Judentum und Umwelt / Realms of Judaism 85

Hanna Liss (ed.)

Philology and Aesthetics

Figurative Masorah in Western European Manuscripts

In collaboration with Jonas Leipziger

PETER LANG

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Philology and Aesthetics

European Bible manuscripts and their Masorah traditions are still a neglected field of studies and have so far been almost completely disregarded within text-critical research. This volume collects research on the Western European Masorah and addresses the question of how Ashkenazic scholars integrated the Oriental Masoretic tradition into the Western European Rabbinic lore and law. The articles address philological and art-historical topics, and present new methodological tools from the field of digital humanities for the analysis of *masora figurata*. This volume is intended to initiate a new approach to Masorah research that will shed new light on the European history of the masoretic Bible and its interpretation.

The Editor

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"How Am I Supposed to Read This?" Challenges and Opportunities of Medieval Western Masorah as a Digital Scholarly Edition

Abstract: The article discusses the impact of Digital Transformation in the Humanities on the design of modern research projects such as manuscript editions. It outlines the opportunities of modern digital manuscript repositories for the field of Jewish Studies and contrasts them with the challenges of digital methodology and the transformation of hermeneutical approaches into „data modeling". Introducing the long-term project "Corpus Masoreticum" as a DH project, controversial aspects of whether to choose a standardized TEI-XML approach or a text-as -a-graph model are being discussed. As a hands-on example, it is shown how alternative encoding practices can be applied to digital editions of so-called *masora figurata* in western medieval bible manuscripts. Finally, an overview of the project's infrastructural and technological architecture is being given.

Keywords: Digital Edition, IIIF, TEI, Graph Databases, masora figurata

What kind of effects does the introduction of digital processes to the humanities have on the design of contemporary research projects? How do we develop a concept of (medieval) manuscripts as a readable "data model"? What kind of structural complexity does the metatextual phenomenon of so-called *masora figurata* in Western medieval Hebrew Bible manuscripts add to the set of methodological and technological requirements for a digital scholarly edition?

These initial questions aim to create connections between some rather general reflections on the opportunities of contemporary digital scholarship and more hands-on application scenarios in medieval Jewish Studies. At the same time, this is meant to be a balancing act between pushing innovative approaches and implementing existing standards.

With regard to innovation and paradigm shifts, the humanities in general have, with some success, developed the narrative of theoretical and methodological "turns." Terms like "linguistic turn," "performative turn," "iconic turn" and others have had an interesting run in discourse since the 1970s and the early 2000s,[1] closely followed by the "material turn."[2] Even if the first use of computational tools and infrastructure now dates back several decades in the field of the humanities, it is not surprising that the label of a "digital turn" adds up quite well to the list of various "turns." Recently, Gerben Zaagsma has discussed the impact of the digital turn on the field of Jewish Studies.[3] We will not follow up here on the discussion of whether Digital Humanities should be thought of as a discipline in its own right or more as an auxiliary science, but rather focus on a more process-related level of "Digital Transformation"[4] and its impact on scholarship in the field of humanities. Furthermore, we will discuss some practical consequences of digital transformation on actual scholarly data modeling, the selection and use of certain technology stacks, and decision-making in real-life research-project management. Following this line of thought, we will focus on aspects of accessibility, collaborativity, data modeling, methodology, and sustainability. As a complex use case we will discuss the basics, concept and implementation of a new digital scholarly edition project, *Corpus Masoreticum*, dealing with medieval masoretic bible manuscript corpora, and the encoding of *masora figurata* as a special type of masoretic annotations in particular.

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1 For an overview, see Bachmann-Medick, Doris: *Cultural Turns. Neuorientierung in den Geisteswissenschaften*. Rowohlt: Hamburg ²2007.

2 See, as an example, Knoll, Martin: "Nil Sub Sole Novum oder neue Bodenhaftung? Der Material Turn und die Geschichtswissenschaft." *Neue Politische Literatur* 59, 2014, pp. 191–207.

3 Zaagsma, Gerben: "#DHJewish – Jewish Studies in the Digital Age." *Medaon. Magazin für Jüdisches Leben in Forschung und Bildung* 12, 2018, pp. 1–11 (open access: https://t1p.de/dr5e), provides an excellent overview on the history of digital approaches in Jewish Studies, esp. pp. 3–5.

4 Having its origin in business informatics, this term is generally used to describe change basic change processes in society in general and business models in particular in digital environments, see as an overview Pousttchi, Key: "Digitale Transformation." In: *Enzyklopädie der Wirtschaftsinformatik*, 2017. https://t1p.de/bmpa.

1 Resources and Infrastructures

One of the most obvious benefits of digital approaches to historical research is the way we could get access to highly diverse selections of different sources of cultural heritage. Digital collections, databases, hypertexts, interactive maps, and online journals (this list being far from complete) not only enhance traditional research tools and infrastructures, but also offer more than a few valuable entry points where scientific research could start off from or even get some inspiration.[5]

For practical reasons, this development has of course had enormous benefits for contemporary research, for example, for medieval manuscripts including paleography and codicology. In the age before the internet, this highly specific field of interest could be seen as a topic for more or less a few experts, requiring years of individual expertise, personal familiarity with the original sources, and, as a consequence, the need for sufficient travel-expense budgets and coping with frequently limited access conditions to libraries and sources. With respect to the physical condition of documents, ownership and licensing issues, etc., this often meant having to depend on hand-written copies, microfilm, or photos of variable quality.

Today, thanks to the many initiatives of leading libraries and institutions and/or foundations, an increasing amount of digitally prepared primary sources has become available to the public and the scientific community likewise, being also extraordinarily beneficial for Jewish Studies: In August 2017, the National Library of Israel (NLI) announced the launch of Ktiv: The International Collection of Digitized Hebrew Manuscripts. Having its origins in the Institute of Microfilmed Hebrew Manuscripts, founded in 1950, it aims to "enable global centralized digital access to all existing Hebrew manuscripts" and listed, at the time of their announcement, approximately 85,000 manuscript items in their catalogue. The Ktiv Collection (https://t1p.de/hefu), which was funded by the Friedberg Jewish Manuscript Society (FJMS) and the Landmarks Heritage Program in the Prime Minister's Office of Israel, has since partnered with libraries and

5 As an inspirational source, medieval hebrew micrographies have found their way into social media and popular culture, see hashtag #micrographymonday on Twitter: https://t1p.de/bjml.

collections like the Bibliotheca Apostolica Vaticana, the British Library, the National Library of Russia, the National Library of Germany, the National Library of France, the Palatina Library in Parma, the Jewish Theological Seminary, the Ets Haim Library in Amsterdam, the National Library of Austria, the Hungarian Academy of Sciences in Budapest and, lately, the National Library of France.

Another recent and massive digitization project has been undertaken by the Polonsky Foundation, as a collaboration between the Bodleian Libraries and the Bibliotheca Apostolica Vaticana (https://t1p.de/cfvp). Besides a huge list of Greek manuscripts and incunabula, an impressive digital collection of 1414 Hebrew manuscripts (773 holdings at the Bodleian, 641 at the Vaticana) has been made available to the public (https://t1p.de/bawh).

Moreover, the Bodleian Libraries contributed the "Digital Manuscripts Toolkit" to the developer community (https://t1p.de/8ggr). It allows small institutions and projects to easily set up their own digital manuscript resources by implementing the "International Image Interoperability Framework" (IIIF: https://t1p.de/k2er), a Linked Open Data exchange protocol that supports viewing, annotating, and sharing distributed digital image resources.

In Germany, the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) funded the development of the DFG-Viewer (https://t1p.de/ii3b), an online service to display and exchange digitized archival sources from decentralized repositories via standardized protocols. The DFG-Viewer, being mainly developed at the Saxon State Library, was initially released as version 1.0 in early 2008 and is used at, among other institutions, the Staatsbibliothek Berlin, the Bayrische Staatsbibliothek München, and the Staats- und Universitätsbibliothek Göttingen.

While access to historical documents, especially manuscripts, always had to be considered "gated" in the pre-digital age – limited to selected scholars, and limited due to the rareness and fragile condition of the material – we see today that technological progress in making cultural heritage available as digital resources is accompanied by a change in culture itself: Digital repositories are more and more seen as openly accessible public services that should be available to everyone. The mission statement

of the Polonsky Foundation Digitization Project mentioned above may serve as an example: It is "committed to democratizing access to information [and] sees the increase of digital access […] as a significant step in sharing intellectual resources on a global scale. […] Twenty-first-century technology provides the opportunity for collaborations between cultural institutions in the way they manage, disseminate and make available for research the information, knowledge and expertise they hold." The foundation's support of the contributing libraries is meant to "[…] make important collections accessible to scholars and the general public worldwide" (https://t1p.de/u3gn).

Another step towards open access to digitized cultural heritage has recently been taken by the British Library, which published complete datasets of 1.300 Hebrew manuscripts as high-quality images (https://t1p.de/w4vd), together with their catalogue records, being released as TEI XML files licensed under a Creative Commons Zero (CC0) Public Domain License (https://t1p.de/wv88). Fig. 1 gives an overview of a selection of libraries offering digital manuscript resources as a service:

Fig. 1: Libraries as digital service providers for *Corpus Masoreticum* (interfaces/APIs, quality, and license terms)

Library	*Server/API*	*Viewer*	*MSS to be edited in CM*	*Quality*	*License*
Bodleian Library Oxford	DeepZoom/ IIIF	Open-Seadragon	n/a	high	Proprietary; allowed for non-commercial & scientific use by attribution (https://t1p.de/f0i6)
British Library	DeepZoom	Open-Seadragon	BM Add. 21160, BM Add. 15282, BM Harley 5710–11	high	Creative Commons Zero (CC0), Public Domain
Staatsbibliothek Berlin	DeepZoom	DFGViewer	Berlin Or. Quart. 9, Berlin Or. Fol. 1213	medium	CC BY-NC-SA 3.0
Biblioteca Apostolica Vaticana	IIIF	AMLAD™ (https://t1p.de/8qcz)	Vat. ebr. 14, Vat. ebr. 468	medium	Proprietary; license fee applies for high-resolution, non-watermarked images
Ambrosiana	IIIF	Mirador	Ambrosiana B 30.31.32. inf.	n/a	Proprietary, "gratuitamente" ("free of charge"), print or download permitted
Österreichische National-bibliothek	n/a	RepViewer	Ms Wien Cod. hebr. 16 (b/w)	High (b/w)	"free access"
Bibliothèque Nationale de France	IIIF	Open-Seadragon	Paris, BnF, hébr. 5–6	high	Public Domain
National Library of Israel	IIIF	Mirador	Parma Cod. 3289, Parma Cod. 2808, Ms Wien Cod. hebr. 16 (color)	high	Parma: proprietary; private use only. Wien: "free access"
Digital Library of University Wrocław	DJVU/PDF	Djvu/html5 viewer	Wrocław 1106	high	Proprietary; allowed for non-commercial & scientific use by attribution (https://t1p.de/igu5)
Bayerische Staatsbibliothek München	IIIF	Mirador	München Cod. hebr. 2		CC BY-NC-SA 4.0

Aside from the undoubted advantages of virtually democratized access to digital sources, we do, however, have to admit that there will be still specific circumstances where examining the original artifact remains indispensable – whether because of the need for detailed examinations of ink and material or the physical condition of the source. Nevertheless, it is clear that the basic conditions for this kind of highly specific research on historical text corpora are further improving, and that the opportunities of digital transformation in manuscript studies (as one of many use cases) open up new perspectives on textual scholarship.

That being said, the question remains why scholars initially advertised this shift toward Digital Humanities as a "challenge" and not as a "benefit." To quote Gerben Zaagsma, "The key challenge for Jewish Studies in the digital age is to work towards solutions for information retrieval and analysis from dispersed, multilingual and multiscriptual sources."[6] As far as our sample use case – the edition of medieval Jewish Bible manuscripts – is concerned, we have only now addressed questions of information retrieval by using digital archival infrastructures and exchange protocols. If we shift our focus towards an analytical perspective, we will still have to deal with questions on how to pre-process data (as raw, distinguishable symbols[7]), make use of such data as interpretable information (data plus context and meaning), and generate knowledge in a scholarly sense (inferring new information based on assumptions and rule sets),[8] which amounts to, basically, processing digital manuscript sources in pursuit of high-quality scholarly editions.

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6 Zaagsma 2019, p. 8.

7 This approach towards "data" is following Alan Turings definition of universal computational machines as operating on sequences of discrete symbols, see Turing, Alan M. "On Computable Numbers, with an Application to the Entscheidungsproblem." *Proceedings of the London Mathematical Society* s2–42(1), 1937: pp. 230–65, here pp. 241–246 (open access: https://t1p.de/geuu).

8 For some general reflections about an understanding of data see Owens, Trevor: "Defining Data for Humanists: Text, Artifact, Information or Evidence?" *Journal of Digital Humanities* 1(1), 2011 (open access: https://t1p.de/qui6); Schöch, Christof: "Big? Smart? Clean? Messy? Data in the Humanities." *Journal of Digital Humanities* 2, 2013: pp. 2–13 (open access: https://t1p.de/xybb).

What we can already see is that within the digital turn, the promise of fully fledged digital scholarly editions has more and more caught up with (if not replaced) that of traditional printed and digitally enhanced editions. But this shift forces us to completely rethink the whole concept of what an edition should represent and what questions it should help answer. It forces us to precisely describe our own methodology and modes of observation – and to formalize them. In order to better ground these reflections in practice, we will now analyze a fairly complex dataset, derived from a preliminary digital edition of the *masora figurata* in MS Vat. ebr. 14, and use the findings to exemplify a few basic conceptual decisions on how to set up data models and digital toolsets for encoding and annotating such material.

The sample is taken from a project dedicated to the digital edition of selected micrographic notes from the manuscript MS Vat. ebr. 14, as part of the Collaborative Research Center 933;[9] Fig. 2 is based on folio 85v and shows a first structural draft of different contexts and text/image relations to be found on the folio. The biblical main text itself is intertwined verse by verse with targum, which results in a sort of bilinear text/reading sequence (either the Hebrew or the Aramaic text sequence can be followed, but both are part of the same line/column sequence). There are circellus marks indicating that a word or phrase will have a masoretic annotation. Sometimes, there are *masora parva* notes without featuring corresponding circelli; we see sequences of *masora magna* notes, but some of them point to lemmata on other folio pages. Moreover, there are masoretic notes written within (and depicted as) a *masora figurata*. These very raw and preliminary observations lead us to a first summary:

1. The structure of the overall texts is not necessarily linear. The basic text reads as interlinear biblical Hebrew text and/or alternates with Targum

9 The digital edition, created as a prototypical proof of concept by C. Liedtke and Kay J. Petzold (http://bima.corpusmasoreticum.de) supplements the results of the printed edition published by Elodie Attia (Attia, Élodie: *The Masorah of Elijah ha-Naqdan. An Edition of Ashkenazic Micrographical Notes*. [Materiale Textkulturen 11]. De Gruyter: Berlin/Boston 2015 [open access: https://t1p.de/5zly]).

text in Aramaic; *masora parva* notes can morph into *masora figurata*; masoretic notes can refer both to preceding and/or subsequent texts.

2. The text can be emblematic text:[10] Figurative Masorah depicts and denotes text at the same time.
3. The text can contain complex implicit and/or explicit reference structures that can even overlap.
4. A comparison with other, presumably similar, texts (given the main hypothesis that we are expecting a specific type of Ashkenazic textual transmission[11]) requires augmentation with additional non-textual data (geography, prosopography, dating [paleographically, codicologically]).

Given these initial observations, we will have to review how and if any of the existing editorial standards in digital humanities will fit into this use case scenario.

Furthermore, it has to be discussed whether these findings will scale well if transferred to a long-term corpus edition project, as in the Heidelberg long-term project *Corpus Masoreticum*, launched in 2018. Its aim is the edition of the entire Masorah from selected Ashkenazi manuscripts and research on the inculturation of the Masorah in Western European Jewish learning culture from the eleventh to the thirteenth centuries.[12] The philological work will be based on approximately fifteen

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10 We will not touch the question here on what a text "is." However, it makes sense to agree about certain basic terms when talking about texts as entities. Patrick Sahle e.g. proposes to distinguish between such editorial text types (Sahle, Patrick: *Digitale Editionsformen, Zum Umgang mit der Überlieferung unter den Bedingungen des Medienwandels*. 3 vols. (Schriften des Instituts für Dokumentologie und Editorik 7–9). Books on Demand: Norderstedt 2013 (open access: vol. 1: https://t1p.de/z4i2; vol. 2: https://t1p.de/nf67; vol. 3: https://t1p.de/1kbu), here vol. 3, pp. 3–9); in this model, emblematic text would be defined as Text_z, i.e. text as symbol or icon (Sahle 2013, vol. 3, pp. 42–43).

11 Liss, Hanna/Petzold, Kay Joe: "Die Erforschung der westeuropäischen Bibeltexttradition als Aufgabe der Jüdischen Studien." In: Lehnardt, Andreas (ed.): *Judaistik im Wandel: Ein halbes Jahrhundert Forschung und Lehre über das Judentum in Deutschland*. De Gruyter: Berlin/Boston 2017, pp. 189–210, here: pp. 203–206.

12 See the introduction by Hanna Liss in this volume, pp. 5–25.

Fig. 2: Structural overview of mise-en-page of biblical text, *masora parva*, *masora magna* and *masora figurata* as linked contexts. Source: http://bima.corpusmasoreticum.de/figurata/tor. © BIMA: Biblical Masora Database

manuscripts (see Fig. 1) plus additional material from different sources (commentaries, glossaries, fragments, etc.). One of the major fields of focus is the analysis of micrographical and figurative metatext and the question of whether these represent specific types of Ashkenazi textual knowledge transfer.

2 TEI XML vs. Knowledge Graphs

While as of the present day, the TEI XML encoding framework[13] has been widely adopted for digital scholarly editions as a *de facto* standard, there is still some kind of hesitant acceptance within Jewish Studies. Well-known exceptions to this observation include the electronic edition of the Westminster Leningrad Codex, Ms. Fircovitch B19a, hosted at the J. Alan Groves Center for Advanced Biblical Research (https://t1p.de/tyy9), and the Digital Mishnah Project (https://t1p.de/m25l) at the Maryland Institute of Technology in the Humanities (MITH).

One of the major reasons for this lack of acceptance could be found in various technical issues in the context of right-to-left scripts. Since most existing TEI editions are manufactured as pure source code with popular XML code editors like "oXygen" (https://t1p.de/bcrz), one has to face up to the fact that these tools are insufficiently prepared for the manual markup encoding of Hebrew or Arabic scripts. The DARIAH Wiki accordingly concludes: "Solange dieses Problem nicht grundsätzlich gelöst ist, wird die Akzeptanz von TEI und/oder XML in Hebraistik und Arabistik gering sein" (https://t1p.de/6c9c).

Even if we leave the question behind of whether researchers actually should be encouraged to craft their XML editions manually in plain text, another more structural aspect of XML encodings should be taken into account as an aspect of methodological decision-making. As a semi-structured, hierarchically organized markup language, an XML-encoded document has to contain strictly coupled markup elements to comply with XML's syntax rules for well-formed and valid documents (https://t1p.de/g2s5); markup elements (being built from opening and closing "tags") can only occur in linear or nested sequences, while they may not overlap. This makes it difficult to represent deeply linked and overlapping structures within either a single document or a whole context of documents (e.g. *masora magna* items being part of a list, but referring to lemmata on other folia). The TEI's solution to this problem, which commonly occurs in edition projects, is to strictly de-couple document-centric

13 For the history of the TEI framework, see Sahle 2013, vol. 3, pp. 342–345.

annotations[14] and text-centric annotations; the main effort of this approach is that the structural requirements of documentary markup (layout, physical features like deletions, lacunae, etc.) do not interfere with the textual markup ("genetic"[15] aspects of whatever is considered to be "text"). This, however, will result in more or less doubled encoding of a document.[16]

Another aspect of considering TEI XML as a data modeling method is its specific schema definition of combinable tagsets and attributes, that on the one hand aims to cover a variety of editorial use cases but, on the other hand, also claims to promote compatibility and collaborativity between different digital editorial applications. The semantic embedding of these schema rules leads both to a certain type of overdetermination and to ambiguous approaches for how to encode certain textual phenomena within the framework. As Laura Estill discusses, giving the example of manuscript marginalia, the TEI specification allows for a multitude of different encoding options for what can be described as marginal text: <label>, <note>, <milestone>, <argument>, <add>, <seg>, <stage>, each slightly varying with regard to structural context, type of scribal addition, editorial intentions, and so on.[17] Since we are considering the modeling of *masora parva*, *masora magna* and *masora figurata* as highly specific types of marginal notes, this has vital consequences for what kind of editorial decisions have to be taken for a digitally representation of their mise-en-page and semantics.

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14 As an example guideline on document-centric editions of medieval manuscripts, see Pierazzo, Elena: "Facsimile and Document-Centric Editing." In: Burghart, Marjorie (ed.): *Creating a Digital Scholarly Edition with the Text Encoding Initiative* (open access: https://t1p.de/stfe).

15 On the principle of "genetic editions," see Rehbein, Malte/Gabler, Hans Walter: "On Reading Environments for Genetic Editions." *Scholarly and Research Communication* 4(3), 2013: 1–21 (open access: https://t1p.de/od21).

16 Which is, from an TEI perspective, considered as best practice, as by example in Brüning, Gerrit/Katrin Henzel/Pravida, Dietmar: "Multiple Encoding in Genetic Editions: The Case of 'Faust.' " *Journal of the Text Encoding Initiative, Selected Papers from the 2011 TEI Conference* 4, 2013 (open access: https://t1p.de/bf0j).

17 Estill, Laura: "Encoding the Edge: Manuscript Marginalia and the TEI." *Digital Literary Studies* 1(1), 2016 (open access: https://t1p.de/3v05).

While a TEI-based encoding will fit seamlessly into the majority of edition projects, especially those which aim to represent research on the writing process of texts as genetic editions,[18] it might not be the best choice for editions where the research interest focuses on any multicontextual aspects of historical sources, with highly linked internal and external contexts, making it desirable to build upon a data model that is well suited to enhancing the pure textual (diplomatic) edition of sources with any kind of non-textual, meta-, or hypertextual resources. The structural downsides and natural limitations of the XML vocabularies described above have been discussed in other contexts – we will highlight two of them, since they result in similar data concepts. Desmond Schmidt has tried to find a data storage model for representing texts that derive from multiple versions as part of a complex, non-linear writing process.[19] As a theoretical model, a representation of textual traditions as directed non-cyclic directed graph, a so-called text variant graph, has been proposed.[20] This points directly to a general mathematical theory of graphs as a description of informational entities ("nodes" or vertices), connected through relations ("edges").[21] From a stemmatological point of view, analyzing stemmata as a specific type of directed variant graphs, benefits massively from computational approaches and algorithmic collation processes, as was, for example, shown by Andrews and Macé 2013 by testing empirical collation models, or by Zundert and Andrews 2016, who design experimental interfaces for handling graph-modeled textual history. As a proof of concept, several visual tools have already been built on that methodological foundation, as shown by an example of the web-based tool "TRAViz" in Fig. 3.

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18 Rehbein/Gabler 2013, p. 3–5.

19 Schmidt, Desmond: "What's a Multi-Version Document?" *Multi-Version Documents* (blog), May 3, 2008. https://t1p.de/r1se; Schmidt, Desmond: " 'Merging Multi-Version Texts: A Generic Solution to the Overlap Problem.' Presented at Balisage: The Markup Conference 2009, Montréal, Canada, August 11–14, 2009." *Proceedings of Balisage: The Markup Conference 2009*, 2, 2009 (open access: https://t1p.de/bn1n).

20 Schmidt, Desmond/Colomb, Robert: "A Data Structure for Representing Multi-Version Texts Online." *International Journal of Human-Computer Studies* 67(6), 2009, pp. 497–514 (open access: https://t1p.de/mn7g), pp. 498, 501–502.

21 A lightweight description of graphs can be found here: https://t1p.de/uzvu.

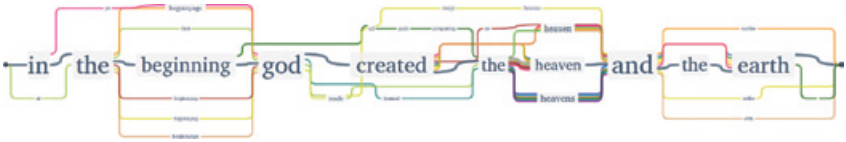

Fig. 3: Sample of a text variant graph: Genesis 1:1 in 24 English translations. © Stefan Jänicke/Annette Geßner. Source: https://t1p.de/7bn0

Another perspective has been brought up by Andreas Kuczera,[22] who analyzes records from the "Regesta Imperii" database (https://t1p.de/aam8) and proposes the implementation of so-called labeled property graphs by using the graph database management system Neo4J. He demonstrates how to build a redescription of TEI-encoded regest documents as property graphs, and how to add multiple non-hierarchical, linked annotation layers to variant streams of texts. As the examples given above suggest, these models could be used for mapping non-textual entities – dates, personal data, place or time indices – as they can be represented as additional data nodes and tied to other relational links/edges. Using this approach, the spectrum of methods known from the familiar technique of "genetic" textual criticism can be expanded upon, with the result that a simultaneous observation of and linking with semantic criteria may be achieved. Such an expansion also makes textual stemmata visible, detecting them not only on the basis of character variance but also from contextual links.

At this point in the discussion, we will draw some further conclusions from the overview given above and follow up on the initial question of what kind of modeling decisions might be derived for the *Corpus Masoreticum* project design, given the previous snapshot-like observations. As we have argued before, a digital scholarly edition – the emphasis is on "digital" now – has to balance the methods and tools used between

22 Kuczera, Andreas: "Graphbasierte Digitale Editionen." *Mittelalter. Interdisziplinäre Forschung und Rezeptionsgeschichte* (blog), April 19, 2016a. https://t1p.de/tymd; Kuczera, Andreas: "Digital Editions beyond XML – Graph-Based Digital Editions." In: Düring , Marten et al. (eds.): *Proceedings of the 3rd HistoInformatics Workshop on Computational History (HistoInformatics 2016)*. CEUR-WS: Krakow 2016b (open access: https://t1p.de/4aa5).

existing standards and innovation. After the pros and cons of well-established XML frameworks and experimental graph technologies have been evaluated, the results should be compared to the requirements of Masoretic bible manuscripts, including the following:

- Diplomatic transcription of main text and Masorah, tokenised lemmata
- Text-critical comparison with related manuscripts
- Biblical references, internal and external
- Structure, content, and references of list material (*masora magna*)
- Layout features (*mise-en-page*), page/binding arrangements

In summary, the design objective targets multicontextual, deeply linked criteria, overlapping physical, textual, as well as metatextual features of interest.

Since it is not clear if existing frameworks like the TEI are capable of mapping the whole set of criteria (without stretching the specifications to the limits or having to create workarounds with separate standoff markup), another structural feature of labeled property graph models has been facilitated, together with a technological feature of the graph database management system tested, Neo4J. From a structural perspective, the feature of loose coupling of nodes and edges – nodes can have any types of arbitrary attributes, edges require a start node and an end node at maximum – allows for building of informational structures of higher complexity than data models with tighter restrictions.[23] From a technological perspective, drafting a complex data model can benefit from Neo4J's labeled-property-graph approach, allowing for a "whiteboard-friendly" (https://t1p.de/i0q9) design of connected data entities, much like those one could create on a traditional whiteboard and without being limited by schema/syntax constraints. On a more abstract level, hypotheses about editorial data exploitation (what are the smallest possible information "entities"; how are they connected to what other data; etc.) can be drawn, tested, and implemented in a single design workflow.

23 E.g. compared to traditional relational database models where strict constraints: attribute schemata validity, coherence of rows, columns and referential integrity of indices and foreign key arrangements have to be met.

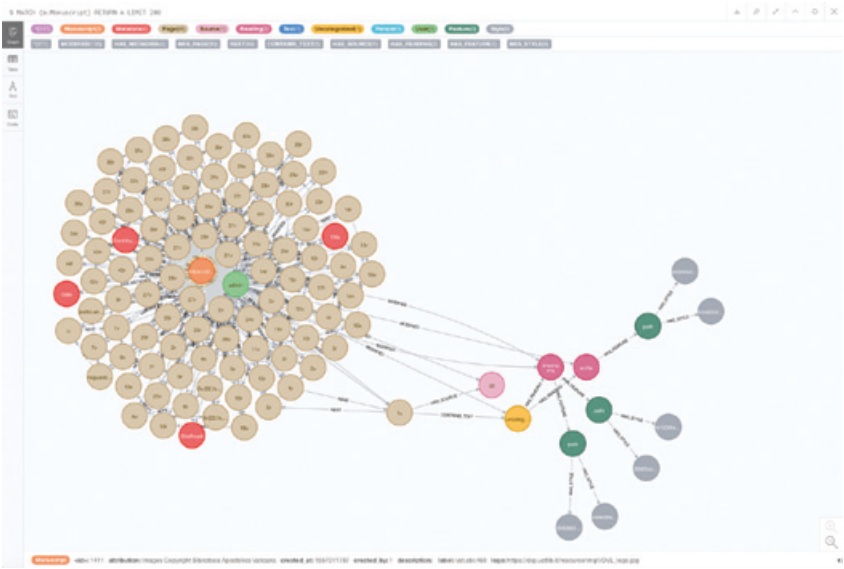

Fig. 4: Example graph representation of Vatican, Biblioteca Apostolica Vaticana, ebr. 468, with folio 1v nodes expanded in Neo4J. © Clemens Liedtke

From that level of model description, we can easily break down the complexity of "graph" data of edited manuscripts by aggregation to other standard vocabularies like the TEI framework, as these are considered to be models of lower complexity (higher constraints) than networks of labelled property graphs. Once defined as a process workflow, such TEI exports can easily be digested by long-term archival institutions (libraries) to share the raw digital-edition documents with the scientific community for further research. The same applies to possible exports of graph data to RDF triple stores, used for Semantic Web applications.[24] The openness of such knowledge-graph-modelled data would even allow for enhanced geomapping applications, relating to the Masorah-based geo-philological categorization of the manuscripts and hypertextual visualizations.

24 For the difference and application context of property graphs and the Resource Description Framework, see https://t1p.de/qo11.

3 Reading *masora figurata*: Scalable Vector Graphics as Encoding Schema for Text/Image Issues

We still have not touched the question of how to provide a standards-compatible editorial documentation of figurative Masorah. Since the default mode of digitally encoding such phenomena is either text-based or image-based, the challenge is how to bridge the gap between these two perspectives. From a technical point of view, common practice would be to deliver graphic files linked as an additional resource, along with a descriptive annotation (e.g. the <figure> markup in TEI XML: https://t1p.de/bhik) or to use browser-specific HTML features of graphic layers (e.g. HTML <area>s as image "hotspots"[25]). However, these approaches either do not fit seamlessly into standard archival formats or are functionally dependent on the browser or display device used.

At the *Corpus Masoreticum* project, sample editions of several figurative Masorah occurrences in MS Vat. ebr. 14 have served as a proof of concept that the use of Scalable Vector Graphics (SVG) fits the encoding requirements well. SVG, basically, is an XML description for drawing object primitives like paths, polygons or circles on a virtual canvas in an x/y coordinate system. It is recommended by the World Wide Web Consortium (W3C) as the default specification of two-dimensional vector graphics (https://t1p.de/77jg). Within this specification, the <textpath> markup allows for attaching strings of text to a drawn path which which will perfectly align with the path; the reading direction of the text attached will be given by the drawing direction of the path and applies to right-to-left in the same way as to western left-to-right scripts. Fig. 5 shows a low-level example of the basic principles of SVG textpaths.

Fig. 6 shows a clipped example of a *masora figurata* depicted in Codex London British Library Or. 2091, folio 203r, the "Knight's Head".[26]

25 This technique is e.g. used at the online edition "Welscher Gast Digital" to provide interactive image annotations: https://t1p.de/0l9h.

26 See the article by Hanna Liss in this volume, pp. 111–148.

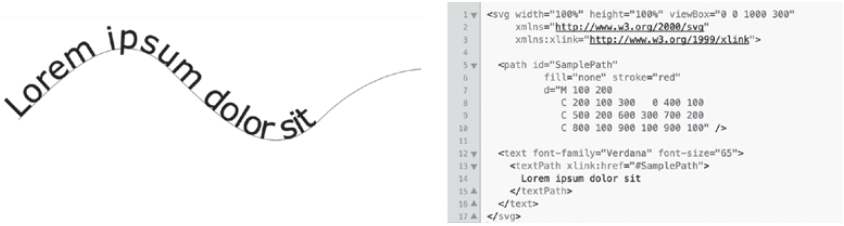

Fig. 5: Sample of a SVG textpath element, result (left) and source code (right). © Clemens Liedtke

Fig. 6: Sample taken from London, British Library, Or. 2091, fol. 203r. Source: http://bima.corpusmasoreticum.de/figurata/ritter (edited by Hanna Liss; SVG code: Clemens Liedtke)

The SVG approach proposed here provides two major benefits: First of all, SVG figures can easily be embedded in the TEI creation and export process, from being an XML dialect itself and by keeping compatibility with the framework's schema rules.[27] Secondly, rather than static bitmap imagery, SVG vector graphics allow for interactive data visualizations of the editing results by just applying standard web technologies like CSS styles and animations. This delivers multiple visual aids that help any user of the digital edition to make the edited scripts, especially the micrographic renderings of *masora figurata content*, readable.

4 Implementing Technologies and Standards: *Corpus Masoreticum* as a "Hybrid" Edition

Once editorial concepts, digital resources, data models, and technological components have been evaluated and settled, the overall architecture of the entire manuscript edition as a DH application has to be designed and implemented. As is recommended for modern and scalable software environments, the architecture should be kept as modular as possible, keeping in mind that several different exchange protocols, application programming interfaces (APIs), document formats, and data storage concepts will be involved.

As discussed above, the primary data models for manuscript transcriptions, annotations, and figurative text will be designed as data graphs, utilizing a Neo4J Graph database server as the main analytics and storage backend. However, this might not be considered best practice from an open access and sustainability perspective, as this technology should be classified as "proprietary" software that is not institutionally guaranteed to be functional or maintained by an open-source community over the long term, something that is usually required by institutional-research data archives. Furthermore, proprietary storage and query protocols like Neo4J/Cypher do not comply with current DH archival standards. As a consequence, a separate export layer has to be implemented to dynamically aggregate and break down knowledge-graph data to standard-compliant, reusable TEI

27 The TEI Wiki discusses several best practices of embedding SVG in TEI XML here: https://t1p.de/vaz0.

documents, containing documentary transcripts, textual transcripts, and figurative text transcripts as embedded SVG markup, as well as supplementary RDF exports to provide users with knowledge-graph representations of the edition's metadata.

Since the underlying digital manuscript facsimiles will be ingested via IIIF-enabled services, it is a reasonable add-on to also deliver supplementary IIIF Presentation API manifests with basic annotations (transcriptions, translations, scholarly notes) as a service. Appropriate server technologies along these specifications will be required accordingly.

The outline of a digital-edition framework for *Corpus Masoreticum* could be summarized as follows (see fig. 7):

- IIIF-compliant API for image resource ingest;
- An IIIF-compliant backup server for hosting intermediary image resources and the creation of enhanced resource manifests (Bodleian Digital Manuscripts Toolkit: https://t1p.de/8ggr; IIP Image Server: https://t1p.de/1zlf);
- Neo4J Graph Database (https://t1p.de/zl27) as storage and analytics backend;
- XML document server for storage and export of TEI XML documents and RDF resources (eXist-Db [https://t1p.de/sts8] with TEI Publisher as an add-on [https://t1p.de/tbqt]);
- Analytics Server for Text Mining and explorative statistics (RapidMiner: https://t1p.de/mu0p);
- Document servers for holding additional resources (Fedora Commons: https://t1p.de/svxo; NextCloud: https://t1p.de/jo2y);
- Service APIs for basic communication and data exchange with user clients/web browser applications and external services.

So far, we have covered the empirical aspects of gathering and processing modelled manuscript data to meet the requirements of a scholarly edition. As for the analytical side, it is yet conceivable that over the long run of a corpus edition project, the processing of approximately fifteen manuscripts and extra material will produce a huge amount of usable research data (transcriptions, metadata, knowledge graphs, etc.). Compared to classical print editions and critical apparatuses, it is apparent that a digital research framework strongly benefits from the strengths of computational procedures by means of methodology and performance.

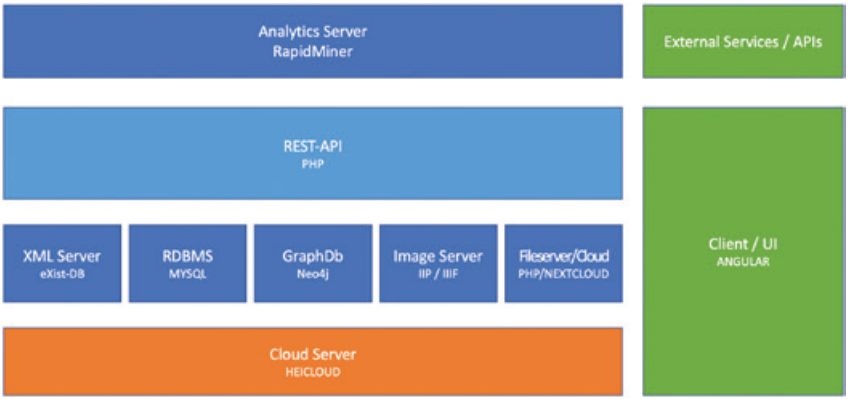

Fig. 7: Schematic outline of the *Corpus Masoreticum* application architecture Corpus Masoreticum as a "Big Data" analytical application. © Clemens Liedtke

From a hermeneutical perspective, it should be made clear that digitally created research data (which is, in a sense, a sort of "number crunching") does not produce results by some sort of magic[28] or black box (as the commonly used notions of "algorithms" and "artificial intelligence" may suggest); it is through formalizing defined hypotheses and the critically confirmed application of digital methods that hermeneutical connectivity is guaranteed.

For the model case of the *Corpus Masoreticum* project, an analytical workflow could be drafted as follows:

1. Concept: formulation of working hypotheses for textual criteria, drawing on existing learning processes for comparable analytical methods, such as the Coherence-Based Genealogical Method (CBGM) devised by the Institute for New Testament Textual Research in Münster (INTF: https://t1p.de/pope).

28 As it has been put by Arthur C. Clarke: "Any sufficiently advanced technology is indistinguishable from magic." (Clarke, Arthur C.: *Profiles of the Future: An Inquiry into the Limits of the Possible*. Revised edition, Harper & Row: New York 1973, p. 36).

2. Development: definition of analytical data models and their criteria. Description of textual features with the help of dependent/independent variables, clusters, directed/undirected graphs; modelling analytical processes and workflows as an iterative process, supported by suitable statistical methods of testing.
3. Implementation: methodologically controlled application of suitable processes (such as data/text mining, learning networks, multivariate analysis); iterative application and evaluation of the analytical results for historical-philological findings can be used at this stage as a form of methodological critique and adjustment.
4. Interpretation: together with purely descriptive statistics, this includes the definition and application of exploratory methods for the enhancement of empirical data; as a continuous, iterative process, it should always refer back to the historical-philological, sociocultural, praxeological main hypotheses of the project.

5 Sustainability and Long-Term Preservation

With an eye towards long-term archiving, the organization of source, research, and metadata storage, document servers, import and export formats, and appropriate quality assurance procedures has to be processed along the lines of a data management concept.[29] Conformity of both the collected and long-term archived editorial data with standardized formats (e.g. TEI or RDF ontologies) should be ensured and guaranteed as sustainable use of the scientific data in the future. As a research-grant-funded project with a defined lifetime, this cannot be guaranteed by the project itself but requires collaboration with scientific archival institutions like university libraries. Therefore, *Corpus Masoreticum* has teamed up with Heidelberg's University Library and their heiDATA service (https://t1p.de/q0ep), which is an institutional repository for the research data of Heidelberg University; additional applications for secondary research are possible starting from here. The development of processes for data transfer, the safeguarding of the archival material, and archive access is

29 The German Research Foundation (DFG) defines requirements for research data management in their guidelines: https://t1p.de/mpx1.

done along the lines of established frameworks like the Open Archival Information System (OAIS: https://t1p.de/o8zs). This ensures the sustainable usage and long-term archiving of the research data and enables their continued use in other editing environments (see Fig. 8).

6 Summary

Digital transformation as a scholarly change-management process has by now become a vital element of the discourse in the discipline of Jewish Studies. Ongoing progress with respect to the availability of high-quality archival resources visibly thrives the efforts in hebrew manuscript studies. At the model case of the long-term manuscript edition project *Corpus Masoreticum*, it has been demonstrated that by the digital access to huge facsimile resources alone, just one side of the story is told; the introduction of digital processes forces to strictly formalize hypotheses and objectives and to deliver detailed redescriptions of hermeneutical workflows as the process of transforming "data" into "information" into "knowledge" as an integral part of the initial project-design phase.

By design, the corpus edition project presented here doesn't just target comparisons of the variation in textual sources and the documentation of diachronic writing processes, but also aims to prepare formerly unread/unreadable texts like micrographical renderings and *masora figurata* in particular to make them readable and analyzable as an annotated digital edition, as has been demonstrated with sample editions from the prototype research platform http://bima.corpusmasoreticum.de. However, the design of a digital research platform should not content itself with providing digital resources, database resources, and visual tools, but should also meet the criteria of archival sustainability and re-usability of research data over the long run. If it can be shown that the previously approved standard frameworks of Digital Humanities do not cover the entire contextual complexity of the historical sources, the careful balancing of best-practice approaches ("genetic" editing, TEI XML encoding) with technological innovation (property graph databases, SVG visualizations encoding) is well advised.

Within the project framework proposed in this paper, *Corpus Masoreticum* as a digital scholarly edition platform has been designed as

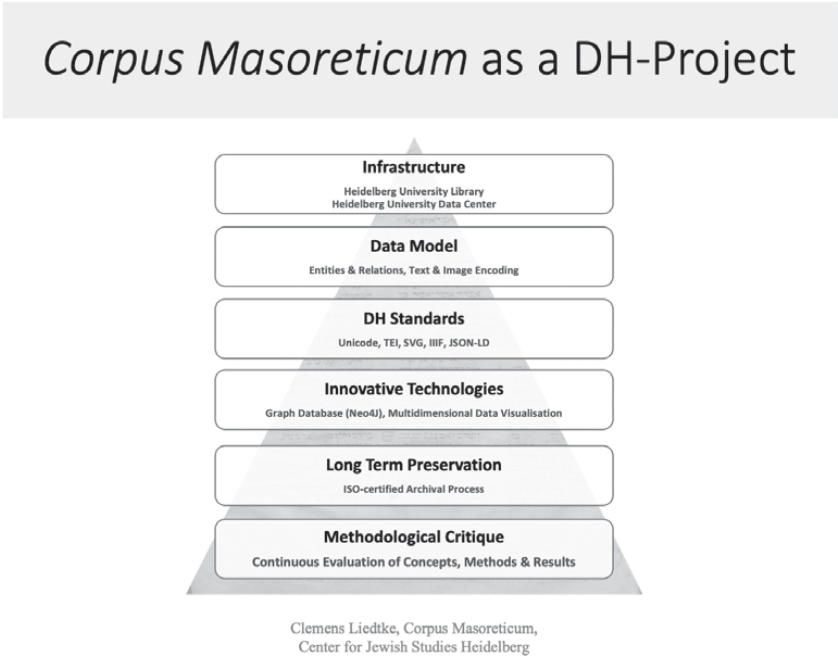

Fig. 8: *Corpus Masoreticum* as a DH Project. © Clemens Liedtke

a hybrid technology stack that provides experimental editorial modeling concepts, but also supplies research data services based on best-practice DH standards. As a long-term corpus edition project, how best to handle the huge amounts of research data that will be produced has to be considered in a separate analytical workflow, providing concepts and tools for the evaluation and interpretation of scholarly data.

All of this is to suggest that the concept of digital scholarly editions as "Big Data" applications might be the next big challenge for the Digital Humanities.

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Indices

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2 Authors and Names

3 Hebrew Bible

In der seit 1979 erscheinenden Reihe „Judentum und Umwelt“ werden aktuelle Studien aus den Teilbereichen Geschichte, Kultur, Religion, Literatur, Philosophie und Philologie des Judentums publiziert. Der Schwerpunkt liegt auf dem Judentum der Vormoderne; die Forschungsgegenstände umfassen im Wesentlichen die Zeitbereiche von der Antike bis zur Frühen Neuzeit. Der geographische Raum umspannt den Nahen und Mittleren Osten sowie das Judentum in Europa. Die Herausgeber sind Judaisten mit fachlich unterschiedlichen Schwerpunkten.

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