The Multiple Faces of Cultural Heritage: Towards an Integrated Visualization Platform for Tangible and Intangible Cultural Assets

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Abstract

Linking and visualizing multiple types of entities in a DH knowledge graph generates the need to deal with multiple types of data and media modalities both on the designer and the user side. The InTaVia project develops synoptic visual representations for a multimodal historical knowledge graph which draws together transnational data about cultural objects and historical actors. In this paper we reflect on the question how to integrate and mediate the informational and visual affordances of both kinds of cultural data with hybrid designs and show how a user-centered design process can help to ground the required selections and design choices in an empirical procedure.

Index Terms: Human-centered computing—Visualization—Visualization design and evaluation methods—; Applied computing—Arts and humanities——

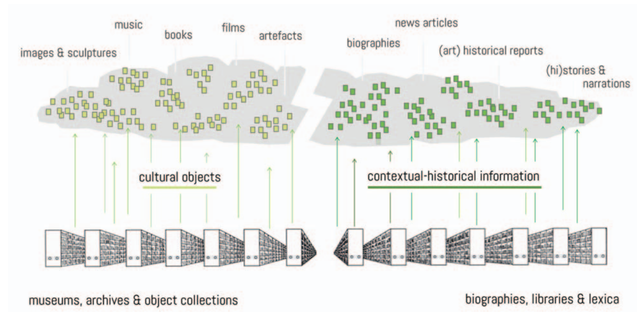

Figure 1: The InTaVia project aims to bridge the gap between mostly unconnected cultural data collections, focusing either on tangible cultural objects (left), or intangible knowledge, such as biographies or other cultural (hi)stories (right).

1 Introduction

Over the last decades, many cultural resources (such as images, objects, buildings, books, newspapers, films) have been digitized and stored as digital twins or digital relatives with highly resource-specific metadata in different local databases. To go beyond such siloed in-house databases, a second wave of initiatives aimed for the harmonization and aggregation of similar cultural assets in meta-databases (e.g. Europeana.eu for European cultural heritage). In parallel, automated extraction procedures such as language and image processing started to work their way into aggregated cultural data to extract further metadata attributes or recognize depicted or described entities. Linked data initiatives then started to classify and combine related entities and thus to build up bigger knowledge graphs of multiple types of cultural resources. These complex emerging *multimodal graphs* often connect large numbers of nodes of different entity types, media, and data schemata [12] by multiple types of semantic relations. As such, they provide a rich source for the visual analysis and communication of cultural heritage topics, but also create various complexity management challenges for visualization designers and users alike [24, 28]. On the design side, this includes the challenge to go beyond the confines of multimodal graph visualization and to effectively leverage the whole range of non-relational information (e.g., geographic, temporal, taxonomic, statistical data) for the versatile multi-perspective visualization of such graphs. On the user side, the integration of multiple types of data also broadens the group of possible users (with a broader range of tasks and practices) and increases the cognitive load of their sensemaking efforts—factors, which need to be taken into account in the visualization design and development. This paper explores how to handle such multi-focal development challenges from the viewpoint of the InTaVia project.

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The H2020 project InTaVia ("In/Tangible European Heritage – Visual Analysis, Curation and Communication", https://intavia.eu) aims to develop a platform for the visual analysis, curation and communication of a large multimodal knowledge graph for cultural heritage data. It draws together structured biographical data from multiple national prosopography projects (including Finland, the Netherlands, Austria and Slovenia) and connects this type of structured personal trajectory data to related cultural objects, which have been mostly stored separately, e.g. by aggregators such as Europeana.eu or Wikidata. Thus, for the first time, this project brings together the multimodal works and lives of artists, scientists, engineers, and other notable people—and aims to make this complex graph visually accessible by multiple methods of data visualization.

In the following, this paper sketches out the InTaVia project (sec. 2), related work on visualizing multiple types of cultural actors and objects (sec. 3) and the handling of related complex design challenges by a user-centered perspective (sec. 4). Finally, we provide an outlook on the future InTaVia project development.

2 Reconciling in/tangible Aspects of Cultural Data in a Multimodal Graph: The InTaVia project

The lives of cultural actors attract scholarly and public attention since centuries [37]—oftentimes in combination with an interest in related cultural objects. Historians and biographers have chronicled the life paths of historical individuals in their cultural contexts and accumulated this knowledge in historical libraries and lexicons in textual form. With the emergence of nation states, biographies of notable citizens have also gained symbolical and political relevance as immaterial historical assets, and became bundled in *national biographies*. These biography collections have recently been transformed by DH initiatives. First and foremost, this has been enabled by technologies of natural language processing, which allow to extract structured entities and interrelations from such historical texts and

978-1-6654-7668-3/22/$31.00 ©2022 IEEE
DOI 10.1109/VIS4DH57440.2022.00008

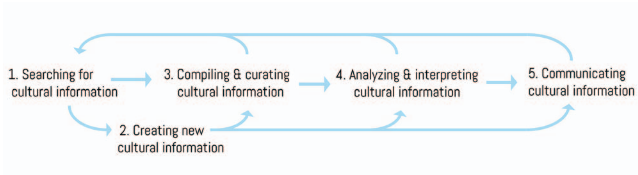

Figure 2: Workflows with cultural information frequently connect multiple practices, including search for existing information, creation of new information, data compilation and curation, analysis and interpretation activities, as well as communication and mediation procedures.

to make these immaterial aspects of cultural history available in large prosopography projects [10, 29, 33]. The resulting databases comprise named entities like actors, institutions, and locations, all in relations to one another, and chronologically interwoven as massive bundle of event-based sequences [3]. Interfaces to these resources allow to query these entities with regard to various metadata dimensions, and to explore the resulting data selections on an individual (i.e., biographical) or aggregated (i.e., prosopographical) level [34].

The digitization of related *material cultural objects*, on the other hand, has mostly taken a different route: Due to their condensed, textual nature, national biographies rarely include pictures of artworks and objects, such as paintings, sculptures, or manuscripts. These objects thus have rather been assembled by galleries and museums and have been digitized by these institutions to become accessible as digital cultural object collections [17]. For these separated collections, specific types of interfaces have been developed in recent years to grant access to their material stocks and associated metadata and to enable the experience of artworks and objects on the web [30].

Scholars in the arts and humanities, as well as practitioners in galleries, libraries, archives and museums (GLAM) and the interested public thus have very few digital places to go, when it comes to the *synoptic* contemplation of the lives and lifeworks of artists and other cultural actors [39]. Figure 1 illustrates, how the division of labor between collectors and custodians of material objects (left), and of biographical or historical-contextual knowledge (right) had a divisive influence on the organization of these assets. While obviously closely related and complementary by nature, both types of data largely remained separated due to institutional and infrastructural constraints. While data models on the object side [6] and general vocabularies for cultural heritage information [9] provide options to link such kinds of information, the two hemispheres remained practically separated from a practical and analytical point of view.

The InTaVia project assumes that experts for cultural information—whether with an academic or a more practical heritage-institutional background—approach cultural information (both about objects or actors) with multiple tasks and intentions (Figure 2): i) They frequently have to query and search for existing cultural information, ii) they create new information for their area of expertise, iii) they compile and curate information from multiple sources, iv) they analyze and interpret this information, and v) they communicate and mediate cultural information to a wide range of audiences. While different cultural experts and professions can specialize on individual steps and practices, most of them connect them into larger sequences and workflows with regard to their subject matter – and do so by following diverse procedural patterns, including iterative and selective sequences with diverse omissions, jumps, and loops.

Figure 3 shows how the InTaVia platform reacts to these multi-procedural requirements for both object and biography data, and how it supports multiple types of expert users with their diverse tasks: A multi-functional interface (tightly coupling the modules of a so called 'Data Curation Lab', a 'Visual Analytics Studio' and a 'Visual Storytelling Suite') will i) support search operations, ii) the creation of new structured information, iii) the compilation and curation of data from multiple sources, iv) the visual analysis of selected data, and v) the visual communication of selected constellations by the means of visual storytelling techniques [22]. While visual representations will obviously play a central role for the two latter scenarios, the InTaVia platform will also support activities of querying, data creation, and essential practices of data curation by visual means [42]. In this paper, we will focus on the fourth task, the visual analysis of a multimodal data selection.

3 Visual Analysis of in/tangible Cultural Data

The visualization of biography data and of cultural collection data arguably constitutes two distinct subfields of visualization for the (digital) humanities. Before we discuss their synoptic visualization, we outline respective data models and state-of-the-art approaches to the visualization of both types of resources individually.

3.1 Visualization of Biography Data

Biographical texts are written in a highly specific style, which procedures of natural language processing can parse and transform into series of semantic triples (i.e. named entity relations such as Gustav Klimt was born in Vienna on 1862-07-14, Gustav Klimt is the son of Anna Klimt, Gustav Klimt is the son of Ernst Klimt, Gustav Klimt created "the Kiss" in 1908, etc.). These sequences of structured relational data allow for the visualization of single biographies as timelines, graphs, or trajectories on maps. On an aggregated level,

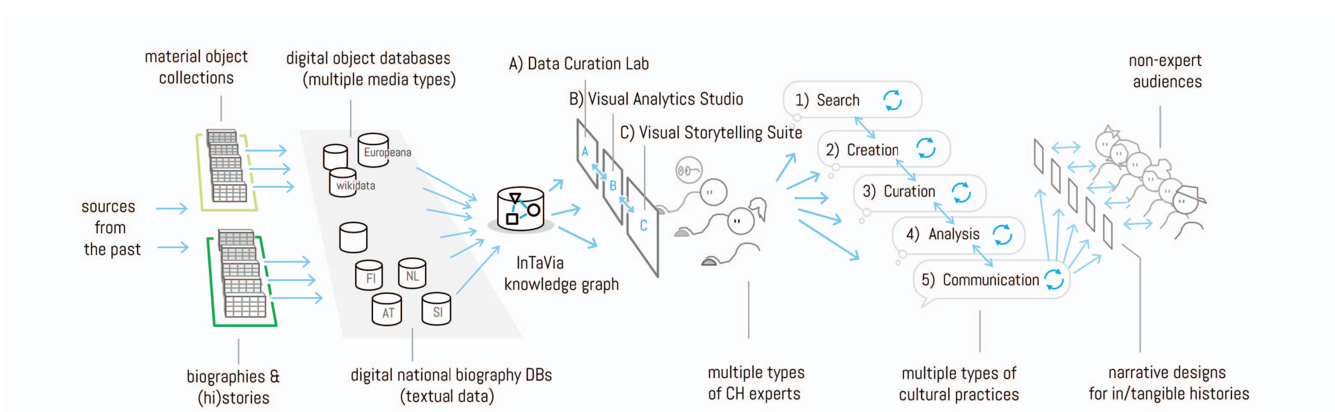

Figure 3: Functional architecture of the InTaVia platform, drawing together multiple types of cultural data and media to support multiple user practices.

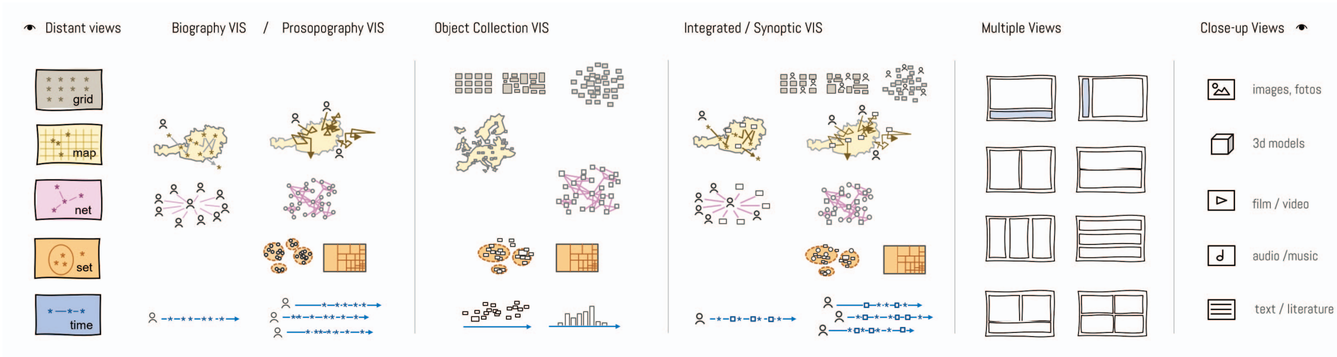

Figure 4: Design space of distant views on biographical and prosopographical data (left), object data (center left) hybrid data (center right), and combined as multiple views, all of which should allow immersive transitions into detailed perception or contemplation of cultural objects (right).

multiple actors can additionally be visualized as trajectory bundles or sets based on shared attributes or relations.

Thus, looking at the prior art, we find a multitude of visualization perspectives: Due to their prominence and availability, map-based visualizations have frequently been adapted for the visualization of biography data [8, 13, 19, 36]. From the relational perspective, network frameworks [2, 11, 32, 35] have been proposed. Attributes of actors or institutions, like professions or fields of cultural production have been visualized by hierarchical or set-based visualization techniques [15, 19, 27, 36, 43]. Due to the multidimensional nature of biographical data, also many mixed method approaches have been developed [2, 8, 15, 19, 27, 35]. As for the visualization of the essential historical data dimension of time, various approaches have been proposed, including timelines [4, 5, 14, 19, 31], animation [1], layer superimposition, or space-time cube representations [8], as well as flexible combinations thereof [25, 26, 40]. The focus of these biography visualization approaches is rather on the structured data than on the original texts (which are sometimes available as linked views) or on related media objects.

3.2 Visualization of Cultural Object Data

In contrast to biographical data, cultural object data rarely contains links to other entities or events on a similar level of detail. By contrast, objects are mainly linked to a set of scarce metadata (e.g. creator, date and place of origin) and a lengthy textual object description—as the main focus is on the digital modality-specific representation of the cultural object itself (including pictures, 3D scans, text, music, or videos). Relations to other objects, events or biographies—which could be visualized in a similarly rich relational way to biographical data—are only rarely available digitally [18, 23].

Prominent visualization approaches to digital object collections are (time-oriented) map-, graph- and set-based approaches to distant viewing [20, 41]. Focusing on the media itself, collection visualizations commonly also include object grids, showing objects as ordered thumbnail constellations, which allow for direct access and close-up views on demand. Also other dimensions play an important role when presenting digitized cultural heritage objects visually—including the targeted audience and supported tasks. While domain experts might prefer a search based-interface letting them specify and constrain the digitized object collections they would like to retrieve for specific analyses [21], others might be more interested in exploring (sub)collections freely [38].

3.3 Synoptic Visualization of Biography and Object Data

By bringing together the tangible and intangible aspects of cultural heritage data in a multimodal graph (see sec. 2), InTaVia aims to pave the way for the integrated handling, analysis and communication of biography and object data. To do so, we have to find ways for their synoptic visualization. While both types of cultural entities contain time-based information, biography data are genuinely time-oriented and temporally structured, while objects commonly are stamped with a date of origin only. Also in biography visualization, the structured (meta)data is the main focus, whereas for cultural objects, the medial representation of the object in all available modalities is a central feature of many visualizations [38].

Figure 4 illustrates conceptually how biographical visualizations (left) and visual representation of object collections (center) could be joined into synoptic representations (right). Depending on the number of entities and the analytical focus, different kinds of visual synopsis are possible: Firstly, if the focus is on life events, cultural objects can be represented as markers of their creation events within related biographies on a timeline or a map trajectory. Secondly, if the focus is on entities, objects can be visualized together with actors within graph or set visualizations. Thirdly, if media representations of the cultural actors are available, they could also be integrated into an object collection grid. While all of these ways of synopsis allow the synchronous exploration of cultural actors and cultural objects, none of these options is able to tap into the full potential of both kinds of data—as they focus either on the objects' medial representation or the actors' rich event-relational data, but not on both. A common option to overcome some of these restrictions is the combination of multiple perspectives in a system of *coordinated views*. However, on the design side this multiplies the already complex space of required design choices: Which combinations of (synoptic) views—to be considered for multiple devices—should be offered? Furthermore, how should the temporal data dimension be integrated into other distant views? Across all these encoding questions, the "scalability" of views is of the essence [7, 16, 38, 41]: How can users be enabled to transition from the modality of diagrammatic distant views to the modality of realistic close-up views (or close readings or hearings) which give users access to rich, multimodal media?

By their nature, multimodal knowledge graphs in the humanities unfold a notably complex design space, which the ideal visualization would fill to provide all possible analytical perspectives to users. However, it is well known on the user side that costs of interface complexity can outweigh the benefits of multiperspectivity due to increased cognitive load. On the other hand, the trivial fact of restricted development capacities on designer side also require the reduction of tool complexity, including the deliberate selection or prioritization of views. To rationalize this selection process in the context of InTaVia and ground it empirically, we implemented a multi-focal user-centered design process and gather requirements, validations and iterative feedback from potential tool users.

4 On Multi-focus Participatory Design

To reduce the complexity of the outlined design space in a rational fashion and to align these selections with the most relevant requirements of future users, InTaVia involves multiple types of users in a formative, user-centered design process on multiple levels: (1) Historians and cultural scientists are part of the project consortium and give continuous feedback. (2) The main concepts and design choices of the InTaVia architecture have been critically discussed in requirement workshops with cultural heritage experts, GLAM practitioners, and potential future users at the beginning of the project. (3) In three iterative test and development phases, developments are critically inspected and evaluated by potential users.

4.1 Requirement Workshops

On two different occasions, 41 international participants (21 academics, 13 cultural heritage professionals, and 7 technicians) gave us insights into their practices with different kinds of cultural data and provided us with feedback on the overall architecture and the visualization concepts of InTaVia. Based on the professional background, the research questions towards cultural actors and objects, we derived and defined ten personas (see Figure 5) with distinct user profiles for the diverse fields of cultural information practice. Their diversity already hints at the multitude of possible tasks and practices with respect to InTaVia's multimodal cultural graph.

In a first phase, we asked the experts about their current practices with cultural data. Their *primary tasks and activities* around cultural actors and objects have been (art-)historical (e.g., convey context and provenance of cultural entities, retrieve metadata and general basic information, establish and reveal connections and relationships), infrastructural (e.g., handle large data volumes, store, compare, display, enrich databases and provide access, licensing and copyright), and related to data modeling (e.g., handle uncertainty related to cultural entities, standardize data structures). When asked about *existing deficiencies and constraints* of their current work with cultural information, they named the lack of suitable tools (71%), heterogeneity of the different data and tools (54%), data quality (44%) and siloed or unlinked data (34%)—confirming the need for integrative DH endeavors like the one undertaken in InTaVia.

In a second phase, experts provided feedback on basic development options for the InTaVia platform (see Figure 3) and on the outlined complex visualization design space—for object data, biography data, as well as for their hybrid combination. For both *objects* and *actors*, experts were most interested in analyzing their data by timelines, maps, and network visualizations. The value of maps was estimated a bit higher for cultural objects than for cultural actors. For the combined visual analysis of *objects and actors*, the preferred methods were network visualizations, followed by maps and timelines. Overall, experts did express less interest in set visualizations and grid views. One reason for their lower ranking could be that analyzes of groups of persons are less common yet because they are difficult to realize without appropriate data and tools for prosopographical analyses. In a similar way, one participant said that all visualization options sound interesting, but he did not feel himself competent to evaluate them without having tried them. For all kinds of data, experts asked for a flexible interface to choose the most suitable from a set of visualization options, to combine the visualizations as multiple coordinated views, to compare data (by juxtaposition, superimposition, brushing) and to view them in the historic context. Regarding the latter (i.e. for the combined representation of other data dimensions with time) five different options have been discussed, with experts being most interested in coordinated timelines, followed by space-time cube visualizations, animation, color coding and data comics.

Figure 5: Ten personas working with cultural objects and/or actors.

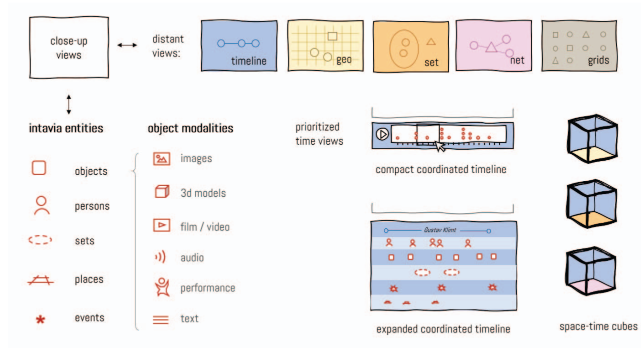

Figure 6: Combinatorial building kit for coordinated visualizations.

4.2 Iterative Development and User Testing

Based on conceptual considerations and the results of the requirement workshops, an empirically validated, modular building kit has been specified for the visualization development which represents the distant views, which users asked for most: timelines, maps, and networks, followed by sets and grids (see Figure 6, top row)—and close-up views on selected entities or multi-modal object types. The prioritized options to represent time are illustrated both as full screen timeline views and as hybrid views (Figure 6, lower right), which could be combined with any other (non-temporal) type of view using *multiple view layouts* from Figure 4.

As such, (coordinated) *timeline visualizations* will be available at multiple levels of details—depending on the number of displayed actors. A compact timeline view shows entities and events in a stacked fashion. With an expanded view, different types of events are split with regard to related entities and depicted on separate temporal swim-lanes. This detailed view allows also to display medial representations of the actual cultural objects (see Figure 6).

Figure 7 shows a first snapshot of the ongoing implementation of this visualization system. The initial development focus is on two prioritized views, i.e. maps and (coordinated) timelines, with networks, sets, and various uncertainty representations following in the next development phase.

Similar to the visualization of time, the amount of information displayed on the *map* can be varied by the user (see Figure 7, top): from single events (e.g. only places of birth and death for a group of actors) to fine-grained life-trajectories, from life events only to the integrated display of object events. Different types of events are color-coded. Related media will be displayed on demand: By clicking on events, digital object representations or textual paragraphs related to biographical events will be shown as an overlay.

As a next step, a workshop with expert users has been set up to gather feedback on the first implemented prototypes (see Figure 7). Further user workshops will follow in the last project year to evaluate and improve the workflow throughout the whole system—

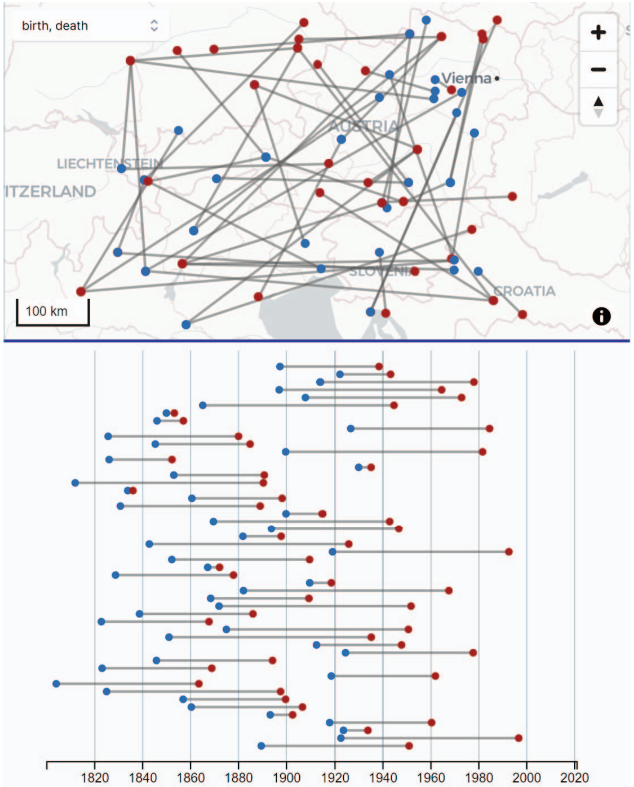

Figure 7: First prototype of the map (top) and the compact timeline (bottom) showing persons' birth (blue) and death (red) events.

from data curation (including import and creation of data sets), via the interactive visual analysis of data, towards the communication of results through visual storytelling.

5 Discussion & Outlook

With this paper, we reflected on the development of an interface for the visual analysis of a multimodal knowledge graph for cultural data. We discussed the two main data modalities resulting from historical actors and cultural objects, the specifics of related data models and different modalities of related object media. Biographies are specific kind of texts which automated procedures transform into series of events as person-entity-relations. Objects are represented by multiple types and modalities of media—depending on the kind of object and digitization methods used. Therefore, the current state of the art of visualizing these two kinds of cultural assets—which have been separated until now—commonly also arrive on differently specified visualization techniques and interfaces.

With regard to both data types and the complex InTaVia knowledge graph integrating them, we unfolded a complex design space of visual representation options which we handled, reduced and prioritized with a formative analysis of user perspectives and requirements collected in two requirement workshops. Participating experts showed similar visualization preferences for both kinds of data. For hybrid data selections they want to analyze their distributions and relations, predominantly with time, map and network-based views, but also want close-up access to the actual texts and digitized objects to flexibly transition from the diagrammatic modality of visualizations to the unique, isomorphic experience of artworks and cultural objects.

A first implementation phase is building on these user analyses and builds up InTaVia's 'Visual Analytics Studio' in close interconnection with its neighboring modules.

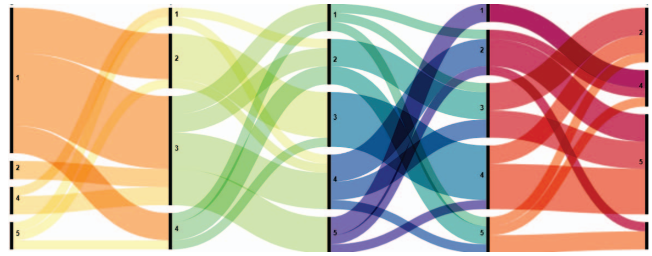

Figure 8: Ordering of cultural heritage experts' practices according to most typical workflows (1: searching, 2: creating, 3: compiling & curating, 4: analyzing & interpreting; 5: communicating).

During the development process we realized how a significant effort of project management, coordination and design discussions was required to manage and handle complexity that arose from phenomena of *multimodality* on multiple levels: Multiple modalities of data sources; a multimodal knowledge graph consisting of multiple types of entities linked by multiple types of semantic relations; cultural objects linked to multiple (types of) media and metadata schemata; and on the user side: multiple cultural heritage experts as users with multiple practices. It is our impression that the relatively new data source of multimodal knowledge graphs in the digital humanities forces such increased investments into efforts of complexity management and that the design of corresponding visualizations has to carefully assess, balance, and mediate between the different affordances of all types of entities—and the different users' practices and requirements regarding each of them. While 'complexity' is arguably a feature of every visualization design space, multimodal, graph-based data sources seem to introduce a new order of magnitude which requires a new kind of awareness on the visualization design side, to not get lost in the hyper-modal weeds of expanding design spaces.

Zooming out from the visualization module, we want to close with an *outlook* on the systemic structure of the InTaVia platform: As Figure 2 pointed out, the practice of (visual) analysis of DH data rarely takes place in an isolated fashion. By contrast, exploratory data visualization in cultural heritage and DH domains is frequently and intimately interwoven with activities of data querying, data creation and curation, as well as (visual) communication. Correspondingly, the visualization module of the InTaVia platform will be tightly interwoven with two further modules, the so-called 'Data Curation Lab' and the 'Visual Storytelling Suite' (cf. Figure 3 and [22]). Arguably it is only such a systemic architecture, which will allow experts and practitioners to pursue their most diverse types of work with the multimodal data, objects and assets of human culture—and to initiate, (re)direct, loop and iterate their personal workflows according to their situational needs. In closing, Figure 8 shows with data collected from the InTaVia requirement workshops how cultural heritage experts interweave and concatenate specific data practices according to their most common workflows. It is the guiding hypothesis of the InTaVia platform development that the emergence of a new generation of complex DH data sources (i.e. "machine-readable" knowledge graphs) requires advanced efforts to make these aggregations accessible, comprehensible and "human-readable" for various user groups. To also provide a solution for the increased diversity of their practices and requirements, the practice of (inter)linking technologies becomes part of DH tool designers' future remit.

Acknowledgments

This work was funded by the H2020 research and innovation action InTaVia, project No. 101004825. The authors want to thank the whole consortium for the ongoing splendid collaboration.

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