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1 Introduction

The Western Christian tradition was and is critically shaped by the methodological paradigm known today as scholasticism, a paradigm that prevailed in crucial periods of both Catholic and Protestant Christian traditions. Scholasticism was marked by literary genres (such as commentaries and compendia) that fostered textual interdependencies to the point that the scholastic corpus can be understood as a huge network of thought. It is our belief that emerging approaches within the digital humanities, and the open semantic web in particular, allow us, for the first time in modern research, to understand the full depth and fundamental interwovenness of scholastic thought. However, the current mechanisms of publishing scholarly editions, be it in traditional book form or as digital presentations, do not help to advance scholarship in this direction. The ongoing fragmentation of editions with different publishers, who prepare data according to proprietary and incompatible data standards, means not only that the creation of an edition requires wasteful redundancy but also that the aggregation and analysis of connected content, which are so essential to scholastic thought, are impossible.

In this article, we would like to present an alternative founded on open community data standards and linked open data; an alternative that promotes the shift from seeing a text as a document, page, or file (the "text-as-document" paradigm) to seeing the text as first and foremost a network of connected data (a "text-as-network" paradigm). We look first more closely at the nature of scholasticism and its interwovenness, arguing why existing publishing paradigms are limiting our potential exploration of this tradition. Secondly, we offer an overview of what a promising shift in publishing could look like, and how the Scholastic Commentaries and Texts Archive (scta.info)[1] and its supporting community

1 All hyperlinks cited in this volume were retrieved on 30 May 2021. As things are constantly improving, this means that we are constantly improving workflows, documentation, and consuming apps. This also means that links listed here may be changed or reorganized. We provide links accessible at time of publication; these links have been archived using Archive.org's Way-

https://doi.org/10.1515/9783110574043-003

are attempting to provide the foundation to actualize this shift. Finally, we offer an example of how a connected corpus of scholastic data, the likes of which the SCTA aims to make possible, will open new avenues of research and exploration on a scale that would be impossible without the aid of digital technology.

2 Scholasticism and the Christian tradition

Scholasticism was a paradigm that shaped academic traditions of Western Christianity for almost 700 years. From the beginnings in the 11th century to the remnants in the late 18th century, the scholastic approach was characterized by a common intellectual tradition reflected in the vocabulary, methods, and framing of traditional academic disciplines.[2] Neither the Renaissance nor the Reformation led to an enduring displacement of scholasticism; in fact, as early as the late 16th century, even in Protestant milieus, a second scholasticism emerged. While complemented by some new tools such as philological studies, it nevertheless presented the traditional features of medieval scholasticism, chief among them the use of compendia and commentaries.[3]

It is this fundamental commitment to compendia and commentaries that makes scholasticism a complex intellectual tradition to study, a tradition that is best understood as a community project (instead of a loose conglomerate of individual contributions). The genre of commentaries epitomizes the scholastics' commitment to other texts and authors.[4] Since these commentaries were used in a scholarly context for the training of the next generation of scholastics, and

back Machine and can be accessed there. But as pages and information get re-routed, readers should consult scta.info for up to date links.

2 See Ulrich G. Leinsle, *Introduction to Scholastic Theology*, trans. Michael J. Miller (Washington, DC: The Catholic University of America Press, 2010); and Herman J. Selderhuis, ed., *A Companion to Reformed Orthodoxy* (Leiden: Brill, 2013).

3 See Willem J. van Asselt, *Introduction to Reformed Scholasticism*, trans. Albert Gootjes, Reformed Historical–Theological Studies (Grand Rapids, MI: Reformation Heritage Books, 2011); and Ueli Zahnd, "Das trojanische Pferd der Scholastik. Antoine de Chandieu († 1591) über Sophistereien, Syllogistik – und Rhetorik," in *Language and Method: Historical and Historiographical Reflections on Medieval Thought*, ed. *idem* (Freiburg: Rombach, 2017): 247–79.

4 Cf. Francesco del Punta, "The Genre of Commentaries in the Middle Ages and Its Relation to the Nature and Originality of Medieval Thought," in *Was ist Philosophie des Mittelalters?*, ed. Andreas Speer and Jan A. Aertsen (Berlin: De Gruyter, 1998): 138–51; and Jan-Hendryk de Boer, "Kommentar," in *Universitäre Gelehrtenkultur vom 13.–16. Jahrhundert. Ein interdisziplinäres Quellen- und Methodenhandbuch*, ed. Jan-Hendryk de Boer, Marian Füssel, and Maximilian Schuh (Stuttgart: Franz Steiner, 2018): 265–318.

since this institutionalized scholarly context narrowed down the number of works commented on to a manageable set of base texts, it was natural that scholastic commentators not only dealt with these base texts but also discussed the commentaries of their peers.[5] After all, students were repeatedly trained and encouraged to engage in rigorous debate through the prevalent scholastic exercise of disputation (*disputatio*), and this environment of perpetual scholarly debate resulted in a complex network of arguments and counter-arguments brought up by peer scholastics on problems emerging in their collective discussion of texts. This "communitarian" approach was condensed in the most basic literary device of medieval scholasticism: the *quaestio*, which, in its essence, consisted of the confrontation of arguments and counter-arguments traditionally brought forward by a problem.[6] Yet, given that a *quaestio* focused on a problem rather than on textual exegesis, scholastic commentaries soon underwent a kind of emancipation from their base texts, and the later we get in time, the more we find them replaced by compendia collecting the relevant material on a topic, such as the huge collections of *loci communes* we find in Protestant orthodoxy.[7] The basic outline of these compendia, however, remained the same: they were inscribed into a huge network of problems, arguments, positions, and well-defined terms that had been developed in the scholastic community. Thus, they represent only a node within the rich complexity and interconnectedness of the entire scholastic tradition.

Despite the deep connectedness of scholastic texts, they have been and continue to be mostly studied by means of the traditional and somewhat romantic paradigm of "individual works." This has resulted in several problems. With regards to the traditional printed editions of works, it is true that scholars have and continue to do their best to account for the scholastic network of ideas by means of a comprehensive *apparatus fontium* or scholarly *scholion*.[8] But the possibilities have remained restricted to what a publisher is willing to print and to what an editorial team is able to take into account. Among other things, this has restric-

5 As an example, see the developments in the *Sentences* tradition as described in the three volumes of *Mediaeval Commentaries on the Sentences of Peter Lombard:* Gillian R. Evans, ed., *Mediaeval Commentaries on the Sentences of Peter Lombard*, vol. 1 (Leiden: Brill, 2002); Philipp W. Rosemann, ed., *Mediaeval Commentaries on the Sentences of Peter Lombard*, Vols. 2–3 (Leiden: Brill, 2010–2015).

6 Cf. Chris Schabel, ed., *Theological Quodlibeta in the Middle Ages*, 2 vols. (Leiden: Brill, 2006–2007).

7 See Günter Frank, "Topische Dogmatik im Zeitalter der Reformation," in *Topik als Methode der Dogmatik. Antike – Mittelalter – Neuzeit*, ed. *idem* (Berlin: de Gruyter, 2016): 172–210.

8 See, for example, the richly commented edition of Bonaventure, *Opera Omnia*, ed. the Collegium S. Bonaventurae (Quaracchi: Typographia Collegii S. Bonaventurae, 1882–1902).

ted the detection of unnamed references, hidden citations, and concealed sources: a problem that affects the whole scholastic network but is particularly virulent in the study of Protestant scholasticism. Most Protestant scholastics had an astonishingly good knowledge of medieval scholastic theology and did not hesitate to draw upon it, but they rarely named their sources.[9] This makes the task of connecting the corpus, in such a way that encourages networked connections of sources and influences, all the more urgent.

Moreover, just as paper editions have had difficulties in providing us with a sense of the scholastic network, most of the digital editions that have appeared in the last few years have not fared much better, largely because they persist within the paradigm of the older medium. Rather than shifting to a new paradigm, they are recreating the book (along with its limitations) within the new medium.[10] There are several problems with this, but let us for the moment name two of the most important ones:

First, the current publication system, whether print or online, is fragmenting the corpus and isolating one text from another. Proprietary publication systems receive returns on their investment only if they retain exclusive control over their content. In retaining an exclusive monopoly over data, publishers have little incentive to share their data with other publications, nor do they have much incentive to create innovative or groundbreaking displays of this connected data.[11] Because they are aware that they are the exclusive silo in which this data can be found, there is no need to improve the quality of the end user viewing and research experience to retain an audience. In an insightful piece, Ruben Verborgh notes that this problem plagues all centralizing tendencies of the web and argues that in order to counteract these tendencies, data must be separated from presentation in a way that frees data to be repeatedly used in a plurality of presentation environments. Verborgh writes:

> The key to a healthy ecosystem is the independence of these two markets, realized through a noncommittal relationship between apps and data. Since there currently exists no such separation, new innovative application platforms have trouble emerging because they

9 Cf. Richard A. Muller, "Scholasticism Protestant and Catholic: Francis Turretin on the Object and Principles of Theology," *Church History* 55, no. 2 (1986), 197 and 205.

10 Joris van Zundert, "Barely Beyond the Book?" in *Digital Scholarly Editing: Theories and Practices*, ed. Matthew J. Driscoll and Elena Pierazzo (Cambridge: OpenBook Publishers, 2016): 83–106.

11 For research on scholasticism, *Library of Latin Texts* published by Brepols (http://www.brepols.net) is a prime example of a proprietary database that purposely prevents these texts from being linked to larger open datasets, while producing rather mediocre results in the quality of data presentation.

> don't have the data – and existing platforms lack incentives to innovate adequately because they already possess data anyway.[12]

The rich complexity and interconnectedness of the scholastic ecosystem suggests that the texts within this tradition must be read within their context. Each text, each paragraph is a thread within a larger tapestry, and the significance and importance of each thread cannot be understood in isolation but only in the context of its connected threads, and ultimately in light of the entire whole. Unfortunately, the desire to retain exclusive control over texts that represent a common cultural inheritance and to profit from this monopoly is incompatible with the goal of bringing these threads together.

Second, even if we succeeded in making every text open access and freely available to all, whether in print or on the web, we would not yet have solved the problem. The current proprietary publication workflow (which is partly a consequence of its interest in publishing siloed presentations of data) is still rooted in the belief that a published text is inseparable from the presentation of that text, namely, the typeset display of that text, either on printed page or webpage. We call this the text-as-document paradigm, inherited from book culture where the separation of text data from its visual presentation in a document was impossible.[13] This paradigm perpetuates the belief that an edited text is something found on a page, whether in print or on a screen, formatted to facilitate a particular kind of visual experience for a human reader. The welding of meaning and presentation together means that a text is locked or siloed in this presentation.

The fact that this kind of coupling occurred prior to the digital revolution is understandable. Prior to the digital revolution, it was not possible to separate presentational form from the function of a text segment. This meant that the data recorded through its visual appearance could only be used and preserved as long as that visual appearance was preserved.

But what is more surprising is that this paradigm of welding meaning to presentation continues today on the web, through HTML and presentational mark-

12 Ruben Verborgh, "Paradigm Shifts for the Decentralized Web," *Ruben Verborgh* (blog), 20 December 2017, https://ruben.verborgh.org/blog/2017/12/20/paradigm-shifts-for-the-decentralized-web.

13 Cf. Peter Robinson, "Towards a Theory of Digital Editions," *Variants* 10 (2013): 105 – 31; van Zundert, "Barely Beyond the Book?"; and Jeffrey C. Witt, "DSE's and API Consuming Applications," in *Digital Scholarly Editions as Interfaces*, ed. Roman Bleier et al. (Norderstedt: Books on Demand, 2018): 219 – 47.

up. Given that publishers of digital texts typically continue to view the web*page* as if it were an actual "page," van Zundert observes:

> Indeed, it is far easier to point to examples of digital scholarly editions that are in essence metaphors of the book, or in other words: translations of a print text to the digital medium, apparently for no other reason than to fulfil the same role as the print text.[14]

Mimicking the printed book and text-as-document paradigm in one digital project after another tightly couples the data of that project to its display on a particular webpage. The consequence is that the data underlying this presentation is encoded only to foster this presentation, and hence is not machine actionable and not reusable. This means that loads of information about the larger corpus to which a given text belongs is simply lost.

To give an example of this, suppose editor A records in her project that author X cites author Z, and editor B records in a different siloed project that author Y cites author Z. Now we have to leave it to Google (if the texts are freely available), or to the random efforts of a well-off researcher, to find out that author Z is cited by both author Y and X. Such discoveries usually occur haphazardly, over coffee or the chance discovery of an article, and can hardly be considered scientific. But scholastic texts consist essentially of such cross-references, such that by pulling the texts out of that network, and treating it in isolation, we do not simply lose this or that interesting footnote, but rather misrepresent the fundamental way a scholastic text works, how it is cross-linked into its context, and to what broader network of concepts and ideas it belongs to.[15]

In sum, the current publication workflow of scholastic texts, its fragmentation and isolation of individual texts (whether in print or digital form), hinders our understanding of scholasticism as a connected corpus. The saying that premodern thinkers considered themselves dwarfs standing on the shoulders of giants is well known,[16] but our persistence with the text-as-document paradigm,

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14 van Zundert, "Barely Beyond the Book?," 103–4.

15 Scholasticism is, of course, not the only intellectual tradition that builds on a high level of intertextuality. One could mention Patristic literature, with its rich borrowings from classical literature, or the huge network of correspondences in the Republic of Letters. In these and similar cases, we assume that our identification of problems (as well as the solutions we propose below) would also apply. One could even imagine that the model we develop here could stand as an example case for other similar text corpora and offer a powerful example of the benefits of hypertextuality. On intertextuality in general, see Graham Allen, *Intertextuality*, 2nd ed. (London: Routledge, 2011).

16 David Sytsma, "'As a Dwarfe set upon a Gyants shoulders': John Weemes (ca. 1579–1636) on the Place of Philosophy and Scholasticism in Reformed Theology," in *Philosophie der Reformier-*

despite the presence of revolutionary media, actively works against our ability to see and appreciate this fact.

3 The text-as-network paradigm and the SCTA

In order to be able to represent and study the interconnectedness of scholastic texts (and consequently enrich our understanding of the Christian tradition), we need a different publication paradigm and workflow. We therefore propose to shift from a text-as-document to a text-as-network paradigm.

This entails first and foremost a commitment to publishing textual data as semantically structured, machine-actionable data. Consequently, this also means making sure this data is freely accessible for reuse and that the standards used to structure this data are well documented and maintained by the community. Finally, it means developing a workflow that clearly describes, in practical detail, how this data, created in distributed environments, can be aggregated and disseminated as a connected corpus.

The Scholastic Commentaries and Texts Archive is a community that is trying to provide the requisite service to affect this shift. Concretely, the work of the SCTA revolves around the following three aims: 1) to maintain a set of domain-specific standards for the publication of distributed textual data *as data*; 2) to help connect this decentralized data by aggregating it and organizing it with detailed metadata; and 3) to disseminate and publish this newly aggregated data through various APIs that enable the proliferation of a variety of data presentation clients.

3.1 SCTA standards and distributed data creation

The dream of being able to access the entire scholastic network of thought, of being able to exploit the computer's inferential power and make discoveries beyond the capability of any individual alone, starts with creating data according to data standards. System independent data standards, far from limiting how data is created or used, creates freedom and flexibility while preserving the possibility of coordination and interoperability. An important example is the freedom that data standards provide for creating data in diverse environments, for

ten, ed. Günter Frank and Herman Selderhuis (Stuttgart-Bad Cannstatt: frommann-holzboog, 2012): 299 – 321.

diverse purposes, while nevertheless still allowing us to merge that data seamlessly into a connected network. In this way, rather than being locked in a particular content management system (like WordPress, Omeka, etc.), individual editors and groups can pick the tools and media that work best for them. At the same time, because the SCTA maintains a data standard independent of any system, all systems can write export functions that convert their data to standards expected by the community.

The contribution of distributed data to the SCTA raw data layer might look something like the illustration in Figure 1 below, where data is created in a particular system, maintained internally, but then exported according to the community standard and announced for inclusion in the SCTA raw data layer, for example via a pull request in GitHub.

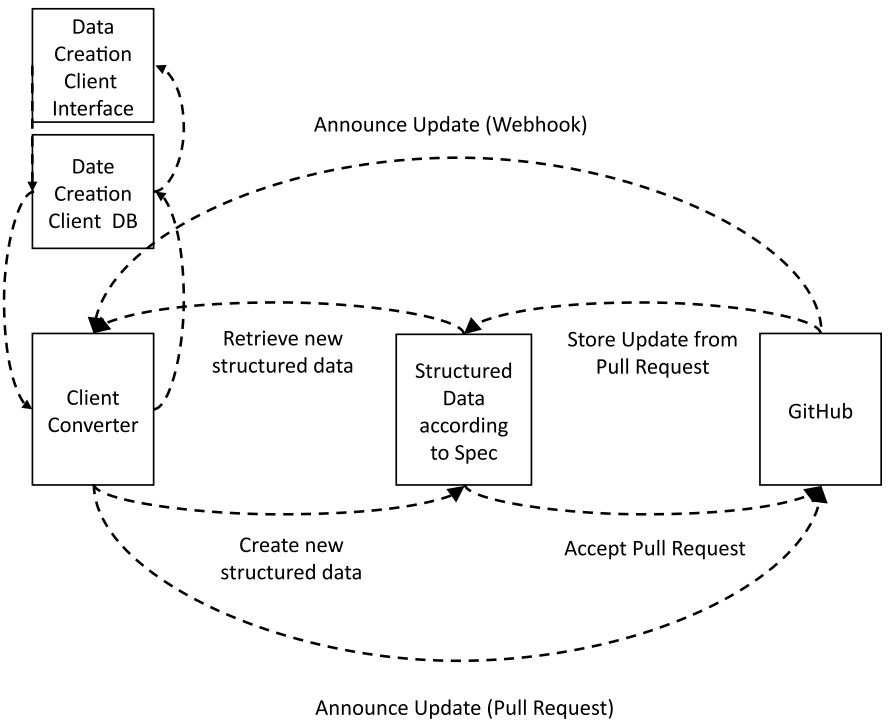

Figure 1: Data synchronization across data creation clients with independent databases.

At the heart of this workflow and automation is a fundamental commitment on the part of the community and data contributors to creating data according to

the community standards. By way of example, two of the most important data standards currently used in the SCTA aggregation process are described below.

3.1.1 Expression Description File (EDF)

The Expression Description File derives its name from a privileged layer within a data model that will be familiar to librarians as the "Functional Requirements for Bibliographic Reference" or FRBR.[17] Briefly, FRBR models a fourfold relationship between works, expressions, manifestations, and items. A work refers to a very abstract notion of a text, for example the idea of Moby Dick: an idea that can be expressed as a novel or a screenplay but by itself indicates no particular expression of this idea or work. Each expression, novel or screenplay, can be further manifested in various forms. The novel expression could be printed (or manifested) in one edition, say the 1959 edition, but then be re-typeset (re-manifested) into an entirely new edition, say the 1980 edition, though manifesting the same expression as the 1959 edition. Finally, each of these editions (manifestations) can be printed thousands of times as items, finding a physical home in public and personal libraries all around the world. To this model, we also add the concept of a transcription, which is meant to identify the digital surrogate of any manifestation, for example a TEI (Textual Encoding Initiative) XML file.[18]

Listing a catalogue of expressions of scholastic works is a central goal for the SCTA. However, one might point out that, to varying degrees, this is also the aim of many world libraries and digital repositories. However, what may be less obvious to the non-specialist of scholastic texts is that simply identifying top level expressions will yield a quite limited and fairly uninformative network or graph. For example, a graph that records that the scholastic author Henry of Ghent quotes a passage from somewhere in Aquinas' *Commentary on the Sentences of Peter Lombard*, somewhere in his seminal work, the *Summa quaestionum or-*

17 For more on FRBR see Peter Noerr et al., "User Benefits from a New Bibliographic Model: Follow-up of the IFLA Functional Requirements Study," paper presented at 64th IFLA General Conference, Amsterdam, Netherlands, 16 – 21 August 1998, http://www.ifla.org/IV/ifla64/084-126e.htm; Edward T. O'Neill, "FRBR: Functional Requirements for Bibliographic Records," *Library Resources and Technical Services* 46, no. 4 (2002): 150 – 59, https://journals.ala.org/index.php/lrts/article/view/5272; Rick Bennett, Brian F. Lavoie, and Edward T. O'Neill, "The Concept of a Work in WorldCat: An Application of FRBR," *Library Collections, Acquisitions and Technical Services* 27, no. 1 (2003): 45 – 59, https://doi.org/10.1080/14649055.2003.10765895.

18 For a discussion of how to understand these concepts, see Jeffrey C. Witt, "A SCTA Modeling Proposal," *Jeffrey C. Witt* (blog), 12 June 2016, http://jeffreycwitt.com/2016/06/12/scta-modeling-proposal; and *idem*, "DSE's and API Consuming Applications."

dinariarum, is about as general as saying Shakespeare quotes the Bible. In both cases, this is so general as to be both obvious and useless. We would rather like to know in which verse, scene, and act of which play Shakespeare quoted which book and verse of the Bible. From that we could ask how often Shakespeare quoted which verses from which books in which plays. Similarly, we do not simply want to know that Henry of Ghent quoted Aquinas; we want to know which precise passages of Aquinas' corpus Henry quoted, in which passages of his own work he quoted Aquinas, whether other scholastic authors mention or quote this precise passage, and whether they do so in similar or different contexts as Henry of Ghent. A catalogue that only records top level expressions is woefully insufficient for these kinds of queries.

Thus, the Expression Description File is a specification that begins the process of cataloguing every level of the text hierarchy from the top level down to a specific level (called the "Structure Item" level), a level determined as the desired division of transcription files. From here, an aggregator can link to individual transcriptions representing the rest of the hierarchy within a text. The hierarchy within this transcription file can then be used to populate the rest of the expression hierarchy to which all further information about manifestations and transcriptions will be mapped. In this way, each level within the hierarchy will *eventually* be catalogued first and foremost as an expression. This means that we mint an ID not only for a specific transcription of a part of a text, but also for the abstract idea of this text part.

Using this hierarchy and the Expression Description File, an aggregator can then begin to generate IDs for every manifestation (and every digital transcription of every manifestation) that corresponds to every chapter, paragraph, and quotation, eventually enabling links from these manifestations back to the corresponding expression IDs. In this way, we model FRBR relationships across all levels of the expression hierarchy, treating the text as an Ordered Hierarchy of Content Objects or OHCO.[19] This is the kind of networking that allows client presentation applications to offer users a choice between the various manifestations of any quote, paragraph, or division, and likewise for every transcription of every manifestation. Figure 2 below illustrates this kind of mapping at multiple levels of the text hierarchy.

It is important here to reiterate the social change that is required alongside the practical technical requirements in order to enable that change. It is rather common for researchers and editors to create and publish question lists of little

19 For more on OHCO, see Steven J. DeRose, "What Is Text, Really?" *Journal of Computing in Higher Education* 1, no. 2 (1990): 3–26.

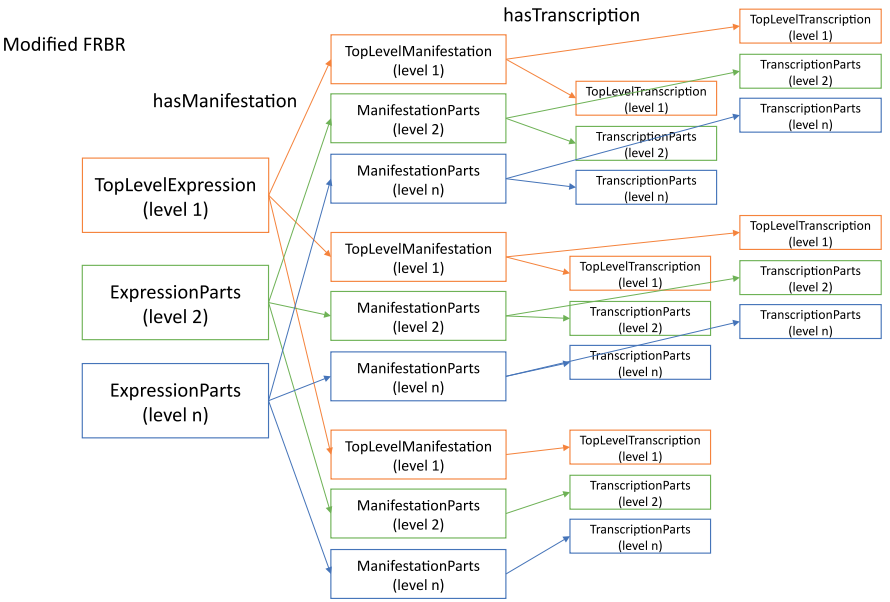

Figure 2: Illustration of expression, manifestation, and transcription relationships between distinct levels of the text hierarchy.

known or newly discovered items.[20] But these question lists are usually visually formatted in a Word document and then printed by a publisher in a proprietary format, where the sole expected use of this data is for it to be read by a human reader. The Expression Description File is an attempt to offer an alternative format: a format that can give us everything that the old workflow gave us (including a nicely formatted list of questions, that if desired can be presented in a PDF, on a static website, or in a printed article). However, because it is thoughtfully structured data according to a community standard, that same data can be aggregated by a machine to begin the process of building a connected corpus. As exemplified here, a large part of what the SCTA is trying to do is to provide a new and better workflow and data structure for the data collection that we,

20 See e. g. Paul M. Bakker, "Natural Philosophy and Metaphysics in Late Fifteenth-Century Paris. I: The Commentaries on Aristotle by Johannes Hennon," *Bulletin de philosophie médiévale* 47 (2005): 125 – 55; *idem*, "Natural Philosophy and Metaphysics in Late Fifteenth-Century Paris. II: The Commentaries on Aristotle by Johannes le Damoisiau," *Bulletin de philosophie médiévale* 48 (2006): 209 – 28; *idem*, "Natural Philosophy and Metaphysics in Late Fifteenth-Century Paris. III: The Commentaries on Aristotle by Johannes de Caulaincourt," *Bulletin de philosophie médiévale* 49 (2007): 195 – 237.

as scholars, already do collect. But because this data is prepared only for visual presentation and we usually have little concern for the underlying data, the community is prevented from taking full advantage of our collective work.

As we will see below, when it comes to the preparation of text editions and transcriptions, we aim to provide similar pathways for doing what we already do in better ways.

3.1.2 LombardPress TEI Schema

As noted above, the Expression Description File is not the only specification needed to allow aggregators to build a complete graph. To build a list of expressions down to the paragraph, quotation, and reference level, we also need to create transcriptions of the actual texts.

The SCTA aggregator, for example, begins by crawling an Expression Description File. At each "Structure Item," the crawler begins to look for a transcription file. We then use this default transcription file to populate the rest of the expression text hierarchy, to which individual manifestation resources can be mapped, and to which individual transcription text fragments can be mapped in turn (see Figure 4 for reference).

The ability to crawl millions and millions of words and thousands and thousands of paragraphs and to reliably organize this data requires data integrity. When it comes to establishing data integrity of text transcriptions, the Textual Encoding Initiative (TEI) is the right starting place. But what is not always obvious to those starting out, and often neglected by those trying to convince others of the merits of TEI, is that TEI itself is not a guarantee of data interoperability. Hugh Cayless, former chair of the TEI Technical Council, writes:

> Just because two documents are marked up in TEI, that does not mean they are interoperable. This is because each document represents the editor's *model* of that text. Compatibility is certainly achievable if both documents follow the same set of conventions, but we shouldn't *expect* it any more than we'd expect to be able to merge any two models that follow different ground rules.[21]

21 Hugh Cayless, "TEI is a text modelling language," *Scriptio Continua* (blog), 11 January 2011, http://philomousos.blogspot.com/2011/01/tei-is-text-modelling-language.html.

TEI is a base standard designed for further customization and refinement. By itself, TEI offers an editor a wide variety of acceptable encoding practices.[22] In order to build the kind of network described above, tighter restrictions need to be enforced. In this respect, the SCTA, by demanding that corpus texts follow supported schema customizations, has chosen to privilege a particular way of modeling texts in order to create an interoperable corpus.

The SCTA community works hard to maintain such a standard. While it is possible for more than one such standard to exist and to be supported by the community, the current supported standard is the LombardPress Schema for critical and diplomatic transcriptions which was developed by the SCTA community.[23]

With this standard, we are looking to affect a social change within the field. We are asking editors, who in their preparation of print editions are already collecting the kind of data we need, to make corpus connections. Every time a name is capitalized, a title is italicized, or a quotation is surrounded in quotation marks, valuable data is being created. Unfortunately, this data is being recorded visually and therefore in an imprecise and non-machine-actionable way. The LombardPress standard exists to alert editors to the fact that there is a better way to do what you are already doing. Recording (or exporting) one's data according to this schema rather than preserving it in Microsoft Word's proprietary format allows us to both continue producing beautiful print layouts (see Figure 9), but also to exploit the data encoded in these editions to construct a connected corpus.

3.2 Connecting decentralized data / the SCTA aggregation and SCTA RDF Schema

Through exporting to a common standard, independent services can then index and re-index the diverse data created by distributed groups in different ways depending on the service provided. One such example is the SCTA RDF Triple Store

22 See Syd Bauman, "Interchange vs. Interoperability," paper presented at Balisage: The Markup Conference 2011, Montréal, Canada, 2–5 August 2011, in *Proceedings of Balisage: The Markup Conference 2011*, Balisage Series on Markup Technologies 7, http://doi.org/10.4242/BalisageVol7.Bauman01; and Desmond Schmidt, "Towards an Interoperable Digital Scholarly Edition," *Journal of the Text Encoding Initiative* 7 (2014), https://doi.org/10.4000/jtei.979.

23 Jeffrey C. Witt, Michael S. Christensen, and Nick Vaughan, "The LombardPress Schema," LombardPress, 2017, http://lombardpress.org/schema/docs .

(Resource Description Framework),[24] a graph database connecting diverse data points into a connected, queryable data structure.

The construction of this graph is the task of the SCTA–RDF Builder application.[25] The builder nightly crawls new data and adds this to the existing graph. Using the raw data, structured according to the specifications described above, the SCTA–RDF Builder first crawls Expression Description Files, then crawls out to individual transcriptions (encoded according to the LombardPress Schema), as well as other data files (e. g. People Description Files and Codex Description Files), and other linked open data repositories (e. g. Wikidata, etc.). Using this information, it transforms this information into an RDF graph that adheres to another community-maintained data standard, the SCTA RDF Schema.[26] The SCTA RDF Schema is a higher order specification describing the logic and rules of the aggregated dataset. This schema itself can be versioned, so that client applications can rely on the logic of the 0.x.x network, even as the SCTA works to fine tune this schema and ultimately release a 1.0.0 specification.[27] The resulting RDF data can then be ingested into any RDF Triple Store and served over HTTP as a public SPARQL endpoint (SPARQL Protocol and RDF Query Language).[28] Further, multiple independent instances of this SPARQL endpoint can be easily run, preventing any single point of failure. At the same time, all instances can stay in sync without consultation with any other instance because no one writes to these databases directly. Instead, each instance responds to updates in the raw data layer and builds the appropriate triples according to the community-established RDF Schema.

Aggregation of this distributed data, along with computational inferences gleaned from combining this information (for example, the discovery that author Z is cited by both author X and Y) is visualized at the center of Figure 3.

24 "RDF," W3C, 25 February 2014, https://www.w3.org/RDF.

25 "scta / scta-rdf," Github, https://github.com/scta/scta-rdf.

26 "scta / scta-rdf-schema," Github, https://github.com/scta/scta-rdf-schema.

27 See Witt, "A SCTA Modeling Proposal."

28 "SPARQL Query Language for RDF," W3C, 15 January 2008, https://www.w3.org/TR/rdf-sparql-query.

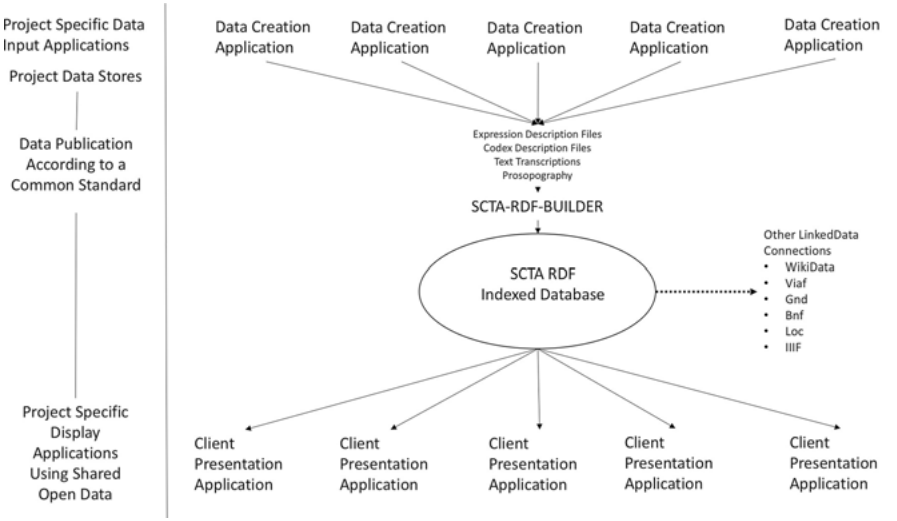

Figure 3: Illustration of data aggregation of the SCTA raw data layer and exposure via public SPARQL endpoint for use by client presentation applications.

3.3 Disseminate and publish through APIs / decentralized data presentations

Finally, aggregators, in turn, can offer a new set of APIs tailored to different presentation applications that can make use of the connected graph in a variety of ways.

Figure 4 offers a simple visualization of how an independent data standard enables data reuse by presentation clients. Data can be created by diverse groups and diverse projects, but once aggregated by the SCTA, the created data, along with the additional information inferred by the computer, becomes available according to documented standards and APIs. Presentation clients can then be written to understand these APIs, agnostic to where and how the data was originally created.

The public SPARQL endpoint constitutes the first and most flexible API (Application Programming Interface) that client applications use. Client applications can then send SPARQL queries directly to this endpoint, receive back JSON data, and begin to display this data however they desire. The SPARQL endpoint likewise is also the point from which more specialized APIs can be created. For

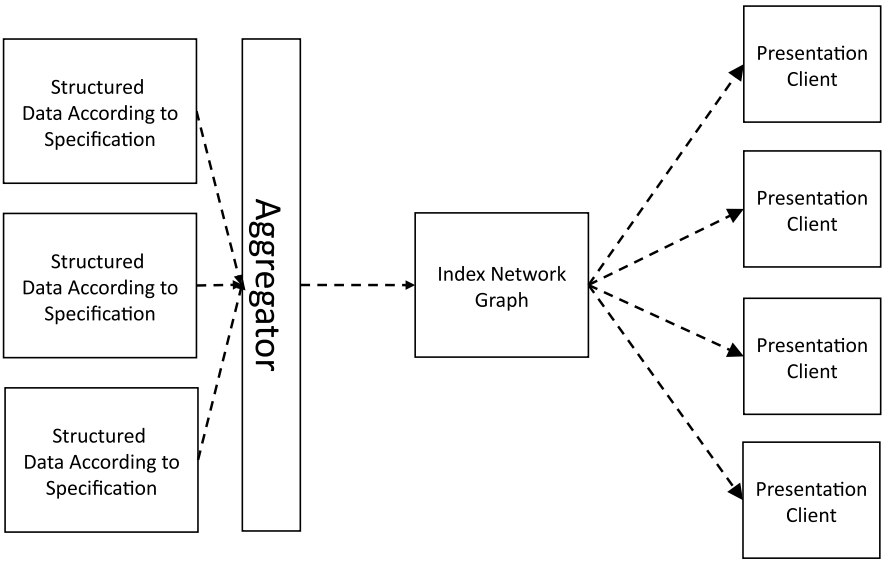

Figure 4: Data reuse by data presentation clients.

example, for digital images of manuscripts, the SCTA offers a IIIF API,[29] which offers IIIF collections, manifests, annotation lists, and ranges, which can be used directly by IIIF compliant viewers.[30] This API is built on the back of SPARQL queries and then translates this information to comply with IIIF specifications. Other APIs might include, for example, an OAI–PMH API to integrate with library discovery layers and WorldCat,[31] or a CTS/DTS API to allow SCTA texts to be viewed by clients designed for these more generic text APIs.[32] In addition to these restful APIs, there are code libraries designed to facilitate interaction with the SPARQL database, including the Lbp.rb Ruby library, the Lbppy python library, and the lbp.js library.[33] Other experimental APIs are also under development. For example, the community is working on a GraphQL API layer[34] to facil-

29 International Image Interoperability Framework, http://iiif.io.

30 Jeffrey C. Witt, "Forscher und Institutionen via IIIF verbinden," *Jeffrey C. Witt* (blog), 15 October 2018, http://jeffreycwitt.com/2018/10/15/leipzig-iiif-scta.

31 https://scta.info. NdE: Project description: https://forschdb2.unibas.ch/inf2/rm_projects/object_edit.php?r=3963280.

32 For CTS: http://cite-architecture.org/; for DTS: https://distributed-text-services.github.io/specifications/.

33 All these libraries can be found https://github.com/lombardpress.

34 See GraphQL, 2020, https://graphql.org/.

itate application queries without requiring raw SPARQL queries and simple CSV API designed for experts in corpus linguistics to easily subject the corpus to different forms of linguistic analysis.[35] While we are only just beginning to realize the potential latent in this kind of connected data, we are already starting to see a number of client applications make use of the data.

A flagship client is the LombardPress–Web application. This is a Ruby on Rails application that underlies the SCTA Reading Room.[36] This application itself is information agnostic and could be used to display any corpus that structures its data according to the SCTA–RDF Schema. On the server of this application, there is no text and there are no images. Rather, as seen in Figure 5, the application understands how to request information from the SCTA–RDF database, to use information in this database to request texts and images from distributed sources, and finally to display those resources to the end user.

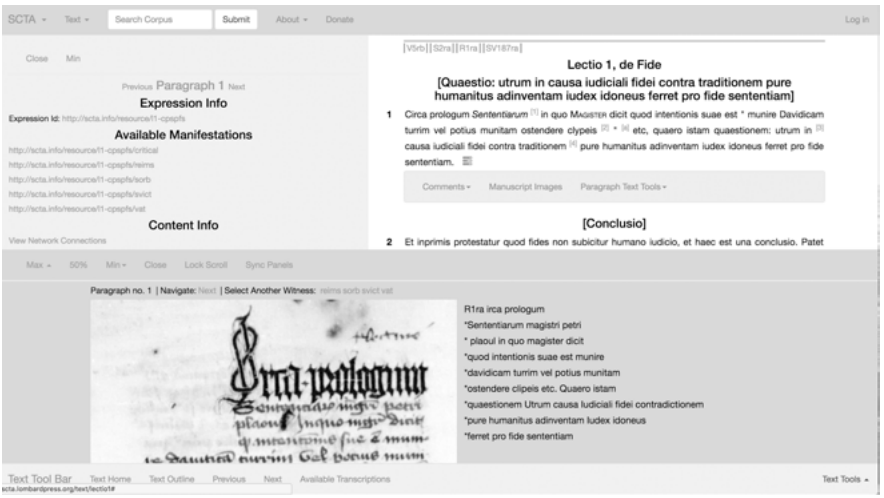

Figure 5: LombardPress–Web, showing text and images retrieved from the SCTA for end user presentation (http://scta.info/resource/lectio1).

Another example, shown in Figure 6, illustrates how this data reuse allows existing applications to enhance their own catalogue. This application offers a

35 http://community.scta.info/pages/technical-overview.html.

36 LombardPress, The SCTA Reading Room, http://scta.lombardpress.org.

web-based updated version of the Stegmüller *Sentences* commentary catalogue.[37] Rather than having to regenerate question lists, this client now easily pulls in question lists from the SCTA aggregation for each text within its catalogue.

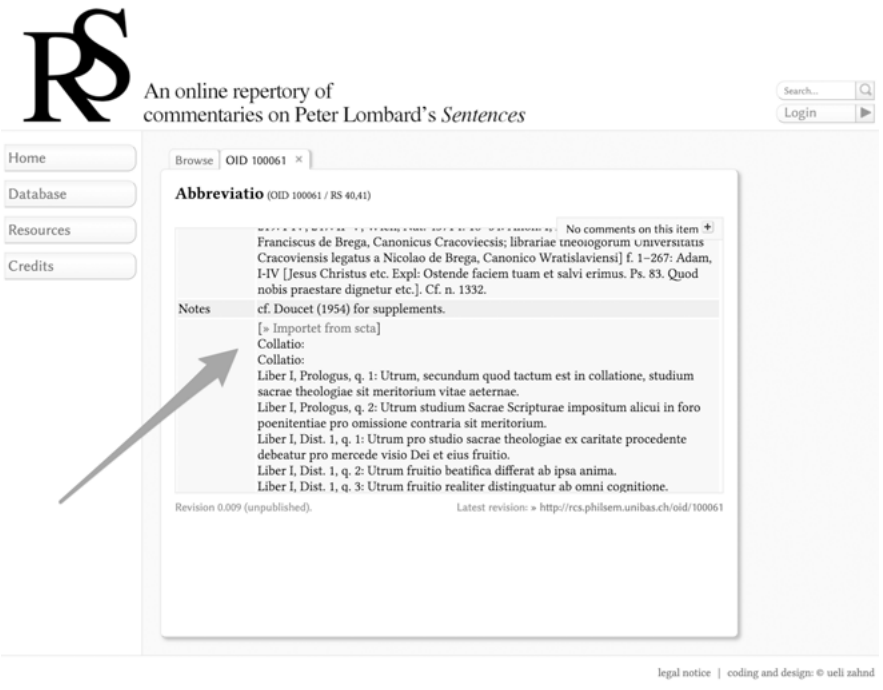

Figure 6: RCS Client showing question list retrieved from the SCTA (see https://drcs.zahnd.be/oid/100061).

Other existing client applications work in a similar fashion. The Ad fontes site (see Figure 7)[38] allows users to navigate the sources, quotations, and references of various texts as though moving through a global index, bi-directionally in time.

Such relations can also easily be visualized in another application designed to emphasize the connections between paragraphs from a bird's-eye view, as shown in Figure 8.

37 Friedrich Stegmüller, *Repertorium Commentariorum in Sententias Petri Lombardi*, 2 vols. (Würzburg: Schöningh, 1947–1948).

38 LombardPress, Ad fontes: A Scholastic Quotation Explorer, http://lombardpress.org/adfontes.

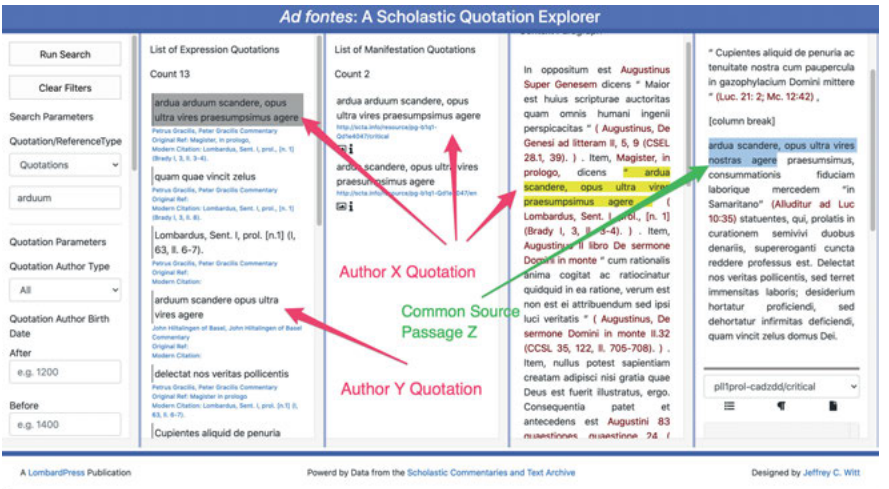

Figure 7: Ad fontes, an exploration of quotations and sources throughout the scholastic corpus.

The LombardPress–Print application[39] uses the SCTA–RDF database to locate the appropriate TEI transcription files and then produces nicely typeset PDF files (see Figure 9). Here we can see clearly that through a commitment to preparing textual data divorced from presentation, we expose the false binary between making a print or digital edition, as if one must choose one over the other. With well-prepared data, we can easily have the best of both worlds.

Figure 10 shows the SCTA Mirador site,[40] which uses the IIIF API to request transcriptions as IIIF Annotation Lists and then loads the text as annotations alongside images of corresponding manuscript pages delivered by world libraries via IIIF image servers.

It is important to emphasize that in each of these applications, users can experience the text and images of the scholastic corpus in different ways, but none of them contain the text or images as part of the application. None of them were required to create redundant data or to figure how to store and index that data within their applications. Nor do any of them silo away data, preventing other applications from using this data. Instead, each application was written with the ability to send queries to the SCTA RDF Triple Store based on the SCTA RDF specification or to consume and appropriate API tailored to the uses intend-

39 https://lombardpress.org/print/.

40 Scholastic Commentaries and Text Archive Image Viewer, http://mirador.scta.info.

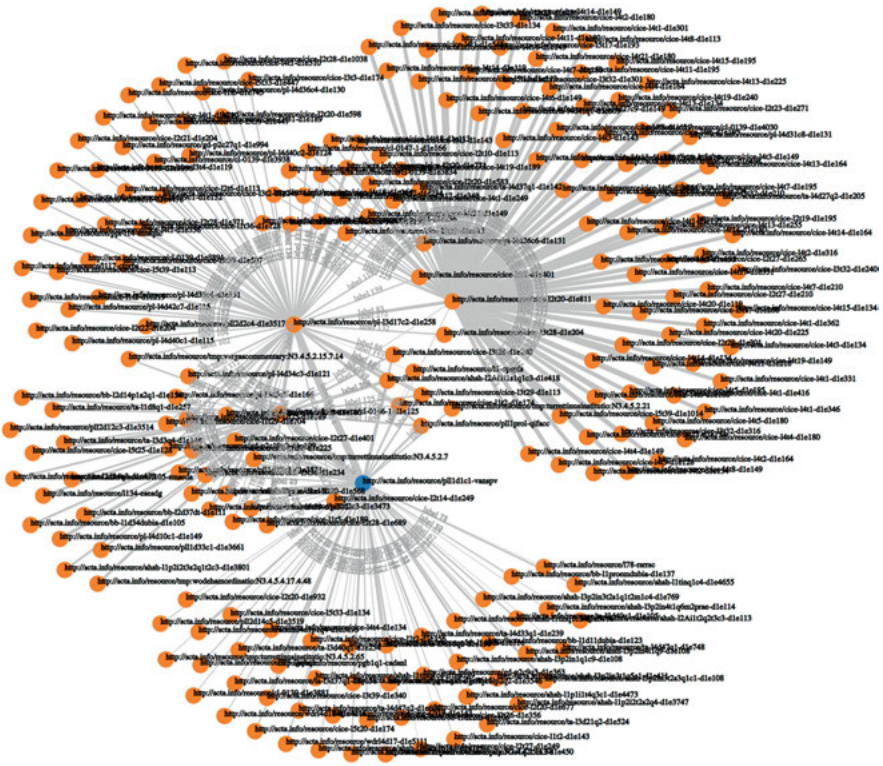

Figure 8: Text relations visualized as a networked graph.

ed by the client. Following the rules of this specification, each application is able to request the information it needs to create its desired presentation. Before the SCTA brought this data together, each application would have been responsible for re-collecting and re-indexing this data. This is an incredibly laborious task that generally prohibits people from investing time in the creation of such applications. But now that we have separated this data from any particular presentation layer, we have dramatically reduced the time it takes to create such applications.

4 Case study: the immortality of the soul

The above overview of the SCTA decentralized workflow, while technical, represents the necessary practical steps that have to be taken in order to realize the theoretical possibilities enabled by the digital medium. These practical steps

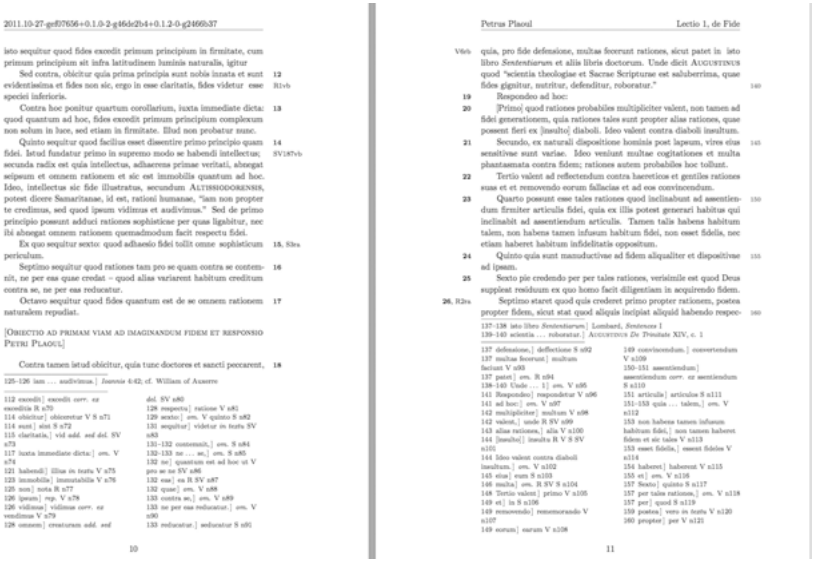

Figure 9: LombardPress–Print: SCTA data, presented in a traditional print format.

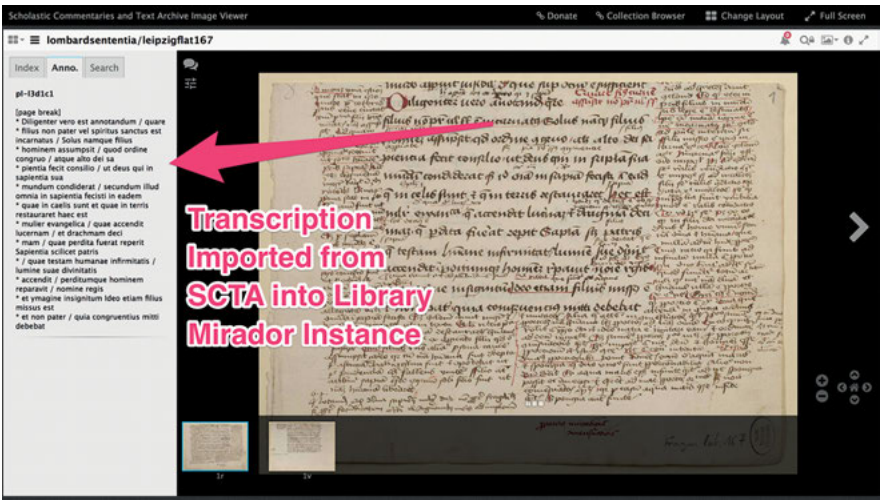

Figure 10: Mirador, displaying IIIF images alongside SCTA aggregated text content.

have already been taken by the SCTA community, and the size and connected nature of the archive grows with each passing day, enabling ever deeper insights into the connected corpus.

To illustrate the kinds of discoveries and perspectives that the resulting networked graph and accompanying client applications can present to end users, we will take up the example of the immortality of the human soul. This is a topic at the intersection between theology and philosophy, treated between 1200 and 1800 by scholastics of any provenance, and thus particularly representative of the "interwoven" of the scholastic tradition.

There are several ways a global graph could enhance research and enable new discoveries. Below we describe two ways this could happen. The first case simply shows the power of breaking down data silos and bringing together question lists from different genres in the scholastic tradition. The second case shows the power of more fine-grained connections through connecting information that is usually confined to an *apparatus fontium*. In this case, the computer's ability to index granular information and make inferences based on existing data helps us build a graph of passages connected through common quotations, references, and reused ideas.

First, discovering related material in a world where content lists are easily available to the scholar, preferably online, would mean obtaining these lists manually, wherever they may be spread across the web and physical publications. This could yield some results, but the haphazard and possibly anecdotal approach would limit the generality and reproducibility of the results. This whole feat becomes simpler with a fully indexed list of questions aggregated in one place. The main terms relevant to the problem of the soul's immortality will be *immortalis*, *(in)corruptibilis*, *aeternus*, and *perpetuus* with related cognates (e. g. forms of *corrumpere* for *[in]corruptibilis*). A search on these terms across the whole corpus yields no less than 448 text headings, but if we use the advanced filtering possibilities of the SCTA system to focus on the Aristotelian side of the corpus, this insurmountable material is reduced to 19 different texts on Aristotle's *De anima* treating this problem.

An interested scholar could then create a subscription to a specific query like the one above so that every time a change occurs relevant to her subject somewhere in the graph, she would be notified. This would mean that once other scholars register new question lists of texts containing information on this material, the results of such a search would be enhanced in a way it cannot be when the question lists are published in disparate places across the internet or in academic journals.

Second, with an extensive scholastic corpus of complete texts where all references and names mentioned are annotated systematically, the next step is to dig into this treasure trove. A good working hypothesis for such an analysis will be that if two different texts make reference to a particular passage in a textual authority, there is good reason to assume that those two texts deal with

some of the same problems. Based on that assumption, we can establish connections between texts that make no reference to each other, where the authors may not even be aware of their existence, and which may be very far from each other in space and time. Such connections can of course be curated in order of relevance of passage, amount of contained references, combination of references, etc. Seen from the perspective of graph analysis, what we do here is to discover all the (unknown) nodes that contain a reference to a passage to which one of our (known) nodes refers (see Figure 11).

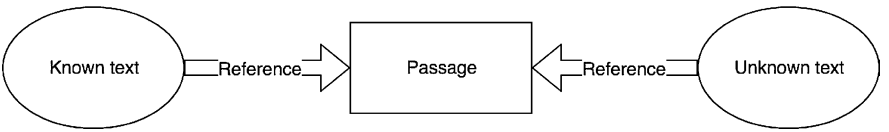

Figure 11: Connection between known and unknown text through shared passage.

A survey of the already discovered section of the Aristotelian material mentioned above would reveal to us all the passages quoted in this context.[41] Based on the working hypothesis just described, we can discover other texts which refer to the same passages and may therefore also be relevant for the analysis. The graph representation of the texts is ideally suited for these types of queries. We would thus find that on the question of immortality, two passages from Aristotle's *De anima* are central to the Aristotelian tradition (i. e. *De anima*, II.2 413b26 – 27 and II.5 430a23). Almost all of the relevant *De anima* commentaries would therefore be connected to Thomas Aquinas' *Quaestiones disputatae de anima* through their shared references to the same passages in the work. At the same time, Aquinas' work is an example of the type of text which incorporates much Aristotelian material as well as theological authorities. This composition of references on the same subject means that from Aquinas' discussion of immortality, the whole domain of theological material also opens up. For example, he refers to Augustine's *De civitate Dei* XIX, 26, which is also included in another discussion of immortality presented by Alexander of Hales.[42] In the SCTA

41 Among others, *De anima* I.1 403a10 – 13; II.2 413b26 – 27; III.4 429a10 – b5 and III.5 430a17 – 24 in whole or in part; *Metaphysics* XII.3 1070a24 – 27.

42 It needs to be noted that the prevalence of examples from Alexander Hales is due to the large quantity of Alexander of Hales material made available through funding from Lydia Schumacher's ERC Project 714427: Authority and Innovation in Early Franciscan Thought, https://www.earlyfranciscans.com/. Her project's financial investment and commitment to the semantic encoding of the *Summa Halensis* according to the SCTA community data standards is what has made these kinds of computational inferences possible. We will see more results of this kind as more

RDF database, the expression of this passage by Hales is referred to with the unique RDF ID <https://scta.info/resource/ahsh-l2Ai4t3q1t2d2c2-d1e377/>. This ID can be given to any client application, which can then render a graphical presentation to help the user navigate and traverse the graph as far as the user wishes to pursue. This is illustrated with a few of the connections in the graph in Figure 12.

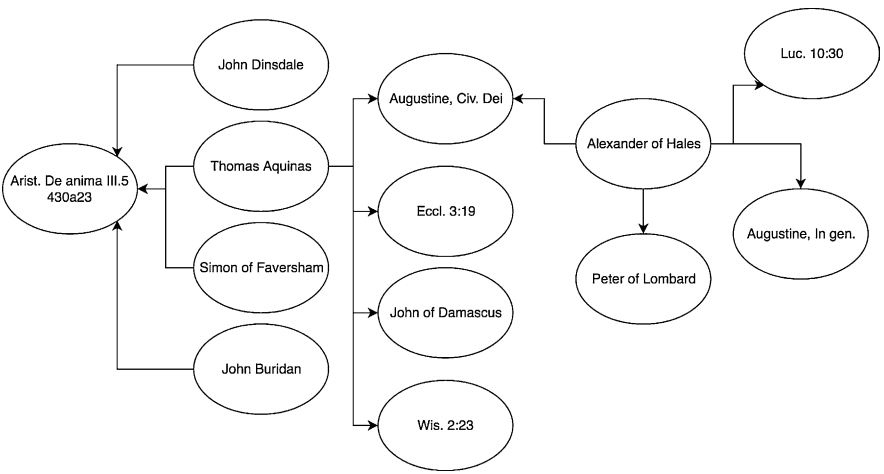

Figure 12: Excerpt of graph starting from *De anima* III.5 430a23.

Remember that this illustration only draws out a few steps in a very narrow selection of the large graph that these quotations constitute. In such a scenario, the challenge for the scholar will probably not be the *discovery* of data, but rather to find ways of *limiting* the results according to her research objectives. Such a curation of raw search results requires detailed metadata, precisely the kind of metadata that SCTA aims to organize. The connections and material discovered through such a procedure would outmatch even the most well-read scholar in its span across genres, text types, geographical areas, and periods.

If we approach the immortality question from the other end of the spectrum, we can look at it from the side of Scripture. In the second part of the second question of his *Summa universae theologiae* (or *Summa Halensis*), Alexander of Hales asks "whether indebted love is hate" (*utrum amor indebitus sit odium*). One of the objections to this claim invokes Augustine's gloss on John 12:25,

projects realize the importance of this kind of data preparation and begin making it a priority in their grant proposal.

"whoever loves his soul shall lose it." Augustine interprets this passage to mean that the "love of the soul is its destruction."[43] In his response to this objection, Hales glosses Augustine's own statement. He says that the term love of soul here means "the carnal and animal love of desire which tends toward destruction and hate of divine reformation."[44] It so happens that this quotation, John 12:25, which is used in a theological discussion of indebted love, is also used as a proof in a 17th-century *De anima* commentary for the immortality of the soul by Placidus Aegidius Melander. As far as we know, this commentary survives in only one manuscript, embedded in a codex with other printed works of similar type (UPenn Ms. Codex 855). This text stands as an example of the kind of text that one would rarely encounter or stumble across when researching arguments for the immortality of the soul. Its profile is simply not large enough to attract attention. But because the SCTA is able to connect this text to other known texts, we make it possible for it to be serendipitously discovered. In this case, Melander is concerned with the second half of the Bible verse, namely that the person who "hates his soul will save it for eternity." Thus, the argument for the immortality of the soul is based on the belief that the hate of the carnal self is rewarded with everlasting life.

Similar patterns could be followed for other verses quoted by both Hales and Melander. In his commentary, Melander argues for the immortality of the soul using the text of Matthew 10:28 and 1 Corinthians 15:19. Alexander of Hales, in turn, quotes Matthew 10:28 in at least two places. One discussion is about the nature of fear, which connects Matthew 10:28 to a quotation by Bede, Isaiah 51:12, and the ordinary gloss on Isaiah 51:12. A second use occurs in a discussion of oaths where Hales uses Matthew 10:28 as a response to an objection supported by a passage from civil law.[45] In this case, a corpus connected at the paragraph and quotation level allows us to crawl from a passage in Alexander of Hales to the uses of the same verse in Melander's *De anima* commentary, to discover other Bible verses used in support of the same premise, which again leads us back to Hales, and finally all the way out to a passage in civil law. This excerpt of the graph is illustrated in Figure 13.

As should be apparent from these two examples, this only illustrates the beginning of the kinds of connections and routes that could be taken through such a multi-dimensional network.

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43 Alexander of Hales, *Summa Halensis*, IIa–IIae, Inq. 3, Tract. 6, Q. 2, T. 2, C. 6, [n. 6]: https://scta.info/resource/ahsh-l2Bi3t6q2t2c6-d1e179.

44 Alexander of Hales, *Summa Halensis*, IIa–IIae, Inq. 3, Tract. 6, Q. 2, T. 2, C. 6, [n. 18]: https://scta.info/resource/ahsh-l2Bi3t6q2t2c6-d1e415.

45 In the Justinian Digest: http://scta.info/resource/ahsh-l3p2in3t2s1q2t2d2 m8c4-d1e474.

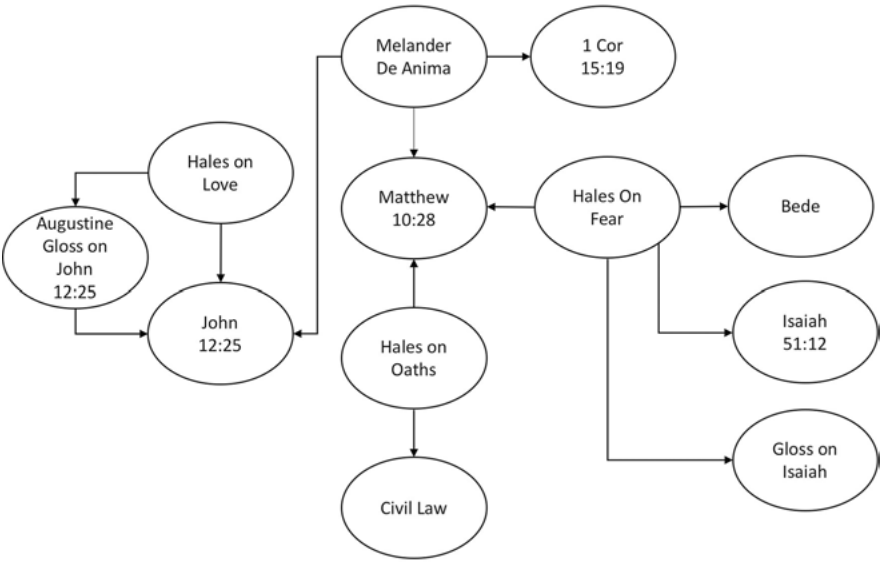

Figure 13: Excerpt of graph of references starting from Augustine's gloss of John 12:25.

5 Conclusion: the SCTA and the SCTA community

It is a curious fact that while technological advances are responsible for creating the possibility of the modern internet, the actualization of these possibilities is due in large part to social and political achievements. The HTTP protocol was not the only proposed protocol for data sharing across a network, nor is its technological achievement of earth-shattering complexity. On the contrary, it is more than likely its simplicity that made the HTTP protocol a social success. The mass adoption of this protocol is, in the end, what makes the internet possible. In a similar way, the achievement of a connected scholastic corpus is already possible from a technological point of view. The greatest hurdles to further progress are therefore social. Long-term success requires a core of committed scholars and technologists who see the long-term payoff of developing and maintaining these standards, and beyond that are willing to change ingrained habits that have been learned through years of training in a paradigm that, rather than advancing the cause, is now beginning to work against progress. A willingness to decouple textual data from presentation will always require a community of people that are committed to a long-term vision for which they are willing to sacrifice the immediacy and convenience of short term pay-offs. This decoupling of data and presentation creates an extra layer of work before one can arrive at

the first presentation. For those only interested in the immediate presentation of this work, this decoupling appears needless and burdensome. But the extra work is also what is required for our work to be reusable for the long term, by generations not yet born and in contexts not yet imagined. The SCTA is already in the midst of forming such a community,[46] and we invite those with passion for the scholastic tradition to join us.

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46 The community already has a number of active and interested contributors from partner projects in Europe and North America. For a list of participating editors and acknowledgment of contributing projects and individuals, see http://community.scta.info/. This burgeoning collaboration represents the first step in the breaking down of silos, given that without the coordination of the SCTA each project would have resorted to creating redundant websites with each project's data locked inside. Moreover, the aggregation of this data by the SCTA does not amount to simply the creation of a larger, regional silo because the SCTA has prioritized the separation of data from presentation and the making of data openly accessible and reusable according to documented standards. As mentioned above, and as Witt has shown elsewhere (e.g. Witt, "Forscher und Institutionen"), this data is available for re-incorporation and reuse in other datasets via linked data standards, such as linked data notifications and a public SPARQL endpoint.

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