

Dhimmis and Muslims – Analyzing Multi-Religious Spaces in the Medieval Muslim World (DhiMu)

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Abstract *For centuries, specific groups of non-Muslims living in regions under Muslim rule were tolerated and, in turn, forced to accept a lower legal status called the Dhimmi status. This legal construction and political pragmatism resulted in great religious diversity in medieval Muslim cities. However, the bias of the medieval writers, who faded out the existence of the other religious communities and the traditional historical narratives have so far inhibited an empirically grounded view of the diachronic and synchronic complexity of these multi-religious populations. This project aims to collect information from primary and secondary sources on religious groups in the urban centres of the Middle East. This information must be stored digitally to aid historians in conducting interactive visual analyses. Historians study the data of religious constellations and compare regions and time periods. By recording the level of confidence together with the data, they can consider the uncertainty of data during visual analysis to improve their judgment of collected historical evidence.*

Project description

The question of how to organize religious diversity in our societies is oft-discussed and politically relevant. At the same time, religious minorities in the Middle East are facing a deadly threat. Regular violence, civil war and religious cleansing will soon wipe out the last vestiges of the region's multi-religious past. The conflict between Sunnis and Shiites is accelerating both the process of topographical separation in cities, such as Baghdad, and the destruction of written and archaeological sources.

Today, a mono-religious situation has emerged in the Middle East. During the medieval centuries, however, the majority Muslim population tolerated specific groups of non-Muslims (especially Jews, Christians and Zoroastrians), but forced them to accept a lower legal status called the Dhimmi-status. This legal construction and political pragmatism led to a great religious diversity in the medieval Islamicate world, that is, the regions of Muslim rule. Thus, diverse Muslim strands (e.g., Sunnis, Shiites) as well as different churches of Eastern Christianity (e.g., the Melkite,

the Syriac Orthodox or the Church of the East) and Jewish traditions (Karaites, Rabbanites) lived side by side in the many cities. Often three or even four Christian bishops resided in the same city. Together they formed the fabric of everyday life and culture in the Islamicate world. This grade of religious diversity is not found in the medieval cities of the Latin, Byzantine and Caucasian worlds which were dominated by Christian rule.¹

Analyzing historical evidence previously relied on printed maps. However, interactive geovisualization offers a more flexible way of presenting, inspecting and analyzing such complex information. Interactive geovisualization also provides new aspects such as the confidence of sources and the reproducibility of findings. Therefore, cooperation between historians and visualization researchers seemed natural for this project.

The project covers the historical period between the emergence of Islam in the 7th century, and the end of many Christian centres brought about by the invasion of the Mongol ruler Tamerlan at the end of the 14th century. Geographically, the project focuses on the areas of Muslim rule from North Africa to Western and Central Asia. This space is covered at the same time by the networks of the churches of the Eastern Christian patriarchates of Alexandria and Antioch, the diverse Eastern autocephalous churches, Jewish communities of different traditions, and also by other tolerated religious groups (Dhimmis) such as Zoroastrians. These tolerated religious groups are the focus of this project. Data on ephemeral religious movements, groups without an institutional framework and religious strands that Muslim authorities considered heretics or idolaters (and therefore did not tolerate), are not included in the project.

Scholars have understudied the diachronic and synchronic complexity of these multi-religious populations. Basic knowledge about the exact distribution and even the mere existence of religious groups in many places is still lacking. There are several reasons for this: Religious interaction in the medieval Muslim world, as such, is a new field that still requires a great deal of basic research (cf. *JewsEast*²; *RelMin*³). On the level of research, the dominant historical narratives of 'the Islamic culture' eclipse non-Muslim communities. The study of Eastern Christianity and of Jews in the Muslim world also predominantly focuses on the history of one denomination. While the relationship of Christians, Jews, Zoroastrians and others to their Muslim

1 Dorothea Weltecke, „Zum syrisch-orthodoxen Leben in der mittelalterlichen Stadt und zu den Huddōyē (dem Nomokanon) des Bar 'Ebrōyō“, in: Peter Bruns and Heinz-Otto Luchte (eds.): *Orientalia Christiana. Festschrift für Hubert Kaufhold zum 70. Geburtstag* (Wiesbaden: Harrassowitz Verlag, 2013).

2 Alexandra Cuffel, "Jews and Christians in the East: Strategies of Interaction from the Mediterranean to the Indian Ocean", <https://www.jewseast.org/>.

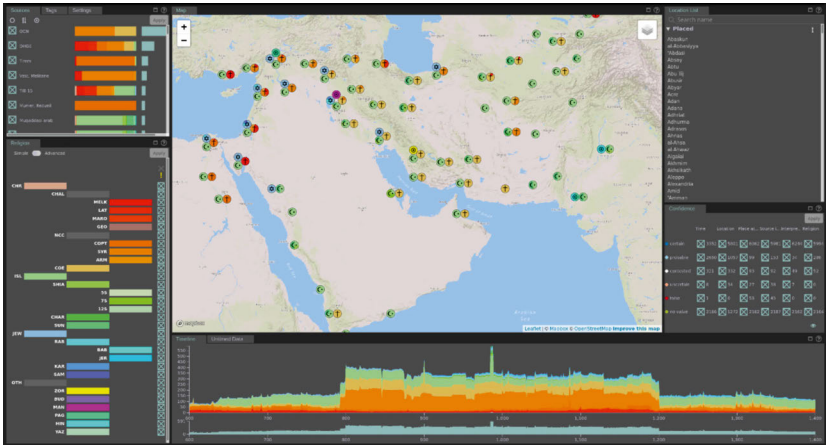
3 John Tolan, "RelMin: The Legal Status of Religious Minorities in the Euro-Mediterranean World (5th–15th Centuries)". <https://www.cn-telma.fr/relmin/index/>.

overlords is a traditional field of research, the analysis of concrete spatial constellations that integrate different groups is still a desideratum. Thus, historical narratives are still based on impressions of singular sources and traditional views rather than empirical data. The historical sources, however, suppress competing religious groups. Often, they primarily report on matters concerning their own community and are less interested in describing everyday interactions with others in any detail.

We want to help overcome the persistent confessional tendency of research and treat all religious communities as one population that shares a common social space. The historical and textual data that we have gathered from a variety of printed sources in different languages and qualities is being integrated into a single repository for the first time. To establish geographical coordinates, we use digital databases of projects like Pleiades⁴ with subprojects such as DARE⁵, syriaca.org⁶, the Prosopographie der mittelbyzantinischen Zeit⁷, the Encyclopaedia of Islam⁸, Encyclopaedia Judaica⁹ and many more. Digital visualization makes our historical data more approachable, surmounting the limits of linear text reading. This way, we seek to produce visual means to study hotspots of multi-religious existence and provide a diachronic as well as geographical perspective to the communities' expansion and contraction.

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- 4 Roger Bagnall and Richard Talbert (eds.), *"Pleiades: A Gazetteer of Past Places"* <https://pleiades.stoa.org/>.
 - 5 Johan Åhlfeldt, "DARE: Digital Atlas of the Roman Empire", <https://dh.gu.se/dare/>.
 - 6 Nathan P. Gibson, David A. Michelson and Daniel L. Schwartz (eds.), "Syriaca.org" <http://syriaca.org/>.
 - 7 Ralph-Johannes Lilie, et al. (eds.), *Prosopographie der mittelbyzantinischen Zeit. Erste Abteilung (641–867). Nach Vorarbeiten Friedhelm Winkelmanns erstellt von Ralph-Johannes Lilie, Claudia Ludwig, Thomas Pratsch, Ilse Rochow und Beate Zielke unter Mitarbeit von Wolfram Brandes und John Robert Martindale. 7 Volumes* (Berlin: de Gruyter, 1998–2002); Ralph-Johannes Lilie, et al. (eds.), *Prosopographie der mittelbyzantinischen Zeit. Zweite Abteilung (867–1025). Nach Vorarbeiten Friedhelm Winkelmanns erstellt von Ralph-Johannes Lilie, Claudia Ludwig, Thomas Pratsch und Beate Zielke unter Mitarbeit von Harald Bichlmeier, Bettina Krönung, Daniel Föllmer sowie Alexander Beihammer und Günter Prinzing. 9 Volumes* (Berlin: de Gruyter, 2009–2013).
 - 8 Peri J. Bearman, et al. (eds.), *The Encyclopaedia of Islam. Second Edition* (Leiden: Brill, 1960–2004).
 - 9 Michael Berenbaum and Fred Skolnik (eds.), *Encyclopaedia Judaica. Second Edition. 22 Volumes* (Detroit: Thomson Gale, 2007).

Fig. 1: A screenshot of the interactive prototype developed for the Dhimmis & Muslims project. The prototype visualizes historical evidence data on the known presence of different institutionalized religious denominations in cities of the medieval Middle East. Different aspects of the data are visualized in multiple coordinated views, meaning that the application of a filter in one view affects the data in all other views as well. Also, the selection of data in one view (brushing) will highlight the same data in all other views (linking). This allows fine-grained analyses and the orthogonal combination of filters on different aspects of the data, together with an understanding of the relationships between different aspects of the data, such as temporal extent and geographical extent. The map view in the middle shows glyphs representing cities or, at lower zoom levels, clusters of cities. A glyph consists of up to four parts, three representing the monotheistic religions of Christianity, Islam, and Judaism, and the fourth representing other religions. The glyphs in combination with the interactive filtering allow exploration of the coexistence of different religions, the main focus of the project.



The results are evaluated on their confidence related to time, place, source and interpretation. The information is accessible through an interactive multiple-coordinated-views visualization (see Figure 1) process, which allows users to aggregate, correlate and compare the data visually in geo-temporal contexts while they extract the information. This approach allows the scholar to develop grounded hypotheses about the multi-religious life in Asia and North Africa. Our visualization approach is implemented by using web technology, which allows the scholar to access the data and visualization from their workplace by using their familiar web browser, instead of going through complicated installation and configuration processes of proprietary software.

The information from primary and secondary sources is stored in a relational database and is accessible for interactive analysis in the visual interface. In addition,

the final approach will offer interactive access to the annotated texts in accordance with their respective copyright restrictions. If the text is not publicly available, either a hyperlink or at least a bibliographical note is given.

Method reflection

Preliminary remarks

Our goal is to advance research and methods for both cooperative partners: We want to revive historiographical methods of heuristics and source analysis and simultaneously strengthen methods of visual analytics, advance the understanding of visual communication of data, interaction design and human cognition. Thus, we are not interested in one-sided cooperation, where information researchers simply design a tool or an environment according to the historians' suggestions. Since the beginning of our cooperation, we have taken pains to avoid such a dynamic. Visualization researchers are prepared to assist humanities scholars in deploying established techniques for their specific research questions. As the complexity of the joint project surpasses the means of such a simple implication, our cooperation must integrate the workflow and creative freedom of both sides. We carried out requirement analysis before developing concrete solutions and created a control loop to evaluate the implemented techniques. The visualization researchers also experimented with new, unproven visualization techniques and suggested solutions that the historians had not previously envisaged. We collaborate closely and discuss our problems, expectations, ideas and concerns on a regular basis. In this way, we ensure that both teams achieve their mutual goal. The structure of our contribution reflects our dialogical method and will represent the differences and similarities in our perspectives on the topics raised for a more general evaluation of our approach to a combination of historical (H) and visualization (VIS) research.

A. Quantification: How to quantify a research question from a domain field to make quantitative research possible? What is the status of statistics involved in your project?

H: For the historians, there are two basic quantitative questions at the core of this project: How many cities in the Islamic world hosted institutionalized communities of Dhimmis? How many different religious communities were living in these cities at a given point in time? Based on our previous research, we started out with a sample of 250 cities with up to 5 different communities in each. Our continuing research into written text sources led to approximately 450 cities and towns with up to 10–15 communities. These numbers represent an important initial result. While

historians are aware of the fact that the Muslim world and Muslim cities were often multi-religious, the exact distribution of non-Muslim communities is unknown.¹⁰ We currently lack even basic knowledge about the existence of religious groups in many places. Historical narratives are largely based on impressions rather than hard data. Research is hampered by the fact that the written sources of the Middle Ages tend to mask other religious communities. Thus, an integrated and empirically valid result of the research question is only possible with the visualization of data accumulated from different religious strands. Obviously, these two quantitative questions require only basic mathematics. The data do not allow of sophisticated statistical research. Additionally, the data and the number of texts we work with are rather small compared to other projects on which our partners usually cooperate.

VIS: From a visualization research point of view, collaboration with humanities scholars presents both an opportunity and a challenge: the former, because field-specific problems as well as different perspectives and workflows can result in novel and interesting visualization approaches being developed; the latter, because it is difficult to evaluate such approaches with user studies due to the relatively few experts that are typically involved. This limits the possibilities of a quantitative evaluation that would require a larger number of test subjects, ideally not involved in the project. Studies in such collaborative projects are thus often reduced to qualitative evaluations, thus limiting insights into the generalizability of the developed visualization approaches. In other words, for visualization research itself, these projects do not necessarily yield valuable new research contributions.

B. Qualitative data: How to deal with qualitative data/insights?

H: Due to the nature of our sources and the time frame of our project, we had to limit our inquiry to established religious communities. But which religious communities do we consider to be ‘established’, especially in their formative period from the seventh to the ninth century? At which point in time do we consider them to be ‘established’ communities? Additionally, the question of what we consider to be a city or a town also arises. On which definition should we base our decision regarding which settlements to study?¹¹ How do we deal with the fact that villages

10 Janet L. Abu-Lughod, “The Islamic City – Historic Myth, Islamic Essence, and Contemporary Relevance” *International Journal of Middle East Studies* 19 (1987): 155–76; Gulia Neglia, “Some Historiographical Notes on the Islamic City with Particular Reference to the Visual Representation of the Built City”, in: Salma Khadra Jayyusi, Renata Holod, Attilio Petruccioli and André Raymond (eds.), *The City in the Islamic World (HdO.Abt. 1 v. 94)* (Leiden, Boston: Brill, 2008), 1–46.

11 Abu-Lughod, “The Islamic City”; Paul Wheatley, *The Places Where Men Pray Together. Cities in Islamic Lands, Seventh through the Tenth Centuries* (Chicago: University of Chicago Press, 2001); Edmund Bosworth, *Historic Cities of the Islamic World* (Boston: Brill, 2007).

grew into cities over time, while other cities sank into oblivion? Here, the historians had to make many hard decisions and reinterpret and readjust our definitions in view of particular groups and settlements in time.

VIS: From a data-centric viewpoint, historical data are very much qualitative data, as very few aspects of them can be quantified. Many of the sources including text, images, etc., are digital representations of artefacts. From a computer science perspective, such historical and hermeneutical information lacks structure, making it difficult to handle it computationally without interpretation and assessment by historians and field-adequate preprocessing (see paragraph D). This can greatly increase computational complexity and complicates algorithmic summarization as well as reasoning while working with this data.

The same can be said about evaluative feedback collected from field experts to help in visualization research. As already discussed in A, these evaluations are mostly qualitative. While some statistics can be collected during longitudinal studies, most feedback is collected in the form of field experts' statements and as anecdotal findings.

C. Uncertainty: Historians and visualization researchers have different ideas of the concept of uncertainty.

VIS: In computer science, 'uncertainty' is an overloaded term. It is often used as a quantitative measure of data quality, for example, for the output of a machine learning algorithm. However, when historians use the term, they instead mean a qualitative measure, where the granularity and interpretation can vary individually, both between different points of data and different field experts. In the project, we decided to use the term 'confidence' to refer to these aspects. Quantifying and digitally storing such hermeneutical interpretations can be tricky: assessing them with numbers may indicate a measure of precision which is not there and, therefore, creates an additional source of uncertainty. We use a small number of categories to specify confidence, which, additionally, ensures a homogeneous interpretation by different researchers.¹²

H: For historians, confidence is a traditional mode of precise narrative description. In principle, however, confidence has been approached by visualization techniques established in the field of history, e.g., printed maps. Historians deal with different layers of uncertainty as temporal, geographical and text-critical confidence. With historical hermeneutical methods, the combination of very uncertain information may still produce absolutely trustworthy results as an historical assertion. On the

12 Max Franke, Ralph Barczok, Steffen Koch and Dorothea Weltecke, "Confidence as First-Class Attribute in Digital Humanities Data" in: Proceedings of the 4th VIS4DH Workshop. IEEE (2019).

other hand, there may be sources with a certain origin and date that nonetheless contain false or anachronistic information, as identified through historical source critique. Thus, the information they yield does not amount to an historical assertion of any validity.

D. Create interpretable models: Choosing a useful modelling framework.

VIS: In computer science, ‘interpretable’ means interpretable for the computer or the algorithm. This invariably means quantification, because computers, on a base level, can only handle numbers. On a more abstract level, this means that all data need to be conformed to some structure of values. Assumptions have to be made about invariants in the data. Almost always, the reality is more complex than the data model, and, consequently, the data must be modified to fit into the model. The goal of data visualization is to bridge the gap between data models that can be interpreted by computers and humans by finding suitable mapping to generate the visualization automatically. The data model must be created carefully so that the data are not oversimplified. After all, the resulting visualization can only represent the data as represented in the model. We have found that restricting data complexity can, to a degree, be alleviated by allowing free-text commentary to be attached to arbitrary data attributes. However, these are data that exist outside the framework of the model, such as a note pencilled in the margin of a book. As such, it is difficult to include such data in algorithmic processes and automatic visualization, and they only exist for the benefit of providing context to researchers in the humanities.

H: Historians use models to define and specify the object of their research. Preliminary research on the multi-religious history of the Middle Ages and on Dhimmis in the Muslim world shows that crowdsourced databases on Christian and Jewish communities in the Middle East generally do not yield useful results. They are simultaneously too large in scope and too arbitrary with respect to their data. Therefore, it was necessary to restrict the data we wanted to collect. A useful starting point in the spatial aspect was cities. This starting point reduced the number of places and restricted us to considering those places that were more likely to be covered by our sources. The main challenge was to single out those cities that were most relevant to our research question without distorting our results. We focused on adherents of established religions, since other, ephemeral forms of religious convictions proved to be too diffuse in their description and too unsteady to leave a social impact. Restriction to institutionalized groups rather than individuals was necessary to yield comparable and robust data that could not be found in information on the Dhimmi population in general.

From our own field of specialization, the history of Eastern Christianity, we knew that Christian history could be a good starting point to identify cities and

towns with Dhimmi groups.¹³ Since the fourth century, Christian churches have appeared as institutionalized structures with a monarchical city bishop and their integration in the diocese of the patriarchs. As bishops were systematically recorded in lists, their spatial existence was much easier to retrieve than in the case of Jewish and Muslim communities. For Christians, unlike for Jews and Muslims, detailed mapping was already available. Cities with bishops thus formed the basis of our databases. In these cities, we used synagogues and mosques, judges and schools to determine which other religious strands established religious institutions. We added cities categorized by medieval Muslim geographers as central cities, and by Jewish tradition as major centres of learning, and investigated them accordingly.

E. What is the status of machine learning in your project? What do you mean by learning within a DH framework for the hermeneutical idea of learning in contrast to the current machine learning?

VIS: We do not use machine learning.

F. How to read the neural clustering/classification by the hermeneutical 'human in the loop'?

We are unfamiliar with the concept of 'neural clustering'. Therefore, our answer relates solely to the concept of 'human in the loop'.

VIS: In visual analytics, the human in the loop is a key figure for generating knowledge. The idea is that users not only consume visualized data but also interact with them, in an iterative way, to steer and improve data quality, data analysis and data visualization. This interaction can improve data quality and user trust in the visualized data, incrementally and on many levels.¹⁴ Collaboration between field experts and visualization researchers may be essential for such incremental improvement: discussions between the two parties lead to the development of a visual analytics system tailor-made for the tasks the field experts want to perform and for their individual workflows. Field experts simultaneously learn about best practices and common techniques in VIS, which, in turn, increases their trust in the system they are using.

We believe that such iterative approaches match well with hermeneutical procedures, given that there are typical restrictions in terms of scope and expressiveness

13 Dorothea Weltecke, "60 years after Peter Kawerau. Remarks on the Social and Cultural History of Syriac-Orthodox Christians from the XIth to the XIIIth Century", *Le Muséon* 121 (2008): 311–35.

14 Dominik Sacha, Hansi Senaratne, Bom ChulKwon, Geoffrey Ellis and Daniel A. Keim, "The Role of Uncertainty, Awareness, and Trust in Visual Analytics", *IEEE Transactions on Visualization and Computer Graphics* 22 (2016): 240–249.

for algorithmic approaches. However, this does not stop scholars from leaving the traditional means.

G. (How) do you visualize the results of your dh-project? What is the status of the data visualization as a research tool/web interface?

H: Visualization was and is the main goal of our research. Traditionally, historians have used graphics and maps to visualize data, even in medieval chronicles. Graphics and maps are even more indispensable elements of data-driven research like ours. As existing digital methods would not answer our research questions, nor were existing analogous methods applicable to this case, the historians were keen to cooperate and develop new modes with greater complexity.

VIS: In this project, data visualization is not merely a means to present our results but a method for historians to reason about and create results by using an interactive visualization approach. The incremental design and evaluation of the visualization are intrinsic parts of our cooperation.

Technically, we provide a web-hosted, multiple-coordinated-views visualization for developing hypotheses and depicting results and findings. The temporal and spatial aspects of the data are visualized in separate views. Other views show the religious denominations and the uncertainty of other aspects of the data. To support a better understanding of the relationships between different aspects of the data, the views are all visually and interactively linked. Because of limits of screen size and human cognition, the data are initially aggregated; and additional detail as well as local nuances can be retrieved on demand.

Discussion

A. How did digitalization change your research/scale of research?

This question is apparently addressed only to the humanities scholars. For joint projects, one should also ask whether and how the contact with humanities and their sources changes computer science research.

H: Historians are most keen to benefit from the sheer enhancement and accessibility of data through digitalization.¹⁵ Historical research on the period from 500 to 1500 welcomes digitization of sources and access to databases, collections, archives and museums. Medievalists are less active in applying digital techniques to gather

15 Laura Busse et al. (eds.), *Clio-Guide. Ein Handbuch zu digitalen Ressourcen für die Geschichtswissenschaften*. 2. erw. und aktualisierte Auflage (Berlin: Clio-online und Humboldt-Universität zu Berlin, 2018).

information and develop critical methods. The challenge of Semitic languages notwithstanding, European text recognition and geographical visualization are among the fields best developed in this area. This focus is easily explained with the importance of textual sources for medievalists and the spatial aspect of all historical developments (comp. The HGIS Club).¹⁶ Thus, from the historian's perspective our research questions as such were designed within a fairly well-established field. Its focus on aspects of space and on the history of multi-religious constellations represents current trends in the history of religions and its cross-cultural approach. The project can benefit from further development of DH in the field as well (comp. Syriaca.org).¹⁷

At the same time, this project changes our research as we must constantly translate narratives into clear-cut definitions and numbers, and learn about professional modes of visualization. This 'culture shock' increases our awareness of the constructedness of visual representation and of research areas such as 'critical cartography', which ultimately fits in nicely with our background in post-colonial theory.

VIS: Digitalization is a prerequisite for all computational science disciplines, including visualization research.

B. What are the conflicts you experience in your own fields?

Possible conflicts may arise from researchers from different disciplines being unfamiliar with one another's terminology, their way of conducting research, and their general background knowledge of the respective fields. While terminology is discussed thoroughly when joint projects and proposals are planned, there seem to be reservations about such collaborations in both fields of computer science and humanities when it comes to publications. This may partially stem from a lack of knowledge, but there are other plausible causes as well.

VIS: The following reflects our observations made in the field of interactive data visualization in several mixed-method projects.

In general, the data visualization community is open to collaborative research endeavours for a good reason. While there is basic research in this discipline that can be undertaken without specific tasks or field-related requirements, data visualization would not make much sense without human interactants from other fields who perceive the visualized data and take action accordingly.

16 Kilian Schultes, Armin Volkman and Stefan Geißler, "The HGIS Club: Interdisziplinärer Arbeitskreis Historische Geographische Informationssysteme & Digital Humanities", <http://hgis.club/>.

17 Gibson, Michelson and Schwartz, "Syriaca.org".

Nevertheless, visualization research, similar to all other research disciplines, aims at advancing research beyond the state of the art, meaning that published work ideally contains original and novel visualization developments. Such novelty, however, may not be a collaborator's primary goal in mixed-methods projects. Often, the application of well-known visualization approaches is exactly what is required to create suitable solutions. While successful approaches can be published in the form of an application paper or design study, they are considered less impactful than general improvements and are more difficult to publish in top visualization research venues. Publication methods and research interests also have an effect on the sustainability of solutions. As things stand, the development of novel approaches in the visualization community is often fast-paced and the sustainable realization and application of these concepts are considered to be implemented by those who would like to use these approaches. Long-term development in VA research profits from exchanging these approaches between fields, adapting them beyond individual project solutions, and combining as well as developing knowledge and experience over time.

One way to circumvent these problems is to collaborate on mixed-methods problems that present the opportunity to both pursue a valid goal in the humanities/social sciences and make progress in terms of visualization development. Obviously, this restricts possible joint project setups. However, the field of data visualization is becoming increasingly receptive to mixed-methods projects. Visualization venues are explicitly requesting submission of mixed-methods approaches and specific mixed-methods venues are being established (e.g., the VIS4DH, an event co-located with the most prominent visualization conference IEEE VIS, will be held for the seventh time this year (2023)). In addition, many funding agencies are becoming aware of the value of sustainable (visualization) developments and beginning to offer funding schemes.

H: As stated, this project can only count established Dhimmi communities and cities. In terms of the complexity of religious history, this is a very limited focus, which may even be considered misleading. We are asked to justify why and how these limits are necessary and still yield robust and methodologically sound historical results. As our approach privileges institutions and social structures rather than ephemeral agency, fluidity of demarcations and change, the design will attract criticism from religious and cultural studies, too: From this point of view, the project is methodologically conservative. Here, it will be necessary to explain why stable structures and labelled affiliations may not reflect the complexity of human religious interaction. But we will be able to point out some of its conditions not taken into account before.

C. Details versus abstraction: is this a conflict/problem of reduction/simplification?

VIS: No! In our understanding, abstraction, reduction and simplification are intrinsic characteristics of data visualization that help comprehend data from abstracted perspectives and explore large and complex data. We would even go so far as to claim that a lack of abstraction or reduction indicates that there is room for improvement in an interactive visualization approach. Having said that, it is, of course, beneficial or even necessary to support interactive ways that allow scholars to understand and verify the creation of visual data abstractions by showing the (digitized) data from which they were derived.

Apart from the optimization of analysis workflows, there are also other constraints that suggest simplification, such as limited resources. They manifest both in the limit to hardware resources, such as screen estate, and in the number of elements that human cognition can possibly process at one time. Even modern screens can hardly display as much information at one time as, for instance, a large, printed map, because of spatial and screen resolution limitations. However, computer-backed visualization can harness the computing power to change the visualization on demand, thus making it interactive. Visualization literature mostly agrees on adhering to the visual-information-seeking principle, introduced by Shneiderman: “Overview first, zoom and filter, then details-on-demand.”¹⁸ Following that mantra, interactive visualizations initially show aggregated data; and, on interaction, more details are shown for a smaller subset of that data.

In our discussions, we noticed that introduction of interactive workflows in the sense of Shneiderman’s principle was a concept the historians first had to adjust to; they still very much desired to analyze—and generate—static images. The advantage of algorithmic visualization is the reproducibility of such static images, given the input data and interaction sequences. We found that the choice of aggregation was essential to adopting the resulting visualizations. In particular, the representation of aggregated data should be noticeable and meaningful; and the degree of aggregation should not be greater than what is dictated by the resource limitations. Further, we agreed that the level of aggregation or abstraction should be kept consistent at one point in time, even in locations with low information density. Doing otherwise yielded a false sense of high information density. Again, we found that a balance must be struck between the two disciplines and that design choices, such as the amount and method of aggregation, should be discussed and communicated clearly in the visualization.

18 Ben Shneiderman, “The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations”, in: *Proceedings of the Symposium on Visual Languages*. IEEE (1996).

H: In terms of our project, three aspects of our initial model proved to be problematic for the historians:

1. The visualization may suggest quantitative relations according to the size of dots or aggregations. To prevent them from being misleading, it is necessary to adapt the modelling of the visualization and categories. As historians interpret large dots as having more importance and greater weight, for example, sizes have to be adapted to meet their traditional expectations of map symbols.
2. As religious distinctions only develop over time, it is difficult to determine the exact point at which an affiliation can be defined. Here, historical research risks falling prey to traditional narratives and assumptions. Our sources were often not specific enough in their designation of strands, so we needed to assign groups to a 'generic' category, e.g., 'generic Judaism'. In the database, this could signify that the group in question either existed before the segmentation of Judaism in the Middle East into Karaites and Rabbanites or no specific information is extant, or that demarcations did not matter in this region. The visualization, on the other hand, conflates this 'generic' group with the sum of all the specific groups. In other words, the visualization does not differentiate between a settlement with only generic and vague information on Jews and another with a variety of well-defined Jewish groups (e.g., Rabbanites, Karaites and Samaritans). Thus, the individual database entries are more precise than the visualization. However, an aggregated view of the data, while not showing every detail at once, could reveal patterns and connections more clearly than a closer reading of the individual data entries would do.
3. We visualize the diversification of religious strands with hierarchical trees to indicate affiliation. But the tree graph seems to imply a model of historical partition and multiplication. The historical process is better described, however, as a reduction of the wide range of religious propositions and practices: Theological standards were constantly negotiated, as were decisions of orthodoxy and heterodoxy. Thus, the fluid beliefs and practices were reduced to more defined categories. New propositions and practices emerged and groups changed over time. We will have to explain these insights in a traditional historical narrative—or create additional graphs as illustrations.

D. Do you consider yourself a DH-laboratory?

Neither partner is exactly sure what the term 'DH-laboratory' implies. Our approach for temporal and geographical visualization will admit of a grounded hypothesis on the scale of multi-religious life in Asia and North Africa. On the one hand, we expect our project to bring the heuristics and analyses of historical information to a new level and create real progress in visualization research. Our approach and research

aims could not be realized with traditional historical techniques. We also hope to create a pilot-model for other complex research in historical topography. On the other hand, this joint project does not change theories of historical research or visual analytics. While we develop techniques of modelling and interpreting our specific data historically and with digital computation, the basic methods and assumptions underlying our cooperation, that is historical research and visual analytics, do not change.

Prospect for future DH research

VIS: DH is a very interesting direction for data visualization research because of the many tasks and research questions that are considerably different from those we see in collaborative projects with engineering, natural science and life science disciplines. In the light of these tasks and questions, we see great opportunities in joint projects with the humanities and social sciences. However, there are also differences, as elaborated in greater detail in B. One of the most important aspects of successful DH research, at least in terms of funding, seems to be sustainability of methods and tools. Interdisciplinary research is an exciting setup that can pave the way for DH research.

H: So far, the application of digital resources and techniques has changed neither the epistemological frame of our historical research nor the methods in general. Additionally, the technical expertise requires specific qualifications. This project proves that professional computer science researchers are the ideal partners for digital history problems. However, the more historians with digital skills or computer scientists with historical skills build the bridge between the two areas of research, the better basic training could be provided for all scholars. Traditionally, historians had to adapt their research designs to the conditions provided by the nature and number of sources. They always had to develop specific skills to use these sources, such as dating of charters, paper or artefacts. In a similar fashion, they will now approach digital sources and techniques with new skills and new methods of historical critique.

In this project, our mutual goal was to advance research and methods for both partners and provide new answers—as well as new questions—to both of our fields. We want to revive historiographical methods of heuristics and source analysis and, at the same time, strengthen the methods of visual analytics and information visualization. The challenges and results of our cooperation demonstrate the validity of this approach.

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