Spatial Cognition in Historical Geographical Texts and Maps: Towards a cognitive-semantic analysis of Flavio Biondo's *“Italia Illustrata”*

Günther Görz[2,4], Klaus Geus[3,4], Tanja Michalsky[4], and Martin Thiering[1,4]

[1] Technical University Berlin, Department of Linguistics
[2] FAU Erlangen-Nuernberg, Department of Computer Science, Digital Humanities
[3] Freie Universitaet, Department of History and Cultural Studies, Berlin
[4] Bibliotheca Hertziana/Max Planck Institute for the History of Art, Rome

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Summary: Bibliotheca Hertziana’s Biondo research group questions an epistemology of spaces and their changes in the early modern history. At focus are relations between historical maps and texts aiming to explore the historical understanding of spaces and the knowledge associated with it. We take up approaches from cognitive science and computational linguistics arguing that cognitive maps depict culture-specific spatial knowledge and practices. Our interdisciplinary project combines cognitive-semantic parameters such as toponyms, landmarks, spatial frames of reference, geometric relations, gestalt principles and different perspectives with computational and cognitive linguistic analysis. Using new text and map markup and corpus-specific quantitative methods, historical geographical texts are processed and reinterpreted. Long-term research questions are: Which forms of knowledge represent spatial relations? How can spatial transformation processes be represented and analyzed? What is the connection between culture-specific practices and cognitive representations? What is the relationship between texts and maps?
Flavio Biondo's work (1392-1463) *Italia Illustrata* written around 1450 serves as the case study. In this work he draws on famous authors of Roman times such as Livius, Vergil, Pliny, as well as Ptolemy. This work is not only used as a data base, but also as a structural principle: Strabo's hodological description is imitated to locate all the Latin cities and locations relative to each other and transform them into a narrative structure on the west coast of Italy and three Roman roads. In contrast to previous scholarship which is mostly dealing with textual criticism, biographical, literary and art-historical references, we focus on the identification of toponyms and the geographical vocabulary, on a linguistic-cognitive analysis of spatial relations, on contemporary cartography and a synthetic approach to mental maps.

1. Introduction

This paper presents new findings in an ongoing project at the Bibliotheca Hertziana with a focus on questions about the historical understanding of social space and its change in the early modern. The study of relations between historical maps and texts aims to explore the diachronic epistemology of spaces and the knowledge associated with it by taking up approaches from cognitive science; cognitive maps depict culture-specific spatial knowledge and practices. Theoretical foundations and first results, of which this paper can only present a few examples, are described in detail in two chapters by the present authors in Geus, Michalsky and Thiering (2018).
In a long-term perspective, our project seeks answering the following research questions: Which forms of knowledge represent spatial relations? How can spatial transformation processes be represented and analyzed? How can space generating texts, images, and maps be interpreted in context? What is the connection between culture-specific practices and cognitive representations? What is the relationship between texts and maps? And last but not least, how is the relationship between historical space and the current space in which the researchers are moving? The project’s epistemic goal is to raise awareness of the processes of individual and social construction of space.
Flavio Biondo's work *Italia Illustrata* (1392-1463) serves as the first case study. In this work he draws on famous authors of Roman antiquity such as Livius, Vergil, Pliny, as well as Ptolemy, and in the Latium book a hitherto undiscovered Latin translation of Strabo. This work is not only used as a data base, but also as a structural principle: Strabo's hodological description technique is used to locate all the Latin cities relative to each other and transform them into a narrative structure on the west coast of Italy and three Roman roads. Starting with the Latium book, in contrast to previous research which is mostly dealing with textual criticism, biographical, literary and art-historical references, we focus on the identification of

toponyms and the geographical vocabulary, on a linguistic-cognitive analysis of spatial relations, on contemporary cartography and a synthetic approach to mental maps. We aim to analyze historical constructions of spaces from which insights about the spatial organization of cultural practices can be gained within the framework of topographical data.

In the example of Biondo, a general observation is that his conception of Italy in the early modern is guided by a historical perspective, i.e., classical authors and their naming of places, landmarks and spatial relations. Biondo makes frequent references to a number of different semiotic encodings such as texts and maps. One major issue regarding place names (toponyms) specifically is that a number of ancient places simply did not exist in the early modern anymore. Biondo has to reconstruct places in his narrative, hence he refers to ancient authors. This reconstruction process is also the task of the present project analyzing the *Italia Illustrata*.

Assuming that Biondo makes frequent use of maps – as Clavuot (1990) and others argue – a number of questions are to be raised: Which maps or map-like depictions are still extant today? How do these maps interact with each other? Why is a specific place or landmark named in one map, and why left out in another? How do maps and texts interact in general? What has been lost in terms of *information containers* or repositories of knowledge through time? These questions ask for a comparative approach using a number of annotation tools as developed in computational linguistics and adopted in digital humanities. As opposed to the canonical assumption that Biondo used a number of maps, we are more cautious with respect to such claims. Certainly he used a number of other information media such as travel reports or registry entries – arguably in addition to maps. Furthermore, Biondo was writing his description of Latium for an audience which was more familiar with texts than maps and was clearly able to build up mental maps (or cognitive scripts) from textual elements.

Our main hypothesis based in a cognitive linguistic background is that his narrative is based on cognitive maps or mental models enabling the reader to mentally triangulate different spatial references. This should come of no surprise regarding the constructive function of cognitive maps.

In the following we first outline few basic comments regarding the available translations and commentaries on Biondo, then present different computational approaches used, our workflow and the various problems with text annotation in general, and Latin text annotation specifically. We also give some first insights into the quantitative statistical distribution of toponyms and landmarks in Biondo's Latium book, followed by some qualitative examples within a linguistic-cognitive analysis of spatial relations. Furthermore, we consider Biondo's geographical vocabulary, as well as contemporary cartography and a synthetic approach to mental maps.

1.1 Remarks on the Latin text and the English translation

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. The reason is that modern editions are based either on the extant manuscripts (Biondo/Pontari 2014) or the first printed edition (Johannes Philippus de Lignamine, Rome 1474), supervised by Gaspare Biondo (Biondo/White 2005, 2016), or the "best-known, most-cited early printed edition" (Froben, Basel 1559, see Castner 2005, 2010). While good arguments can be advanced for all choices from a philologist's point of view, we nevertheless deemed it necessary to choose another approach. 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. Our text aims at reconstructing Flavio Biondo's "intended" text from both the manuscripts and the *editio princeps* – transmitted in two versions, which are, contrary to the common belief, not identical –, thus harmonizing, as far as necessary and sensible, orthography and punctuation. The reasons for providing a translation of our own are grounded in textual deviations from White's and Castner's texts which already amount to more than one hundred just in the case of the Latium chapter. The second reason concerns our superordinate interest in Flavio Biondo's "spatial language'". In order to analyze and evaluate it from a cognitive linguistic point of view, the English translation has had to be as uniform in diction and phraseology and as close to Biondo's Latin as possible. In other words: we have aimed less for an elegant than for a literal interpretation. A final reason was to avoid copyright issues by submitting our translation under a creative commons license.

2. Project Workflow

2.1 Actual work units

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. These steps are necessary to enable a large text corpus analysis for textual comparison. Its ultimate goal is to annotate, that is, to mark individual words – features like place names or locations – in different text sources and spatial relations in texts in the framework of cognitive semantics. Moreover, we relate these annotations to similar annotations in geographical maps.

Basically, we work with two UTF-8[1] encoded text representations, plain text and TEI/XML.[2] Although many software tools already accept TEI encoding as a text input format, there are still some which require plain text. All texts have been generated digitally, in some cases based on spelling-corrected OCR (Optical Character Recognition) files. For our current purposes we work mainly with the English translation; the Latin text still needs linguistic annotation and glossing.

2.1.1 Word Lists, Concordance and Part-of-Speech Tagging

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. The tools we used were some command line scripts of our own. We applied a KWIC Concordance program[3] and the Tree Tagger with the Stuttgart-Tuebingen Tag Set (STTS)[4]. For word lists and statistics, concordances, n-grams and collocations – which are de facto word co-occurrences – also the interactive AntConc[5] tool as well as the browser-based on-line Voyant tools[6] are very useful. All results for English and Latin which we got in batch processing mode have been put up on a project web page[7] for quick lookup. They include:

- 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,
- word list, Tree-tagged (STTS), with lemmata; word list, Tree-tagged (STTS), with frequencies, sorted by tags.

For English, we also used Lancaster University's wmatrix3 toolbox[8], which provides a semantic tagger, too.[9] These tools are flexible in a variety of output formats, including XML.

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[1] UTF-8 is a Unicode character encoding; http://unicode.org/. All URLs have been checked on Mar.6, 2018
[2] TEI: Text Encoding Initiative, providing a modular set of tags for various text sorts; http://www.tei-c.org/.
[3] KWIC for Windows Version 4.7 and 5.3 by Satoru Tsukamoto; http://downloads.informer.com/kwic-concordance/download/.
[4] http://www.ims.uni-stuttgart.de/forschung/ressourcen/lexika/TagSets/stts-table.html.
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analysis, e.g., to annotate clusters, to mark single lexical items embedded in their textual context etc. See: http://www.laurenceanthony.net/software/antconc/.
[6] https://voyant-tools.org.
[7] http://www.biblhertz.it/forschung/forschungsprojekte-des-instituts/historische-raeume-in-texten-und-karten-biondo-projekt/ will link to the freely available results.
[8] http://ucrel.lancs.ac.uk/wmatrix/.
[9] http://ucrel.lancs.ac.uk/usas/USASSemanticTagset.pdf.

In the case of annotating Latin only a few computational resources and tools are available. Besides a few scanned classical lexica, as a lexical resource there is an online version of WordNet for Latin.[10] A powerful freely available lemmatizer and morphological analyser for Latin texts is Collatinus[11] in web-based and standalone versions. The Perseus Digital Library provides access to its "word study tool", an online version of a Latin morphological analyzer.[12]

In very general terms, a lemmatizer parses word forms into its basic (verb) stems excluding inflections. For the well-known Tree Tagger[13] – a tool for annotating text word by word with part-of-speech, lemma, word class, and inflection information – many language models are provided, among them Latin and English. Therefore we decided to work in parallel language mode, that is, with English and Latin as far as appropriate tools are available, synchronized sentence by sentence. Ideally, we could synchronize glossing word by word using linguistic terminology as known from field linguistics research (Levinson and Wilkins (2006); Thiering (2015)).

Our goal in the first phase of the analysis and interpretation of Biondo's text in the framework of cognitive semantics is the identification of locations, place names, definite descriptions, and of spatial relations between them. Hence, beyond the morphosyntactic and semantic information on words as provided by the mentioned tools we also need 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 important for semantic representation as well (cf. Fischer and Ágel 2010). We decided to use the Stanford Parser,[14] a lexicalized stochastic parser whose English language model generates dependency trees of reliable and sufficient quality. Finally, we aim for annotated logical forms which express the spatial relations of different objects described in the text. Because up to now no general tools for spatial role labeling are at hand, we decided for a semi-automatic procedure on the geographical passages only at this point.

2.1.2. The Recogito 2 Annotation Tool and Named Entity Recognition

Although the parser contains a good Named Entity Recognition module, we used the Recogito 2 annotation tool[15] for semi-automatic markup of places – and also of persons and named events – in the Latin and English texts. The plain text annotation provides an integrated geographical verification mode by means of several gazetteers, where for historical texts we prefer the Pleiades gazetteer[16]. Using the Recogito platform, the results can be exported in several formats, e.g. as tables (CSV) – which are particularly useful for comparison and further processing –, GeoJSON, RDF, and also as a simple TEI/XML files with appropriate tags, which are well suited as a basis for further tagging processes.

Furthermore, Recogito (see fig. 1,3) also allows for annotating map images and the display of (annotated) places on different types of maps like OpenStreetMap[17] or the Digital Atlas of the Roman Empire[18].

The most important text processing step in this project phase is spatial role labeling, i.e., markup of spatial object descriptors and of the relations which hold between them. For this purpose, international standard proposals have been developed (see Mani (2010); also SpaceEval Annotation Guidelines[19]). At several international computational linguistics conferences, e.g. LREC (Linguistic Resources and Evaluation Conference)[20], competitions on automatic spatial role labeling by means of machine learning techniques were organized. For this purpose, labeled texts had to be provided as training data, but a closer look revealed that those differed too much from our historical text sort. Independent of our decision to apply machine learning in the long run, we would have to manually label our actual chapter anyway to provide a

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10 http://multiwordnet.fbk.eu/online/multiwordnet.php.
11 http://outils.biblissima.fr/en/collatinus/.
12 http://www.perseus.tufts.edu/hopper/morph?redirect=true&lang=la.
13 http://www.cis.uni-muenchen.de/~schmid/tools/TreeTagger/.
14 https://nlp.stanford.edu/software/lex-parser.shtml.
15 cf. Simon et al. (2015), http://recogito.pelagios.org/.
16 https://pleiades.stoa.org/.
17 https://www.openstreetmap.org/.
18 http://dare.ht.lu.se/.
19 http://jamespusto.com/wp-content/uploads/2014/07/SpaceEval-guidelines.pdf.
20 https://www.cs.york.ac.uk/semeval-2013/task3/.

labeled training corpus of considerable size. For our purpose, we decided to use the interactive *brat* rapid annotation tool.[21] We defined a configuration file defining all entities, relations, and events to be annotated according to the requirements for spatial construals – that is, the ascriptions of meaning components such as figure-ground asymmetries – and its parameters.

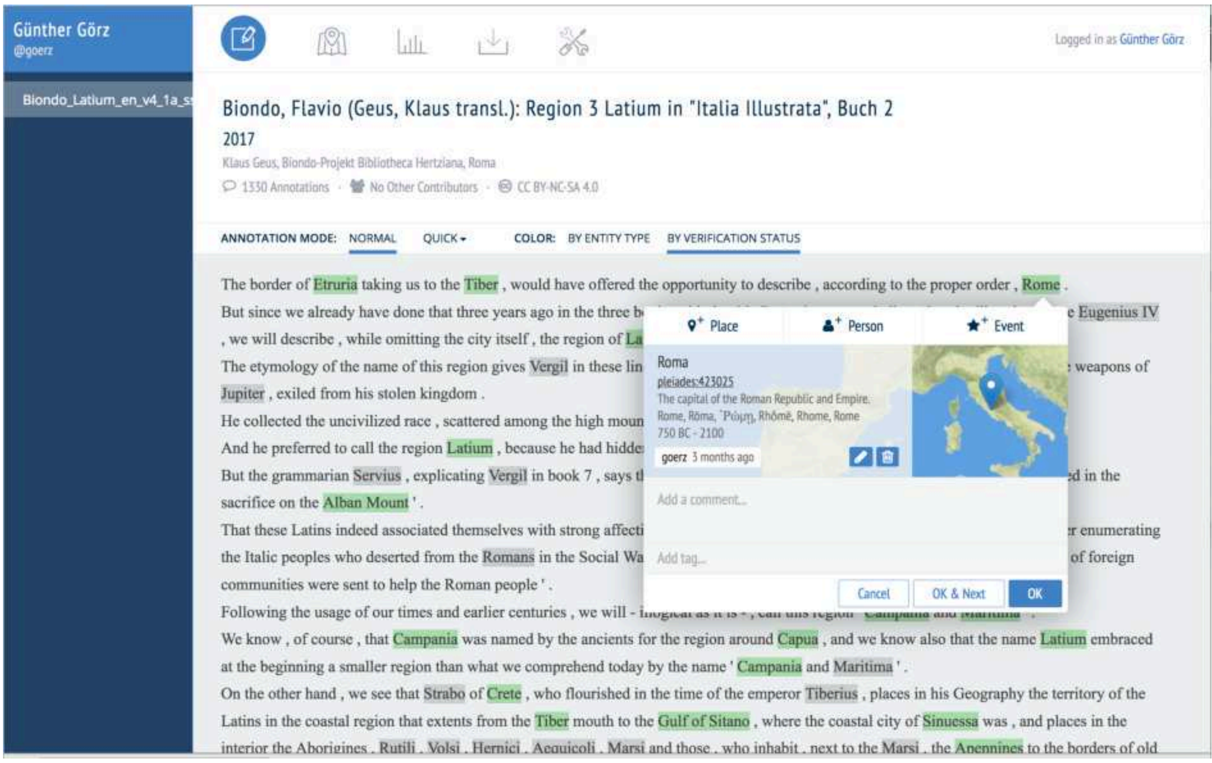

Figure 1: Text annotation with Recogito 2

The Latin text and its English translation were split into individual, aligned sentences. An example annotation is shown in fig. 2. The marks and lines are entered graphically using the mouse-track function (basically one can drag from point A – a landmark, toponym or other spatial encoding – to a point B and thus related these two points to form a unit or construction) and stored in a purely text-based standoff format from which an XML-formatted file can be exported for further processing. *brat* also allows for a parallel display of aligned sentences, such that the already labeled English sentence can be shown statically together with the unlabeled Latin sentence which is ready for labeling. To facilitate this task, a full bilingual linguistic glossing of the text is a prerequisite for our analysis which has still to be supplied.

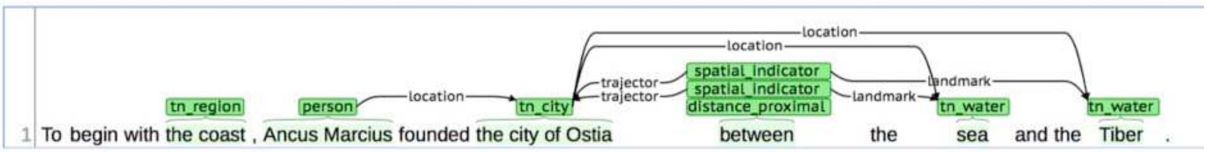

Figure 2: Example annotation with *brat*

[21] http://brat.nlplab.org/index.html.

2.1.3. Map Annotation

Finally, in this project phase we are interested in the relations between text and images, which in our case are maps of Italy of the fourteenth and fifteenth century. Biondo mentions his use of maps, in particular of Ptolemaic maps (cf. Clavuot 1990), but more discussion about the role maps played for him is needed (see above). In any case, it seems worthwhile to survey contemporary maps in detail – Ptolemaic and other maps as well – for a comparison of toponyms mentioned in the text and displayed on maps. We are convinced that there is a priority of texts over maps, i.e., the production of maps is in general based on texts (cf. Ptolemy's *Geography*, or portolan texts vs. portolan charts). In most cases, limitations of space are more restrictive for map images than for descriptions. On the other hand, visualisation adds a new dimension to the understanding geographical texts (cf. MacEachren 1995).
Our selection of maps for annotation comprises the earliest single maps of Italy by Paulinus Minorita (14th century), six further maps of Italy from the 15th century according to the excellent selection by Milanesi (2007/8), two relevant sections of the *Tabula Peutingeriana* – which show Roman streets –, some Portolan charts before 1465 for coast cities, and more than 25 Ptolemaic maps from the 15th century, traditional ones as well as "tabulae novae" from the redactions of Donus Nicolaus Germanus, after 1466.
The annotation of maps, mainly focusing on toponyms and ethnonyms, is performed with the on-line tool Recogito 2 in a similar fashion as text annotation. This browser-based tool enables not only transcription and commentary, but also geographic "verification" with different gazetteers. First and foremost Pleiades[22], but also Digital Atlas of the Roman Empire (DARE)[23], GeoNames and others provide the necessary information. The results from Recogito's map and text mode as well can be visualized on modern maps and on the DARE, and can also be exported in various formats. A remarkable feature of Recogito is that – if defined by the gazetteer – the places are further tagged with controlled terms from a thesaurus, e.g. the Pleiades vocabulary[24]. It allows for a more detailed characterization of the named place, e.g., as a settlement, a river, or a mountain. This characterization is a prerequisite for establishing a connection to the semantic level, given in terms of a formal ontology. Appropriate formal ontologies are another important issue of this project, because such ontologies could also be applied to other, e.g., cultural heritage, data sets.

Figure 3: Map annotation with Recogito 2. A Ptolemaic map by Berlinghieri, 1482

[22] https://pleiades.stoa.org/.
[23] http://dare.ht.lu.se/.
[24] https://pleiades.stoa.org/docs/partners/pleiades-rdf-vocabulary.

A sufficient number of maps – Ptolemaic "traditional" and "novae" as well as others – have been annotated and the corresponding tables are being analyzed, comparing the occurrences of toponyms and their spellings, and in relation to the text. Whereas toponyms on the "traditional" Ptolemaic maps correspond very well with the listing in the text (*Geography*, Book 3, Tabula 6), including Ptolemaic coordinates, there are no coordinate lists for the "tabulae novae" in editions of Ptolemy´s *Geography*. With the results of geographic verification, spatial relations and distances between the places can be calculated for maps and text as well. A closer look has revealed that many of the high-resolution digital facsimiles we acquired nevertheless require further digital image processing to enhance readability. Hence, we are actually developing appropriate digital filters and performing a series of experiments. 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. It should be noted at this point that we are performing some experiments with MapAnalyst[25], an image registration tool for the analysis of ancient maps.

2.2 Next project steps

The annotations described are on the linguistic level, i.e., close to the "surface" text in a given language. To achieve a deeper and more generic semantic level with richer semantic indexing, we pursue the transition to another methodological level, characterized as "knowledge representation". First of all, the spatial information contained in both kinds of linguistic representation, i.e., the grammatical dependency relations generated by the parser and the manually produced cognitive-linguistic spatial role annotations, shall be adjusted and combined. The semantic/epistemic level in which these representations are anchored is presented by domain models. These are called "formal ontologies"[26], which may be regarded as the conceptual kernels of appropriate domain theories. Hence, their underlying abstractions are integrated providing much more content about the conceptualization of space[27] and the geographic domain than just the semantic lexicon entries.[28] In particular for the level of generic knowledge, e.g., of time and space, reference ontologies provide a framework in which specific domain knowledge can be incorporated. The CIDOC Conceptual Reference Model (CRM) is such a reference ontology,[29] originally defined for the cultural heritage sector, and acknowledged as ISO[30] standard 21127 since 2006. We implemented it in a Description Logic Language, the Semantic Web Ontology language OWL-DL.[31]
Using the CIDOC CRM opens up a wide spectrum of interoperability and linking to many web resources, such as the gazetteers mentioned above. Ontological enrichment with CRM as top conceptual model, which in its basic design is *event-based* and hence compatible with the representation scheme just mentioned, would provide a generic "assignment event" which has open positions to be filled or linked with the semantic roles, resp., for agent, (material and immaterial) constituents, time-span, and place. Finally, we expect to gain annotated logical forms which express the spatial relations of objects described in the text, represented by property graphs as introduced below.
Actually, we are defining a domain ontology based on CIDOC CRM and its spatio-temporal extension CRMgeo.[32] This allows for a semantic interpretation of annotations such that for, e.g., each tagged PlaceName, we can generate an instantiated CRM description in RDF/OWL format, ready for publication as Linked Open Data.
At least at this point, it will be necessary for semantic evaluation and disambiguation to apply some formal reasoning to the cognitive semantic representations. Of course, it depends on the pertinent research

[25] http://mapanalyst.org/.
[26] A formal ontology defines the conceptual system of a domain of discourse; e.g. Noy (2003).
[27] The conception 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: How does Biondo (and/or his reader) orient himself in his construed world? Traditionally ancient geographical literature uses natural points of orientation (constellations, winds, rivers, mountains 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.
[28] See Guarino (1998); Menzel (2002).
[29] http://www.cidoc-crm.org/.
[30] International Organization for Standardization.
[31] Görz et al. (2008); http://erlangen-crm.org/.
[32] cf. Hiebel et al (2016); see also http://new.cidoc-crm.org/crmgeo/sites/default/files/CRMgeo1_2.pdf.

questions which kind of reasoning and to what extent it is required. For ontologies implemented in OWL-DL powerful reasoning engines are available which can efficiently solve consistency checking, classification and retrieval problems.[33] Reasoning is also the key to exhibit implicit information.

2.3 An outlook on cognitive maps

We follow the general idea that all maps are cognitive maps (Blakemore and Harley 1980). This hypothesis 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 above, the idea of cognitive maps provides us also with a synthetic view in the sense that we will use the data found by the analytic steps to reconstruct plausible sketch maps.

There are several formal approaches to qualitative theories of geographic (Euclidean) space which are suitable for spatial reasoning.[34] Vieu (1993) has elaborated a theory which is particularly well suited for our approach. 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.

For a description of places, depending on the frame of reference, a specification of 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 to find 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. 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 well as directions or orientation and distance. We argue that perceiving and identifying these elements and to refer 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.

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

- Toponyms,
- Enumeration of ethnogeographical terms including modifiers like 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 as they were extracted from the text, into plausible cognitive sketch maps. The first step will be to extract from *brat*'s XML export simple propositions in subject-predicate-object form, so-called triples, in RDF format, adjusted and enriched with dependency relation information as generated by the parser. These triples encode cognitive parameters *figure–trajectory/path*$_{[=spatial\_relation]}$–*ground* constructions. They are basic constituents of graphs, representing two nodes and an edge between them, from which spatial property graphs can be built. With the help of these graphs, we will survey the possibilities to generate plausible cognitive sketch maps, similar to the procedures outlined in Vasardani et al. (2013) and Kim et al. (2016). Technically, we will fall back to the approach of "cellular geography" developed by the geographer Waldo Tobler (1979), which, built upon a coordinate grid, offers advantages for over the irregular spatial polygons following political or other borderlines. Similarly, in IBM's LILOG project[35], Khenkar (1991) developed a procedure for the object-oriented representation of depictions on the basis of a (coordinate) grid, so called cell matrices. Finally, these sketch maps will be evaluated in comparison to the mentioned geo-visualization and contemporary maps as well.

[33] See for example Pellet, cf. Parsia and Sirin (2004), or HermiT, cf. Shearer et al. (2008).
[34] E.g., Egenhofer and Mark (1995); Vieu (1997); Hernández (1994).
[35] For an overview of LILOG see Herzog and Rollinger (1991).

3. Remarks on Annotation Principles

In theoretical groundwork on the cognitive linguistics foundations[36] of our project we identified the following basic abstract spatial parameters which in turn apply a number of theoretic principles:

1. Spatial frames of reference: relative/deictic, intrinsic/geometrical, absolute/allocentric
2. Toponyms: place, settlement names, buildings, bridges, churches, fountains, walls, streets, squares, gates, memorial, region, sites, temples etc.
3. Landmarks [natural vs. man-made]: hills, mountains, rivers, forests
4. Gestalt principles of figure(F)[trajector]–ground(G)[landmark] asymmetries; trajectory/path of F and G
5. Object classifications: mental rotations, 2,5/3-D (dimensional) sketch, geometrical dimensions
6. Distances: scale, scope, size; encoded in adjectives, adverbs, verbs, but mostly in adpositions and case systems
7. Metrical systems: verbal systems such as posture verbs and case systems
8. Perspective: bird's/frog-eye perspective, hodological perspective, vectorial perspective
9. Common sense knowledge: itineraries, traveler reports, myths, travelogues etc.
10. N-spaces: historical space, linguistic, memorial, mental, urban, rural space, mystical space etc.
11. Motion events: Source–Trajectory–Goal
12. Topology/Geometry.

Biondo's narrative presents enough spatial cues to reconstruct a cognitive map; he even gives detailed references to distances between places.
Our ideal scenario is an automatic annotation procedure that does not only annotate lemmas (word forms), but bases its analysis on the mentioned cognitive parameters. This means that a parser does not only search a text and its lexical semantics for spatial encodings such as downriver/upriver or down the slope of a mountain, but for, e.g., absolute frames of reference as in the case downriver/upriver in some cultures. Again, a frame of reference is an abstract cognitive representation of spatial alignment between different participants enabling spatial orientation. In the case of an absolute frame of reference no perceiver is indicated as it is the case in the relative frame of reference (encoded as left and right in many languages).
Moreover, the parser enables all occurrences of topological relations +/–contact, +/–inclusion, +/–adjacent, +/–support or +/–containment between objects. The argument is that this analysis is not about the actual lexical semantic encoding, the lemmas, but about the conceptual representation. A preposition like English *on* encodes in its spatial alignment (not the temporal one as on *s/he is on time*) a +contact relationship between a container (an object=figure) and a flat, horizontal surface (another object = ground). From a formal logical point of view, e.g., *on* encodes a referent figure *x on* a relatum ground *y* if certain contains occur: (inclusion(x, region(surface(y))) & support(y,x)) or path(y) & by(x,y). By means of the semi-automated *brat* annotation, we have annotated the different cognitive parameters showing various spatial relationships as displayed in fig. 2.

4. Qualitative and Quantitative Examples: Flavio Biondo's *Italia Illustrata* from a Cognitive Semantics Point of View

We performed an extended analysis of Biondo's spatial references in the Latium book. In the following, we present a very coarse statistical analysis and, due to space limitations, only a few selected language examples.

4.1 Statistics

For the quantitative data presented in this section, we used primarily AntConc for the English word list, concordance list, clusters, collocates, and frequencies, and for Latin text analysis Collatinus. The overall analysis is based on a Parts-of-Speech (POS) description using the Stanford Parser (548 sentences). The dependencies based on the Stanford Parser are paralleled with the graphical *brat* annotation tool.
For the Latium section we have 3041 word types and 15102 tokens (AntConc). It should be noted that there is a slight difference in frequency using Collatinus for the English frequency count. Regarding the

[36] Thiering et al. (2018).

frequency account of lexical entries/spatial reference encodings it should also be noted that it is important to consider not atomic lexical items, but collocates or constructions. That is, instead of singling out a spatial preposition only, the analysis considers figure, ground, trajectory constructions including other parameters as displayed above. Our main focus is not on the pure statistical analysis, but rather on the qualitative data sets. Nevertheless, the following table presents just the beginning of a list of 64 most frequent entries in our corpus based on White's translation. For future steps we also plan to compare White, Castner and our own translation and its frequencies.

Table 1 reads as follows: The first column (ranking) presents in parentheses the table numbering, the square brackets are the actual rankings (AntConc). We have only included entries encoding spatial information disregarding a number of other more frequent entries. The second column presents prototypical functions of the relevant lemma. The spatial preposition *to* (01/4), for example, encodes a direction in a motion event. A direction prototypically has a starting point (SOURCE), a PATH and a GOAL. In addition, when applicable, we added the subdomains like lemma + __. The *to* entries add a number of toponyms specifically, beside the general parameters like __border, __land, __ground, __river, __sea and __territory. We hence analyze the different constructions regarding the actual parameters encoded. The third column presents the actual English lemma in singular and plural. The fourth column shows the Latin translation based on the Collatinus tool and the related semantic field, if applicable. We present the frequency for the Latin corpus and the different meanings or rather semantic networks associated with the lemma. Grammatical functions are also given, that is, preposition, case marking, adverbial etc. The final column presents simply the frequency of the lemmas in their singular and plural distribution. The general ranking follows top-down from the most frequent to the least frequent lemmas. The Latin text has been searched for its various encoding patterns, that is, English *from* (03/11/148) is distributed in the Latin corpus as *de*, *a (or ab)*, *unde*. This shows the polysemy of the preposition in Latin. In Latin, the preposition is followed by the ablative case, hence, the direction is specified.

*4.2 Flavio Biondo Text Examples: Landmarks, Toponyms, Spatial Frames of Reference and Perspe*ctives

We now present a few selected text examples based on the most frequent entries.[37]

Table 1: Parts-of-Speech Analysis[38]

Rank	Prototypical function	Lemma	Latin (Collatinus frequency)	fre-que ncy
01[4]	PP[direction: source-path/trajectory-goal=lm] to (the)__lm: border(2), land(1), ground(5), river(4), sea(3), territory(3); to__top: Alba, Algidus, Anxur, Aricia, Bologna, Campania, Formia, Frosinone, Gabii, Gaeta, Genzano, Herculaneum, Labici, Mentana, Monte Catillo, Palestrina, Rome, Sezze, Sinuessa, Terracina, Torre Astura, Valleria, Valomontone, Vesta	*to*		369
02[5]	PP[container-region]: source-trajectory[=loc]-goal[lm] in__container: book(61), the coastal region, __district[bounded region], __forests, __lake[bounded region], marshes[unbounded region], mountains,	*in*	*in* (255) PP+ACC: into; about, in the mist of; according to, after (manner); for; to, among [*in* PP+ABL: in, on]	343

[37] Structure of the examples: a) text examples (N= Ranking; S = sentence; () = occurrences in the corpus; capitalized = concepts), b) underlined parts refer to spatial entities (often as constructions), the [...] refer to the different concepts, c) cognitive parameters summarized, d) cognitive grammatical diagrams. The top-down order follows from the most frequent to less frequent occurrences.

[38] Abbreviations:
Grammatical Functions: ACC = ACCUSATIVE, ADJ = adjective, ADV = adverbial, DET = determiner (a, the), NP = noun phrase, PL = plural, PP = preposition
Cognitive Semantic Concepts/Spatial Role Labeling: DIR = directional, DIS = distance, FOR = frames of reference[INTR = intrinsic, ABS = absolute, REL = relative], LM = landmark (ground object), LOC= locative, MAN = manner, REG = region, TOP = toponym; TR = trajector (moving figure object)
[...] = ORDER KWIC/ANTCONC; TECHNICAL TERMS = [CAPITALIZED], LANGUAGE EXAMPLES = (language examples)

	__PLACE, __REGION, __SEA[UNBOUNDED REGION], __TERRITORY, __TREE[UNBOUNDED REGION]S, __VICINITY, __WOODS [BOUNDED REGION]			
03[11]	PP$_{[\text{SOURCE[DIS-DIR]-GOAL[LM+TOP]}]}$ __FROM__REGION+TRAJECTORY FLOWING DOWN__, COME__ __DISTANCE EXTEND__, STADES5)/MILES(23)__	*from*	*de* (61) PP+ABL: down/away from, from, off; about, of, concerning; according to; with regard to; *ab* (44) PP+ABL: by (agent), from (departure, cause, remote origin/time); after (reference); *unde* (18) ADV+INTERR: from where, whence, from what or which place; from which; from whom	148
04[13]	PP$_{[\text{+CONTACT/HORIZONTAL/+SUPPORT/CONTIGUOUS}]}$ ADV: ON THE OTHER HAND (2); FURTHER ON(7); LATER ON(1))/ADJ: DEPENDING ON (1)	*on*		139
05[14]	PP$_{(\text{BY + DET (51)})}$	*by*	*apud* (13) PP+ACC: at, by, near, among; at the house of; before, in the presence/writings/view of	122
06[18]	PP$_{[\text{+CONTACT, +VERTICAL, + REGION}]}$[39] RULE SYSTEM: AT (X,Y) =A REFERENT X IS AT A RELATUM Y IF AND ONLY IF: (I) INCLUSION(X, REGION(Y)) (II) ≠ (INCLUSION(Y,REGION(X)) __TOP[BOUNDED REGION]: ANAGNI, ANZIO, ASTURA, FORMIA, FUMONE, FREGELLAE, GAETA, LAVINIUM, OSTIA, ROME, SINUESSA, TERRACINA	*at*	to *ut* (68) CONJ+IND+IND: to (+ subjunctive), in order that/to; how, as, when, while; even if	86

Starting from the frequency of entries we then take linguistic examples and decompose their meaning according to the cognitive parameters:

(a) Strabo says that the two cities, Tivoli and Palestrina (Praeneste), are located in the same mountainous region but a hundred stades apart, and that the distance from Rome to Palestrina is twice that, but somewhat less to Tivoli.

It is not only that the translation from *stades* to miles is not that clear and highly discussed (see Geus and Guckelsberger 2017), but also the actual distance from Rome to Palestrina is implicit (twice that, but somewhat less to Tivoli).

(b) Near the mouth of the Aniene (Anio), where it enters the Tiber, but beyond it in the region of Umbria, was where I reckon the ancient city of Fidenae (Borgata Fidene) was located.

The cognitive semantic analysis does not have to struggle with these unclear geographic reference systems. For example, in the same mountainous region, but a hundred stades apart. Applying cognitive construals helps to identify the cognitive domains and by that the cognitive maps or image schemas.
In both examples (a) and (b), the following parameters apply:

Parameters for (a):

SOURCE=Tivoli + Palestrina$_{[\text{TOPONYMS}]}$
DISTANCE$_{[\text{DISTAL}]}$=100 stades apart/distance to Rome 200 stades
REGION=mountainous$_{[\text{UNBOUNDED REGION}]}$

Parameters for (b):

LOC=near[40]$_{[\text{mouth Aniene}][\text{tr}]}$
FIG=Aniene
$\text{LM}_1[=\text{GND}]_1$=Umbria$_1$

[39] FIG is near or in GND, with the constraint that FIG is portable relative to GND; FIG = contiguous to the place of GND, where the dimensionality of GND is not significant.
[40] The preposition *near* has been described above as follows: FIG and GND are separate (-contact) and FIG is located internal to the space z (+container) which is contiguous with GND. In this example the locative is accompanied by a landmark, *mouth of Aniene*.

FIG$_1$=Tivoli
FIG$_2$=Palestrina
LM[=GND]=mountainous region

LM$_2$=Fidenae$_2$
DIR=enters$_{\text{[trajectory]}}$
BOUNDED REGION=near mouth of
MANNER=enter

These parameters reveal general cognitive patterns based on the lexical information and the cognitive mapping process. These very simple text examples indicate already the degree of specificity or semantic detail outlined in the descriptions.

4.2.1 Direction

The first example uses the border of a region to direct the reader to the natural landmark, that is, the river. Interestingly, interior and exterior relations are profiled not based on a geographical region, but rather on different peoples.

() The border of Tuscany taking us to the river Tiber, in the normal course of things Rome would be the next to be described. [...]
On the other hand, we note that in his Geographia the Cretan Strabo$_{\text{[PERSON]}}$ *[...] locates the lands of the Latins in the coastal region*$_{\text{[UNBOUNDED REGION]}}$ *that extends from*$_{\text{[PATH/TRAJECTORY/BOUNDED REGION]}}$ *the Tiber mouth*$_{\text{[LOC]}}$ *to the Gulf of Sitano*$_{\text{[TOP]}}$ *(where the coastal city of Sinuessa*$_{\text{[TOP]}}$ *was), while in the interior*$_{\text{[LOC/CONTAINER/REGION]}}$ *he places the aboriginals, the Rutuli*$_{\text{[PERSON]}}$*, Volsci*$_{\text{[PERSON]}}$*, Hernici*$_{\text{[PERSON]}}$*, Aequicoli*$_{\text{[PERSON]}}$*, Marsi*$_{\text{[PERSON]}}$ *and those who inhabit the Apennines*$_{\text{[LM]}}$ *next to*$_{\text{[LOC/REGION]}}$ *the Marsi right up to the borders of old Campania*$_{\text{[LM]}}$*.*[41]

Different lemmas point to the following cognitive parameters (note that we take the "border of Tuscany" as the starting point of an imagined route, hence, we encode it as the source of the motion event):

PARAMETERS:
SOURCE=Tiber mouth$_{\text{[TOP+REGION]}}$

GOAL=Tiber, Gulf of Sitano$_1$ + Campania$_2$
REGION$_1$=coastal
REGION$_2$=Tiber mouth$_{\text{[LOC]}}$
FIG=border of tuscany
LM$_1$=Tiber$_{\text{[TOP]}}$
LM$_2$=Gulf of Sitano
LM$_3$=Campani$_{\text{A[TOP]}}$

LOC=mouth$_{\text{[REGION]}}$, interior$_{\text{[CONTAINMENT]}}$, right up to the borders$_{\text{[REG]}}$; coastal city of Sinuessa$_{\text{[TOP]}}$
LOC=extend$_{\text{[(REGIONX)PATH(REGIONY)]}}$
LOC/REGION=next to

The source or point of departure and spatial anchorage is the Tiber mouth, a rather unspecified region – where does the mouth start and end? It profiles the region, that is, the domain of coastal region. The directions X$_{\text{[SOURCE:Tiber mouths]}}$ to Y$_{\text{[GOAL:Gulf of Sitano+Campania]}}$ are encoded implicitly as extension. This extension is not specified as *stades* or miles, but rather as the opposition between exterior and interior. Also, the reader has to know implicitly the *borders of old Campania*.

N61 *towards*
S: *And because Livy follows Hannibal's route with when Hannibal was refused admission by the Tusculans, he turned down to the right towards to Gabii, I am quite sure that, as I said above, Gabii was what is now the town of Gallicano*.
This passage refers to rather implicit knowledge, that is, Hannibal's route is the spatial anchorage here. But what is Hannibal's route? Hence, *he turned down to the right towards* is rather unspecific. Our translation presents a more spatially and geographically correct description:

[41] *Sed contra videmus Strabonem Cretensem, qui Tiberii Augusti temporibus floruit, ponere in Geographia fines Latinorum maritimam regionem ab ostiis Tiberinis ad Sitanum sinum, in quo fuit Sinuessa, urbs maritima, et in mediterraneis Aborigines, Rutilos, Volscos, Hernicos, Aequicolos, Marsos et eos qui proximum Marsis incolunt Apenninum usque ad veteris Campaniae terminos*.

And because Livius follows Hannibal when he was not received within the walls of Tusculum, he descended on the right-hand side to Gabii, we are quite sure that, as we said above, Gabii used to be where the town of Gallicanum is now.
The *right-hand side* encodes a relative frame of reference based on the mental route the reader takes.

In the same way, we analyzed:

- *Road* as Landmark and Direction; Roads are usually conceived as hodological perspectives. It can clearly be seen that roads serve as spatial coordinate systems, i.e., they present a grid-like sketch.
- Spatial Alignments: vertical (*above*) and surrounding.
- Toponyms: Cities and Rivers
- Spatial frames of reference: Relative, intrinsic, and absolute

The final example relates to toponyms which is interesting because it uses between (*inter*) as a spatial indicator; it has already been presented in fig. 2.

N42 *Ostia*
S: To begin with the coast, Ancus Marcius founded the city of Ostia between the sea and the Tiber.[42]

PARAMETERS:
SOURCE=coast+city of Ostia
GOAL=sea+Tiber
REGION=coast, city of Ostia
TOPONYM=Ostia
LOC=between$_{[\mathrm{DIST+REGION}]}$
Between the sea and the Tiber is rather indefinite. At the same time *between* encodes a tripartite relationship of the trajector (coast) and n-landmarks (city of Ostia = LM_1, the sea = LM_2, Tiber = LM_3).

5. Conclusion

We could show that Biondo presents a number of different spaces in his (re)construction of *Italia* (*Illustrata*). From the perspective of contemporary research on different kind of spaces we can see that different affordances such as functions of maps or the structuring mechanisms of a narrative influence the construction of spaces. Our main aim is to analyze historical constructions of spaces, but also the spatial encodings from a cognitive semantic point of view.

Furthermore, we could show that Biondo's text in particular in its many quotations of classical authors makes frequent references to their naming of places, landmarks, toponyms and spatial relations. 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 task to tackle spatial conceptions of the Renaissance with respect to the ancient world as the guiding spatial matrix. A problem of Biondo's text is that many place names and ancient places were no longer extant or at least not identifiable at his time anymore. Hence, the author could not easily refer to a number of places to be used as a reference system. Biondo's task was to reconstruct the different known and unknown places in his narrative referring to ancient authors and also different maps.
The tables answer the question regarding the different forms of knowledge represented in spatial relations and spatial perception as being elaborated from these representations. With respect to the interaction we show that linguistic encoding patterns point to different cognitive parameters which in turn motivate different cognitive maps. Interestingly we find also a mixture of spatial frames of reference (note that according to Levinson and others cultures prefer one frame of reference). That is, the relative frame of reference as in right/left occurs, but more often the absolute frame of reference depending on

[42] [2] *Ut ergo a maritimis incipiamus: Ostiam urbem condidit mare inter et Tiberim Ancus Marcius, quamquam Servius grammaricus, (in Vergilii VII, dicit exitum Tiberis naturalem non esse, nisi circa Ostiam ubi primum Aeneas castra constituit - cum postea in agro Lavino castra fecerit ingentia, quorum vestigia suis temporibus viderentur.)* Our translation: *To begin, then, with the coast: Ancus Marcius founded the city of Ostia between the sea and the Tiber although the grammarian Servius says in Vergil's book 7 that 'there is no natural mouth of the Tiber unless around Ostia, where Aeneis first set up a camp', although he later founded an enormous camp in the territory of Lavinium, traces of which were to be seen in Servius' time.*

environmental landmarks such as rivers, lakes, shores, mountains, streets. We also find to a lesser degree the intrinsic frame of reference, that is, a house, doorway, gate, entrance serve as spatial anchor independent of the viewer's perspective. Not surprisingly, Biondo refers to a number of cities and villages that are lined up along the three main roads he used as a spatial grid. These roads serve indeed as the major spatial guiding points in the narrative. The data also indicate a number of geometric alignments such as vertical extension (e.g. from above), inclusion (in, inside), region (territory).
To conclude, we come back to our main hypothesis form above: Biondo's narrative is based on cognitive maps or mental models. These cognitive maps enable the reader to mentally reconstruct different spatial references or rather a spatial grid. This should come of no surprise regarding the constructive function of cognitive maps. In addition to that, we have developed a semi-automatic IT environment designed to faciliate annotating and analysing historical texts and maps with geographical content and presented a new methodology which may help to understand and compare mental models/maps across different cultures.

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