

# The Map in the Graph

Understanding non-Cartesian Spatial Narratives through Graph meta-models

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## 1 Introduction

In the premodern world, the experience of the landscape through wayfinding and navigation was essentially connected to practice, rather than map-making. This lack of connection between diagrammatic representations and wayfinding processes is usually indicated as a dichotomy between “hodological” and “cartographic” cognition (Brodersen, 2003; Janni, 1981, 1984): the former presupposes an understanding of space as a linear, narrative sequence of features, the latter as a Euclidean, bird’s eye view, representation. Even though this dichotomy is not necessarily radical (Barker et al., 2016; Peretti, 1979), many societies, mostly but not exclusively premodern, did not use or conceive of maps for navigation in the same way many of us are used to. In this sense, premodern conceptions of space seem to have something in common with some indigenous societies, such as the South Pacific islanders, the Sami, the Hai||om, or the Navajo, whose spatial practice is mainly informed by storytelling (Gladwin, 2009; Kelley and Francis, 2007; Lewis, 1994; Widlok, 2008). This marks a radical cognitive difference with many contemporary societies, and it challenges prevalently map-based representational models.

The increasing decentralization of maps in the analysis of human navigation has marked an emphasis on narrative and storytelling mechanisms, which, together with language, play a central role in the encoding and transmission of spatial knowledge. The cognitive importance of storytelling has been emphasized by various scholars as instrumental to wayfinding (Bickerton, 2014; Eichenbaum, 2000; Levinson and Wilkins, 2006; Scalise Sugiyama, 2001; Thiering, 2015; Thiering and Geus, 2014; Widlok, 2008; Winston, 2011). Storytelling and narrative are especially effective in encoding relational sequences of features, and therefore support the effort of understanding and describing navigation in the landscape (Hutchins, 1995; Ingold, 2000).

While GIS and maps are frequently used for the representation of literary sources (Bodenhamer et al., 2010; Dunn, 2019; Murrieta-Flores et al., 2016, 2019; Palladino, 2021), their limitations are inevitable when it comes to modeling spatial storytelling. Maps are certainly useful to provide real-world context and geographical perspective on narrative descriptions of the landscape: however, they are generally more difficult to use to represent semantic complexity. Most importantly, they can be epistemologically problematic, since their use implies the imposition of a very specific ideology on a system of knowledge that does not presuppose Western cartography as a wayfinding tool in the first place (Eide, 2013; Pearce and Louis, 2008; Pickles, 2012).

The purpose of this paper is not to deal with any and every cultural expression of space and wayfinding, but to emphasize that it is important to investigate non-cartographic knowledge systems as the expression of an articulated worldview with its own formalisms (Barker et al., 2016; Thiering and Geus, 2014), and to propose a way forward in identifying and addressing their structural aspects.

## 2 Methodologies

In the extended version of the paper, we will broadly address the problem of modelling textual information in Digital Humanities (Buzzetti, 2002; Flanders and Jannidis, 2018; McCarty, 2014). We will, however, especially focus on graphs and graph databases as a way to efficiently represent the high semantic richness and the relational nature of spatial narratives, and as a way to address the complexity of the semantic information layer we described. Graphs and networks have often been used in GIS modeling of primary sources, and as a new paradigm to represent ancient historical phenomena (Constantakopoulou, 2007; Malkin, 2003; Murrieta-Flores et al., 2016): graph databases, in particular, can be used to expose complex data models for the analysis of texts (Neill and Kuczera, 2019).

Although the relational character of spatial narratives is often associated with networks and graphs, this association does not need to be visual: graphs rather provide a meta-model, a high-level abstract knowledge structure that offers a way to map out the document, modelling the knowledge it expresses in a formalized way (Ciula and Eide, 2017). Graphs are useful because they allow the representation of semantically meaningful relations, without losing the specifications of the different functions expressed by links between nodes: in addition, the prominence of relationships in graph databases allows semantic distinction of the information, making them particularly flexible for the modelling of heuristic information such as narrative and language. Therefore, while graphs offer a suitable meta-model according to which we can map our texts, graph databases provide a method for storing and querying the resulting relationships and object classes in a flexible way.

## 3 Modelling non-Cartesian geographies with graphs

In non-Cartesian geographies, narrative and linguistic structures are the foundation of an articulated spatial knowledge system. These can be defined as regular linguistic-expressive patterns, which are functional to the encoding of different types of spatial information. The strongly networked nature of the system is a function of its storytelling aspect: in general, information about the landscape is more easily communicated through language as a set of relationships between features, rather than using an abstract set of coordinates. So, relations can be used as structural defining elements of the underlying formalism of spatial narrative.

The strongly hermeneutic nature of information expressed through narrative makes analytical approaches very challenging, and it requires a high level of formalization. We propose here a preliminary conceptual data model, illustrated in Figure 1: its function is to define a high-level formalization that can serve practical efforts in the annotation and modeling of spatial documents. The semantic labels used are intentionally broad, and should be increasingly defined through the analysis of the sources. In the extended version of the paper, we will further explore some concrete examples.

We may think about spatial narrative as a system consisting of three layers: 1)

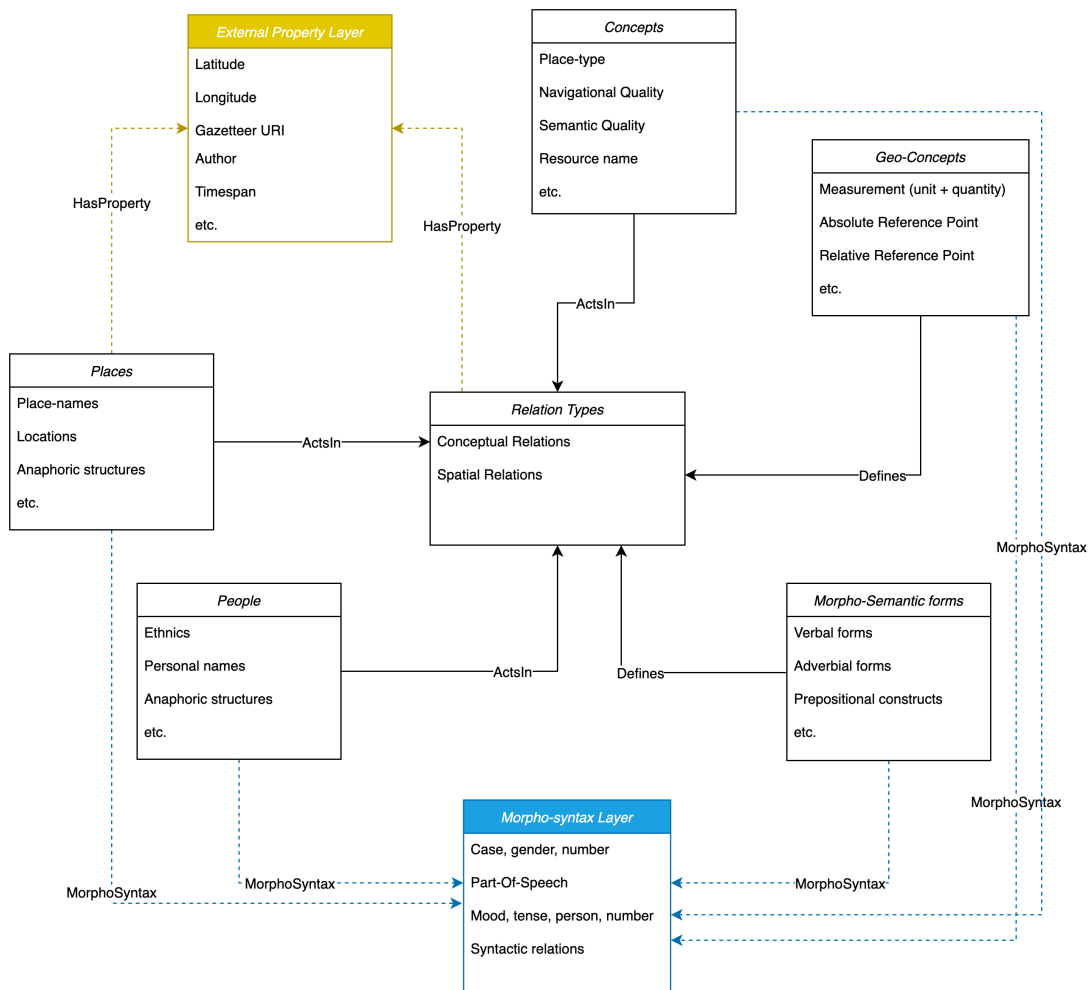


Figure 1: Preliminary data model, illustrating a Semantic Layer, combined with an External Property Layer and a Morpho-Syntactic Layer.

the purely linguistic aspect, which includes elements like morphology, syntax, and grammar (Morpho-Syntactic Layer);<sup>1</sup> 2) a real-world layer: for instance, places in a description can be connected with identifiable features recurring elsewhere (External Property Layer); 3) a layer of relational expressions connecting spatial features in various ways, to express navigational functions such as distance and direction, but also typological classification (Semantic Layer). In this system, information is stored and exposed through a set of relations connecting features in various functional ways: Place A may be connected to Place B by means of a semantically meaningful connection, such as a numerical distance or a direction; Place C may be connected to a place-type, category, or idea, by means of a conceptual relation; Place D is connected to an identifiable real-world entity by means of a link established by the researcher. Finally, morpho-syntax provides an additional networked layer by establishing links between various linguistic features.

In our model, the Relation Type is the focal node of the spatial relationship, where entities are agents of different kinds depending on their function in the pattern. Places are generally either subjects or objects of the relation, in an RDF-like manner, while intermediate structure like Geoconcepts (e.g. “north” or “500 stades”) will participate in the relation as functional nodes.

The three information layers described above can be represented as a system of relations. While the Morpho-Syntactic and the Property layer can be modelled according to existing standards with a controllable amount of ambiguity,<sup>2</sup> the most complex is certainly the Semantic Layer. The semantic content, function, and expressive encoding of spatial relations is incredibly diverse, and it tends to vary also depending on period, context, and geographical area (Barker et al., 2016; Ilyushechkina et al., 2014; Nikitina, 2012; Palladino, 2016; Stell, 2019). Yet, being able to systematically investigate the ways in which a society expresses distance or orientation, and all the concepts and ideas attached to spatial features is extremely important for a full understanding of their spatial knowledge. For this reason, our data model locates itself half-way between two opposed approaches in DH modelling: top-down, which uses a pre-existing standard ontology, and bottom-up, which usually requires the empirical observation and formalization of the evidence, and where the standard takes shape gradually during the investigation.

## 4 Conclusions and limitations

The graph meta-model offers a way of formalizing data by means of a conceptual transformation: a text is translated into the graph model, where information is represented as a hyperconnected structure of nodes and edges of different kinds. In this sense, graphs can also be extremely useful to visualize data in a different way, and they can certainly provide a different kind of bird’s eye perspective than a map.

Any effort in modelling, however, implies loss of data. By definition, models will provide suitable ways of representing certain aspects of a phenomenon, but in so doing

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<sup>1</sup> On this topic, various resources are available, although relatively little has been done specifically in the domain of premodern orientation systems (Kutscher and Werning, 2013; Verhoeven et al., 2008; Zwarts, 2017).

<sup>2</sup> Morphosyntactic relations are here defined according to the principles of dependency grammar, which represents clauses in the form of graphs, or “syntax trees” (Haug and Jøhndal, 2008). The linking of entities to external resources such as gazetteers is a well-established practice in the Semantic Web, with defined annotation standards that are currently used in projects like Pelagios (Vitale et al., 2021).

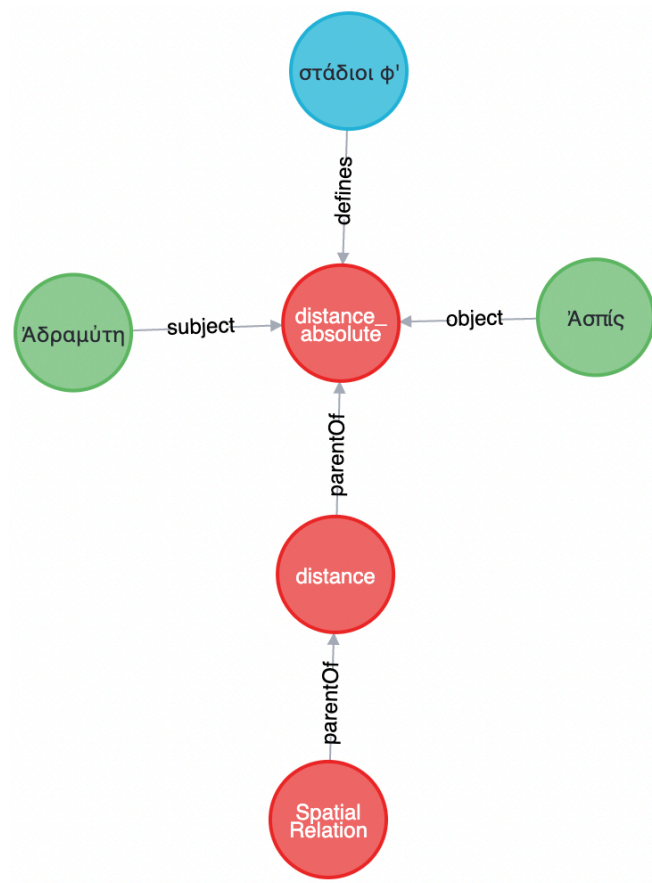


Figure 2: Representation of a sample sentence from an Ancient Greek travelogue modeled in the Semantic Layer according to the preliminary data model: “ ” (“from Adramyte to Aspis, 500 stades”). Nodes in red are labeled as “Relation Types”, nodes in green as “Places”, and nodes in blue as “Geoconcepts”.

they also impose a framework that is at risk of overlooking other information: this risk is valid for premodern sources, where certain implicit aspects in the practice of wayfinding are not expressed through words (Medas, 2004), and is even more crucial for indigenous spatial knowledge, where the imposition of external reference systems like graph modeling is not that far from the epistemological issues of GIS mapping (de Leeuw and Hunt, 2018). There are also practical limitations: when representing a narrative in the shape of a graph, for instance, it is extremely difficult to model the sequential nature of that narrative and its temporal dimension. Finally, while maps do not necessarily provide insights into wayfinding practice, they are often crucial in understanding dynamics of spatial conceptualization, even for societies that did not primarily conceive of them as navigational aids (Brodersen, 2001; Kelley and Francis, 2007; Rathmann, 2012): so, visualization and mapping are complementary, not opposed to semantic annotation of texts (Barker, 2021; Hac güzeller, 2012; Mayr and Windhager, 2018). Digital Humanities methods provide the necessary flexibility to allow a combination of models, rather than a single choice: while graphs help us conceptualize the hermeneutic complexity of travel narratives and storytelling, GIS provides a layer of context. More recent methodologies, like game development and 3D annotation, may provide new ways of visualizing complex spatial frameworks. In the future, it will be necessary to strive for an integration (or at least an interaction) of these methods to achieve a comprehensive understanding of what it could mean to conceptualize navigation through narrative.

## References

- Barker, E. (2021). On Space, Place, and Form in Herodotus. *Histos* 15, 88–130.
- Barker, E., L. Isaksen, and J. Ogden (2016). Telling Stories with Maps: Digital Experiments with Herodotean Geography. In E. Barker, L. Isaksen, S. Bouzarovski, and C. Pelling (Eds.), *New Worlds from Old Texts: Revisiting Ancient Space and Place*, pp. 181–224. Oxford: Oxford University Press.
- Bickerton, D. (2014). *More than Nature Needs. Language, Mind, and Evolution*. Harvard: Harvard University Press.
- Bodenhamer, D. J., J. Corrigan, and T. M. Harris (2010). *The Spatial Humanities: GIS and the Future of Humanities Scholarship*. Indiana University Press.
- Brodersen, K. (2001). The presentation of geographical knowledge for travel and transport in the Roman world: *itineraria non tantum adnotata sed etiam picta*. In C. Adams and R. Laurence (Eds.), *Travel and Geography in the Roman Empire*.
- Brodersen, K. (2003). *Terra cognita: Studien zur römischen Raumerfassung*, Volume 59 of *Spudasmata*. Hildesheim: Olms.
- Buzzetti, D. (2002). Digital Representation and the Text Model. *New Literary History* 33(1), 61–88.
- Ciula, A. and Ø. Eide (2017). Modelling in digital humanities: Signs in context. *Digital Scholarship in the Humanities* 32(suppl\_1), i33–i46.
- Constantakopoulou, C. (2007). *The Dance of the Islands: Insularity, Networks, the Athenian Empire, and the Aegean World*. Oxford Classical Monographs. Oxford, New York: Oxford University Press.

- de Leeuw, S. and S. Hunt (2018). Unsettling decolonizing geographies. *Geography Compass* 12(7), e12376.
- Dunn, S. E. (2019). *A History of Place in the Digital Age*. Routledge.
- Eichenbaum, H. (2000). Hippocampus: mapping or memory? *Current biology: CB* 10(21), R785–787.
- Eide, O. (2013). Why maps are silent when texts can speak. Detecting media differences through conceptual modelling. In *Proceedings from pole to pole. The 26th international cartographic conference 2013*. Dresden: International Cartographic Association (ICA).
- Flanders, J. and F. Jannidis (2018). *The Shape of Data in Digital Humanities: Modeling Texts and Text-based Resources*. Routledge.
- Gladwin, T. (2009). *East is a Big Bird: Navigation and Logic on Puluwat Atoll*. Harvard University Press.
- Hac güzeller, P. (2012). GIS, critique, representation and beyond. *Journal of Social Archaeology* 12(2), 245–263.
- Haug, D. T. and M. L. Jøhndal (2008). Creating a Parallel Treebank of the Old Indo-European Bible Translations. In *Proceedings of the Second workshop on Language Technology for Cultural Heritage data (LaTeCH 2008)*, Marrakech, pp. 27–34. European Language Resources Association (ELRA).
- Hutchins, E. (1995). *Cognition in the Wild*. Cambridge, MA, USA: A Bradford Book.
- Ilyushechkina, E., M. Thiering, and G. Görz (2014). Towards a cognitive-linguistic reconstruction of the spatial orientation in ancient texts - The example of Dionysios Periegetes. In M. Thiering and K. Geus (Eds.), *Features of Common Sense Geography: Implicit Knowledge Structures in Ancient Geographical Texts*, *Antike Kultur und Geschichte*, pp. 231–249. Berlin-Münster-Wien-Zürich-London: Lit Verlag.
- Ingold, T. (2000). *The Perception of the Environment: Essays on Livelihood, Dwelling and Skill*. Psychology Press.
- Janni, P. (1981). Orientamento. *Quaderni linguistici e filologici* 1, 53–70.
- Janni, P. (1984). *La mappa e il periplo : cartografia antica e spazio odologico*. Roma: G. Bretschneider.
- Kelley, K. and H. Francis (2007). Traditional Navajo Maps and Wayfinding. *American Indian Culture and Research Journal* 29(2), 85–111.
- Kutscher, S. and D. A. Werning (2013). *On Ancient Grammars of Space, Linguistic Research on the Expression of Spatial Relations and Motion in Ancient Languages*. Berlin, Boston: De Gruyter.
- Levinson, S. C. and D. P. Wilkins (Eds.) (2006). *Grammars of Space: Explorations in Cognitive Diversity*. *Language Culture and Cognition*. Cambridge: Cambridge University Press.
- Lewis, D. (1994). *We, the Navigators: The Ancient Art of Landfinding in the Pacific*. University of Hawaii Press.

- Malkin, I. (2003). Networks and the Emergence of Greek Identity. *Mediterranean Historical Review* 18(2), 56–74.
- Mayr, E. and F. Windhager (2018). Once upon a Spacetime: Visual Storytelling in Cognitive and Geotemporal Information Spaces. *ISPRS International Journal of Geo-Information* 7(3), 96.
- McCarty, W. (2014). *Humanities Computing*. London: Palgrave Macmillan.
- Medas, S. (2004). *De rebus nauticis: l'arte della navigazione nel mondo antico*. L'ERMA di BRETSCHNEIDER.
- Murrieta-Flores, P., C. Donaldson, and I. Gregory (2016). GIS and Literary History: Advancing Digital Humanities research through the Spatial Analysis of historical travel writing and topographical literature. *Digital Humanities Quarterly* 011(1).
- Murrieta-Flores, P., M. Favila-Vázquez, and A. Flores-Morán (2019). Spatial Humanities 3.0: Qualitative Spatial Representation and Semantic Triples as New Means of Exploration of Complex Indigenous Spatial Representations in Sixteenth Century Early Colonial Mexican Maps. *International Journal of Humanities and Arts Computing* 13(1-2), 53–68.
- Neill, I. and A. Kuczera (2019). The Codex – an Atlas of Relations. In A. Kuczera, T. Wübbena, and T. Kollatz (Eds.), *Die Modellierung des Zweifels – Schlüsselideen und -konzepte zur graphbasierten Modellierung von Unsicherheiten*, *Zeitschrift für digitale Geisteswissenschaften*. Wolfenbüttel.
- Nikitina, T. (2012). The Many Ways to Find the “Right” and the “Left”: On dynamic projection models in the encoding of spatial relations. *Annual Meeting of the Berkeley Linguistics Society* 38(0), 338–353.
- Palladino, C. (2016). New Approaches to Ancient Spatial Models: Digital Humanities and Classical Geography. *Bulletin of the Institute of Classical Studies* 59(2), 56–70.
- Palladino, C. (2021). Representing Places in Texts: A Spatial Investigation into Agathemerus’ Sketch of Geography. *International Journal of Humanities and Arts Computing* 15(1-2), 33–59.
- Pearce, M. W. and R. P. Louis (2008). Mapping Indigenous Depth of Place. *American Indian Culture & Research Journal* 32(3), 107–126.
- Peretti, A. (1979). *Il Periplo di Scilace: studio sul primo portolano del Mediterraneo*. Pisa: Giardini.
- Pickles, J. (2012). *A History of Spaces: Cartographic Reason, Mapping and the Geo-Coded World*. Routledge.
- Rathmann, M. (2012). The Tabula Peutingeriana in the mirror of ancient cartography Aspects of a reappraisal. In K. Geus and M. Rathmann (Eds.), *Vermessung der Oikumene*, pp. 203–222. Berlin, Boston: De Gruyter.
- Scalise Sugiyama, M. (2001). Food, foragers, and folklore: the role of narrative in human subsistence. *Evolution and Human Behavior* 22(4), 221–240.



- Stell, J. G. (2019). Qualitative Spatial Representation for the Humanities. *International Journal of Humanities and Arts Computing* 13(1-2), 2–27.
- Thiering, M. (2015). *Spatial Semiotics and Spatial Mental Models, Figure-Ground Asymmetries in Language*. Berlin-Boston: De Gruyter.
- Thiering, M. and K. Geus (Eds.) (2014). *Features of Common Sense Geography: Implicit Knowledge Structures in Ancient Geographical Texts*. Antike Kultur und Geschichte. Berlin-Münster-Wien-Zürich-London: Lit Verlag.
- Verhoeven, E., S. Skopeteas, Y.-M. Shin, Y. Nishina, and J. Helmbrecht (2008). Grammaticalization and sets of form-function pairs: Encoding spatial concepts in Greek. In *Trends in Linguistics. Studies and Monographs [TiLSM]*. Berlin, New York: Mouton de Gruyter.
- Vitale, V., P. d. Soto, R. Simon, E. Barker, L. Isaksen, and R. Kahn (2021). Pelagios – Connecting Histories of Place. Part I: Methods and Tools. *International Journal of Humanities and Arts Computing* 15(1-2), 5–32.
- Widlok, T. (2008). Landscape unbounded: space, place, and orientation in Akhœ Hai//om and beyond. *Language Sciences* 30(2-3), 362–380.
- Winston, P. H. (2011). The Strong Story Hypothesis and the Directed Perception Hypothesis. *Proceedings of the AAAI Fall Symposium on Advances in Cognitive Systems*.
- Zwarts, J. (2017). Spatial semantics: Modeling the meaning of prepositions. *Language and Linguistics Compass* 11(5), e12241.