. Ed. by Ang Yang and Yin Shan. IGI Publishing, 2008. Chap. X, pp. 300–330.

[10] The Historical Context Ontology (HiCO) [11], for example, provides advanced modeling provencance and interpretations of content and context information.

[11] Campbell [8, 9] presents a chronology of 32 historical events identified and extracted from 10 different narratives about the Bosnian War. His review and analysis of the 10 monographs opens up a straightforward case study in modeling: I consider this chronology as (chronicle-like) 'background narrative' in the sense of Bergmann [see 6, p. 58]. Ontology-based modeling with the DnS pattern will show how these events are conceptualized and interrelated in the controversial perspectives as presented in the different narratives (see fig. 2). Furthermore, it provides an interesting example for a critical examination of perspectival explanation (see the critique of Campbell's Nietzschean perspectivism in his *MetaBosnia* by Wight [54]—see also Jensen [28] for the concept of Nietzsche's perspectival explanation) and identity criteria for historical events in narrative explanations (as done for example by Shaw [47, p. 40] referring to Mink [35, p. 147]).

[12] GFO (General Formal Ontology) would already allow to model *strata* (material, mental, social) and different *layers* within these by default [24].

[13] See [41, 42] for some elaborated examples.

[4] Valentina Bartalesi and Carlo Meghini. “Formal Components of Narratives”. In: *Digital Libraries and Multimedia Archives*. Springer, 2017, pp. 112–121.

[5] Neil Benn et al. “Ontological Foundations for Scholarly Debate Mapping Technology”. In: *Computational Models of Argument: Proceedings of COMMA 2008*. IOS Press, 2008, pp. 61–72.

[6] Klaus Bergmann. *Multiperspektivität: Geschichte selber denken*. 3rd ed. Methoden historischen Lernens. Schwalbach/Ts.: Wochenschau Verlag, 2016.

[7] Onno Boonstra, Leen Breure, and Peter Doorn. “Past, present and future of historical information science”. In: *Historical Social Research* 29.2 (2004), pp. 4–132.

[8] David Campbell. “MetaBosnia: Narratives of the Bosnian War”. In: *Review of International Studies* 24.2 (1998), pp. 261–281.

[9] David Campbell. “Ontopology: Representing the Violence in Bosnia”. In: *National Deconstruction: Violence, Identity, and Justice in Bosnia*. Minneapolis: University of Minnesota Press, 1998. Chap. 3, pp. 33–81.

[10] Johann Martin Chladni. *Allgemeine Geschichtswissenschaft – worinnen der Grund zu einer neuen Einsicht in allen Arten der Gelahrheit geleget wird*. vollständige digitalisierte Ausgabe. Leipzig: Deutsches Textarchiv (Kernkorpus), 1752.

[11] Marilena Daquino and Francesca Tomasi. “Historical Context Ontology (HiCO): A Conceptual Model for Describing Context Information of Cultural Heritage Objects”. In: *MTSR 2015: Metadata and Semantics Research*. Vol. 544. Communications in Computer and Information Science. 2015, pp. 424–436.

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

[13] Øyvind Eide. “Ontologies, Data Modeling, and TEI”. In: *Journal of the Text Encoding Initiative* 8 (2014).

[14] Thomas C. Eskridge and Robert Hoffman. “Ontology Creation as a Sensemaking Activity”. In: *IEEE Intelligent Systems* 27 (5 Oct. 2012).

[15] Aldo Gangemi. “Design patterns for legal ontology constructions”. In: *Proceedings of the 2nd Workshop on Legal Ontologies and Artificial Intelligence Techniques*. Ed. by Pompeu Casanovas et al. 2007, pp. 65–85.

[16] Aldo Gangemi, Carola Catenacci, and Massimo Battaglia. “Inflammation Ontology Design Pattern: An Exercise in Building a Core Biomedical Ontology with Descriptions and Situations”. In: *Ontologies in Medicine*. Ed. by Domenico M. Pisanelli. Vol. 102. Technology and Informatics. IOS Press, 2004, pp. 64–80.

[17] 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.

[18] Aldo Gangemi et al. “Sweetening Ontologies with DOLCE”. In: *Knowledge Engineering and Knowledge Management: Ontologies and the Semantic Web*. Ed. by Asunción Gómez-Pérez and V. Richard Benjamins. Berlin, Heidelberg: Springer Berlin Heidelberg, 2002, pp. 166–181.

[19] Paweł Garbacz and Robert Trypuz. “Representation of tensed relations in OWL: A survey of design patterns”. In: *Research Conference on Metadata and Semantics Research*. Springer, 2017, pp. 62–73.

[20] Anna Goy, Diego Magro, and Marco Rovera. “On the role of thematic roles in a historical event ontology”. In: *Applied Ontology* 13.1 (2018), pp. 19–39.

[21] Karl Grossner. “Representing historical knowledge in geographic information systems”. PhD thesis. University of California, Santa Barbara, 2010.

[22] Thomas R. Gruber. “A translation approach to portable ontology specifications”. In: *Knowledge Acquisition* 5.2 (1993), pp. 199–220.

[23] Willem R. Hage et al. “Design and use of the Simple Event Model (SEM)”. In: *Web Semantics: Science, Services and Agents on the World Wide Web* 9.2 (2011), pp. 128–136.

[24] Heinrich Herre. “Formal Ontology and the Foundation of Knowledge Organization”. In: *Knowledge Organization* 40.5 (2013), pp. 332–339.

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

[26] Rinke Hoekstra et al. “LKIF Core: Principled Ontology Development for the Legal Domain”. In: *Law, Ontologies and the Semantic Web*. IOS Press, 2009, pp. 21–52.

[27] Edmund Husserl. *First Book: General Introduction to a Pure Phenomenology*. Ideas Pertaining to a Pure Phenomenology and to a Phenomenological Philosophy. The Hague: Martinus Nijhoff, 1983.

[28] Anthony K. Jensen. “Positivism and perspectivism”. In: *Nietzsche’s Philosophy of History*. Cambridge: Cambridge University Press, 2013. Chap. 5, pp. 119–154.

[29] Ewa Kowalczuk and Agnieszka Ławrynowicz. “The Reporting Event Ontology Design Pattern and Its Extension to Report News Events”. In: *Advances in Ontology Design and Patterns*. Vol. 32. Studies on the Semantic Web. 2017, pp. 105–117.

[30] Daniel Little. “Historical Concepts and Social Ontology”. In: *New Contributions to the Philosophy of History*. Vol. 6. Methodos. Springer, 2010, pp. 41–72.

[31] Willard McCarty. *Humanities Computing*. Basingstoke: Palgrave Macmillan, 2005.

[32] Alexander Mehler and Andy Lücking. In: *Computational Humanities – Bridging the Gap Between Computer Science and Digital Humanities*. Ed. by Chris Biemann et al. Vol. 14301. Dagstuhl Seminar. Schloss Dagstuhl – Leibniz-Zentrum für Informatik, 2014, pp. 91–92.

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

[34] Louis O. Mink. *Historical Understanding*. Ithaca: Cornell University Press, 1987.

[35] Louis O. Mink. “Narrative Form as a Cognitive Instrument”. In: *The Writing of History: Literary Form and Historical Understanding*. Ed. by Robert H. Canary and Henry Kozicki. Madison: University of Wisconsin Press, 1978, pp. 129–149.

[36] Ruth Mostern and Ian Johnson. “From named place to naming event: creating gazetteers for history”. In: *International Journal of Geographical Information Science* 22.10 (2008), pp. 1091–1108.

[37] Davide Picca, Alfio Massimiliano Gliozzo, and Aldo Gangemi. “LMM: an OWL-DL MetaModel to Represent Heterogeneous, Multilingual Lexical Knowledge”. In: *Proceedings of the International Conference on Language Resources and Evaluation, LREC 2008*. European Language Resources Association (ELRA), 2008.

[38] Roberto Poli. “The Basic Problem of the Theory of Levels of Reality”. In: *Axiomathes* 12.3-4 (2001), pp. 261–283.

[39] Valentina Presutti, Francesco Draicchio, and Aldo Gangemi. “Knowledge Extraction Based on Discourse Representation Theory and Linguistic Frames”. In: *Knowledge Engineering and Knowledge Management. EKAW 2012*. Vol. 7603. Lecture Notes in Computer Science. Springer, 2012.

[40] 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.

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

[42] 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.

[43] Muriel Van Ruymbeke, Pierre Hallot, and Roland Billen. “Enhancing CIDOC-CRM and compatible models with the concept of multiple interpretation”. In: *SPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*. Vol. IV-2/W2. 2017.

[44] David J. Saab and Frederico Fonseca. “Ontological Complexity and Human Culture”. In: *Philosophy, Computing and Information Science*. Ed. by Ruth Hagengruber and Uwe V. Riss. Pickering & Chatto, 2015, pp. 131–144.

[45] Ansgar Scherp et al. “F—A Model of Events Based on the Foundational Ontology DOLCE+DnS Ultralight”. In: *Proceedings of the Fifth International Conference on Knowledge Capture*. ACM, 2009, pp. 137–144.

[46] Paul W. Schroeder. “History and International Relations Theory: Not Use or Abuse, but Fit or Misfit”. In: *International Security* 22.1 (1997).

[47] Ryan Shaw. “A Semantic Tool for Historical Events”. In: *Proceedings of the The 1st Workshop on Events: Definition, Detection, Coreference, and Representation*. Association for Computational Linguistics, 2013, pp. 38–46.

[48] Ryan Shaw. “Events and Periods as Concepts for Organizing Historical Knowledge”. PhD thesis. Berkeley: University of California, 2010.

[49] Barry Smith. “Beyond Concepts: Ontology as Reality Representation”. In: *Formal Ontology in Information Systems (FOIS)*. Ed. by Achille C. Varzi and Laure Vieu. 2004, pp. 1–12.

[50] Barry Smith and Werner Ceusters. “Ontological realism: A methodology for coordinated evolution of scientic ontologies”. In: *Applied Ontology* 5.3-4 (2010), pp. 139–188.

[51] Rudi Studer, V. Richard Benjamins, and Dieter Fensel. “Knowledge Engineering: Principles and Methods”. In: *Data & Knowledge Engineering* 25.1–2 (1998), pp. 161–197.

[52] Johannes Trame, Carsten Keßler, and Werner Kuhn. “Linked Data and Time – Modeling Researcher Life Lines by Events”. In: *Spatial Information Theory*. Ed. by Thora Tenbrink et al. Springer International Publishing, 2013, pp. 205–223.

[53] William Henry Walsh. *An Introduction to Philosophy of History*. London: Hutchinson, 1951.

[54] Colin Wight. “MetaCampbell: the epistemological problematics of perspectivism”. In: *Review of International Studies* 25.2 (1999), pp. 311–316.