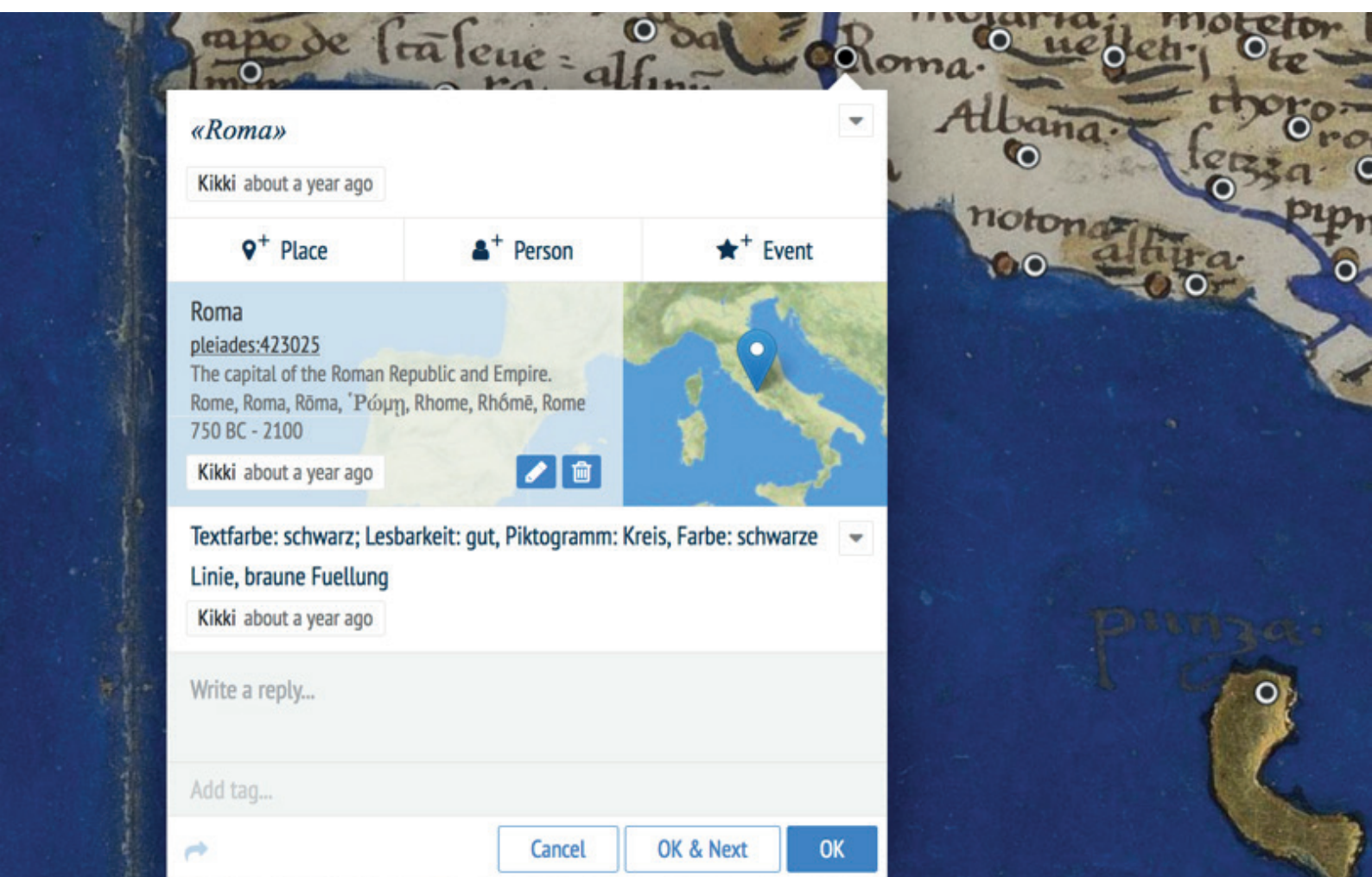


Walking Through History

An Interdisciplinary Approach to Flavio Biondo's Spaces in the "Italia illustrata"

Edited by Tanja Michalsky & Martin Thiering



BIBLIOTHECA HERTZIANA
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Abstract

Günther Görz, Chiara Seidl, Martin Thiering
Linked Biondo: Generating and Processing Research
Data Based on Geographical Feature Modeling

keywords – *Linked Open Data, Map annotation,
Text annotation. Text analysis, Spatial cognition*



Bibliotheca Hertziana's project "Historical spaces in texts and maps" aims at a cognitive-semantic analysis of Flavio Biondo's Italia Illustrata (1474) linking with contemporary maps. At focus are relations between historical maps and texts aiming to explore the historical understanding of space and the knowledge associated with it. Our research combines cognitive-semantic parameters such as toponyms, landmarks, spatial frames of reference, geometric relations, gestalt principles and different perspectives with computational linguistic analysis. Contributing to Spatial Humanities, we are convinced that all maps are cognitive maps, depicting culture-specific spatial knowledge and practices. This chapter focuses on data modeling comprising all research data generated within the project, their storage and access as well as their publication as Linked Open Data in the Semantic Web. Recogito is being used as the main tool for static annotations of places and persons/peoples in text and maps. These are complemented by cognitive-linguistic spatial role markups by means of the BRAT tool. To achieve a deeper and more generic semantic level of linguistic and map-related annotations, we pursue the transition to an ontology-based representation. For this purpose, we defined a domain ontology based on the event-based CIDOC Conceptual Reference Model (CRM) and its spatiotemporal extension CRMgeo in OWL-DL, and appropriate mappings to be applied to

the annotations exported in CSV, RDF and JSON formats. Using the CRM opens up a wide spectrum of interoperability and linking to many web resources, such as the gazetteers being used with Recogito. For ontological enrichment and processing of the primary data, we use the Virtual Research Environment WissKI with CRM as the top conceptual model. This allows for a semantic interpretation of annotations such that, e.g., for each place, we generate an instantiated CRM description in triple format, ready for storage and publication as Linked Data. In the same fashion, mappings are applied to the results of spatial role labeling – these triples encode cognitive parameters, primarily figure – spatial_indicator – ground constructions.

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Linked Biondo: Generating and Processing Research Data Based on Geographical Feature Modeling

Günther Görz
Chiara Seidl
Martin Thiering

1. Introduction: Research Question and Methodological Approach

This chapter deals with the generation and processing of research data in the Bibliotheca Hertziana's research project "Historical Spaces in Flavio Biondo's *Italia Illustrata*", investigating the historical understanding of social space and its evolution in the Renaissance. The study of the relations between historical maps and texts aims to explore the historical understanding of space and the knowledge associated with it by taking up approaches from cognitive science and in particular cognitive linguistics. Cognitive maps depict culture-specific spatial knowledge and practices. This knowledge is represented in different ways, which change historically through different processes and practices. The epistemological focus is therefore framed by questions such as which forms of knowledge represent spatial relations, how can processes of spatial transformation be represented and analyzed, and what is the connection between culture-specific practices and cognitive representations? In order to approach this complex of questions, the project combines cognitive-semantic parameters such as toponyms, landmarks, spatial frames of reference, geometric relations, gestalt principles, and different perspectives with computational linguistic analysis methods deployed according to our "Common Sense Geography"¹ approach.

The project design had its starting point in the introduction and description of its general objectives, as stated in the project outline on the Bibliotheca Hertziana's website.² The project design is based on the assumption that precise

research questions can be derived from it that will lead to operationalized hypotheses, which in turn can be tested on data. In the following, the data aspect of the project is addressed, i.e., the generation, organization, indexing, storage, and publication of research data. In principle, the underlying theoretical ([art]-historical, cognitive) framework had determined which data should be obtained from the available sources and in what way. The selection of sources was guided by various parameters: availability and effort for provision as well as the quality of digital reproductions (especially readability) of the texts and map images in digital form. For our work with geographic/cartographic data, we owe valuable suggestions to the geographic research group around Werner Kuhn³ (formerly of the Universität Münster, now UCSB) and Simon Scheider⁴ (previously at Universität Münster, now Universiteit Utrecht), particularly for their clear reference to cognition and knowledge representation and processing. Accordingly, we developed a three-phase structure for the project:

1. Analysis
2. Cognitive-linguistic and (art-) historical interpretation
3. Synthesis (sketch reconstruction).

In the analysis phase, historical texts are processed and reinterpreted using new text and map markups and corpus-specific quantitative methods. The very general categorization pattern of spatial relations in visual perception is based on the gestalt theoretic figure-ground asymmetry adapted from the founders of cognitive linguistics, Ronald W. Langacker⁵ and

¹ Geus/Thiering 2014.

² URL: <https://www.bibl.hertiz.it/en/dept-michalsky/historical-spaces-texts-maps>. All links in this paper were accessed and verified on May 4, 2020, and again on August 4, 2020.

³ For example, Kuhn 2013; see also his "Research Questions" page: <http://geog.ucsb.edu/~kuhn/Questions.htm>

⁴ In particular Scheider 2014 and Simon

Scheider's website "Geographic Knowledge Representation", URL: <http://www.geographicknowledge.de>

⁵ See Langacker 2008.

Leonard Talmy.⁶ This asymmetry is not only constitutive in visual perception, but also in components of linguistic meaning in a sentence; hence, rather than clausal phrases with a subject and object, the theory instead uses figure and ground. Here the “figure” is a moving or conceptually movable entity whose site, path, or orientation is conceived as a variable, whose particular value is the relevant issue. The “ground”, meanwhile, is a reference entity, one that has a stationary setting relative to a frame of reference, with respect to which the figure’s site, path, or orientation is characterized.⁷

Flavio Biondo’s (1392–1463) work *Italia Illustrata*, published posthumously in 1474, serves as the key text. Flavio Biondo is rightly regarded as the true founder of archaeological science and antiquarian topography. Particularly in his *Italia Illustrata*, the first premodern description of Italy, he draws on famous authors of Roman antiquity such as Livy, Virgil, and Pliny. Greek authors such as Strabo and Ptolemy, on the other hand, are rarely considered – despite their geographical and topographical content and despite the intentions of Biondo’s work. An exception is the Latium chapter (“Regio Latina”), in which Biondo draws intensively on a hitherto undiscovered Latin translation of Strabo. Strabo’s work not only serves as a data basis but also as a structural principle: Biondo uses Strabo’s hodological description technique to locate all the Latin cities and settlements relative to each other and transforms them into a narrative structure on the west coast of Italy and three Roman roads (Via Appia, Via Latina, Via Valeria). This raises the question of whether the *Italia Illustrata* was actually written using many maps, as current Biondo research⁸ generally assumes. Since only a few regional sheet maps from the early fifteenth century have been preserved and even literary references to cartographic knowledge are rare, this problem has to be put into a larger context and possible alternatives have to be discussed in an interdisciplinary approach. Our main hypothesis within a cognitive-linguistic framework is that Biondo’s narrative is based on cognitive maps or mental models enabling the

reader to mentally triangulate different spatial references. In particular, it is necessary to discuss which strategies Biondo used to collect, filter, and process his heterogeneous material of historical, geographical, archaeological, and art-historical information and to translate it into a text that could be read by a contemporary audience. Because the Latium chapter (Book II) plays a key role within *Italia Illustrata*, the interdisciplinary project begins with the analysis and commentary of “Regio tertia: Latina”. In contrast to previous publications on Biondo, which are comprehensive in textual criticism, biographical, literary, and art-historical references as well as in the ‘afterlife’ of Biondo’s writings, we pay particular attention to the identification of toponyms and the geographical vocabulary, spatial relations, the reception of Strabo, contemporary cartography, and mental maps.

Thus, after preparing and conditioning the sources, our next step entailed elementary text statistics, concordance generation, morpho-syntactic tagging, dependency parsing, and the creation of geographical annotations. Furthermore, the spatial relations expressed in the text were annotated according to the above-mentioned cognitive-linguistic parameters, especially figure-spatial_indicator-ground triples. All research data (text and map annotations) developed so far were semantically represented by an application ontology for historical texts and maps as well as annotated content and stored in the Virtual Research Environment WissKi (see section 5. Generated Research Data and Their Semantic Enhancement through Ontology-Based Data Modeling). They are thus available as linked open data (LOD) for publication on the Semantic Web. Further research data, especially the linguistic analyses, are stored in a repository in the framework of WissKi.

The second phase – cognitive-linguistic and (art-) historical interpretation of the data (i.e., the text compared to contemporary maps) – constitutes the center of the project. To answer questions about the historical understanding of geographic space and its shifting development in premodern times, the research topic

6 Talmy 2000 and Talmy 2003.

8 See, for example, Clavuot 1990.

7 Talmy 2003, p. 184.

is “cognitive maps” in the broadest sense, as stated above in the paragraph on Biondo. The interpretation phase is not the subject of this paper; the first results of a cognitive-linguistic analysis are available in the contribution by Berthele and Thiering⁹ in this volume.

Finally, it should be mentioned that the plan to reconstruct map sketches from the data (synthesis phase) was from the very beginning part of the agenda as a long-term project goal. This would require the following steps at the least:

- Extraction of triples (in particular *figure-spatial_relation-ground*) from spatial role labeling.
- Generation of relation graphs.¹⁰
- Graphical realization of sketches on a coordinate grid based on an outline map of Italy.¹¹
- Evaluation based on the existing geovisualization.

2. Sources, Their Preparation, and Conditioning

First of all, there are some fundamental issues regarding the available text sources. The textual transmission of Flavio Biondo’s *Italia Illustrata* is rather complex due to different available editions. Modern editions are based on the surviving manuscripts,¹² or the first printed edition (Biondo 1474) as supervised by Gaspare Biondo,¹³ or purportedly the “best-known, most-cited early printed edition” (Biondo (1531) 1559).¹⁴ The manuscripts, written and reworked over a long time span, are not uniform in orthography, punctuation, or style, thus making it difficult to use the text for digital and linguistic analyses. According to his own confession, Gaspare changed Flavio’s original for stylistic reasons before printing; and the Froben edition clearly deviates in many instances from the earlier ones. The *editio princeps* has been transmitted in two versions, which are, contrary to common belief, not identical, and there are, for instance, more than one hundred textual

deviations between White’s and Castner’s texts in the Latium chapter alone. In the long run, our study will be extended to apply to the complete text. We decided to work with the White edition because it is still the closest one to the *editio princeps*; unfortunately, his English translation is not error-free and is inspected in this analysis purely for heuristic reasons and as a reference point for comparative studies.

3. Preprocessing Steps, Word Lists, Concordance, and Part-of-Speech Tagging

As a prerequisite for the analysis and interpretation of Biondo’s text in the framework of cognitive semantics, we designed a workflow for text analysis, which contains automatic and semi-automatic processing steps. Its ultimate goal is to annotate, that is, to markup individual words or word sequences such as proper names of places (and also of persons and events) in different text sources as well as spatial relations in texts in the framework of cognitive semantics. Moreover, these annotations will be related to similar annotations in (historical) geographical maps.

Basically, we worked with two UTF-8¹⁵ encoded text representations, plain text and TEI/XML.¹⁶ All texts have been generated digitally, mostly based on spelling-corrected OCR (Optical Character Recognition).

To get a first overview of the language register used in our selected text passage, we ran some simple analysis procedures on the Latin text and its English translation as a whole. As for the tools, we used some command line scripts of our own, and we applied a Kwic (Key Word in Context) concordance program¹⁷ and the Tree-Tagger with the Stuttgart-Tübingen Tagset (STTS).¹⁸ For word lists and statistics, concordances, n-grams, and collocations (by de facto word co-occurrences), we also found the interactive AntConc¹⁹ tool and the browser-based

⁹ Thiering/Berthele 2022.

¹⁰ As outlined by, for example, Vasardani et al. 2013, algorithms 1 and 2.

¹¹ Compare Tobler 1979.

¹² Biondo 2011, Biondo 2014, Biondo 2017.

¹³ Biondo 2005b, Biondo 2016.

¹⁴ Biondo 2005a, Biondo 2010.

¹⁵ UTF-8 is a Unicode character encoding; see

URL: <http://unicode.org/>.

¹⁶ TEI: Text Encoding Initiative, providing a modular set of tags for various text types; see URL: <http://www.tei-c.org/>. Although many software tools already accept TEI encoding as a text input format, there are still some which require plain text.

¹⁷ Kwic for Windows Version 4.7 and 5.3

by Satoru Tsukamoto; URL: <https://kwic-concordance.software.informer.com/4.7/>.

¹⁸ See “German Tagsets”, Universität Stuttgart, Institut für Maschinelle Sprachverarbeitung (IMS), URL: <https://www.ims.uni-stuttgart.de/forschung/ressourcen/lexika/germantagsets/>.

¹⁹ AntConc is an easy to use word statistics

online Voyant tools²⁰ very useful. All results for Latin and English acquired in batch processing mode have been posted on a project webpage²¹ for quick lookup. They include:²²

- Alphabetic word (form) list with frequencies, endings-sorted word (form) list with frequencies, ascending and descending word (form) lists with frequencies.
- Concordance (KWIC), and word index for concordance.
- TreeTagged (STTS) word list with lemmata, TreeTagged (STTS) word list with frequencies, sorted by tags.

For the annotation of Latin, there are still only a few computational resources and tools available. Besides a few scanned classical lexica, there is an online version of WordNet for Latin as a lexical resource.²³ Powerful lemmatizers and morphological analyzers for Latin are Collatinus,²⁴ freely available in web-based and standalone versions, and the recent LEM-LAT 3.0.²⁵ The Perseus Digital Library provides access to its “word study tool”, an online version of a Latin morphological analyzer.²⁶ The well-known TreeTagger²⁷ – a tool for annotating text word by word with part-of-speech, lemma, word class, and inflection information – is available for many language models, among them Latin and English. We therefore decided to work in parallel language mode for some steps, that is, with Latin and English, as far as appropriate tools were available, synchronized sentence by sentence. Ideally, we could synchronize glossing word by word using linguistic terminology, as is known in field linguistics research.²⁸

Our goal in the first phase of analyzing and interpreting Biondo’s text in a cognitive-semantic

framework was the identification of places by toponyms or definite descriptions, and of spatial relations between them. Hence, beyond the morphosyntactic and semantic information on words as provided by the above-mentioned tools, we also needed information about grammatical structures. Parsers are computational tools for grammatical analysis beyond the word level which provide structural data about constructions and collocations and reveal the constituent and dependency structures of sentences. In particular, the latter grammatical structures are particularly important for semantic representation.²⁹ For Latin, a promising dependency parser has only recently become available,³⁰ which we applied to the full text with promising results.³¹

Finally, we aim for annotated logical forms which express the spatial relations of different geographical objects described in the text. Because up to now no general tools for spatial role labeling have been available, we opted for a semi-automatic annotation procedure.

4. Toponyms and Spatial Relations: Text and Map Annotation

4.1 Text Annotation

For semi-automatic markup of places (but also of persons and named events) in the Latin and English texts, we use the Recogito 2 annotation tool,³² which contains a good named entity recognition (NER) component. The plain text annotation provides an integrated geographical verification mode with several gazetteers that provide the necessary information, whereas for historical texts we prefer using Pleiades,³³ but also the Digital Atlas of the Roman Empire

and concordance program. It has several options to support semantic analysis, such as annotating clusters or marking single lexical items embedded in their textual context, etc. See URL: <http://www.laurenceanthony.net/software/antconc/>.

²⁰ URL: <https://voyant-tools.org>.

²¹ URL: <https://www.biblertz.it/en/dept-michalsky/historical-spaces-texts-maps>, containing links to the freely available results.

²² For English, we also used Lancaster University’s Wmatrix3 toolbox (URL: <http://ucrel.lancs.ac.uk/wmatrix/>), which also provides a semantic tagger. These tools

are flexible in a variety of output formats, including XML.

²³ URL: <http://multiwordnet.fbk.eu/online/multiwordnet.php>.

²⁴ URL: <http://outils.bibliissima.fr/en/collatinus/>.

²⁵ URL: <http://www.lem-lat3.eu/>.

²⁶ URL: <http://www.perseus.tufts.edu/hopper/morph?redirect=true&lang=la>.

²⁷ URL: <http://www.cis.uni-muenchen.de/~schmid/tools/TreeTagger/>.

²⁸ Levinson/Wilkins 2006, Thiering 2015.

²⁹ Ágel/Fischer 2010.

³⁰ Straka/Straková 2017.

³¹ Udpipes Dependency Parser Ud 2.4 (URL:

<http://ufal.mff.cuni.cz/udpipe>) with the Latin language model latin-ittb-ud-2.4-190531. The check against the results of the manually generated spatial role labeling is still awaiting completion. For heuristic reasons, we initially used the Stanford Parser (URL: <https://nlp.stanford.edu/software/lex-parser.shtml>) on the English translation, a lexicalized stochastic parser whose English language model generates dependency trees of reliable and sufficient quality.

³² Compare Simon et al. 2015; Recogito, URL: <http://recogito.pelagios.org/>.

³³ URL: <https://Pleiades.stoa.org/>.

(DARE)³⁴ and GeoNames. The annotation results can be exported in several formats, for example as Open Annotation/RDF³⁵ data or as tables (containing comma-separated values, Csv: particularly useful for comparison and further processing), GeoJSON,³⁶ and also as simple TEI/XML³⁷ files containing appropriate tags that are well suited as a basis for further tagging. Furthermore, Recogito (see below and figure 1 and figure 3) also allows users to annotate map images and display (annotated) places on different types of maps like OpenStreetMap³⁸ or DARE.

The most important step of text processing is spatial role labeling (i.e., the markup of spatial object descriptors and the relations between them). For this purpose, international standard proposals have been developed,³⁹ including, for example, the “SpaceEval Annotation Guidelines”⁴⁰ and competitions on automatic Spatial Role Labeling by means of machine-learning techniques organized at several international computational linguistics conferences, most notably at LREC (Linguistic Resources and Evaluation Conference).⁴¹

In this case, labeled texts have to be provided as training data. Independent of our decision to apply machine learning in the long run, we still had to label our actual text manually anyway so as to create a labeled training corpus of considerable size. Therefore, we decided to use the interactive *brat rapid annotation tool*⁴² (BRAT) and made a configuration file defining all entities, relations, and events to be annotated according to the requirements for spatial construals (i.e., the ascriptions of meaning components such as figure-ground asymmetries) and its parameters. To be compatible with the subsequent step of semantic modeling, we selected the entity types of the Pleiades vocabulary.

The Latin text and its English translation were split into individual, aligned sentences. In BRAT, the marks and lines are entered graphically using the mouse-track function – essentially allowing the user to drag and drop a landmark,

toponym, or other spatial encoding from point A to point B, and thus relate these two points to form a unit or construction. The results are stored in a purely text-based standoff format that can also be exported in an XML version. BRAT also allows for a parallel display of aligned sentences, so that the already labeled English sentence can be shown statically together with the Latin yet to be labeled.

The annotation principles were first identified according to the cognitive-linguistic foundation of our project. We identified the following basic abstract spatial parameters that in turn apply to a number of theoretic principles:

- Toponyms (place names, buildings, roads, squares, regions, etc.) and landmarks, natural (mountains, rivers, forests, etc.) versus man-made.
- Gestalt principles of figure-ground asymmetries as *figure-trajectory/path [=spatial_indicator]–ground* triples.
- Spatial frames of reference: relative/deictic, intrinsic/geometrical, absolute/allocentric
- Topology and geometry.
- Perspective: bird’s eye perspective frog’s eye view, hodological perspective, vectoral perspective.
- Distances: scale, scope, size – linguistically encoded in adjectives, adverbs, verbs, but mostly in adpositions and case systems.
- Metrical systems – encoded in verbal systems such as posture verbs and case systems.
- Motion events: source-trajectory-goal.
- References to common-sense knowledge, such as itineraries or travel reports.

Biondo’s narrative presents enough spatial cues to reconstruct a cognitive map; he even gives detailed references to distances between places.

In the long run, the ideal scenario is the adoption of an automatic annotation procedure that not only annotates lemmas (word forms) but bases its analysis on the above-mentioned cognitive parameters. This would not only result in

34 URL: <http://dare.ht.lu.se/>.

35 Open Annotation Data Model, URL: <http://www.openannotation.org/spec/core/>.

36 JSON (JavaScript Object Notation) format for encoding geographic data, URL: <http://geojson.org/>.

37 TEI: Text Encoding Initiative, URL: <https://tei-c.org/>.

38 URL: <https://www.openstreetmap.org/>.

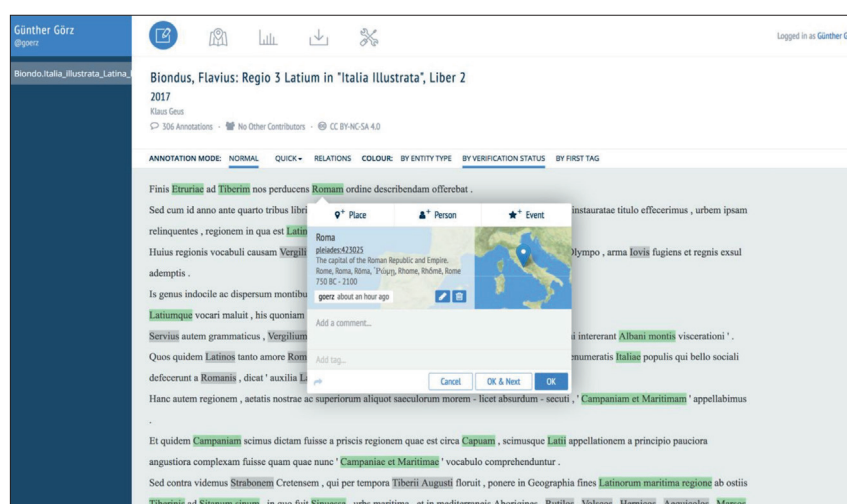
39 Mani et al. 2010.

40 URL: <http://jamespusto.com/wp-content/uploads/2014/07/SpaceEval-guidelines.pdf>.

41 URL: <https://www.cs.york.ac.uk/semEval-2013/task3/>.

42 URL: <http://brat.nlplab.org/index.html>.

Figure 1
Screenshot from Recogito 2 with text
annotation example.



a text and its lexical semantics being searched for spatial encodings such as upstream/downstream or up/down a mountain slope, but for absolute frames of reference, such as upstream/downstream in some cultures. Again, a frame of reference is an abstract cognitive representation of spatial alignment between different participants, enabling spatial orientation. For an absolute frame of reference, no perceiver is indicated, as it is in the case of the relative frame of reference (encoded as “left” and “right” in many languages).⁴³

4.2 Map Annotation

Besides the survey of text, it is also important to annotate maps in their relation to each other. Biondo mentions his use of (not identifiable) maps, but further discussion of the role they played in aiding him is essential. In any case, it is worth studying fourteenth- and fifteenth-century maps of Italy in detail for a comparison of toponyms mentioned in Biondo's text and those displayed on maps. We are convinced that texts, maps, and images were often used in parallel as a complement to each other rather than existing in a hierarchical order. Nevertheless, some maps are known to have been produced based on textual sources (see, for instance, Ptolemy's *Geography*, or portolan texts versus portolan charts). Furthermore, limitations of space are more restrictive when it comes to drawing up and reading map images than is the case for written descriptions.

Nevertheless, visualization adds a new dimension to the understanding of geographical texts.⁴⁴

Our selection of maps for annotation comprises the earliest single sheet maps of Italy by Paulinus Minorita (fourteenth century), six further maps of Italy from the fifteenth century (chosen here according to the excellent selection by Marica Milanese),⁴⁵ two relevant sections of the *Tabula Peutingeriana* (showing Roman roads), some portolan charts dating from before 1465 for coastal towns, and more than twenty-five Ptolemaic maps from the fifteenth century, both of the traditional variety as well as *Tabulae Novae* from the edition of Donnus Nicolaus Germanus, after 1466.

In order to annotate toponyms and ethnonyms in maps, the online tool Recogito 2 with its geographic verification mode is being used as well (figure 3). Up to now a sufficient number of maps – ‘traditional’ and ‘novae’ Ptolemaic maps, as well as others – have been annotated and their corresponding tables analyzed, comparing the occurrences of toponyms and their spellings, in relation to the text. With the results of geographic verification, spatial relations and distances between the places can be calculated for maps and the text as well. Furthermore, we plan to visualize Biondo's imaginary routes in historical and modern maps. It is still a matter of debate whether further investigations such as cartometric measurements would provide useful information for the interpretation. At

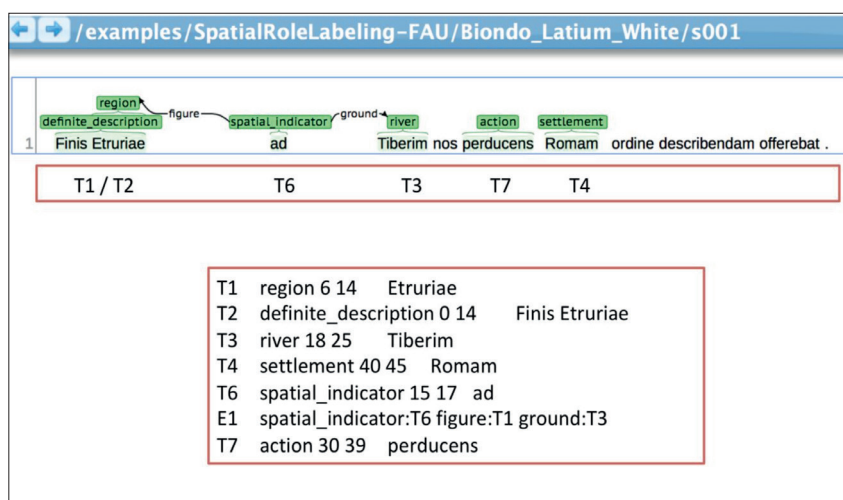
⁴³ See the cognitive-linguistic evaluation of the chapter by Thiering / Berthele 2022 in this

volume, as well as Görz et al. 2018.

⁴⁴ See MacEachren 1995.

⁴⁵ Milanese 2008.

Figure 2
Screenshot from annotation tool.



this point, we are performing some experiments with MapAnalyst,⁴⁶ an image registration tool for the analysis of ancient maps.⁴⁷

4.3 Case Study: Ptolemaic *Tabulae Novae*

In a case study, we completely annotated and analyzed three *Tabulae Novae* of Italy, from the second and third editions of Donnus Nicolaus Germanus.⁴⁸ Over the course of several centuries, many ancient places have been renamed or disappeared, while many new places have sprung up. Therefore, it was an obvious task to ‘update’ the maps by way of juxtaposing more recent maps with the older ones. Which early modern sources the *Tabulae Novae* were based upon is not known, but they were probably the same kind of sources also available to Biondo. The maps in the Latin editions of Ptolemy translated from the Greek provide the names of ancient places in accordance with the respective coordinate tables in the text *Geography*, Book 3, Europe, Tabula 6, but there are no coordinate lists of the *Tabulae Novae*.

The selection of these three maps from the *Tabulae Novae* – all ascribed to Donnus Nicolaus Germanus known as L20-nova⁴⁹ from the year 1466, L23-nova from 1467, and L26-nova from 1468 – are to be understood as a preliminary case study comparing contemporary cartographic representations with Biondo’s text. Three different re-editions are known today which were prepared by himself or under his supervision. While L20-nova and L23-nova were part of the second edition, L26-nova appeared in the third.

L23-nova is dated just one year later than L20-nova and is part of *Codex Urbinas Latinus* 277 (Bibliotheca Vaticana). In appearance, this map is nearly identical to its predecessor in the edition before it. Minor differences are to be found, however, in the inscriptions. The names of the islands are mostly set on the blue ground of the surrounding sea, not on the area of the islands themselves. Due to discoloration through aging, these inscriptions are more difficult to read. In general, however, both maps feature the same style of writing, so one may assign them to the same scribe. This conjecture is further confirmed by the identical use of abbreviations and diacritics. For instance, suffixes such as *-us* and *-um* are replaced by *ũ* (“alsinũ” = alsinum), and the tilde is set within a word to replace the following *n* (“pallestrĩa” = pallestina). Both maps (L20-nova and L23-nova) do not write the usual *s*, but instead use the *ʃ* (as in “oftia” or “aftura”).

L26-nova is a map taken from Germanus’s third edition of 1486 and covers a double page of the *Codex Vaticanus Latinus* 3811. The information inscribed on the map is similar insofar as place names are set horizontally in dark brown script and combined with the same pictograms. But a distinction is made between major cities, where the names are rendered in majuscules, and smaller towns with names in minuscules.

The names of rivers are also set parallel to the curvature of the river, and the names of islands are mostly placed in the blue water zone, like

⁴⁶ URL: <http://mapanalyst.org/>.

⁴⁷ See also the contribution by

Guckelsberger/Geus in this volume.

⁴⁸ Compare Dalché 2007.

⁴⁹ The identification labels given here are cited after Joseph Fischer, see Geus 2009.

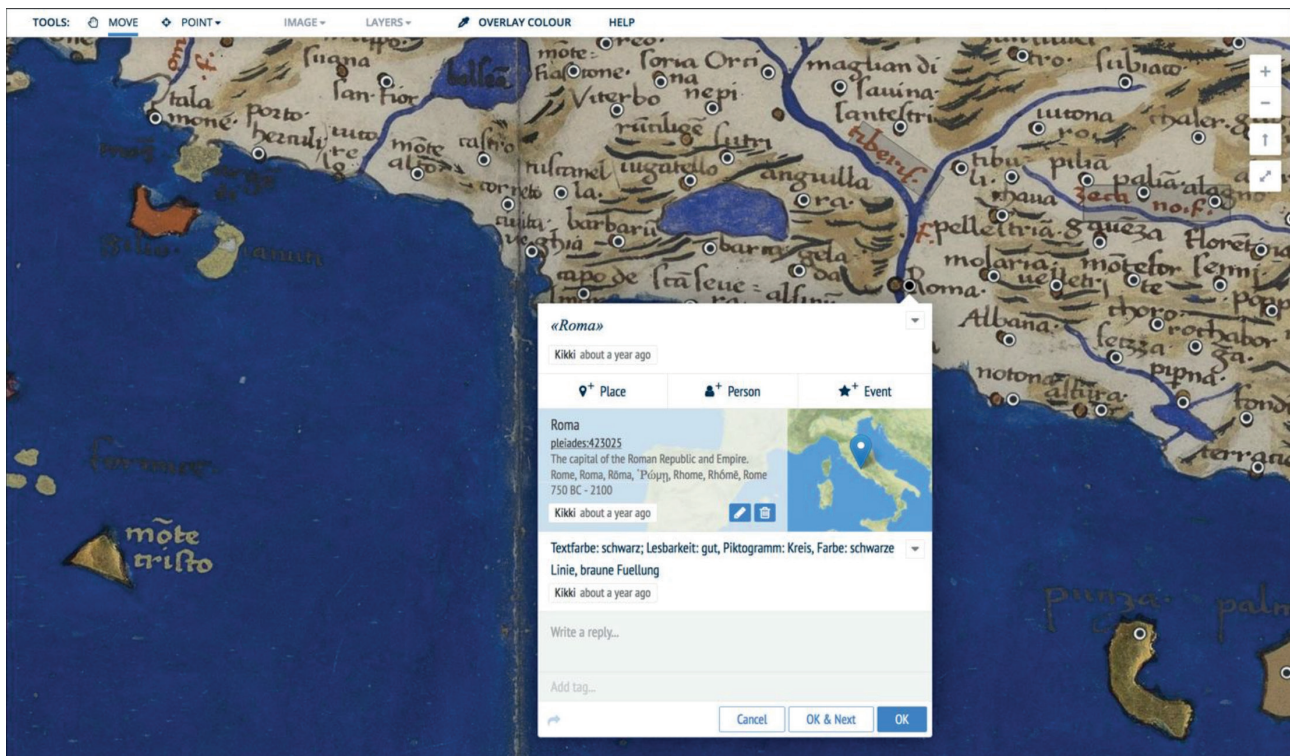


Figure 3
Map annotation in Recogito 2 of Ptolemaic Tabula Nova by Donnus Nicolaus Germanus.

on map L23-nova. A golden inscription in majuscules, “ITALIA”, has been placed on the violet ground in a black-framed box, the only indication of the name of the whole country on any of the three maps. In addition to these differences, close inspection of all the writing makes it evident that it was executed by another hand. This scribe sometimes uses the long s (ſ) (as in “of-tia”), but also the standard s when it stands as an initial (as in “subiaco”). Furthermore, suffixes are partially marked by diacritics like in the older maps (“alsinũ” = alsinum), partially written out (“paliam”). The tilde is used only rarely to replace the *n* (“belmõte” = belmonte).

Using Recogito, it was possible to identify further differences with reference to the names of places. L20-nova was indicated with 626 annotations, L23-nova with 647, and L26-nova with 615 annotations. For places, point annotation was used, whereas mountains, rivers, and also lakes were annotated with rectangular boxes. A short description of the annotation (text color, readability, pictogram) was added and completed by geographic verification. If possible,

the respective location was verified with the *Pleiades* gazetteer, in other cases also with DARE or, as the last option, with GeoNames. If a location could not be verified,⁵⁰ the annotation was marked “flag this place” and tagged with “settlement”, “river”, etc.

A problem in verification with a gazetteer is encountered when the available places do not refer to a town or city as such but to theaters, spas, or other physical objects named after the city. In such cases we tried, if possible, not to work with *Pleiades* but to use DARE or GeoNames (as long as it contained the city or town).⁵¹ In general, by way of the annotations and verifications, it could be shown that there are several differences amounting to a general shift between the maps of the second and third edition, especially with regard to outline and handwriting. For some places, naming or spelling had changed or even disappeared completely.

1. Singular letter:

L20-nova/L23-nova: *lexi*; L26-nova: *Lesi* (Pleiades: 442642).

⁵⁰ This was true of 25 percent in L20-nova, 26 percent in L23-nova, and 24 percent in L26-nova.

⁵¹ L20-nova: 63 percent annotated with *Pleiades*, 2 percent annotated with DARE, 35 percent annotated with GeoNames.

L23-nova: 65 percent annotated with *Pleiades*, 2 percent annotated with DARE, 33 percent annotated with GeoNames.

2. f and s:
L20-nova: *chiverf*; L23-nova: *chiaverf*; L26-nova: *chiavers* (Pleiades: 383555).
3. Tilde:
L20-nova/L23-nova: *levãto*; L26-nova: *levanto* (GeoNames: 3174793).
4. Upper and lower case of initial letters:
L20-nova/L23-nova: *lamatrice*; L26-nova: *Lamatrice* (GeoNames: 3183121).
5. Shift of lines:
L20-nova/L23-nova: *alagno* (in one line)
L26-nova: *alag-no* (over two lines) (Pleiades: 422833).
6. Places not indicated on L26-nova:
Sora (Pleiades: 433126), *Sausa* (Pleiades: 167919), *Fumione* (GeoNames: 3176486), *Asti* (Pleiades: 383669), *Ostiglia* (Pleiades: 393438), *Frusolone* (Pleiades: 432851).
7. Places not indicated on L23-nova at all:
Panego (GeoNames: 3170937), the indication of the *Anguillare* (Pleiades: 413015).

The observation that there must have been a change of scribe between the second and third edition is also confirmed by the Recogito analysis of these three maps. Specific changes are recognizable over the course of the maps' reproduction during the three years considered here (1466–1468). Single letters have been exchanged, or the f has been replaced by the regular s, there is less frequent use of tildes, and the names of places are written out more often. Conspicuously, some names are not indicated any more in the later version, perhaps because they could no longer be identified. In two cases where places are indicated in L20-nova and L26-nova but not in L23-nova, a scribal error might be the cause, but the frequency of places which are missing in L26-nova should make us wary of leaping to this assumption.

Although there were obviously formal restrictions of space for placing toponyms on a map, it nevertheless seemed reasonable to compare the toponym lists of the three maps with the downloaded table of Biondo's Latium chapter in the *Italia Illustrata*. The annotated toponyms in

the White edition ("Lazio") amount to a total of 334. But there are also many repetitions of the same places with different names (in English and Latin), such as "Campagna", "Campania", or "Campania and Marittima". Also, some places are titled with two different names, for example "Subiaco" and "Sublaqueum" or "Supine" and "Trasacco".⁵² Furthermore, these labels are not limited to towns and settlements, but also apply to trails ("Via Latina", "Via Salaria"), rivers and lakes ("Lake of Subiaco", "Tiber"), regions ("Lazio", "Sicily", "Umbria"), hills ("Mt. Alban", "Mt. Algidus"), and other names ("Roman Empire", "Roman Republic", "Kingdom of Naples", "Italy"), as well as names not located in Italy ("Nicaea", "Athens").

Regarding our research question for the relation of historical spaces in text and maps, we consider the use of the toponyms in both. Although the space for placing toponyms on maps is restricted, it seems reasonable to compare the geographical annotations in the Csv tables of the three maps with the table of annotations from Biondo's Latium chapter as translated by Jeffrey White, drawn from Recogito. It was found that of 191 place names stated in the text, the maps indicated 48 place names. Among these, 33 are written identically in the text and on the maps, while the remaining 15 are also spelled differently among the maps themselves. Among the 33 identical toponyms, 14 toponyms are written identically on all three maps as well as matching the spelling in the White edition.⁵³ With all other annotations, the spelling changes mostly only minimally ("Anagnia" becomes, for example, "Alagno", "Celano" becomes "Cela").

In two individual cases, L20-nova and L23-nova contain the toponym, but L26-nova does not.⁵⁴

What is the result of this analysis? It is interesting that the White edition titles the same places with different spellings. Whether this is due to White's translation or not is questionable. Within the maps, there are only minimal differences in spelling.

L26-nova: 63 percent annotated with Pleiades, 2 percent annotated with DARE, 35 percent annotated with GeoNames.

⁵² Further examples include: Alatri/

Aletrium, Anxur/Terracine, Capua/Casilinum, Praeneste/Palestrina, Astura/Torre Astura, Veroli/Verulae.

⁵³ These places are Alba, Astura, Benevento,

Civitella, Capua, Bologna, Velletri, Gaeta, Itri, Roma, Suessa, Ravenna, Ostia, Tagliacozzo.

⁵⁴ Celano (L20-nova/L23-nova Cela), Fratte (L20-nova/L23-nova Fratta).

The first conclusions we can draw are: (a) geographical knowledge changed considerably during the fifteenth century; and (b) this change is reflected in the differences between the maps as well as between them and the *Tabulae Novae*. Part of this change can be understood as the evolving geographical knowledge which took place in the process of re-editing and revision. Thus, it may be assumed that the editions of Donnus Nicolaus Germanus were based on similar – if not the selfsame – sources on which Biondo drew.

5. Generated Research Data and Their Semantic Enhancement Through Ontology-Based Data Modeling

As already mentioned, Recogito offers several formats for exporting text and image annotation results. Annotations of toponyms, but also of persons (in our case also geographically important, because names of peoples often reflect names of regions), and named events can be exported, grosso modo, on two different levels of information:

- In RDF Open Annotation format and equivalently in JSON-LD,⁵⁵ which identify the described object, the annotator, the data of annotation, the comment, and, if identified in a gazetteer, the URI of the identified place.
- As a CSV table or equivalently in GeoJSON, which presents the annotation content in more detail, including geographical information from the gazetteer(s).

In the latter format, in particular CSV tables, the following information is contained:

- `UID`, a unique identifier for the particular annotation.
- `Quote_transcription`, the textual transcription of the inscription.
- `Anchor`, the position of the annotated item in the text (character position) or image (pixel coordinates).
- `Type`, either Place or Person or Event
- `uri`, the unique web identifier of the place in a gazetteer, if the place can be geographically verified.

- `Vocab_label`, the spelling of the name in the gazetteer, including variants.
- `Lat`, geographical latitude of the place.
- `Lng`, geographical longitude of the place.
- `Place_type`, a descriptor from a standardized vocabulary, such as the Pleiades vocabulary, e.g., “settlement”, “river”, “mountain”, etc.
- `Verification_status`, either geographically Verified, or Not_identifiable, if the place cannot be found in one of the available gazetteers, or Unverified, if the verification step has not been completed.
- `Tags`, a free field which can be used for place types in the case of not identifiable places.
- `Comments`.

Recently, a possibility for annotating relations between annotated entities in the text has been introduced in Recogito 2. Relations can be exported as CSV tables – nodes and edges lists – ready for processing with the Gephi⁵⁶ graph visualization platform. Generally, the relations can be chosen arbitrarily, but we found it more useful to have a predefined set, as is given in BRAT configurations and the constraints that come with them, which is why we chose to use BRAT instead. For now, we are focusing on the *figure-spatial_indicator-ground* triples.

The annotations described so far are bound to the linguistic level (i.e., directly related to the text and map image “surface”). To achieve a deeper and more generic semantic level, we pursued a transition to the methodological level of general knowledge representation.⁵⁷ This allows the toponyms and other place descriptions in the cognitive-linguistic spatial role annotations – primarily *figure-spatial_indicator-ground* constructions – to be identified, enriched with general geographic information, and linked to a variety of (online) resources. The semantic and epistemic level in which these representations are anchored is determined by domain models, so-called ‘formal ontologies’,⁵⁸ which may be regarded as the conceptual core of appropriate domain theories. Their underlying abstractions are hence integrated, providing much more

⁵⁵ JSON (JavaScript Object Notation) for Linking Data, URL: <https://json-ld.org/>.

⁵⁶ URL: <https://gephi.org/>.

⁵⁷ Compare, for example Allemang/Hendler 2011.

⁵⁸ A formal ontology defines the conceptual system of a domain of discourse, see, for example, Noy 2003.

content about the conceptualization of space⁵⁹ and the geographic domain.⁶⁰

For the conceptual framework we built upon the CIDOC CRM (the conceptual reference model of the International Council for Documentation/International Council of Museums), a fairly generic ('reference') ontology,⁶¹ originally defined for the cultural heritage sector, and acknowledged as an ISO⁶² standard 21127 since 2006.⁶³ A decisive reason for choosing the CRM and its spatiotemporal extension CRMgeo⁶⁴ was that being a standard, it opens up a wide spectrum of interoperability and linking to many web resources. Ontological enrichment with the CRM as a top conceptual model, which, in its basic design, is *event-based*, provides, for example, a generic 'assignment event' which has open positions to be filled or linked with the semantic roles, regarding agent, constituents (material and immaterial), time span, and place.⁶⁵

A remarkable feature of Recogito is that – if defined by the gazetteer – the places are further tagged with controlled terms from a thesaurus, for example the Pleiades vocabulary.⁶⁶ It allows for a more detailed characterization of the named place (for example, as a settlement, a river, or a mountain), which can immediately be integrated with the ontology-based representation. The same controlled vocabulary is used for classifying the linguistically annotated entities in spatial role labeling, defined in a BRAT configuration.

With formal ontologies, we provide an answer to the question: what is the meaning of annotations? And, at the same time, in particular with the use of a standardized formal ontology like CRM, we can directly transform the annotations

into semantic representations ready for publication as linked open data.

First of all, we defined a domain ontology for the description of historical maps and their content ("hmap:"), connected to the generic CRM/CRMgeo ("ecrm:" for Erlangen CRM), based on an extension of an ontology we had already developed for a database of medieval maps several years ago.⁶⁷ The ontology offers a framework for the general metadata of maps and geographical texts as well as for descriptions of their content as provided by the above-mentioned annotations.⁶⁸ The meaning of each metadata component (property) is defined by a so-called 'ontology path' (i.e., a sequence of triples built from entities and properties of the ontology). As an example, in a map production event (*hmap:M9_Map_Production*) there is an actor, the creator, defined by:

```
hmap:M28_Map -> hmap:A3i_was_
produced_by -> hmap:M9_Map_Production
-> hmap:A4_carried_out_by_map_author
-> hmap:M1_Map_Author -> ecrm:P131_is_
identified_by -> ecrm:E82_Actor_Appellation
```

As an illustration, we shall present a small selection of metadata components of a historical map (*hmap:E28_Map*) in a simplified manner:

- ID: an *ecrm:E42_Identifier*.
- Title: a *hmap:M2_Title*.
- Creator: an *ecrm:E82_Actor_Appellation*.
- Material: an *ecrm:E75_Conceptual_Object_Appellation*.
- Production Place: an *ecrm:E44_Place_Appellation*.

⁵⁹ The concept of space is related to the question of the spatial orientation of the ancients, and more specifically to Biondo's adaption of ancient spatial thinking.

Traditionally, ancient geographical literature uses natural points of orientation (coastlines, rivers, mountains, winds, etc.), with which the observer may locate different directions or geographical objects. All geographical points of orientation depend on the perspective of an imaginary observer. See, for example, papers on 'Common Sense Geography' in Geus/Thiering 2014; see also Dan et al. 2016.

⁶⁰ Compare, for example, Guarino 1998, and Menzel 2002.

⁶¹ URL: <http://www.cidoc-crm.org/>.

⁶² International Organization for Standardization.

⁶³ We implemented CRM in a description logic language, the Semantic Web Ontology Language (OWL-DL): Götz/Oischinger/Schiemann 2008. URL: <http://erlangen-crm.org/>. For OWL-DL, URL: <https://www.w3.org/TR/owl2-primer/>.

⁶⁴ See Doerr/Eide/Hiebel 2017. URL: http://new.cidoc-crm.org/crmgeo/sites/default/files/Crmgeo1_2.pdf (accessed 04.08.2020).

⁶⁵ For a similar approach, see the ontological framework developed by Grossner/Janowicz/Kessler 2016, and in particular their Ontological Design Pattern for

"setting" which comes close to the definition of "spacetime volume" in CRM.

⁶⁶ URL: <https://pleiades.stoa.org/docs/partners/pleiades-rdf-vocabulary>. In principle, other controlled vocabularies could be considered as well, such as the ones released by the Getty, available as linked open data, see URL: <http://www.getty.edu/research/tools/vocabularies/>.

⁶⁷ See Götz 2007, pp. 539–572.

⁶⁸ For very similar work, compare Gkadolou/Stefanakis 2013, 813 or p. 6 in online version; and Chalkias/Vradis/Kokla 2017, 6, with their historical map ontology design pattern, URL: <http://ontologydesignpatterns.org/wiki/Submissions:HistoricalMap> (accessed

- Production Date: an *hmap:M10_Production_Date*.
- Scale: an *ecrm:E75_Conceptual_Object_Appellation*.

For each map we may have several images in which depicted objects are annotated. For this reason we have an analogous data model for images (*hmap:M34_Image*). For each annotated place (*hmap:M3_Annotated_Place* is a subclass of *CRMgeo:SP6_Declarative_Place*) where the (geographical) contents of the annotations are encoded in the columns of the *Csv* tables, each column is transformed into a component, with similar ontology paths defined for it. The annotated place is linked to the image by:

```
hmap:M3_Annotated_Place -> hmap:A43i_
is_depicted_by -> E36_Visual_Item ->
P65i_is_shown_by -> hmap:M34_Image
```

So, for example, the path for *QUOTE_TRANSCRIPTION* is:

```
hmap:M3_Annotated_Place ->
P48_has_preferred_identifier ->
hmap:M42_Transcribed_Place_Appellation
```

Each annotation, represented as a line in the table, has a universally unique identifier (*UUID*) and refers to a visual item (*E36*) which represents at least an inscription (and may in some cases also consist of an image like a wall or tower, etc.), for example:

- *QUOTE_TRANSCRIPTION*: an *hmap:M42_Transcribed_Place_Appellation*.
- Type: an *ecrm:E55_Type* (here: *PLACE*, *PERSON*, OR *EVENT*).
- URL: an *ecrm:E51_Contact_Point*.
- *VOCAB_LABEL*: an *ecrm:E44_Place_Appellation*.
- *LAT/LNG*: *crmgeo:SP5_Geometric_Place_Expression*.

There are also further data models for image series and suites or portfolios of works, such as map collections or atlases. The triples resulting from the *BRAT* annotation are modeled as “Annotated Connections” with a Source (figure), a Label (spatial_indicator), and a Target (ground).

Recogito also offers an export option for annotated texts in *TEI/XML* format. To define the semantics of *TEI* annotations⁶⁹ of named entities (i.e., place, person, and event names in texts), a mapping is applied to the respective *TEI* tags (thus defining the meaning of these tags in terms of *CRM*), as outlined, for example, by Christian-Emil Smith Ore and Øyvind Eide.⁷⁰ Of course, in terms of Recogito annotations, there is a strict equivalence between *TEI* tags and *Csv* table entries.

6. Linked Open Data with the Virtual Research Environment WissKi

In recent years, semantic technologies have become increasingly popular to represent, manage, and publish data in the humanities. Therefore, virtual research environments with semantic backends are used to build complex knowledge networks. Data is exposed as triples using *RDF*, and important vocabularies and thesauri are available as linked data. Ontologies like the *CIDOC CRM*, mentioned above, are the semantic backbone of this approach and provide interoperability and data exchange beyond pure linking.

WissKi⁷¹ is a ready-to-be-used web-based virtual research environment and publishing framework that, at its core, relies on Semantic Web technologies to represent curated knowledge. The system enables digital humanists to produce high-quality linked data without having to cope with the technical issues of the Semantic Web and ontologies, in particular those of *CIDOC CRM*. This is achieved by defining, on the one hand, a mapping between traditional index card or tabular styles and, on the other, graph-based linked data. The mapping may be opaque to the users and only managed by a (modeling) administrator.

By default, data may be input and displayed either as structured data via forms or as free text. Free text may be input through a graphical editor and is semantically indexed in terms of named entity recognition results, calendar date specifications, mentioned events, and also

04.08.2020). See also Scheider 2014, pp. 251–73.

⁶⁹ For the verbal, albeit not formal definition of tags, see the *TEI* Guidelines, URL: <http://www.tei-c.org/>.

⁷⁰ Smith Ore/Eide 2009. As suggested by the late Sebastian Rahtz, the mappings are expressed by transformation rules, see Rahtz 2010, URL: <http://tei.it.ox.ac.uk/Talks/2010-11-12-Crm/talk.pdf> (accessed 04.08.2020).

⁷¹ WissKi (URL: <http://wiss-ki.eu/>) was developed by our Digital Humanities Research Group at FAU Erlangen-Nuremberg in cooperation with the Germanisches Nationalmuseum, Nuremberg, and is currently in use in more than 150 projects,

technical terms as far as appropriate authority files such as gazetteers are available.

Form input provides mechanisms for error reduction by showing autocompletion hints that are backed by available authority files. From the textual annotations, *RDF* triples may be generated and reused as structured data. Furthermore, the system allows the upload, derivation, display, and processing of images based on *IIIF* (International Image Interoperability Framework).⁷²

From a technical perspective, *WissKi* is based on *Drupal*⁷³ (version 8), a widely used web content management system with a big and active user and developer community. It has a modular architecture with a vast variety of third-party extensions available. Being such an extension, *WissKi* profits from a stable core system and also from these community contributions, providing all sorts of functionality.

We decided to use *WissKi* for the representation, storage, and access of all research data which are produced in our project.⁷⁴ First of all, the system has to be configured with the ontology introduced above, *ECRM* with *CRMgeo*, extended by *hmap*. Then, with its *Pathbuilder* tool, all ontology paths for the metadata of images, image series, maps, and work suites (collections) have been defined. In addition, for images, the paths for the annotated content are defined in the same way; a *URL* provides access to the digital image. For each object type, *WissKi* generates an input form (and also an equivalent search form), based on the paths. Whenever the value of a metadata component is entered, the underlying ontology path is instantiated and broken down into triples, which are stored in a triple database. For the transfer of the annotations in *Csv* tables, *WissKi* provides a table input mode. Images and raw data of different types can be stored in *WissKi* as well, using *Drupal* pages for the latter ones. Hence, everything represented in the lower part of figure 4 is implemented in *WissKi* (and *Drupal*).

Using the semantically enriched geoinformation from text (and map) annotations as *CRM* instances, the spatial entities (*figure*, *ground*) and relations obtained by spatial role labeling as *figure-spatial_indicator-ground* triples can now be upgraded to this rich semantic level by linking data. Due to the fundamental underlying triple structure for all kinds of annotations, the data are immediately ready for publication as standardized Linked (Open) Data. For this purpose, *WissKi* provides a *SPARQL* query interface. These triple data constitute a huge knowledge graph; they are the ‘raw material’ for further research steps (i.e., the exploration of the historical understanding of spaces and the associated knowledge). It is crucial to operationalize the research questions in order to address them as questions to the processing of data. Of course, a *SPARQL* query interface is primarily suited for machine access. For a user-friendly exploration of the database and the formulation of queries in accordance with the dimensions of space and time as well as other semantic concepts, a graphical interface would be the first choice. At this point we can only refer to the experimental query interfaces of the British Museum’s *ResearchSpace* project⁷⁵ and the exploratory query system adopted by Simon Scheider *et al.*⁷⁶ In this context, standardized query forms in the sense of (cultural-historical) ‘query patterns’ would be helpful.⁷⁷

7. An Outlook on Cognitive Maps and Spatial Reasoning

The statement that “[i]n the last analysis all maps are cognitive maps” by Michael Blakemore and Brian J. Harley⁷⁸ indicates an important topic of recent research in the history of cartography. Georeferencing (i.e., reference to geographical locations), is the underlying principle for organizing and presenting all kinds of information in maps. In addition to the analytic perspective, as described in the above sections, the idea of cognitive maps also provides us with a synthetic view, in the sense that we will use

see Görz/Scholz 2012, p. 2, URL: <http://www2.lirmm.fr/ecai2012/> (accessed 04.08.2020).

72 URL: <http://iiif.io/technical-details/>.

73 URL: <http://drupal.org/>.

74 URL: <http://wisski.bibl.hertz.it>.

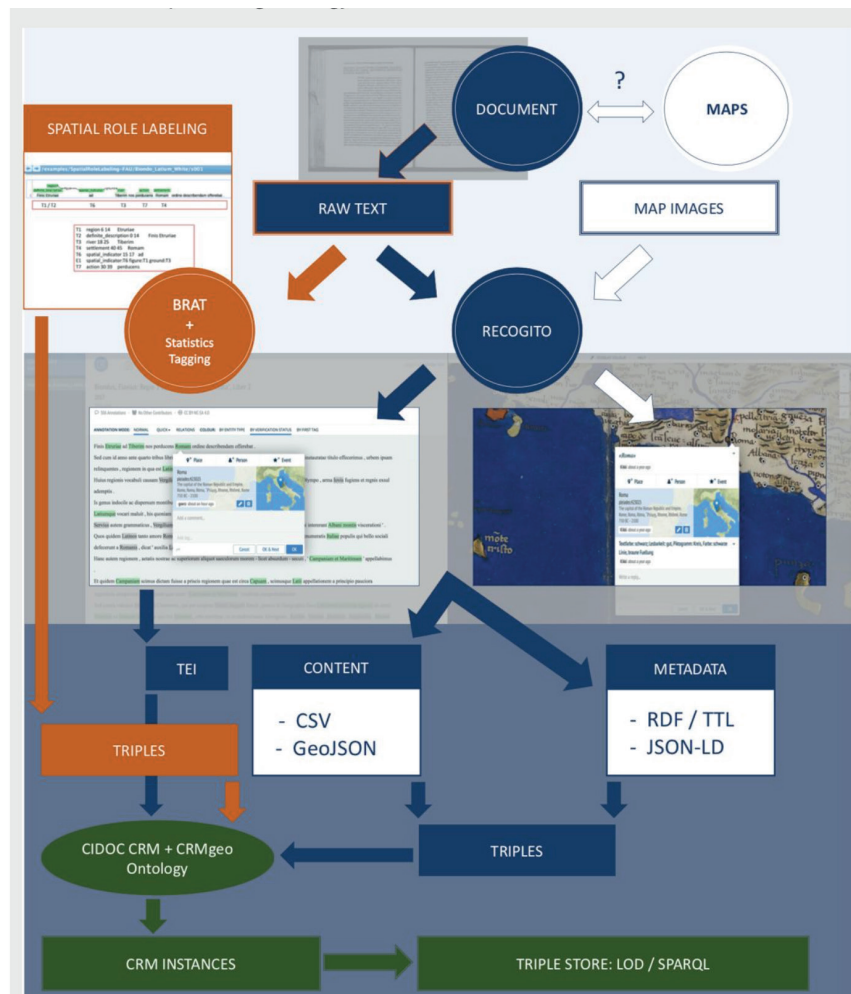
75 URL: <https://researchspace.org>, in particular the “Demo” link (Semantic Search).

76 Scheider *et al.* 2017.

77 Compare, for example, Constantopoulos 2008.

78 Blakemore/Harley/Dahl 1980.

Figure 4
Overview of the processing ontology.



the data found by the analytic steps to reconstruct plausible sketch maps.

Easy access to cognitive mapping can be achieved by systematically investigating the questions of “where”, “what”, and “when”.⁷⁹ For the “where” question (i.e., spatial information in a proper sense), naming is an elementary means to determine identity. It should be noted, though, that “where” and “what” questions are not readily applicable to all languages. Hence, it is not clear how universal these markers are.⁸⁰

For a description of places, depending on the frame of reference, a specification of states or processes and of distance and direction must be added. An example of a process specification would be a route description, how a certain place can be reached. “What” (the objective) and “when” become important for the solution

of spatial problems: a set of suitable properties must be given which are useful in finding a solution by means of cognitive mapping. In other words, first of all, we have to identify the elements which are necessary for an epistemological organization of spatial knowledge. And then, in a second step, we need to develop an analogical or depictional representation suitable for computational processing. Obviously, regions and their relative positions play a key role as do directions, orientation, and distance. We argue that perceiving and identifying these elements and referring to them in discourse is an accomplishment in abstraction which has in any case also a cognitive foundation. Hence, we are considering the assembly of maps and their description in terms of those primarily qualitative categories with (qualitative) spatial reasoning in mind.

⁷⁹ Levinson 2003, Landau/Jackendoff 1993.

⁸⁰ For an extensive crosslinguistic overview, Levinson/Wilkins 2006; Thiering 2015.

There are several formal approaches to qualitative theories of geographic (Euclidean) space which are suitable for spatial reasoning.⁸¹ Thus, the most obvious approach is to combine spatial reasoning with logical inferences in the framework of the formal ontology, expressed in OWL-DL. Laure Vieu has elaborated a theory which is particularly well suited for our approach.⁸² On the basis of mereology as an axiomatized part-whole relation, she provides a formalization of topological concepts as well as geometrical concepts, in particular distance and orientation in first-order logic.

The Region Connection Calculus (RCC-8),⁸³ developed by Anthony Cohn *et al.* is an elementary topological theory with regard to qualitative spatial reasoning. An interesting question here is whether or not the theoretically identified primitives (in RCC-8, for instance) are not only epistemologically but also cognitively plausible. We are aware of the fact that testing the plausibility of cognitive salience is commonly outlined based on online psycholinguistic test designs with individual participants. Our argument is that a large database of historical encodings in texts and maps does indeed reveal fundamental spatial patterns grounded in general cognitive principles of, for example, visual perception processes. On the other hand, there are theoretical considerations which point in the same direction, such as the concept of ‘primary theory’ in cognition, in particular in the geographical domain.⁸⁴

For the final step of generating a cognitive map representation of Biondo’s *Italia Illustrata*, the salient data to be considered from linguistic analysis are:

- Toponyms.
- Enumeration of ethno-geographical terms including modifiers of size, shape, etc.
- Spatial relations, directions, etc., from prepositional phrases.
- Subject/object from predicate-argument structures.

- Frame of reference with the help of movement and position verbs and toponyms.

Starting with the analysis based on spatial role labeling, we plan to transform the descriptions of spatial objects and their spatial relations extracted from the text into plausible cognitive sketch maps.⁸⁵

Cognitive-linguistic annotation results in the *figure-spatial_indicator-ground* triples – geographically adjusted and semantically enriched – that deliver a set of cognitive parameters from which we can build spatial property graphs. With the help of these graphs, we will survey the possibilities to generate plausible cognitive sketch maps, similar to the procedures outlined by Maria Vasardani and Junchul Kim and others.⁸⁶ Technically, we will fall back to the approach of ‘cellular geography’ developed by the geographer Waldo Tobler in 1979⁸⁷, which, built upon a coordinate grid, offers advantages over the irregular spatial polygons following political or other borderlines. Similarly, in IBM’s LILOG project,⁸⁸ Mohammed Nadjib Khenkar developed a procedure for the object-oriented representation of depictions on the basis of a (coordinate) grid, the so-called ‘cell matrices’.⁸⁹ Finally, these sketch maps will be evaluated in comparison to the above-mentioned geo-visualization and contemporary maps as well.

8. Conclusion

We built a semi-automatic environment designed to facilitate annotating and analyzing historical texts and maps with linguistic and geographical content and outlined a new methodology based on the generated data which may help scholars understand and compare cognitive maps. Biondo presents a number of different spaces in his (re)construction of Italy. Our main aim is to analyze historical constructions of spaces, but also the spatial encodings from a cognitive-semantic point of view. In

⁸¹ For example, Egenhofer/Mark 1995, Vieu 1997, Hernández 1994.

⁸² Vieu 1997.

⁸³ Cohn *et al.* 1997.

⁸⁴ See Smith/Mark 2001.

⁸⁵ See Vasardani *et al.* 2013, Kim/Vasardani/Winter 2016.

⁸⁶ Vasardani *et al.* 2013, Kim/Vasardani/Winter 2016.

⁸⁷ Tobler 1979.

⁸⁸ For an overview of LILOG, see Herzog/Rollinger 1991.

⁸⁹ Nadjib Khenkar 1991.

Thiering/Berthele 2022, referring to Biondo's text, we present the different forms of knowledge represented in spatial relations and spatial perception as elaborated from these representations. Particularly in his many quotations of classical authors, Biondo makes frequent reference to their naming of places, landmarks, toponyms, and spatial relations. Facing the problem that many place names and ancient places were no longer extant or at least no longer identifiable in his time, he was unable to refer to many places as a reference system. The text also refers to a number of different semiotic encodings such as other texts and maps. These intertextual traces are one of the major tasks facing scholars in tackling spatial conceptions of the Renaissance with respect to the ancient world as the guiding spatial matrix.

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