Communities of Knowledge: Interreligious Networks of Scholars in Ibn Abī Uṣaybiʿa's *History of the Physicians* (Project Report)

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The project »Communities of Knowledge: Interreligious Networks of Scholars in Ibn Abī Uṣaybiʿa's *History of the Physicians*« aimed to examine the social encounters of Christian, Muslim, and Jewish scholars in the Abbasid Near East, in the period 132-656 AH/750-1258 CE. The Arabic biographical dictionary of Ibn Abī Uṣaybiʿa (b. after 590/1194, d. 668/1269 or 1270) provides rich accounts of such interactions, sometimes occurring directly between scholars, but other times involving much larger networks of people with a wide variety of religious affiliations. Ibn Abī Uṣaybiʿa weaves these figures throughout his biographical entries, revealing networks of scholarly interchange. In our project, we wanted to discover which people, places, and types of communication he shows as most central to exchange between communities of differing religious affiliations. The networks themselves we understand to be historiographical presentations by a physician who wished to trace the art of medicine through elite practitioners to his present day, relying in the process on both Islamic and other sources, as well as on information from his own broad range of acquaintances in the field.

In this project report, we describe three processes crucial to our project. First, we identified and »tagged« people and places in Ibn Abī Uṣaybiʿa's text. This included creating entries for each person or place, which also served as authority data to which we could link using tags in the text of the *History of Physicians*. Second, we created prosopographical »factoids« for passages we wanted to study in detail. These are information nuggets that record in a machine-readable way what we understand the text to be asserting about people, relationships, and events. Finally, we loaded the tagged text and factoids into networks to help identify which persons, places, or features call for in-depth qualitative study in regard to exchange between religious communities.

Keywords: interreligious networks, knowledge exchange, Near East/Middle East, Abrahamic religions, Abbasid caliphate (132-656 AH/750-1258 CE), Arabic, biographical literature, medieval science, medieval medicine, Ibn Abī Uṣaybiʿa (b. after 590 AH/1194 CE, d. 668/1269 or 1270), network analysis

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Introduction

The project »Communities of Knowledge: Interreligious Networks of Scholars in Ibn Abī Uṣaybiʿa's *History of the Physicians*« aimed to examine the social encounters of Christian, Muslim, and Jewish scholars in the Abbasid Near East, in the period 132-656 AH/750-1258 CE.[1] Its primary source was the text of Ibn Abī Uṣaybiʿa (b. after 590/1194, d. 668/1269 or 1270), a physician active in Syria and Egypt who wrote an Arabic biographical dictionary of physicians from antiquity until his time titled *ʿUyūn al-anbāʾ fī ṭabaqāt al-aṭibbā* (literally, »Choice accounts of the classes of physicians«, hereafter abbreviated as *History of Physicians*).[2] This work provides rich accounts of interactions across religious communities, sometimes occurring directly between scholars, but other times involving much larger networks of people, including students, patrons, patients, family members, and assistants. Moreover, the religious affiliations of the people he mentions are richly varied, encompassing not only a wide range of Muslims (Sunni, Shi'i, and Sufi); but also Christians from the East and West Syriac, Melkite, and Coptic churches; Rabbanite and Qaraite Jews; Samaritans; Zoroastrians; Sabians; and Hindus.

Several distinctive features allowed the project to contribute to under-researched areas. First is that it focused on social, interpersonal encounters rather than the more commonly investigated area of textual and literary exchange. Biographical works, especially those detailing social relationships as richly as Ibn Abī Uṣaybiʿa does, are uniquely positioned alongside documentary texts to reveal the specific social circumstances in which cross-communal exchange took place.[3] Second, the project explored such interactions in the context of medicine and other disciplines that are not explicitly religious. On the one hand, collaboration in such fields across Near Eastern religious communities is well known; on the other hand, texts such as the *History of Physicians* typically fall into the disciplinary domain of the history of science, where their interreligious implications may be overlooked. A third distinctive feature of the project was the attempt to transcend the biographical dictionary's explicit structure, using digital tools to take into account all the characters appearing in the text, not just those who are the subject of biographical entries.

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1   The project was funded from 2018 until 2022 under the title »Wissensgemeinschaften: Interreligiöse Gelehrtennetzwerke in Ibn Abi Usaybiʿa's *Geschichte der Ärzte*« (grant number 01UL1826X) by the German Federal Ministry of Education and Research (BMBF) in the program »Kleine Fächer – Große Potentiale« and was hosted by Ronny Vollandt, professor of Judaic studies, at the Institute of Near and Middle Eastern Studies, Ludwig-Maximilians-Universität München. Team members included Nathan P. Gibson (principal investigator); Nadine Löhr (academic associate); Vanessa Birkhahn, Hanna Friedel, Lukas Froschmeier, Robin Schmahl, Malinda Tolay, and Flavio Zeska (student researchers, in alphabetical order); and Fabio Ioppolo (intern). Carolin Willimsky (student researcher) has done additional tagging since the project concluded. The individual contributions of each of the team members will be visible as data is iteratively published to the project website.

2   Although works of the *ṭabaqāt* genre like this one provide individual biographical entries, they do not strictly qualify as »biographical dictionaries« according to Goudie, Historiography, sec. 2, who reserves the term for the alphabetically organized *muʿjam* works.

3   The articles in the thematic section of the previous volume (*Medieval Worlds*, vol. 17) include several studies emphasizing the social dimension of interreligious knowledge exchange, as well as an expanded discussion of interpersonal versus literary exchanges in the introduction (Gibson, Knowledge collaboration, 60-61). For many examples of cross-communal exchange in Arabic-speaking regions and some of the settings in which they occurred (including teacher-student relationships, patronage and clientele, and shared workplaces), see Gibson and Vollandt, Cross-communal scholarly interactions.

In the following, we introduce the text of Ibn Abī Uṣaybiʿa and then describe three processes crucial to our project: (1) tagging people and places in the text, (2) creating prosopographical »factoids«, and (3) building and analyzing networks.

Choice Accounts of the Classes of Physicians (History of Physicians)
Over the course of approximately 420 entries (*tarājim*, sg. *tarjama*) in the *History of Physicians*, ranging from a single paragraph to several pages long, Ibn Abī Uṣaybiʿa describes physicians' medical training and practice, the patrons who supported them, anecdotes of their most surprising treatments, poems composed by them or for them, aphorisms they imparted, and books they wrote.[4] Although the text was originally edited by August Müller in 1882-1884,[5] it was re-edited in recent years on a much improved manuscript basis as *A Literary History of Medicine* (hereafter »LHOM«), with a parallel English translation, by a team from the universities of Oxford and Warwick.[6] The digital version of this edition and translation was released under an open-access license, allowing it to be reused with appropriate attribution.

Ibn Abī Uṣaybiʿa's text falls into the *ṭabaqāt* genre, in which biographical entries are given for a certain category of individuals, for example, those associated with a particular place, profession, or legal school, and are arranged by »generations« or »classes« (*ṭabaqāt*).[7] It is generally agreed that this kind of taxonomizing biographical work originated in – or at least received a major impetus from – the burgeoning study of hadith.[8] Essential to the reliability of hadith reports were certain characteristics of their transmitters; thus, what was known about the individual transmitters had to be documented. Nevertheless, as the genre flourished, it was adapted in many directions.[9] Ibn Abī Uṣaybiʿa's *History of Physicians* was more focused on medicine than were *ṭabaqāt* works about the transmission of Greek sciences in general, such as those of his predecessor Ṣāʿid al-Andalusī (420-462/1029-1070) and his contemporary Ibn al-Qifṭī (568-646/1172-1248).[10] But it was also more expansive and up-to-date than the biographical collection of physicians by Ibn Juljul (332-after 384/944-after 994), with a large part of the book dedicated to developments since the fourth/tenth century.[11]

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4   The number of biographical entries and their contents differ among the three different versions of Ibn Abī Uṣaybiʿa's work. See Sánchez, Textual and manuscript tradition, sec. 5, for a detailed discussion. For an overview of what Arabic biographical entries typically contained in this period, see Goudie, Historiography, sec. 2; Khalidi, *Arabic Historical Thought*, 210.

5   Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbāʾ*, ed. Müller.

6   Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbāʾ*, ed. Savage-Smith *et al*.

7   Jaques, Arabic Islamic prosopography, 398; Goudie, Historiography, sec. 2. For some examples of how *ṭabaqāt* works were structured, see Jaques, Arabic Islamic prosopography, 406-408.

8   Jaques, Arabic Islamic prosopography, 400, compare 395-396; Goudie, Historiography, sec. 2.

9   Goudie, Historiography, sec. 2; Doufikar-Aerts, Arabic biography. Regarding historiographical concerns in medical histories, see Millán, Ibn Juljul, 142-145. For such considerations regarding Arabic biographical literature generally, including its literary aims, see Bray, Literary approaches to Arabic biography, 237-238. Also see the articles in *Medieval Worlds* 15si, especially Mahoney and Vocino, Medieval biographical collections; Heiss, Biographical collections from South Arabia; Mahoney, Obituaries in Yemen.

10   For Ṣāʿid al-Andalusī and Ibn al-Qifṭī, see Martinez-Gros, Ṣāʿid al-Andalusī, and Dietrich, Ibn al-Ḳifṭī, respectively.

11   For Ibn Abī Uṣaybiʿa's historiographical perspective, see Sánchez, Art of compilation, 77-79, 97-113. On Ibn Juljul, see Dietrich, Ibn Djuldjul. The *Taʾrīkh al-aṭibbāʾ* (»History of the physicians«) by Isḥāq b. Ḥunayn (d. 298/910) is older but is more of a chronology than a *ṭabaqāt* work as such (Isḥāq b. Ḥunayn, Taʾrīḫ al-aṭibbāʾ, ed. Rosenthal). See also the brief comparison of Ibn Juljul with Ibn Abī Uṣaybiʿa in Millán, Ibn Juljul, 143-144.

Altogether there are fifteen »classes« or chapters into which Ibn Abī Uṣaybiʿa divides the physicians recounted in his work, »with the information regarding them arranged sequentially in chronological order«, as the author states in the preface.[12] The first five of these deal with the ancient origins of medicine, and include Asclepius, Apollo, Hippocrates, Galen, and their successors. Chapters 6-7 treat pre-Islamic and early Islamic physicians. Following this, chapters 8-15 constitute the bulk of the text. Chapter 8 – one of the largest – deals with the »Syriac« (*Suryānī*) physicians of the early Abbasid period, many of them renowned, beginning with Jūrjis b. Jibrīl (d. after 152/769), the ancestor of the celebrated Bukhtīshūʿ family. Thus, chapters 1-8 are roughly chronological, covering from antiquity through to approximately the third/ninth century.

Chapter 9 carries the heading, »Physicians who translated works on medicine and other subjects from Greek into Arabic, and their patrons«. This chapter has a unique, list-like format, in which brief comments rather than long entries focus on the quality of the translators' work more than on the details of their lives or medical practice. The first part appears to be derived from an unidentified source which Ibn Abī Uṣaybiʿa and the earlier bibliographer Ibn al-Nadīm (d. 385 or 388/995 or 998) both drew from for their work; the second part uses Ḥunayn b. Isḥāq's *Risāla ilā ʿAlī b. Yaḥyā* (»Epistle to ʿAlī b. Yaḥyā«) about the translations of Galen.[13] Many of the scholars mentioned here are described in more detail in the biographical entries of chapter 8.

Finally, chapters 10-15 proceed geographically. In each of these chapters, the author recounts the lives and work of physicians from the given region up to his own times: Iraq (in the pre-modern sense) with »al-Jazīrah and Diyār Bakr« (ch. 10); Persian lands (ch. 11); India (ch. 12); »Western lands« (*bilād al-maghrib*, here used to mean North Africa west of Egypt, and Andalusia, ch. 13); Egypt (ch. 14); and Syria (*al-Shām*, ch. 15). Of these, chapters 10, 14, and 15 are the most substantial, and the latter two, representing places Ibn Abī Uṣaybiʿa himself lived and worked, are replete with information from his own experiences and networks.

Among *ṭabaqāt* literature, two things make Ibn Abī Uṣaybiʿa's *History of Physicians* particularly suitable for investigating networks extending across multiple religious communities. First, the discipline of medicine was one populated by practitioners with many different religious affiliations, as attested by a number of sources besides Ibn Abī Uṣaybiʿa, whether other biographical dictionaries, chronicles, or documentary sources from the Cairo Geniza.[14] This multi-religious cross-section of a profession is in contrast to *ṭabaqāt* works dealing with some other subjects, such as hadith transmitters, for example.

Second, over and above the nature of the discipline itself, Ibn Abī Uṣaybiʿa himself shows little overt religious bias in the way he selects and presents his biographical subjects and their networks. Both Muslims and non-Muslims receive biographical entries; both can, according to his account, be good doctors or poor ones; both can be pious or impious. To be sure, the

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12 Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbāʾ*, ed. Savage-Smith *et al.*, Preface.

13 Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbāʾ*, ed. Savage-Smith *et al.*, sec. 9.1n1.

14 See Pormann and Savage-Smith, *Medieval Islamic Medicine*, 2, and the many examples from the Cairo Geniza (Goitein, *Mediterranean Society*, 2:240-261; Lev, *Jewish Medical Practitioners*). That non-Muslims occupied prestigious positions as physicians sometimes drew criticism. See, for example, al-Jāḥiẓ's recurring critique of Christian physicians throughout his *Refutation of Christians* (Jāḥiẓ, *Rasāʾil al-Jāḥiẓ*, ed. Hārūn, 3:314-316) and al-Qalyūbī's complaint about Muslim patients preferring Jewish doctors (Sánchez, Why Muslims shouldn't practice medicine, 83-87).

selectivity of the sources upon which he relies can affect which persons from which communities appear in his history; moreover, Thomas A. Carlson argues that Ibn Abī Uṣaybiʿa was more likely to include non-Muslims as biographical subjects when they were his acquaintances than when he was drawing on historical sources farther afield.[15] But even his selection of sources is indicative, for he is not afraid to draw extensively from Christian sources such as Pethion or Ḥunayn b. Isḥāq. Where the author tells of his own intellectual lineage, he unabashedly includes non-Muslim teachers. Whatever the calculations behind Ibn Abī Uṣaybiʿa's portrayal of scholarly networks, there seem not to have been any simple formulas that automatically led to excluding or disparaging non-Muslim scholars.[16]

Although organized under rubrics devoted mostly to famous scholars, the *History of Physicians* consciously portrays its subjects within networks. R. Kevin Jaques remarks that *ṭabaqāt* texts show the authority not just of individuals, but also of »networks of ideas«.[17] The same might be said, in this case, regarding networks of *people*. Accompanying the approximately 420 subjects of biographical entries are more than 2,200 other individuals whom Ibn Abī Uṣaybiʿa mentions within the entries.[18] Many of these people occur in multiple entries, and the author sometimes seems to expect readers to track these actors across entries. At least in the cases of teacher-student relationships, patronage, and book dedicatees and addressees, the author traces pedigrees in a way that is reminiscent of attempts to establish the authority of a legal school or of a chain of hadith transmitters.

Ibn Abī Uṣaybiʿa's conscious selection of biographical subjects and their networks means that simply counting the persons who receive entries and categorizing them by period and religious affiliation, as Max Meyerhof and later Mohammad Hannan Hassan did, is unlikely to provide insight into the multi-religious dynamics he describes. Such a tally cannot, for example, accurately show the relative growth or decline of Muslim versus Jewish physicians.[19] This is partly because such approaches do not take into account Ibn Abī Uṣaybiʿa's selection criteria, which appear to have included whether he had access to biographical information about the person in the sources available to him, the nature of the person's intellectual lineage, and the books, poetry, and anecdotes attached to them.[20] But it is also because such approaches omit approximately 85% of the persons Ibn Abī Uṣaybiʿa discusses, those who are not the subject of biographical entries, including the many non-physicians in the work.

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15   Carlson, Garden of the reasonable, 104-106. Carlson moreover comments: »Medieval Middle Eastern society was almost certainly less Islamic and more mixed than even Ibn Abī Uṣaybiʿa was willing to admit« (*ibid.*, 100).

16   In a comment on an earlier draft of this article, Nadine Löhr pointed out that Ibn Abī Uṣaybiʿa's portrayal of non-Muslim scholars can also be weighed against the fact that he dedicated one version of his text to the Samaritan convert to Islam Amīn al-Dawlah Abū l-Ḥasan ibn Ghazāl ibn Abī Saʿīd (d. 647/1249; see Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbāʾ*, ed. Savage-Smith *et al.*, Preface and sec. 15.49.1).

17   Jaques, Arabic Islamic prosopography, 408.

18   This number is based on 2,416 persons from the LHOM index and 230 additional persons we have identified during the course of our tagging work on chapters 8-15, as of 30 January 2023.

19   Meyerhof, Quelques médecins juifs; Hassan, Jews in the development of sciences. See the evaluation in Carlson, Garden of the reasonable, 100, 104-106, regarding the fundamental flaws of this approach as well as problems with both Meyerhof's and Hassan's assumptions.

20   Compare Ibn Abī Uṣaybiʿa's selectivity with that of Ibn Juljul (Millán, Ibn Juljul, 149-150).

Tagging Persons and Places

In order, then, to trace the interreligious relationships Ibn Abī Uṣaybiʿa presents in his text, it was necessary to decide which entities should be represented in these networks and then identify and collate references to them in the source. Persons and places were of primary relevance to the project's goals. Moreover, since the project focused on the Abbasid period (132-656/750-1258), the selected corpus consisted of chapters 8-15. This would enable closer prosopographical work on persons appearing throughout the text and provide a survey of the text's networks by showing which people or places were involved with each other in the same passages.

Accomplishing this involved two steps: establishing identifiers for persons and places and then tagging their occurrence in the text. First, the project team created authority lists of persons and places on the basis of the LHOM edition's index, assigning Uniform Resource Identifiers (URIs) with the base usaybia.net/person/ or usaybia.net/place/ plus a unique numeric ID to each entity. We did this using a shared spreadsheet in Google Sheets, which could be updated by any team member, and which used formulas to generate unique IDs and extract or match particular kinds of data (such as names, dates, textual references, and relationship keywords) from the index entries. The spreadsheet was also a convenient way to search for URIs for specific persons or places.

We added new entries with corresponding URIs to this list as we encountered places or persons not mentioned in the index. Since we were concerned primarily with individuals, the only groups we included in our list of persons were small ones whose membership was unambiguous but for whose members we did not have individual references. Thus we excluded tribes (Banū Awd), ethnicities (Nabataeans), and institutions or schools of thought (Muʿtazilites). Such large, subjective, and fluctuating groups would be poorly suited to analyzing in a network alongside individual actors who might belong to them. We did, however, include as persons both legendary figures (Achilles) and anonymous individuals, since these are part of Ibn Abī Uṣaybiʿa's representation of relationships between individuals. For anonymous persons, we modeled our practices after those of the »SPEAR: Syriac Persons, Events, and Relationships« prosopographical project (spear-prosop.org), in which each anonymous person is given an ID and a description based on the textual reference, which allows the person to be distinguished from other anonymous persons or, in some cases, even to be identified in another reference. For example, two anonymous persons who appear in the biography of al-Yabrūdī are Anonymous 2444, with the description »Father of al-Yabrūdī«, and Anonymous 2447, with the description »The man whom al-Yabrūdī watched eating too much horse meat«.[21]

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21   For the biography of al-Yabrūdī, see Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbāʾ*, ed. Savage-Smith *et al.*, sec. 15.3.

These lists of persons and places, with short descriptions, dates, and alternate names extracted from the index entries of the LHOM edition, were then turned into individual records according to the Text Encoding Initiative (TEI) guidelines for eXtensible Markup Language (XML).[22] Team members, particularly Robin Schmahl, Malinda Tolay, and Hanna Friedel, also linked many of the persons in the list to external identifiers from resources such as the Virtual International Authority File (viaf.org), Onomasticon Arabicum (onomasticon.irht.cnrs. fr), and Wikipedia. By hosting them on a server running an XML database (eXist-db) with the Srophé application (srophe.app), we could present the entries as web pages on the project website (usaybia.net), with each URI taking the user to a corresponding web page (e.g., usaybia.net/person/32). The person or place entry contains a list of all its occurrences within the text (according to the LHOM index) and additional information such as alternative names and links to other projects or databases. Planned additions to the entries include adding more name forms and occurrences attested in the text (as discovered during the tagging work) and displaying literature related to the entries (as entered and tagged by Flavio Zeska and Nadine Löhr, primarily from the bibliographies of the LHOM edition and the Ptolemaeus Arabus et Latinus project, ptolemaeus.badw.de).

Once the initial authority records and infrastructure were in place, the second step was to tag occurrences of persons and places in chapters 8-15 of the Arabic text of Ibn Abī Uṣaybiʿa's *History of Physicians*. In 2018-2019, before the publication of the LHOM edition, the base text for this tagging work was planned to be the 1884 edition of Müller. There were several problems, however, with producing a reliable electronic transcription of this. The text was poorly printed and required extensive manual correction after transcribing it with handwritten text recognition in the Transkribus software, even though we achieved a moderately good character accuracy rate of about 95%. Although we had hoped to mitigate this by aligning the results from the text recognition with a transcribed text available from al-Maktaba al-Shamila (www.shamela.ws), this text does not indicate page breaks, which we had to find manually, and its editorial conventions (vocalization, orthography, etc.) made it difficult to align with Müller's text using automated processes.

Fortunately, the LHOM edition became available in open-access from the publisher's website, downloadable in TEI-XML form. This much superior edition immediately became our new base text. Although a reliable English version was now available through the LHOM translation, we chose to continue tagging the Arabic rather than the English text, in order to capture the original formulations of names. After standardizing and formatting the LHOM files, team members Vanessa Birkhahn, Hanna Friedel, Lukas Froschmeier, Nadine Löhr, Malinda Tolay, Robin Schmahl, and later Carolin Willimsky attached URIs to person and place references.[23] These references could be names (tagged with the TEI persName and placeName elements) or indirect references (tagged with rs), such as personal pronouns, anonymous persons, or general descriptors like »son of« or »friend of«. Overall, we tagged over 10,000 occurrences of persons and places in these chapters.

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22 For the TEI guidelines, see tei-c.org/release/doc/tei-p5-doc/en/html/index.html. Our TEI-XML records can be downloaded in various versions at doi.org/10.5281/zenodo.3975505 or directly from the project's GitHub repository at github.com/usaybia/usaybia-data/releases.

23 As a rule, persons and places occurring more than once in a paragraph element (p) or list item element (item) were tagged only once within that element. Occurrences in footnotes were not tagged.

In order to effectively manage changes being made by various team members, we used GitHub as a version control and project management system. Changes to the tagged text could be tracked, reviewed, and merged, and tasks could be assigned to specific team members via the »issues« feature.

The following passage (with brackets indicating the translators' interpolations) from the *History of the Physicians* serves as an example of our tagging process:

> Abū ʿAbd Allāh Muḥammad of Malaga [in al-Andalus], the copyist, has related to me [Ibn Abī Uṣaybiʿah] that the mind of Ibn Riḍwān became deranged toward the end of his life. The reason for this change occurred during the period of the famine when he adopted an orphan-girl whom he raised in his house. One day he left her by herself in the house where he had accumulated valuables and gold worth about 20,000 dinars. She took all of it and fled. She was never heard from again, and Ibn Riḍwān was not successful in finding out where she had gone. From then on, his mental faculties deteriorated.[24]

We are able to detect four persons within the network mentioned in this paragraph: (1) Abū ʿAbd Allāh Muḥammad of Malaga, (2) Ibn Abī Uṣaybiʿa, (3) Ibn Riḍwān, and (4) the orphan girl. Two of these four persons are mentioned by their proper name, one (Ibn Abī Uṣaybiʿa) is referred to with a relational descriptor while his identity is known to us, and one (the orphan girl) remains anonymous. Accordingly, after our tagging process, the passage is marked in the following manner (here in English rather than Arabic for illustrative purposes):

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<persName ref="https://usaybia.net/person/2394">Abū ʿAbd Allāh Muḥammad of Malaga</persName>
[in al-Andalus], the copyist, has related to <rs ref="https://usaybia.net/person/926">me</rs>
[-- Ibn Abī Uṣaybiʿah --] that the mind of <persName ref="https://usaybia.net/person/1093">Ibn
Riḍwān</persName> became deranged toward the end of his life. The reason for this change
occurred during the period of the famine when he adopted an <rs
ref="https://usaybia.net/person/2503">orphan-girl</rs> [...]
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By utilizing unique and stable identifiers (that is, the URIs) this process allows us to consistently tag persons who are mentioned in the text in a variety of ways. As such, in this example we can accurately tag Ibn Abī Uṣaybiʿa, although he is simply mentioned as »me«, and link to his entry within the database. The same applies to Ibn Riḍwān, whose full name does not appear in this particular passage. Furthermore, we created a URI for the orphan girl, so that she too will receive her own entry within our database, although the text does not mention her name. This step allows any future network analysis to take unnamed actors such as this orphan girl into consideration.

In the tagging process, the encoder brings together the processes of structuring data with close reading, making a combination of quantitative and qualitative analyses possible. While close reading by a human alone could not efficiently track thousands of persons across the text in over ten thousand occurrences, machine processing alone could not resolve indirect references and nuanced hints as accurately as a researcher with knowledge of Arabic and the historical context can.

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24   Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbāʾ*, ed. Savage-Smith *et al.*, sec. 14.25.4.

It was with these factors of efficiency and accuracy in mind that we developed a particular workflow for tagging the text, partly through trial and error. At first, we expected to use the user-friendly Recogito web interface for tagging so that team members did not have to work directly in the TEI-XML code. Although this would probably now be feasible, at the time the TEI-XML export features of Recogito were not yet sufficiently developed to allow us to download our text from Recogito in the necessary format after tagging it. Instead, the team quickly learned to work directly in the code. Winona Salesky, the lead developer of the Srophé web application that visualizes our XML database on the project website, adapted the TEI Publisher Extension for Visual Studio Code (VS Code) so that the person tagging could search the person and place authorities on our website directly from the tagging application (VS Code).[25] This was done by simply highlighting a name in the text and pressing a key command. Clicking on one of the results in the sidebar inserts the persName or placeName tag with the associated URI (*see Figure 1*).[26]
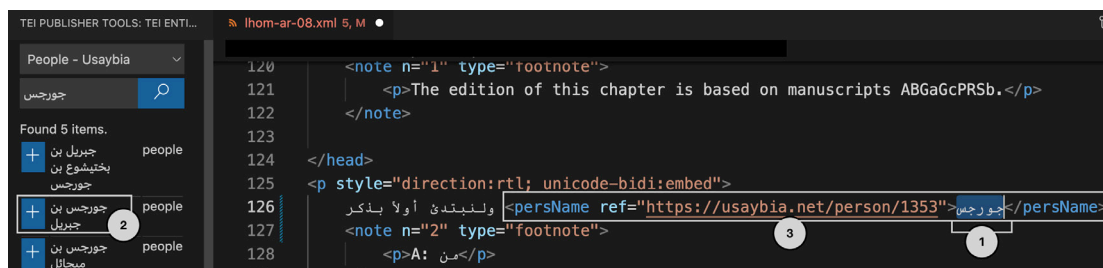

Figure 1: Tagging the personal name Jūrjis using the TEI Publisher Extension for VS Code: 1. The encoder selects the name. 2. The encoder chooses a search result. 3. The persName element and URI are automatically inserted.

The team found this process to be quite efficient compared to other methods. Although we experimented with automatically wrapping person names in persName elements by matching them against common patterns (regular expressions) for Arabic name elements (e.g., Abū, Umm, Ibn, bin, bint), the team found correcting these tags to be laborious. The primary issue was that Arabic names are composed of many elements chosen contextually: a given name (*ism*), an honorific filionym (*kunya*), one or more patronymics sometimes comprising multiple generations of a genealogy, and various other honorific and informative titles. Thus it proved difficult to construct patterns that correctly recognized the boundaries of a name. An Arabic phrase such as the word-by-word equivalent of »called Abū ʿAmr the doctor«, could be understood to refer to either one person (<persName>Abū ʿAmr the doctor</persName> called ...) or two persons (<persName>Abū ʿAmr</persName> called the doctor ...). Theoretically, a natural language processor with named entity recognition capabilities might recognize name boundaries more accurately than our pattern searches, but, given the complexity of Arabic name structures, we were uncertain that this possibility would increase accuracy and offset the time we would have needed to invest to incorporate named entity recognition into our workflow. In the context of a longer-running project with a larger dataset, this would be worth testing.

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25 github.com/eeditiones/tei-publisher-vscode. The fork of the plugin for use with Usaybia.net is at github.com/usaybia/tei-publisher-vscode.

26 See also the documentation of the feature »Entity Markup« at github.com/eeditiones/tei-publisher-vscode.

Overall, the authority creation and tagging process took the majority of the project's personnel hours and funding period, while also providing tangible data to the project's other stages. This includes a text enriched in over 10,000 loci with identifications of persons and places. It also includes name attestations and comprehensive references to augment the person and place entries. And, most importantly for the analytical aspects of the project, it allows us to explore networks of the people and places mentioned together in the text. To summarize, our tagging process allows for stable and consistent identification of known as well as anonymous entities despite their varying names and designations within the text, while building a database that is especially suitable for cross-linking to other projects and offering the potential to take otherwise obscured actors into consideration for future analyses.

Prosopographical Techniques

For the majority of Ibn Abī Uṣaybiʿa's large text, we had to be content with locating the words the author used to refer to specific people or places, due to the project's time constraints. This is sufficient for identifying which persons, places, and communicative modes should be examined more closely, but not for the closer examination itself. To achieve a deeper layer of interpretive reconstruction, we added a procedure we could implement on a case-by-case basis. Nadine Löhr's study of manuscripts connected to Ibn Riḍwān served as the best occasion to develop this.[27]

For this interpretive reconstruction, we borrowed techniques from the approach known as »factoid prosopography«. Prosopography on the whole has to do with studying a group of persons by interpreting references to them (often minor or passing ones) dispersed across a source or corpus. While this was traditionally done by constructing a narrative about each individual on the basis of these references, factoid prosopography turns each of the text's assertions about a person into structured, machine-readable data.[28] »Factoids« in this sense

> capture assertions made in primary source texts and not necessarily confirmed truths about the past. The factoid approach to prosopography thus captures the scholar's interpretation of what a historical source asserts about persons. As a result, factoids may or may not be verifiable and in some cases are demonstrably false.[29]

The »Communities of Knowledge« project is not a prosopography per se, in that it does not attempt a collective portrait of a group or class at the comprehensive level that a prosopography would. Nevertheless, we have used the factoid approach for certain passages or themes of Ibn Abī Uṣaybiʿa's text to add an interpretive, analytical layer that is closely connected to the text itself but also more machine-processable than the tagged text alone. This is especially important in the case of relationships that will be used to construct networks. On the basis of the tagged text alone, networks can be constructed that show which subjects are mentioned together, but not the more detailed nature of the relationship between them. A factoid recording a particular interaction, however, can specify quite precisely what the text has asserted and even provide machine-readable dates and places for the interaction, when the text states or implies these.

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27 One of the articles in the present volume (Löhr, Off the record) partially relates to this investigation.

28 Bradley and Short, Texts into databases.

29 Schwartz *et al.*, Factoid prosopography, sec. 5.

In keeping with our use of TEI-XML for the tagged text and authority records, we have implemented factoids in TEI using the format pioneered by Daniel L. Schwartz and colleagues.[30] For relationship types and certain other kinds of keywords, we used terms from the »Taxonomy of Syriac Studies« (https://syriaca.org/taxonomy), which had already established many of the keywords we needed and to which we submitted new terms as needed.

Overall, team members Nadine Löhr and Malinda Tolay created approximately 180 factoids, which focused on passages from chapter 14 (Egypt). Factoid types included relations, events, and personal characteristics such as occupation. The following passage and the relation factoid derived from it illustrate the model:

> Ibn Buṭlān was a contemporary of the Egyptian physician ʿAlī ibn Riḍwān, and the two of them exchanged extraordinary letters and shocking and astonishing writings. Neither of them would compose a book nor form any opinion without the other responding to it and exposing the folly of his opinion.[31]

```
<ab type="factoid" subtype="relation" xml:id="factoid-3" resp="#nloehr">
 <idno type="URI">https://usaybia.net/factoid/10-38-3</idno>
 <listRelation>
    <relation type="person" ref="http://syriaca.org/keyword/refuter-of"
       mutual="https://usaybia.net/person/961 https://usaybia.net/person/1093">
       <desc>Neither of them would compose a book nor form any opinion without the other
       responding to it and exposing the folly of his opinion.</desc>
    </relation>
 </listRelation>
 <bibl type="urn">
    <ptr target="urn:cts:arabicLit:0668IbnAbiUsaibia.Tabaqatalatibba.lhom-ed-ara1:10.38"/>
    <citedRange unit="part">2</citedRange>
 </bibl>
</ab>
```

The above factoid, authored by Nadine Löhr, captures the relationship (»refuter of«) between Ibn Buṭlān and ʿAlī ibn Riḍwān both in a narrative description and in a way that can be put into nodes and edges of a network. In the bibl element, it also provides the information for locating the assertion in a specific passage of the text.

In the example below, the encoder (again Nadine Löhr), has created an event factoid that includes her inferences about the date range in both Julian and Hijri calendars and about the place the incident occurred, in machine-readable form.

> He [ʿAlī ibn Riḍwān] adopted an orphan-girl whom he raised in his house. One day he left her by herself in the house where he had accumulated valuables and gold worth about 20,000 dinars. She took all of it and fled.[32]

30 Schwartz *et al.*, Factoid prosopography.

31 Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbāʾ*, ed. Savage-Smith *et al.*, sec. 10.38.2.

32 Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbāʾ*, ed. Savage-Smith *et al.*, sec. 14.25.4.

```xml
<ab type="factoid" subtype="event" xml:id="factoid-8" resp="#nloehr">
    <idno type="URI">https://usaybia.net/factoid/14-25-8</idno>
    <listEvent>
        <event ana="https://usaybia.net/keyword/crime">
            <desc>In
                <choice>
                    <reg>
                        <date notBefore="1053" notAfter="1061" calendar="julian">1053-1061</date>
                    </reg>
                    <orig>
                        <date notBefore="0445" notAfter="0453" calendar="hijri">445-453</date>
                    </orig>
                </choice>,
                <persName ref="https://usaybia.net/person/2457">an orphan girl</persName> whom
                <persName ref="https://usaybia.net/person/1093">he</persName> raised in his
                house in <placeName ref="https://usaybia.net/place/458">Qasr al-Sham</placeName>
                took valuables and gold worth about 20,000 dinar and fled.
            </desc>
        </event>
    </listEvent>
    <bibl type="urn">
        <ptr target="urn:cts:arabicLit:0668IbnAbiUsaibia.Tabaqatalatibba.lhom-ed-ara1:14.25"/>
        <citedRange unit="part">4</citedRange>
    </bibl>
</ab>
```

Here it would be expected that another factoid would also be created to describe the relationship between ʿAlī ibn Riḍwān and the orphan girl.

While factoids such as the above might appear arduous to code, much of the structure is formulaic. This allowed us, using VS Code's snippet feature, to create and call factoid templates with a few keystrokes, such as »abfr« for a relation factoid.[33] The result is essentially like filling in a form. We also contemplated using the persons and places tagged in the text to pre-populate draft factoids for review, but this could not be accomplished within the project's timeframe.

Network Analysis

The ultimate goal of the »Communities of Knowledge« project was to discover the people, places, and modes of communication most central to knowledge exchange between Jewish, Christian, and Muslim communities in Ibn Abī Uṣaybiʿa's depiction. Central to this is the task of constructing networks from the persons and places tagged in the text. A large-scale analysis of the data created through the tagging and factoid work is planned for a monograph and accompanying network diagrams on the project website. Nevertheless, we will explain some of the preliminary considerations for this analysis here.

As mentioned above, these networks can be constructed on the basis of two different forms of data: (1) the co-occurrence of entities (persons, places, etc.) in the tagged text and (2) factoids. The fundamental units of a network graph are nodes and edges (the connections between nodes). There are multiple ways to transform each of the above two forms of data into networks, depending on what is chosen to be the nodes and edges.

In the case of constructing co-occurrence networks from the tagged text, one reasonable approach is to show nodes as persons and the passages in which they co-occur as edges. The network-building logic is as follows:

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33 See code.visualstudio.com/docs/editor/userdefinedsnippets#_create-your-own-snippets for the custom snippets feature and github.com/usaybia/usaybia-data/blob/3c186311615e8e7b8ef37297c28293ab44f73c80/.emmet/snippets.json for our snippets file.

1. For each numbered subsection or list item in the text
    1.1. get a list of unique person URIs tagged in it.
    1.2. For each person URI in the list
        1.2.1. create an edge connecting it to each of the following person URIs in the list.[34]

This results in a network graph with many thousands of edges, which, due to its size, lends itself to quantitative analysis and, conversely, is not a feasible target of qualitative analysis until the most relevant parts of the network can be identified. This is the well known »spaghetti monster« problem (*see Figure 3*). In line with the project goals, we are looking for (1) interreligious and (2) interpersonal connections and, further, want to identify (3) the nodes most significant to knowledge exchange. The last aspect might be understood as corresponding to »centrality« in network terms, perhaps specifically »betweenness centrality«, which has to do with the number of shortest paths in a network that pass through a particular node (*see Figure 2*). In terms of knowledge exchange, this could be put as the likelihood that knowledge exchanged between groups went through a particular person.[35]
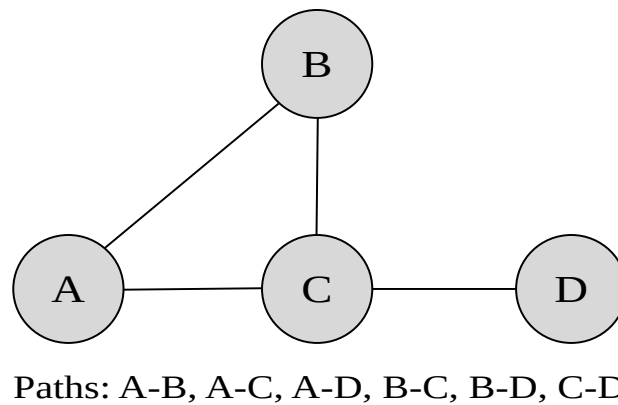
Paths: A-B, A-C, A-D, B-C, B-D, C-D

Figure 2: In this simple undirected network graph, node C has the highest betweenness centrality. When the shortest path (least number of edges) is taken between every node and every other node, more of them pass through C than through any other node.

To focus the network on (1) interreligious connections, it is necessary to label the religious affiliations of persons in the network, where discernible. This is a complex task that must be done in a nuanced way.[36] Once labeled, it is possible to use religious affiliation as a visualization feature in the network, for example indicating it through the color or position of the nodes, or even to filter the network to include only persons connected to persons across different religious affiliations.

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34   This example is non-executable pseudocode. We have typically used xQuery on the TEI documents to construct these networks.

35   For a discussion of the appropriateness of centrality measures for evaluating historical networks, see Düring, How reliable are centrality measures?

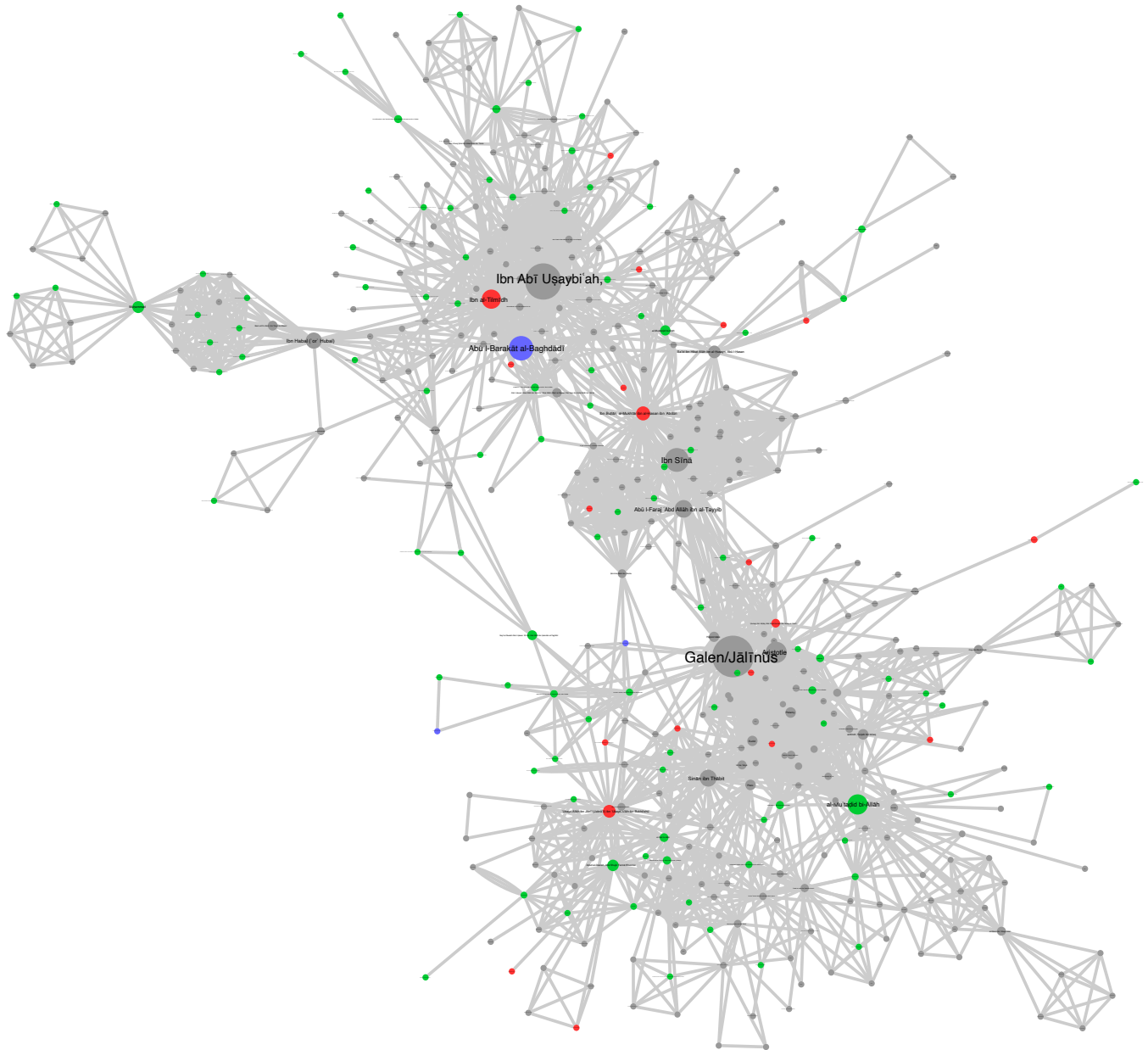36   As discussed in one of the articles in the present volume, Gibson, Labeling religious affiliation.

Figure 3: A co-occurrence network derived from chapter 10 of the History of Physicians, *illustrating a spaghetti monster of 416 nodes (persons) and 2,384 edges (co-occurrence relationships). Also note that Ibn Abī Uṣaybiʿa and Galen are most prominent in the network. Node size indicates betweenness centrality. Colors indicate religious affiliation: green = Muslim, red = Christian, blue = Jewish, gray = undesignated. Layout created with the Prefuse Force Directed OpenCL Layout in Cytoscape.*

Regarding (2) interpersonal connections, the project prioritizes understanding social interactions among contemporaries above literary exchanges that may have taken place across centuries. Truly distinguishing between literary and social interactions would require categorizing them manually, perhaps using the factoid approach above or sophisticated natural language processing. However, it is possible to eliminate at least some of the connections, those between people whose approximate life dates are known and who were not contemporaries (*see Figures 4-5*).

Another advantage of trying to limit network edges to those between contemporaries is that it is less critical to try to determine the direction of the flow of information. If Person A died before Person B was born, Person A could have transmitted information in written form or orally through a third person to Person B, but Person B could not, of course, have transmitted information to Person A. Co-occurrence networks are undirected, meaning that they do not try to distinguish the A → B relationship from B → A; instead, paths between nodes can be traversed in either direction (A ↔ B). Co-occurrence relationships between non-contemporaries, which should be directed but are in an undirected network, reduce the accuracy of network measurements that differentiate between directed and undirected networks.

In order to remove non-contemporary relationships, the work of assigning dates to the persons mentioned in the text is ongoing. Nathan P. Gibson and Hanna Friedel were able to extract dates from the LHOM index entries for approximately 850 people (around 35% of the index entries for persons). Where persons were matched with other databases (Onomasticon Arabicum, Virtual International Authority File, and Wikidata via Wikipedia), dates could sometimes be retrieved from these linked records. For the remainder of the persons, approximate dates will need to be determined based on contextual information in the *History of Physicians*. A more sophisticated approach, which we might take in the future, would be to determine the overlapping time period between person nodes and assign a date range property to the edge itself based on this.

Finally, before considering (3) betweenness centrality or indeed any quantitative metrics of the network, we must first try to account for some features of the co-occurrence networks that, for our purposes, are unwanted artifacts. For example, the subjects of the biographical entries, although often undoubtedly significant figures in the history of medicine, are exaggerated in importance in the co-occurrence networks. Each person mentioned *within* an entry is in some way connected to the person who is the *subject* of that entry. But this means that the subjects of detailed biographies have many edges (co-occurrences) and will appear more »central« in the network, simply because Ibn Abī Uṣaybiʿa devoted more attention to them (or had more source material for them). While this might reveal some of the author's priorities, it also obscures the importance of other persons whose role in knowledge exchange in this text may have been just as significant. One way to mitigate this is to look for persons in the network who have high betweenness centrality despite not being biographical subjects, or to remove the biographical subjects from the network entirely for some analyses.[37]
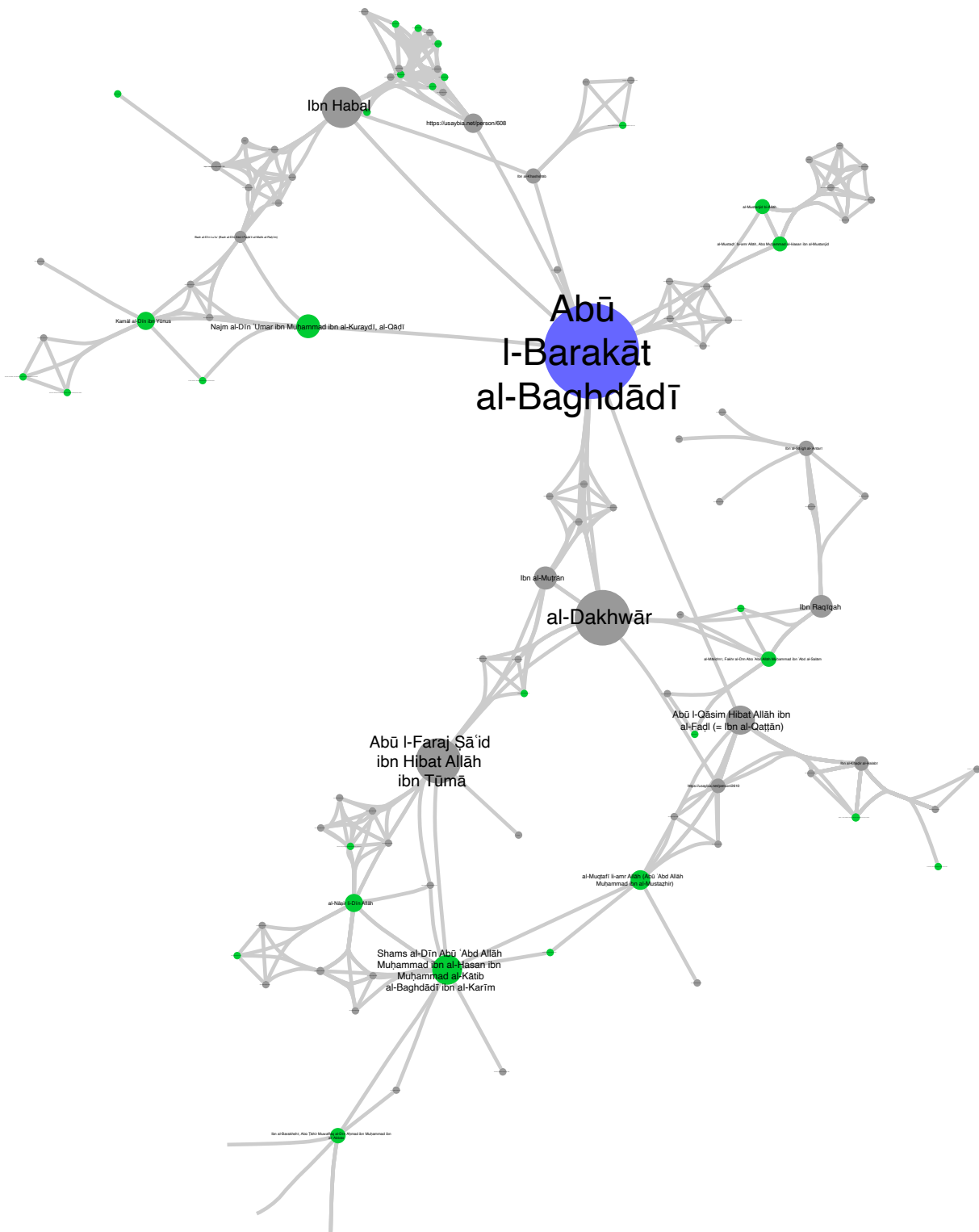

Figure 4: A co-occurrence network for chapter 10 derived from the network in Figure 3 above, having removed Ibn Abī Uṣaybiʿa as well as all persons with known dates earlier than the 6th/12th century, in order to focus on relationships among contemporaries. Note that it is now possible to clearly see interreligious connections such as those of the at first Jewish, later Muslim, scholar Abū al-Barakāt al-Baghdādī (d. after 560/1164). Key and layout: see Figure 3.
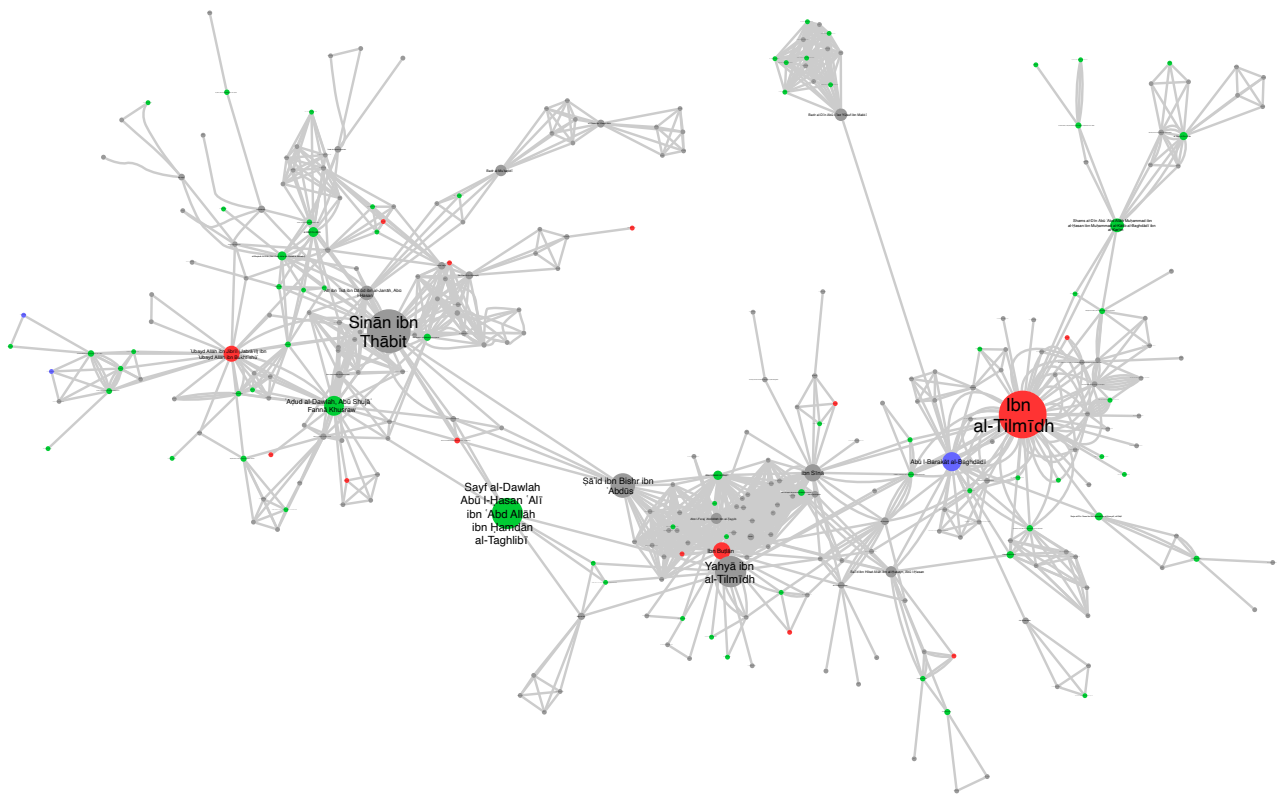
Figure 5: A co-occurrence network derived from the one in Figure 3 above, isolating persons with known dates in the 4th-6th/10th-12th century (and including persons with dates not yet designated). Although this visualization is rather more complicated than Figure 4 and shows a chronological range beyond contemporaries, the centrality of the scholars Ibn al-Tilmīdh (Christian, d. 560/1165) and Sinān ibn Thābit (Sabian, later Muslim, d. 331/943) as well as of the emir Sayf al-Dawla ʿAlī ibn Ḥamdān (Muslim, r. 333-356/944-967) can still be seen. Key and layout: see Figure 3.

Another artifact in our co-occurrence networks is the high centrality of people whom Ibn Abī Uṣaybiʿa mentions as part of lists. While people may be listed together because they share some characteristic, being mentioned in the same passage with many other people gives them many edges in the network, sometimes resulting in a high centrality that does not represent their actual connectedness (*see Figure 6*). This could be mitigated by only drawing edges when the number of people mentioned in a paragraph is below a certain threshold.

The fact that Ibn Abī Uṣaybiʿa often mentions the authors of his sources also means that the high frequency of these persons and their corresponding high centrality can obscure the social interactions we are looking for. In Figure 3, for example, a co-occurrence network from chapter 10 (physicians of Iraq), Ibn Abī Uṣaybiʿa himself as well as Galen dominate the network. It makes sense to remove these persons altogether from the network in some analyses. In future work, a list of sources could be compiled from those the editors of the LHOM text have identified and could be used to exclude persons who are probably mentioned as literary sources rather than in regard to their social interactions.[38]

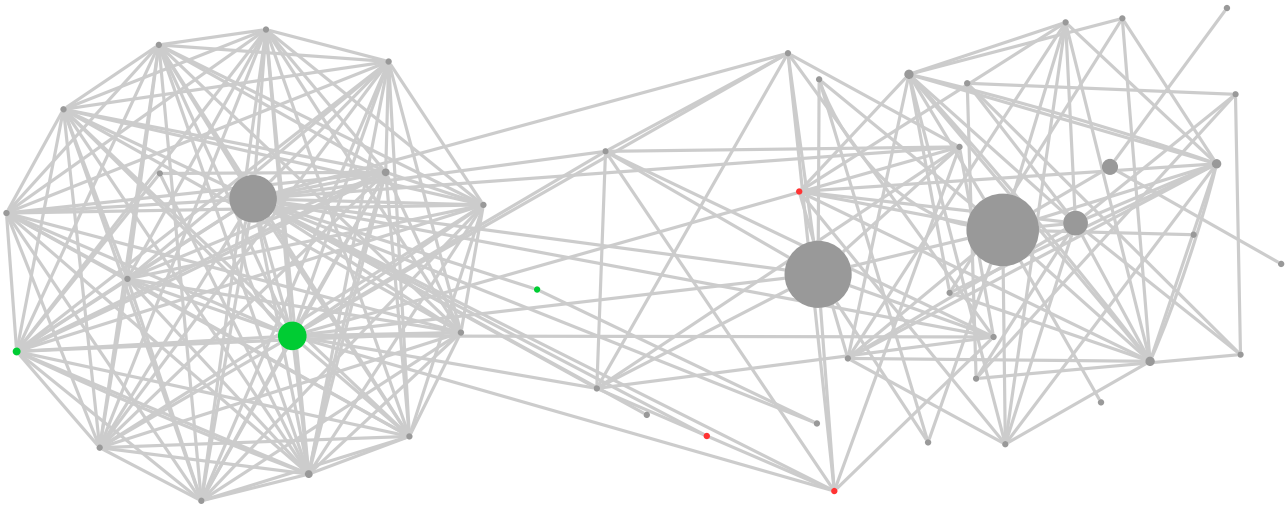
38 Sánchez, Textual and manuscript tradition.

Figure 6: Clusters like the one seen on the left of this diagram illustrate the artifact created by lists when building a co-occurrence network. In this case, Ibn Abī Uṣaybiʿa is discussing the students of Abū al-Faraj ibn al-Ṭayyib but has also provided a long list of the latter's contemporaries (shown as interconnected), who may not have interacted with him.[39]

The primary usefulness of network graphs like these is using metrics and visualizations to identify persons and relationships that need further study, whether in the text of the *History of Physicians* or comparatively across sources. For example, the above networks suggest focusing on the circles of Abū al-Barakāt al-Baghdādī, Ibn al-Tilmīdh, Sinān ibn Thābit, and Sayf al-Dawla ʿAlī ibn Ḥamdān as ones whose interreligious connections deserve further investigation – not only these persons individually (the first three of whom are biographical subjects in Ibn Abī Uṣaybiʿa) but also the figures immediately connected to them who may have facilitated such interactions. This qualitative study can be done by constructing a network with more precise relationships based on factoids, which distinguish between various types of personal and literary contact, as well as through more typical historical-critical methods with narrative description.

Finally, although our examples above apply to persons, the very same process could be utilized for places or other features. With that, it is possible to adapt the outlook of the future quantitative analysis by featuring, for example, places as nodes and persons as edges within the network.

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39   Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbāʾ*, ed. Savage-Smith *et al.*, sec. 10.37.4.

Summary

In the »Communities of Knowledge« project, we aimed to find the people, places, and communication modes that Ibn Abī Uṣaybiʿa represented as bridging various religious groups. The lion's share of this work, as we discovered, lay in identifying and tagging these comprehensively in the text of chapters 8-15 of the *History of Physicians*. By early 2020, we greatly benefited from the edited text, translation, and indices of the work created by the LHOM team. Building on this, we created individual records for persons and places with unique identifiers in the form of URIs along with a digital infrastructure to provide these TEI-XML records as (1) online entries, (2) information we could search and apply in our tagging work, and (3) entities in a linked-open-data ecosystem that included other projects. Tagging names in the text was done entirely manually, but we were able to integrate a lookup capability that streamlined the work.

Beyond tagging the text, we employed a second layer of analytic annotation in order to study certain passages in more detail. This layer consisted of prosopographical factoids, which we implemented in TEI-XML format. Factoids are self-contained nuggets expressing the reader-encoder's understanding of a particular passage in a form that can be aggregated and queried by machine. This technique allowed us to work with Ibn Abī Uṣaybiʿa's assertions, particularly about relationships, in a more precise way than we could have by simply tagging the text.

Finally, in order to locate and better understand cross-communal interactions, we loaded the tagged text as well as the factoids into networks. While the detailed analysis of these networks will be published elsewhere, we illustrated here some of the procedures we used along with their methodological challenges. Our tagging work provided the basis for co-occurrence networks, that is, networks in which entities (persons or places) appearing together in a text passage are shown as related. Besides the hindrance that co-occurrence is a very generic kind of relationship, we had to mitigate for ways that building and measuring such co-occurrence networks might misrepresent certain features of the text, including macro-structures (biographical entries) and micro-structures (lists). Overall, the co-occurrence networks are particularly useful for pointing the way to passages, persons, places, and themes in Ibn Abī Uṣaybiʿa's text that need more detailed study using factoids.

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Figure 1: Tagging the personal name Jūrjis using the TEI Publisher Extension for VS Code: 1. The encoder selects the name. 2. The encoder chooses a search result. 3. The persName element and URI are automatically inserted.

Figure 2: In this simple undirected network graph, node C has the highest betweenness centrality. When the shortest path (least number of edges) is taken between every node and every other node, more of them pass through C than through any other node.

Figure 3: A co-occurrence network derived from chapter 10 of the *History of Physicians*, illustrating a spaghetti monster of 416 nodes (persons) and 2,384 edges (co-occurrence relationships). Also note that Ibn Abī Uṣaybiʿa and Galen are most prominent in the network. Node size indicates betweenness centrality. Colors indicate religious affiliation: green = Muslim, red = Christian, blue = Jewish, gray = undesignated. Layout created with the Prefuse Force Directed OpenCL Layout in Cytoscape.

Figure 4: A co-occurrence network for chapter 10 derived from the network in Figure 3 above, having removed Ibn Abī Uṣaybiʿa as well as all persons with known dates earlier than the 6th/12th century, in order to focus on relationships among contemporaries. Note that it is now possible to clearly see interreligious connections such as those of the at first Jewish, later Muslim, scholar Abū al-Barakāt al-Baghdādī (d. after 560/1164). Key and layout: see Figure 3.

Figure 5: A co-occurrence network derived from the one in Figure 3 above, isolating persons with known dates in the 4th-6th/10th-12th century (and including persons with dates not yet designated). Although this visualization is rather more complicated than Figure 4 and shows a chronological range beyond contemporaries, the centrality of the scholars Ibn al-Tilmīdh (Christian, d. 560/1165) and Sinān ibn Thābit (Sabian, later Muslim, d. 331/943) as well as of the emir Sayf al-Dawla ʿAlī ibn Ḥamdān (Muslim, r. 333-356/944-967) can still be seen. Key and layout: see Figure 3.

Figure 6: Clusters like the one seen on the left of this diagram illustrate the artifact created by lists when building a co-occurrence network. In this case, Ibn Abī Uṣaybiʿa is discussing the students of Abū al-Faraj ibn al-Ṭayyib but has also provided a long list of the latter's contemporaries (shown as interconnected), who may not have interacted with him.