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›Sortes Dictae Sunt‹. Methods for Editing Mediaeval Books of Fortune

Abstracts

Superstition has long played a vital role in both traditional and modern societies. In the Middle Ages, people used *sortes* (books of fortune) to seek answers about the future, both in serious and in playful contexts. Sortes texts, like the *Prenostica Socratis Basilei*, provide insights into the mediaeval system of values, as well as in the worries and hopes of the people. However, the majority of these texts have not been edited yet, with none available as a digital scholarly edition. Our novel methodology, which combines graph-based modelling and computational editorial methods, allows for a dynamic, precise representation, enabling deeper analysis and making these historical documents more accessible and meaningful to modern audiences.

Aberglaube spielte schon immer eine Rolle in traditionellen und modernen Gesellschaften. Im Mittelalter nutzten Menschen Losbücher, um Antworten auf zukünftige Ereignisse zu finden, sowohl in ernsten als auch in spielerischen Kontexten. Losbücher wie das *Prenostica Socratis Basilei* geben Einblicke in das mittelalterliche Wertesystem und in die Sorgen und Hoffnungen der Menschen. Dennoch ist der Großteil dieser Texte noch nicht ediert, und keiner liegt als digitale Edition vor. Unsere neue Methodik, die graphbasiertes Modellieren und computergestützte Editionsmethoden kombiniert, ermöglicht eine dynamische und präzise Darstellung, tiefere Analysen und macht diese historischen Dokumente für moderne Leser*innen zugänglicher und bedeutungsvoller.

1. Introduction

Sortes texts, also referred to as *lot books* or *books of fortune*, trace their origins back to late Antiquity.[1] These texts represent a divination practice that achieved widespread popularity during the Middle Ages and continued to be used thereafter. Rather than being designed for linear reading, these texts required randomising tools to initiate a series of hints that would guide readers from a specific question, typically about the future, to its answer. The highly interactive nature of these texts led to their reinterpretation as social games, suitable for enjoyment even at court. This shift in focus also acted as a means to obscure their divinatory purpose, thus evading Church scrutiny.[2] [1]

During the German Middle Ages, sortes texts experienced significant growth, with fifty-five German examples still extant today, as noted by Marco Heiles.[3] Regrettably, these sources have not consistently attracted sufficient scholarly attention. Although a number have been edited, most editions primarily emphasise the textual aspect, often neglecting the intricate illuminations, diagrams, and interactive tools that accompany these works. Surprisingly, no sortes text has yet been published as a *digital scholarly edition* (DSE), even though this genre appears well-suited to be presented in more dynamic forms than in traditional printed editions. There are several compelling reasons to consider editing these texts using more innovative methods, making such an endeavour highly worthwhile. [2]

From an anthropological perspective, sortes texts illuminate the daily lives, doubts, and values of mediaeval people. They reflect the era's value system also through the cultural adaptations introduced by the scribes who translated these texts from Latin to vernacular languages. Analysing these texts qualitatively and quantitatively can offer deeper insights into the mediaeval cultural system. Linguistically, these texts provide a rare glimpse into a less standard use of language, given their classification within common literature and the need to fit content into constrained spaces, due to the very peculiar layouts of the documents, characterised by a frequent occurrence of tables and diagrams. The organisation of the text on the folios, [3]

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1 Cf. Heiles et al. (eds.) 2021; Luijendijk / Klingshirn (eds.) 2018.
2 Cf. Heiles 2018.
3 Cf. Heiles 2018.

therefore, often required not only a high use of abbreviations, which is a common phenomenon in pre-modern texts, but also resulted in a great number of sentences quite abruptly interrupted, which now make valuable data for research in *diachronic syntax*. Several studies in synchronic syntactic theory address the themes of disfluency and interruption in spontaneous talk: as a matter of fact, »speech does not wholly consist of complete, well-built sentences [...] but rather of incomplete sentences«.[4] For the study of these phenomena in older linguistic stages, though, the data at our disposal is of course much rarer, making sources such as sortes texts even more worth studying. This genre also needs to be contextualised in the study of historical prognostication and magical practices, a field of research with a rich history.[5] The late-mediaeval reinterpretation of the sortes as games, finally, highlights their importance within historical gaming practices.[6]

2. ›Prenostica Socratis Basilei‹

Turning to a specific example within the broader context of sortes texts, the *Prenostica Socratis Basilei* (PSB) is of Arabic origins, but the first attestations which have come down to us are in Latin and date back to the 13th century. Scholars have identified two versions of the PSB, a ›Christian‹ and an ›Arabic‹ one.[7] The mediaeval German branch of the PSB, descending from the Christian text, includes five versions surviving through ten witnesses from the 15th and 16th centuries. While Alberto Alonso Guardo produced a critical edition of the Latin texts,[8] following an introductory study,[9] there remains a noticeable gap in scholarly attention towards the German versions of the work. Heiles made some important contributions by discussing the German transmission in his book and catalogue,[10] yet no dedicated studies have been published so far, nor has the text been (critically) edited, with the exception of a normalised transcription of one of the witnesses transmitting the text.[11]

[4]

The project for a computational edition of the German versions of the PSB, currently under review for funding, aims to create an edition comprising the five extant mediaeval German versions of the PSB. It includes two main edition modes: one focused on the document and text dimensions and another centred on the game experience. This involves a comprehensive modelling effort that will rely on a graph database to address the non-linear, highly interactive nature of the texts.

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2.1. Material

Regarding the material and its affordances, an important aspect to underline is the dizzying variance of the transmission. Of the five German versions that have come down to us, two are fragmentary,[12] partially preserving the final section of the text, while the rest of the structure is missing. The three complete versions of the German PSB are the so-called *Losbuch gereimt II*, Bollstatter's *Seltzsams Loßpuch*, and Peter Jordan's edition first printed in 1532, *Geomantia. Eyn kunst des warsagens...*[13] Interestingly, these three versions all show

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[4] Cf. Martinera 1980.
[5] Cf., among others, Heiduk et al. (eds.) 2020, as well as earlier works by Grässe 1843, Burr 1890, and Thorndike 1923.
[6] Research by scholars such as Flanagan 2009, Walz / Deterding (eds.) 2014, Patterson (ed.) 2015, Kopp / Lapina (eds.) 2020, and Conrad 2022 underscores the significance of understanding historical games in their cultural context.
[7] Cf. Alonso Guardo 2015.
[8] Cf. Alonso Guardo 2015.
[9] Cf. Alonso Guardo 2006.
[10] Cf. Heiles 2018.
[11] Cf. Schneider 1976.
[12] These are referred to as »Prenostica Socratis Basilei, dt« and »Bollstatter's ›Losbuch‹ gereimt II Bearbeitung« in Heiles (2018)'s catalogue.
[13] Cf. Heiles 2018.

different game structures and employ different randomising mechanisms. Starting from the Latin antecedent, a brief overview of its structure and components will serve as a basis to analyse the directions the work has followed in the different German copies.

In the Latin version of the PSB, the reader / user needs to obtain a number from 1 to 9 by drawing a random number of dots in the sand or by moving a wheel (volvelle). After that, from a list of sixteen questions concerning the future, the user has to choose one. The latter actually needs to be located twice, in two different lists: in each list, the same question is associated with a different letter of the alphabet, resulting in a combination of two letters for each question. Subsequently, combining the number obtained at the beginning with the letter combination identifying the question, the user can find the name of a ›thing‹ in a table: the ›thing‹ could be an animal, a city, a spice, a tree, etc., covering a long list of possible topics. Once the right object is found, the user has to find the right thematic sphere associated with it. Each of the twelve thematic spheres, divided into twelve sections, contains information concerning the names of the kings who will answer the questions. Sixteen kings mark the final part of the PSB, each giving nine answers. Using the number obtained at the beginning, the user can find the right line pronounced by the king indicated by the sphere and obtain the prediction.

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Considering this as the starting point, it will now suffice to examine how the German versions have adapted the structure of the work, as a more in-depth comparison of the variation of the actual contents of each section would definitely go beyond the limits of this paper.

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In the *Losbuch gereimt II*, we find a volvelle as a randomising mechanism, but the numbers from one to nine are replaced by the names of the twelve apostles. The questions, in this version numbering twenty-four, remain associated with a letter combination, but the latter is given directly with each question, without making the user ›build it up‹ by locating the same question in two different lists. The table of things is kept, as well as the thematic spheres, which are very similar to the Latin version in their contents but which also include new topics, reaching the number of twenty-four circles. An important change concerns the oracle-like authorities: the kings in the Latin version are substituted by prophets in the *Losbuch gereimt II*, indicating a stronger integration of the PSB into a Christian paradigm.

[9]

In the case of Bollstatter's version, also known as *Seltzsams Loßpuch*, the structure varies greatly. In this version, there are sixteen questions, which are not associated with letter combinations. After choosing a question, the user needs to throw two dice; however, only a resulting sum in the range from 2 to 10 is accepted, while other results (11 and 12) need to be discarded. After throwing the dice, the user has to leaf through twelve pages with thematic spheres. Each page is dedicated to a theme and three possible dice results (e. g., »the mountains, numbers eight, two and five«). Each sphere is divided into twelve sections, each presenting a combination of a number and the first words of a question. The user needs to find the sphere where his / her question is associated with the right dice result. Once this step is achieved, the information found in the section of the sphere will guide the user to a king. In this version, despite all the innovations, the oracle-like figures are still kings, like in the Latin antecedent. However, these kings do not always have the answers to the questions, but sometimes refer the user to another authority: after the pages with the kings, the user namely encounters sixteen following pages, each presenting a group of four authorities (such as the four winds, the four elements, the Evangelists, etc.), who answer the questions for which the kings had no responses.

[10]

Turning now to the 16th-century print *Geomantia*, it is striking how this text presents strong innovations in some respects while remaining highly conservative in others. Starting from the questions, they are organised exactly like in the Latin version, preserving both the same contents and the exact letter associations. However, the randomising mechanism is remarkably different: starting from the name of the person asking the question, it is necessary to associate each letter to a number as prescribed by a table in the book. The

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sum of all the numbers associated with the letters of the name needs to be added to the number related to the planet governing the (unequal) solar hour of day or night when the person is consulting the book. If no sundial is available, or if it is cloudy or dark, the book contains an astronomical instrument to calculate the solar hour based on when the sun rose that day (for which there is also a table in the book giving the exact times of sunrise for the city of Tübingen). Once the planet has been identified and its associated number added to the number resulting from the letters of the name, the user needs to subtract the number nine from that sum until the result is a number from one to nine. At this point, the reader needs to proceed in the book to find a table containing all numbers from one to nine for each question. For each number, the name of an object is given, as well as the Arabic number of the related chapter (which substitutes the spherical format of the thematic sections) and a Roman number for the right line in that chapter. The process of finding the right thematic chapter in this version is therefore facilitated by the indication of the chapter number itself, but the chapters still preserve the themes found in the Latin version. The right line of the chapter guides the reader to the king who, exactly like in the Latin model, will finally answer the question.

2.2. Conceptual model of structural variance

Clearly, a traditional critical apparatus is insufficient to model this kind of fundamental structural variance, either in print or digital form. Established methods indeed fail to fulfil the complex requirements of an edition which needs to represent and analyse multiple interconnected levels spanning from orthographic and linguistic matters, going through substantial variants to finally address deeply structural questions. Keeping now our focus on the structural matters, which represent the most significant challenge in the context of editing the sortes, it is clear that an innovative approach is needed to grasp the level of variation we face. Before proposing and discussing a possible technological solution, we will illustrate the approach from a conceptual perspective. The following figure is intended as a visual aid to facilitate the understanding of the complexity at stake. The circles on top of the scheme represent a conceptual level which includes the structural nodes found in the German versions and serve the goal of allowing for convergence and communication between versions and witnesses. On an abstract level, the general structure of the PSB can be sketched as follows: after a list of questions the user of the PSB needs to use a randomising tool, whose result is combined with the chosen question to identify a thematic section, in which the user learns which authority will give him / her the response. The rectangular boxes in the scheme represent the corresponding sections in each of the German versions, illustrated by a label and an icon. As an example of the contents of the sections, a path is followed in the German versions, starting from the same question (whether an ill person will recover or die) and going through all the necessary steps leading to the response.
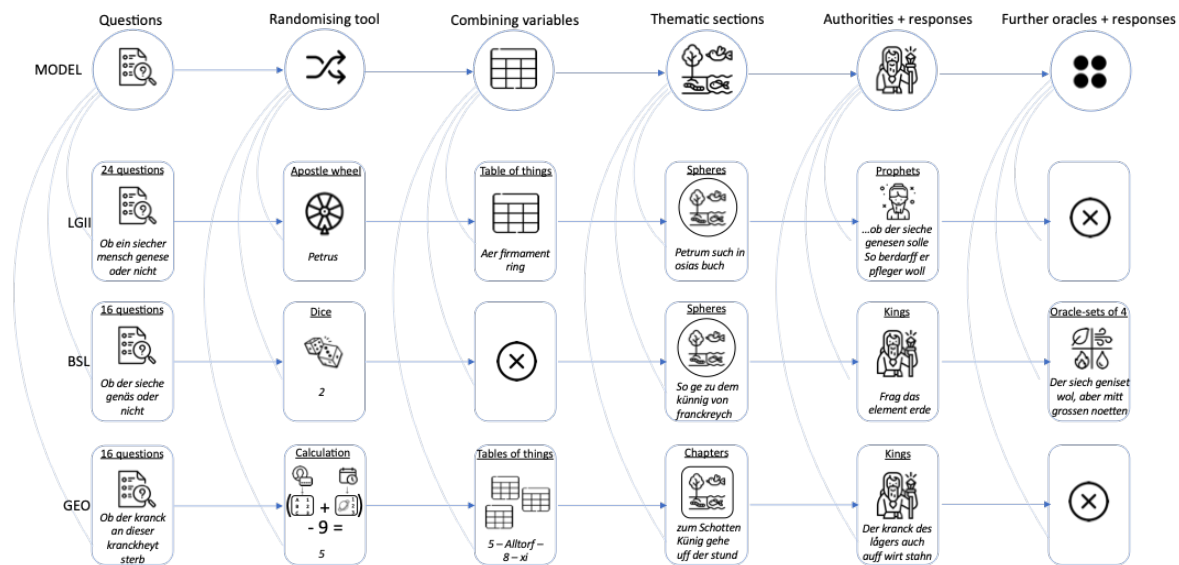
[12]

Fig. 1: Structural comparison of the versions *Losbuch gereimt II* (LGII), Bolstatter's *Seltzsams Loßpuch* (BSL) and *Geomantia* (GEO). On top, a conceptual level which represents the components of the PSB. [Model by: Elisa Cugliana, 2024]

In this particular case, the same question, already present in the Latin antecedent, is found in all three complete German versions, although with some linguistic and orthographic variants.[14] This allows us to create a node, at a conceptual level, referring to that question. That conceptual node is then connected to the three actual realisations in the versions, each documented in different historical documents (manuscripts and prints). From there, the next step involves using a randomising mechanism, which varies greatly among the versions.

[13]

Having obtained the variable from the randomising method (which in two of the three versions, *Geomantia* and Bollstatter's text, is still a number from one to nine or from two to ten respectively), the next conceptual node is the presence of thematic spheres (in the two manuscript versions, Bollstatter's and *the Losbuch gereimt II*) or chapters (in the early print *Geomantia*). This conceptual node is characterised by a certain congruence of structure and themes, although the actual objects cited in the sections may vary significantly, especially in the case of Bollstatter's version. While the scheme in Figure 1 remains quite surface-level concerning the presence or absence of thematic spheres, in the edition project connections are created between the single contents of the spheres in the different versions, going through conceptual sublevels for specific thematic sections and the objects they contain. The conceptual level serves as a mediation, making similarities and dissimilarities visible, traceable, and analysable. This is also true for the oracle-like figures, who, for instance, in the case of the *Losbuch gereimt II*, are prophets instead of kings, and for the answers they provide. In this sense, the conceptual level can be seen as a way to allow for a structural collation, which might precede the establishment of a critical text in a Neo-Lachmannian sense.[15] This approach allows for reconstructive hypotheses where reasonable, while referring exclusively to the historical evidence when no hypothesis can be formulated, letting the paths go separate ways. Clearly, such a model can easily host the addition of further levels of texts and conceptualisations, including critical editions of the single versions of the text and, if deemed relevant, a critical text based on all extant witnesses as well.

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14 The levels of modelling dedicated to documentary and linguistic aspects are not represented in this scheme to maintain clarity, but they are taken care of in detail in the framework of Applied Text as Graph (ATAG; cf. Kuczera 2024) in the edition project, as will be argued below.
15 Cf., among others, Trovato 2014.

3. Digital approach

3.1. Modelling requirements

Coming now to the concrete requirements of the digital scholarly edition, the creation of a detailed data model serves a number of purposes, which can be summarised as follows:

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- Enabling qualitative and quantitative analyses of the contents and structures of the witnesses and versions of the PSB, as well as their inter- and intratextual connections. The modelling of the data will allow for the examination of patterns in the associations of question topics, entities such as realia and other objects, authorities answering the questions, etc. Moreover, it will make it possible to explore shifts and changes in the selection of contents from the Latin model to the five German versions.
- Creating a computational workflow, where editorial decisions referring to different phases of the editing process are formalised and expressed through programming languages. The metadata stored in the graph database will facilitate the creation of rules for the operationalisation of the editor's work on the texts, in line with the principles of computational philology.[16]
- Storing the information necessary to publish the edition as a website. The website will include both a more text-centred visualisation mode, with documents, transcriptions and critical texts, and a path-centred game-edition, where the user will be able to navigate the different paths from questions to answers in the five versions of the German PSB.

3.2. Limitations of existing methods

Although *TEI XML* is nowadays a de facto standard in digital scholarly editions, it proved unsuitable for storing the information necessary to reach the goals expressed in the previous paragraph. In fact, scholars have already criticised the use of TEI XML for different reasons: Dino Buzzetti argues that hierarchical models (such as the *OHCO* model at the basis of the use of XML syntax for modelling text, according to which the latter is representable as a an Ordered Hierarchy of Content Objects) fail to fully capture the essentially non-hierarchical aspects of text. The scholar also reflects on questions of linearity, stating that

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»[t]he linearization of the expression cannot […] bring about the linearization of the content and its structure. So strongly embedded markup is not able to represent non-linear structures of the data content. But it does not even allow for the acquisition of functionally adequate text representations. In fact, the linear representation of a non-linear structure of data, the format of the data expression obtained by strongly embedded markup systems, is not usually associated with the definition of operators which may be applied to the elements of the representation«.[17]

[17]

In this context, it is important to note that sortes texts lack linear structure in both their content *and* their expression, as reading paths need to be assembled selectively reading parts of the work connected with each other by different kinds of hints. Other scholars have pointed out the shortcomings of existing models in adequately addressing issues of document complexity and textual dimensions, as well as origin and subjectivity of annotations.[18]

[18]

Editing the sortes, and especially the German PSB, other challenges emerge: these texts namely derive their coherence from explicit connections, such as textual references (»ask the king of…«), numeric indications (e. g., dice results in München, BSB Cgm 312), and illustrative cues (e. g., an angel pointing to an apostle in the version *Losbuch gereimt II*, as in Figure 2): after reading a portion of text, the user needs to determine where

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[16] Cf. Barabucci / Fischer 2017, van Zundert 2018 and Cugliana / van Zundert 2022.
[17] Buzzetti 2002, p. 73.
[18] Cf. van Zundert / Andrews 2017, and Neill / Kuczera 2019.

to find the next relevant segment, rather than continuing linearly. Unlike more canonical textual forms, where spatial arrangement guides the reading order, sortes texts require explicit connection-based navigation. It follows that annotating meta-information about these connections is crucial. Now if we relied on TEI XML, such connections would probably be captured by attributes such as, among others, *@next*, *@select* and *@target*. The problem, however, is that apart from setting the values of these attributes, the editor cannot add specific annotations to the single connections, something which is instead possible in *labelled property graph*s (LPG), about which we will speak more in detail below.

Fig. 2: Moveable volvelle with an angel pointing to the apostles' names in a witness of the *Losbuch gereimt II*. [Heidelberg, Universitätsbibliothek, Cpg 552, front pastedown]

Another key reason for preferring a graph data model over TEI XML for data input lies in the inherent structure and layout of the sources. XML enforces a hierarchical organisation, which does not align well with the nature of sortes texts. These texts defy traditional hierarchical and linear formats; although the texts are arranged on the folios of codexes, suggesting a particular sequentiality of the material, the reading order is dictated by the paths that connect questions to answers throughout the book, linking together segments of texts spread throughout the portion of the codex dedicated to the PSB. This path structure introduces a new form of linearity, which is determined by the randomising strategies employed at the beginning of the divination process.

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Finally, the layout of these texts on the folios often leads to overlapping elements that challenge a strictly hierarchical data model. For instance, a single item like the number »zway« in Figure 3 can be part both of the page header and of the title of the central section of the sphere, demonstrating how one element can belong to multiple conceptual units. This overlapping further complicates the use of XML for accurately representing the structure of the text in the document.

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Fig. 3: The word »zway« belongs both to the page header »achte zway vnd fünffe« and to the section header together with the beginning of a question (»ob der geselle gut...«), the repetition of the number »zway« and the name of a mountain (»Synoy«). [München, BSB Cgm 312, f. 121 r.]

3.3. Graph-based modelling

As Figure 1 illustrates, the fundamental structure of the PSB is a graph. This is even more so, when, in the editorial effort, we establish connections among corresponding sections and their components in different versions and witnesses. To accurately represent both the internal structure of each witness and version, and to be able to operate on a conceptual level establishing connections in the German branch of the PSB's *stemma codicum*, we employ a graph-based modelling approach using a graph database that supports LPGs (labelled property graphs), such as *Neo4j*. This methodology effectively captures intricate connections and multidimensional aspects of textual and non-textual content.[19] LPGs consist of nodes, relationships, and properties, providing a flexible representation of elements and their interconnections. They enable users to annotate and query various paths, modelling pages and their spatial organisation alongside the different reading paths that link questions to answers throughout the dataset. This approach addresses the challenges introduced above, both on a theoretical level (cf. Buzzetti's critique) and in editorial practice. As a matter of fact, this approach to modelling does justice both to detailed representations of single parts of the PSB, such as a specific page in a given witness like in the following figure, and to a more comprehensive contextualisation in the textual transmission.

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[19] Cf. Kuczera 2022.

Fig. 4: »Die perge«: the sphere of the mountains. [München, BSB Cgm 312 f. 121r.]

Figure 4 presents one of the thematic spheres from a German witness of the PSB, in the version *Seltzsams Loßpuch* by Bollstatter. The diagram is designed with multiple segments, each containing various texts which give indications on how to navigate the book based on the combination of variables such as questions and dice results. The spatial organisation on the page is complex, and the pathways between the segments extend beyond the immediate page, linking to other text elements. These interconnected reading paths require navigating across different sections throughout the book, making text elements inherently multi-linked. Figure 5 demonstrates how these connections can be translated into a graph-based model using *Neo4j*. In this model, nodes represent individual text elements, while edges illustrate the relationships between them. This graph-based model not only incorporates the reading path but also captures the spatial organisation of the texts on the page within a single, human-readable dataset.[20] The spatial organisation is managed by defining relationships between nodes that represent both the conceptual and physical proximity of textual elements. These relationships effectively group and position nodes next to each other within the model, reflecting their spatial arrangement on the original manuscript page. Moreover, using coordinates it is possible to include metadata regarding the absolute position of each element on the digital facsimile. This approach allows for a clearer, more interactive exploration of the textual and non-textual dimensions, enabling queries of different paths and visualisation of relationships between various elements. Additionally, it accommodates the complex, multi-linked nature of nodes, facilitating a seamless representation of reading paths and spatial structures.

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[20] Cf. Kuczera 2022.

However, it is important to underline that the graph-based model is not intended as the final user interface. The spatial distribution of the nodes within the graph, apart from the inclusion of coordinates in the metadata, is not formalised, meaning that the nodes can be repositioned as needed, since the model describes the sequence of relationships between elements, rather than their exact physical placement on the page. As a matter of fact, graphs, being abstract mathematical concepts, do not have an inherent spatial dimension, but can use visual aids to favour analysis and scholarly communication.
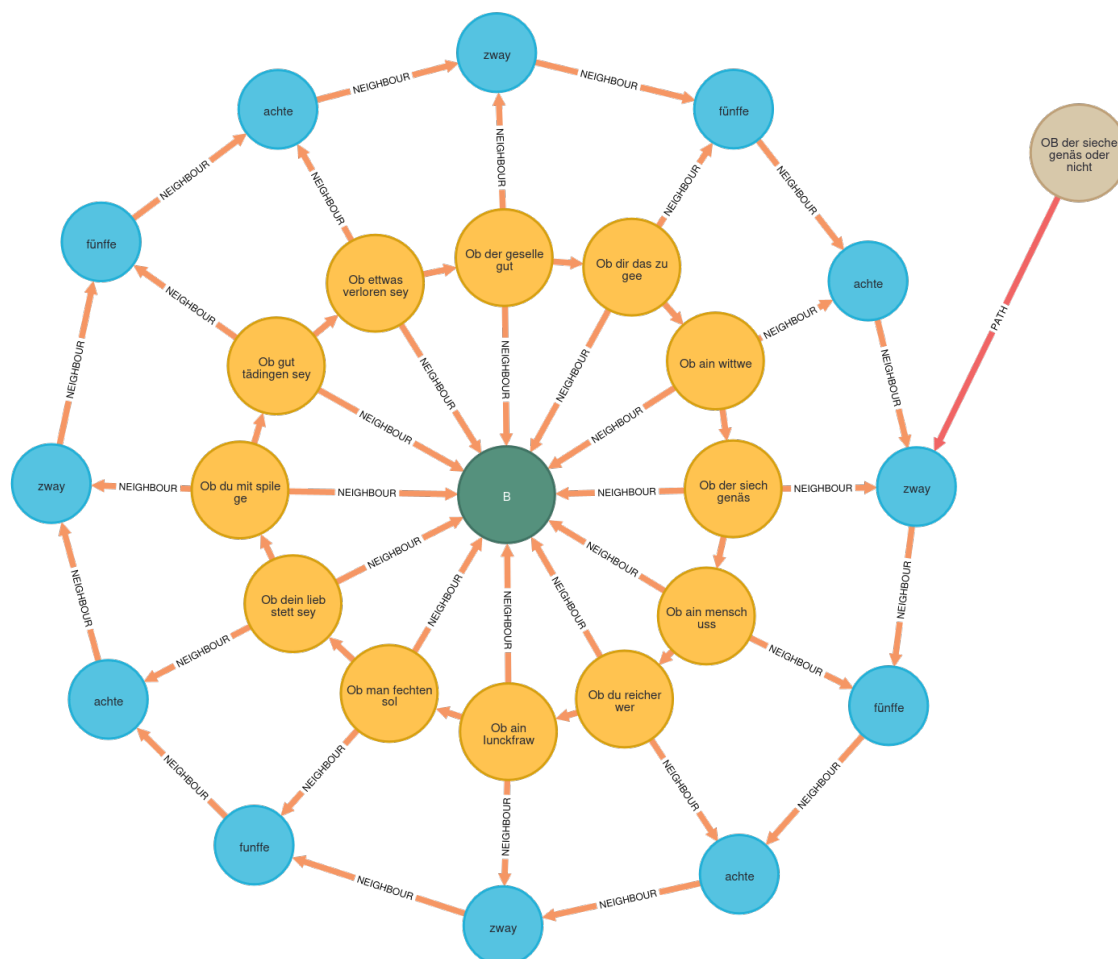
[24]

Fig. 5: Simplified subgraph model of the sphere of the mountains shown in Fig. 4. Although *Neo4j* graphs only display directed edges, the conceptual relations between the nodes are *bidirectional*. [Graphic by: Elisa Cugliana, Sebastian Enns, Andreas Kuczera, 2024]

Figure 5 illustrates how the graph-based model in *Neo4j* handles the complex interconnections within the PSB witness in Figure 4. This model, which is enhanced by the precision of the framework *Applied Text as Graph* (ATAG),[21] supports character-precise and potentially overlapping annotations. The use of a graph-based approach for text encoding simplifies the visualisation, querying, and editing of text and annotations. It allows for the management of multiple non-hierarchical annotation layers without compromising the structural integrity of the text. Moreover it detaches TEI semantics from the hierarchical constraints of XML, enabling flexible and multidimensional annotation layers within the same system,[22] as shown in projects like *Liber Epistolarum*[23] and *The Socinian Correspondence*[24]. This detachment is achieved by transitioning from XML to a graph-based approach, where TEI structures can be integrated using standoff properties (SPO), as developed

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[21] Cf. Kuczera 2024.
[22] Cf. Kuczera 2022.
[23] Graph-based digital edition funded by DFG (Daugirdas et al. (eds.) 2024).
[24] Graph-based digital edition funded by DFG (Dreyer et al. (eds.) 2024).

by Desmond Schmidt[25] and demonstrated by Iian Neill and Andreas Kuczera.[26] In the ATAG framework, annotation nodes serve a similar purpose, allowing for precise, overlapping annotations that are not bound by a strict textual hierarchy. In this context, it is important to mention that TEI XML is not identical with the TEI Guidelines: while the former defines a data format, the latter include valuable work on the conceptual modelling of texts and data which will be taken into great consideration in this edition project and used as far as possible to ensure easier export formats and to allow for a more effective communication of the results of the project.

The textual elements within the witnesses are systematically organised into designated sections according to a schema. Each section connects to a witness, forming part of a larger version tied to overarching concepts. Non-textual elements, such as illustrations and diagrams, are implemented through a dedicated non-textual node, which references the respective non-textual element, which is in turn connected to a witness. In this context, annotations can be used to supplement the structure or add interpretations, which of course is true for both textual and non-textual elements. This dynamic and intertwined structure promotes categorisation and linking of texts within the *Prenostica Socratis Basilei* (PSB) framework, thereby enhancing the understanding of the internal structure and the complex textual relationships. This approach allows for multiple perspectives and interpretations, enabling a flexible and evolving organisation of both textual and non-textual elements, which can be reconfigured as needed to reflect different conceptual viewpoints.

[26]

3.3.1. Abstracting and connecting structural layers

In Sebastian Enns' ongoing doctoral research titled *Management of Heterogeneous Data in Digital Editions: A Model-Driven Approach*, the primary goal is to enhance the efficiency and applicability of digital editions through a model-driven infrastructure. This research focuses on abstracting the structural connections of digital editions into a comprehensive meta-model. This meta-model utilises a limited set of syntax-neutral units, such as collections and texts, that are independent of specific underlying technologies. By adding a project-specific layer, it enables the inclusion of detailed PSB concepts, including sections, textual witnesses, versions, and overarching concepts, all while maintaining a neutral foundational structure as depicted in Figure 6. This ensures that the model can be easily adapted to various stages of creating a digital edition. The project-specific layer not only enhances data modelling flexibility but also provides detailed documentation of the internal structure. Adopting this methodological approach deepens insights into the textual and internal structures of the PSB, promoting a nuanced understanding of its complex content, starting from minimal units such as glyphs to cover matters of structure and (inter-)textuality. Moreover, this approach does not focus solely on textual data but also supports the integration of intertextual and contextual connections within the digital edition, as well as being able to include the illustrative and diagrammatic dimensions, facilitating a comprehensive analytical and interpretative framework. In particular, with this methodology we are able to model reading / gaming paths across multiple witnesses (and / or versions), for instance in those cases where fundamental parts of a witness, such as the randomising tool, are missing, as will be explained more in detail below. This case is covered by the model in Figure 6, with a gaming path crossing multiple witnesses.

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[25] **Cf.** Schmidt 2016.
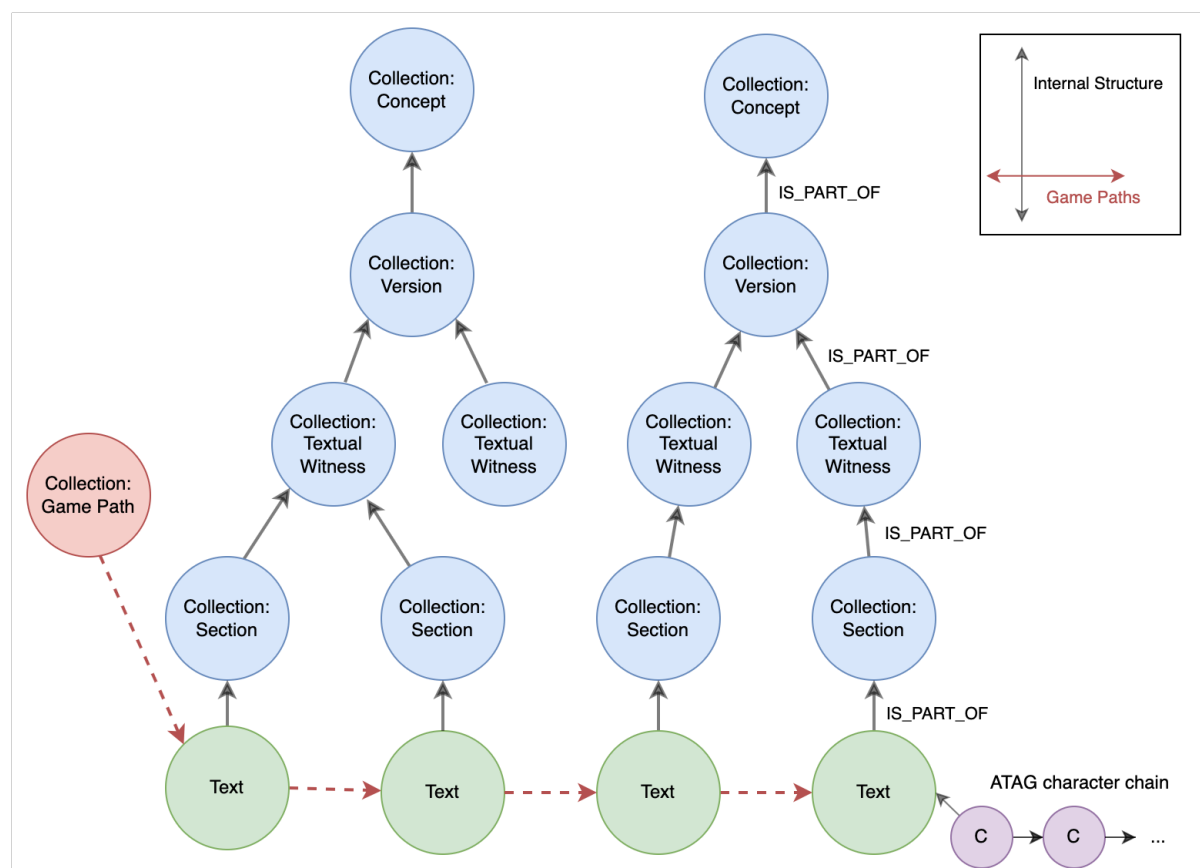[26] **Cf.** Neill / Kuczera 2019.

Fig. 6: Example of a generic graph-based model of witness-internal structure and game paths in the PSB digital edition, illustrating the relationships from concepts to text sections and the integration of game paths. [Model by: Sebastian Enns, 2024]

Figure 6 demonstrates the application of graph-based modelling concepts from the described current doctoral research within the digital edition project of the German versions of PSB. This model captures the intricate, non-linear structure typical of sortes texts, renowned for their interactive, game-like engagement facilitated by random selection mechanisms and diverse potential reading paths.

[28]

At the top of the model, the »Collection: Concept« nodes outline the overarching components of the PSB (corresponding to the uppermost level in Figure 1 above), serving as a framework for comparing the PSB versions considered in the edition, which are categorised as »Collection: Version« nodes. This dynamic and intertwined structuring not only simplifies the complex information structure but also enhances navigability across different textual layers. Linking each version to specific textual witnesses, the model captures the diversity of PSB transmission as represented in various manuscripts or prints. The witnesses are in turn segmented into sections, which are crucial for precisely identifying and cataloguing distinct portions of text. This segmentation facilitates detailed study and analysis, ensuring that each text part is accessible and clearly defined. The model also incorporates game path collections at its base, highlighting the non-linear reading patterns through which a user interacts with the text, moving from questions to answers. These paths are visualised in the scheme utilising red dashed lines, representing the dynamic, interactive connections that could be used during gameplay. Multiple game path collections can be created, each leading to a different starting point and designed to be dynamic. These paths can either be single-pathed, guiding the user in a direct, linear progression, or multi-pathed, where one node branches into several possible outcomes. Typically, in the original context, the next path would be chosen randomly, such as by rolling dice. However, in this model, all possible outcomes are meticulously mapped out, providing a comprehensive view of the

[29]

potential routes through the text. This approach allows for the incorporation of a randomiser in a web-based implementation to determine the next step when a node is multi-branched, capturing the full complexity and variability of the original texts while maintaining the dynamic, interactive nature of the game paths.

The game paths might stretch over different witnesses, for example when some witnesses have lost crucial parts of the game, which however can be critically reconstructed. This is the case of, for instance, the version *Losbuch gereimt II*: the witness Nürnberg, Germanisches Nationalmuseum, Hs. 7032, fol. 1r-55r, as a matter of fact, is very similar to Heidelberg, Universitätsbibliothek, Cpg 552, fol. 1r-40v, but it lacks the volvelle with the apostles' names, which is absolutely necessary for using this version of the PSB (see Figure 7). [30]

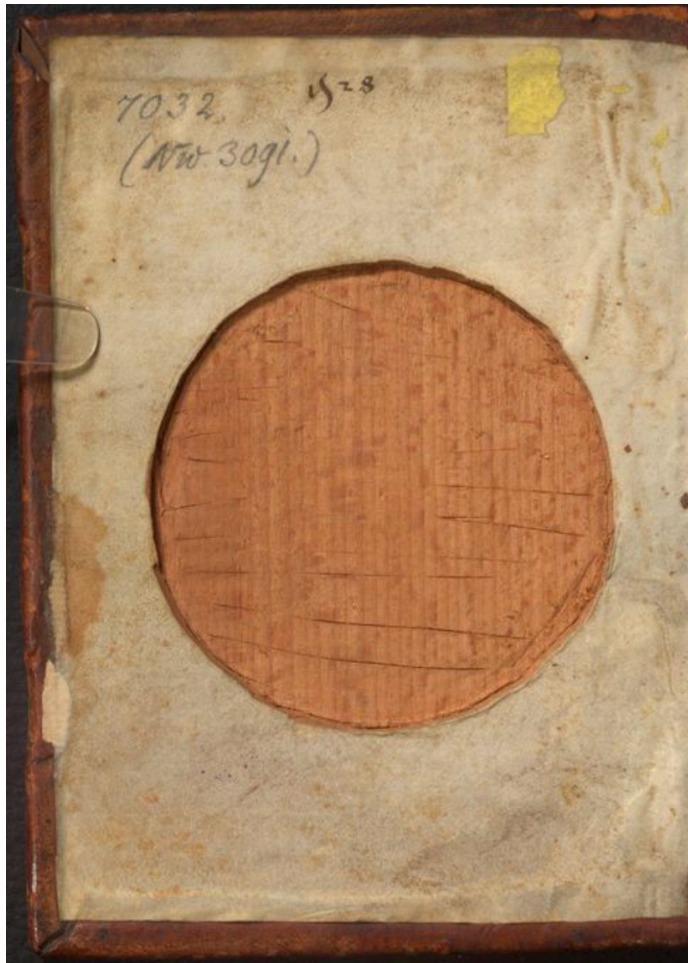

7032.
(Nw. 3091.)
1528

Fig. 7: Front pastedown of *Losbuch gereimt II* with a hole which very likely hosted the volvelle. [Nürnberg, Germanisches Nationalmuseum, Hs. 7032]

Clearly, the front pastedown, which now shows a circular hole, once contained the volvelle, exactly like in the manuscript preserved in Heidelberg whose volvelle is shown in Figure 2 above. Being able to connect the paths of different witnesses, therefore, can make sense of documents such as Nürnberg, Germanisches Nationalmuseum, Hs. 7032, which are otherwise categorised as »unlesbar«, that is, unreadable.[27] As the German scholar Marco Heiles writes, »[b]etrachtet man die handschriftliche Losbuch Überlieferung insgesamt, so fällt auf, dass erstaunlich viele Losbücher als solche teilweise oder sogar ganz unlesbar sind« (»if one considers the comprehensive manuscript transmission of the sortes texts, it is noticeable that an astonishing number of them are partially or even entirely unreadable«[28]). It seems therefore that [31]

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[27] Cf. Heiles 2018.

[28] Our translation of Heiles 2018, p. 69.

the integration proposed in our model is essential for understanding and representing the structure not only of the PSB, but of the sortes texts as a genre, demonstrating the interactive nature of these texts and their dependency on user interaction as well as the fundamental role played by their contextualisation and comparison with other witnesses belonging to the same (and possibly to a different) textual transmission. Furthermore, the utilisation of *Neo4j*, a graph database management system, is instrumental in achieving efficient modelling and visualisation of these complex connections. The architecture of the database supports concurrent management and querying of both textual contents and interactive game paths. This option is pivotal in promoting an innovative representation and analysis of mediaeval sortes texts, showcasing a novel way to engage with historical literary works through modern technological means. In other words, the graph-based methodology adopted in this project not only represents the text's complex internal structures but also enhances the interactive exploration of its game paths and their historical transmission, bridging historical content with contemporary digital analysis techniques. This integration provides a deeper insight into the text's multifaceted nature as well as into its historical and philological contexts.

4. Conclusion

In this paper, we introduced the computational edition of the mediaeval German versions of the *Prenostica Socratis Basilei* and the methodological challenges which emerged while modelling the data as well as the solutions we adopted. Presenting the PSB case study, we were able to show how sortes texts call for novel methodologies tailored to their distinct characteristics, highlighting the shortcomings of existing methods and fostering progress in scholarly editing. While designing solutions for this genre, therefore, we advance the field as a whole, creating new ways to solve problems which have already been recognised by scholars working with more canonical texts. The method we propose embraces the concept of text as a graph, while at the same time pushing this approach further by addressing critical questions of textuality and intertextuality, as well as integrating non-textual dimensions. More specifically, it allows for different degrees of granularity in modelling, ranging from minimal units, such as glyphs, to reach the level of versions and common antecedents going through accurate representations of single witnesses. Working with labelled property graphs, we have the possibility of annotating both nodes (single units) and edges (connections) of different categories specifically tailored for the project but at the same time aligning with standard labels and / or definitions such as those provided by the TEI Guidelines. The level of formalisation achieved in a data model designed in this way allows not only for advanced queries and quantitative analysis of contents and structures, but also paves the way for the application of a computational workflow where editorial decisions can be expressed with programming languages. This allows ultimately to achieve a higher level of traceability and transparency of scholarly processes.

[32]

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Fig. 1: Structural comparison of the versions *Losbuch gereimt II* (LGII), Bolstatter's *Seltzsams Loßpuch* (BSL) and *Geomantia* (GEO). On top, a conceptual level which represents the components of the PSB. [Model by: Elisa Cugliana, 2024]

Fig. 2: Moveable volvelle with an angel pointing to the apostles' names in a witness of the *Losbuch gereimt II*. [Heidelberg, Universitätsbibliothek, Cpg 552, front pastedown]

Fig. 3: The word »zway« belongs both to the page header »achte zway vnd fünffe« and to the section header together with the beginning of a question (»ob der geselle gut...«), the repetition of the number »zway« and the name of a mountain (»Synoy«). [München, BSB Cgm 312, f. 121 r.]

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Fig. 6: Example of a generic graph-based model of witness-internal structure and game paths in the PSB digital edition, illustrating the relationships from concepts to text sections and the integration of game paths. [Model by: Sebastian Enns, 2024]

Fig. 7: Front pastedown of *Losbuch gereimt II* with a hole which very likely hosted the volvelle. [Nürnberg, Germanisches Nationalmuseum, Hs. 7032]