



# Linking structure, texture and context in a visualization of historical drawings by Frederick William IV (1795-1861)

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**Abstract:** In this article we present a case study on digital representation of the art historical research and metadata brought together for a scientific collection catalogue by the Prussian Palaces and Gardens Foundation Berlin-Brandenburg. The resulting interface aims at linking the structure and texture of a collection of drawings by Frederick William IV of Prussia (1795–1861) with additional contextual information. The article describes the context of the larger research project and presents the resulting visualization and interaction techniques specifically designed for dynamic exploration along time and subjects.

**Keywords:** information visualization, metadata, zoomable user interface, direct visualization, case study, inventory catalogue, digital art history

**Link:** <https://uclab.fh-potsdam.de/fw4/en>

## Introduction<sup>1</sup>

»Every idle moment [...] he draws on paper; sketches for great historic pieces, [...] persons and things that he has seen while travelling, mythical beings and allegorical matters. He even paints heaven and hell; and quite often biblical things.«

*Johann Friedrich Herbart (1810)<sup>2</sup>*

According to its definition, a museum does not only serve as a (semi-) public space for education, indulgence or even enjoyment. Its self-perception and objective is deeply rooted in an obligation to conduct research

and ensure conservation<sup>3</sup>. Thus, institutional exhibition and publication activities target a broad range of different activities and audiences. For the non-scholarly public, the most visible has been so far the physical exhibition in a museum or gallery, often accompanied by an exhibition catalogue. Adding to that, the scholarly and expert public seeks to be informed on the research conducted in the specialised departments of a collecting institution on a more scientific level. Among these publishing activities that are aimed at an expert public are inventory or collection catalogues that provide domain experts and researchers with a fully developed art historical examination of a set of artefacts, which

are often thematically focused on well-defined parts of a collection. The still predominant medium of publication for both non-scholarly exhibition catalogues and scientific collection catalogues is the printed book format. Museums and other collecting institutions have meanwhile understood that the digitization of their collections is an inevitable need in order to provide reproductions of objects and artworks for research, make them accessible via e.g. databases with web interfaces, and secure the conservation of sources and material. Correspondingly, the Prussian Palaces and Gardens Foundation Berlin-Brandenburg (SPSG) has started to employ digital forms of publication and is working on digitizing their collection. However, as is the case for many collecting institutions engaged with digitization efforts, it is still an open question how to make the newly digitized collections available for open exploration and visual analysis.

In this context, the objective of our overall research project “VIKUS–Visualizing Cultural Collections” is to examine the potentials of visualization techniques when applied to, and developed for, digitized cultural collections. Given the fact that the SPSG manages and administers several historical buildings, palaces, gardens, vast collections of paintings, furniture, sculptures, porcelain, drawings, and other historical objects (that have not all been entirely digitized, yet), the first step of our research project was to identify a suitable subset from the range of collections that could serve

as the first case study. Accordingly, the existing digital resources had to be analyzed together with professionals from various areas of the foundation. We conducted a first co-creation workshop<sup>4</sup> in order to identify promising collection areas and aspects that could suit our aim to conceive a dynamic visualization using the existing digital sources and material provided by the SPSG. After these early stages of the research project, we decided to use a fully developed digital inventory catalogue of the drawings by Frederick William IV of Prussia. The decision was mainly influenced by the ambition to explore the potential of visualization as a tool that does not only allow for an overview (e.g. analytical visualizations of metadata<sup>5</sup>), but also serves an exploratory gateway to the collection by combining overview and detail (on a visual as well as textual level) while also integrating contextual observations and scientific findings. The inventory catalogue had already been published digitally, but in a static format, comprising high-resolution digital copies of 1492 sheets of drawings by the King alongside the corresponding metadata and a full art historical analysis, indexing, and interpretation in several object-related and thematic texts.

## Aspirations

Being the first use case developed in the framework of the VIKUS research project, the visualization of drawings by Frederick William

## Linking structure, texture and context

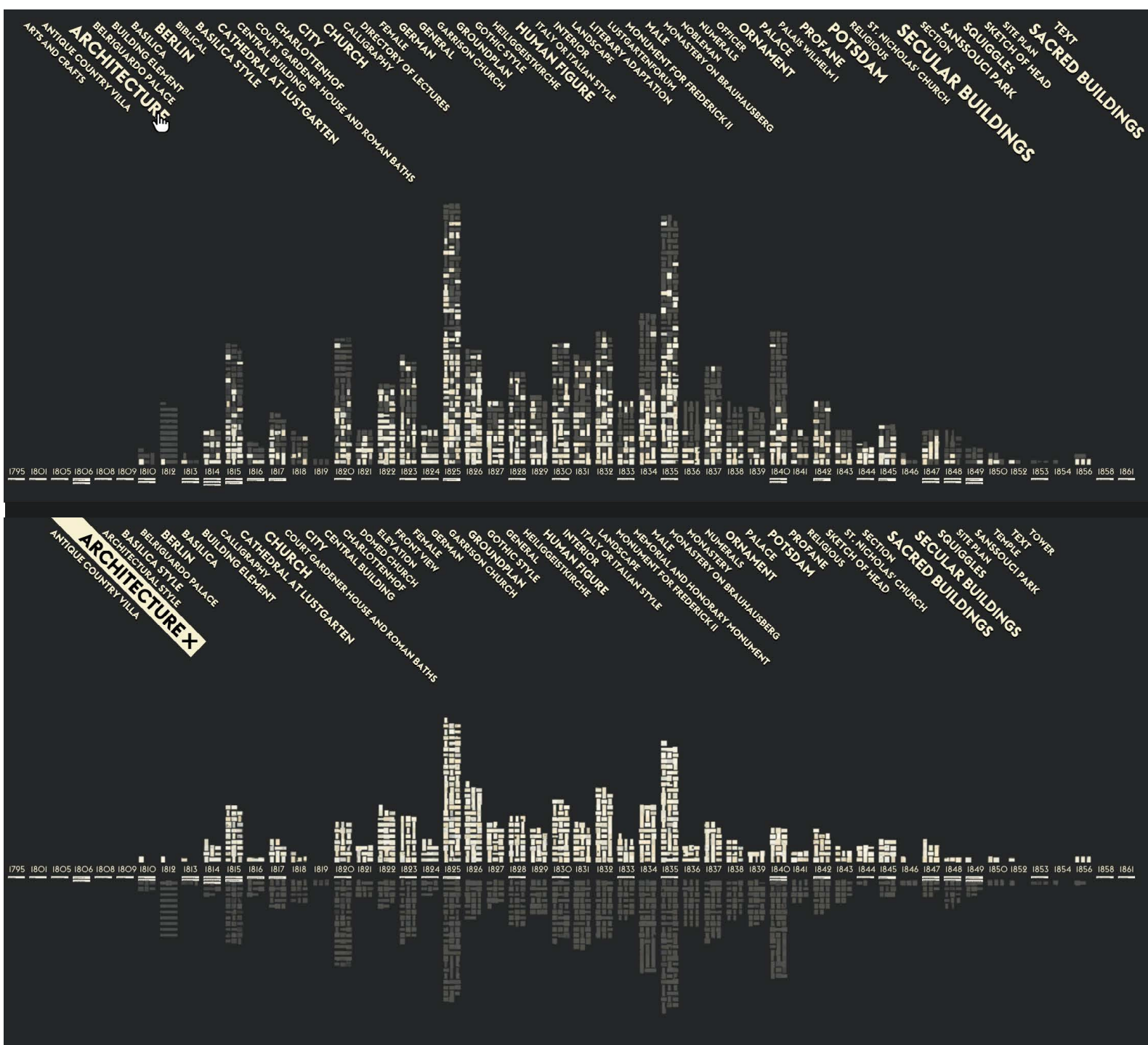


Figure 2: Hovering over a keyword (top) and selecting the keyword "Architecture" (bottom).

## Linking structure, texture and context

IV serves as an object of study that is, on a more general note, aimed at investigating the potentials inherent to visual exploration of digitized collections. In the scope of our research, we develop and evaluate graphical interfaces that are aimed at enabling interactive examination of cultural objects. We thereby practically contribute to the overall challenge that archives, museums, libraries and other collecting institutions are now facing, namely the need to improve the accessibility of their digitized inventories while also providing new modes of engagement with digitized artifacts. While conducting applied research and working in close collaboration with cultural institutions - in this case the SPSG - we also wish to engage in the ongoing discourses that are prevailing in disciplines like computer sciences and visualization research, (digital) humanities, (digital) art history, museology, as well as design research and adjoining disciplines.

This decidedly interdisciplinary approach offers the possibility to build upon and draw from previous disciplinary and interdisciplinary research. At the same time, it also poses the challenge to translate between different academic cultures, methodologies and assumptions. To put this in concrete terms, digitizing a collection does not implicate that this process is nested in a thoroughly digital approach. As Johanna Drucker has pointed out, there is a distinction between *digitized* art history and *digital* art history<sup>6</sup>. This in our view

important distinction also served as a vantage point for Benjamin Zweig in his “attempt to help define [...] what »digital art history« is.”<sup>7</sup> Reflecting the course of the project, we were challenged to transfer or rather translate a *digitized* art historical source into a *digital* art historical source. More specifically said, although the source for our visualization already is a digitally published inventory catalogue, its internal logic, framework, and structure still resembles non-digital ways of working and researching in art history. Thus, we had to identify properties, metadata, and structures together with our project partner, and in turn communicate the logic and functionality of data-driven visualizations. Our self-proclaimed goal consequently led to interdisciplinary co-creation, continuous integration and discussion of approaches and priorities. Another feature that developed throughout the process was the aim to widen the audience that might engage with the collection of drawings.

As pointed out earlier (and emphasized in interviews with our cooperation partner), the inventory catalogue is mainly published for a scientific expert public and is distinctly conceived within the research department (Department Palaces and Collections) of the foundation. The King’s drawings are predominantly consulted by researchers in the domain of art history and architecture as well as by experts on Prussian history. Only on the occasion of the King’s 150th day of death in 2011, the drawings

were made publicly accessible in an exhibition at the Roman Baths in Sanssouci Park.<sup>8</sup> With the visualization, we built upon the scientific content of the inventory catalogue and enhanced it with contextual information within the visualization, aiming at making the collection of drawings explorable also by a non-expert audience. We are investigating if and how novel visualizations of cultural collections and the corresponding art historical research can be employed to also encourage innovative ideas in the field of cultural mediation and be used to communicate scientific findings to a broader public.

## Drawing on data

**F**rederick William IV of Prussia (1795 – 1861) left a collection of drawings behind. They bear witness to historical events such as wars and revolutions, literary influences or personal obsessions with the devil. Numerous sheets reveal the planning eye of the King in the form of architectural visions and dreamy drafts. So far, 1492 sheets of drawings produced by the King have been fully accessed. The existing inventory catalogue that was published by the SPSG online in 2013 comprised the high-resolution digital copies of the drawings and sketches and corresponding metadata. Not all, but most of the following fields were available for each sheet: an image id, an inventory number derived from the internally used database, a description of the sheet, an art historical commentary or interpretation, labelling (e.g.

hand-written notations by the King or markings by later researchers), watermarks, measurements of the sheet, time and year, material, title(s) of corresponding thematic text(s), list of corresponding secondary literature, and a hierarchical index-based list of descriptors. The descriptors were worked out by the group of art historians during the analysis and research process alongside a controlled vocabulary and were developed in two parallel strings: a thematic order and a topographical order.<sup>9</sup> In accordance with our aspiration to make the art historical sources explorable by a non-expert public, we also included the content of the exhibition catalogue<sup>10</sup> into our choice of data. The texts from the exhibition catalogue – in contrast to the object description and interpretation – were written and published for a broader audience and offered background information on the King's life, prevailing interests, and historical context. Although our aim was to only use existing digitized material and leave the art historical content and structure of the data intact, we decided to manually extract the information from the exhibition catalogue and request additional information supplied by historians of the SPSG in order to create a custom timeline structure. Nonetheless, the extent of work that had to be put into the manual gathering and structuring of the additional timeline data was still moderate. Hence, for the most part we only used the existing data derived from the art historical research and identified those properties that could



be used to offer dynamic insights. By focusing and limiting the data mainly to existing parameters and content, we wish to illustrate how *digitized* art historical research can be reused and adapted when developing a *digital* and data-driven exploratory gateway.

## Interaction and Design

The visualization is conceived as a dynamic canvas arranging the King's drawings by their creation year, linked with contextual information, and made accessible through interactive filtering and zooming capabilities. On the one hand, the interface mechanics are inspired by zoomable interfaces<sup>11</sup> and more recent applications to cultural collections.<sup>12</sup> On the other hand, the design is based on the recurring wish from our collaborators to be able to see and explore the collection along temporal and thematic aspects while not abstracting the individual drawings into aggregated shapes. Thus, the overall aim for the interface is to reveal structures of temporal and topical distributions in the collection that invite the viewer to explore the collection and provide seamless access to the rich textures of individual drawings in high resolution. The interface has three main parts: 1) the zoomable canvas containing the scans of the drawings, 2) the index-based list descriptors or "keywords", representing the main subjects and places associated with the drawings, and 3) contextual information for each

drawing and several time periods. In the following we briefly describe these three parts.

The drawings are positioned according to their year of creation in horizontally arranged columns. As some sketches do not have specific dates or years, but rather estimated time ranges, the median of their estimated range is used for the positioning. Within the columns, sketches are sorted vertically based on their complexity, i.e., the number of motives, themes, and places that are associated with each sketch. When the interface is launched (see Figure 1, top), the initial view offers a bird's-eye view on the complete set of sketches with each of the 1492 images being displayed at a relatively small size of about 20 mm on a 13" laptop display. Similar to the image plots promoted by Lev Manovich and colleagues,<sup>13</sup> it is almost indistinguishable shades and shapes that can be differentiated from this perspective. In order to gain a better sense of the actual artifacts, it is necessary to move closer to the individual items. For this purpose, the canvas serves as a continuously zoomable space, allowing for the gradual increase of detail for particular segments of the arrangement of images. Zoom operations can be carried out either through the mouse wheel or by performing scrolling or zoom gestures on touchpads and touch-enabled displays. By zooming into particular groups of images, the thumbnails continuously grow into larger images with a higher resolution. By clicking and dragging, it is possible to pan the



Figure 3: The timeline provides historical context at varying levels of detail.



## Linking structure, texture and context

canvas in all directions. The viewer can examine sketches in the same year by performing vertical movements and shift in time between different year columns by moving horizontally. Besides zooming and panning, it is also possible to select individual sketches (by clicking or tapping on them) in order to immediately focus on this particular sketch and display it in high resolution. Once an image is in focus, the neighboring images fade out and contextual information becomes available on the right side of the display. In the same visual context of the canvas, it is now possible to further zoom into the image of the drawing to closely inspect the texture of the paper and even the grain of the pencil strokes (see Figure 1, bottom).

In the top part of the interface, the most prolific subjects and places are displayed as a horizontal list of keywords that are derived from the index-based list of descriptors. The list contains between 30 and 50 words and phrases, depending on the size of the screen. Akin to word clouds, the font sizes represent the relative frequency of sketches per subject. The keywords are sorted alphabetically to allow viewers to quickly locate a subject they might be looking for. Hovering over a keyword highlights all the sketches that are associated with this subject (see Figure 3, top). Ironically, the resulting aesthetic does remind of urban skylines, however, not those envisioned by Frederick William IV in Prussian times. When selecting a keyword, all images not associated

with this word move to the bottom of the timeline and are displayed with a lower opacity. The drawings that match the keyword selection remain above the timeline. As more and more tags are clicked, the selection of drawings gets more constrained, resulting in smaller image columns. Clicking on a selected keyword again cancels its selection. Changing the selection of keywords also changes the display of the remaining keywords. As some keywords may not be associated with the drawings in a given selection, they will be hidden, making space for more related keywords to be revealed, thus increasing the level of accuracy or specificity in the descriptors' content.

In addition to the general contextualization of the drawings provided by their temporal arrangement and the keyword visualization, the interface features two additional levels of in-depth information about the collection. On the one hand, a zoomable timeline just below the years presents biographical and historical information in the temporal context of the drawings. On the other hand, the metadata, descriptions, and art historical interpretation for each drawing contained in the collection is displayed in the single-image view in a text panel. In addition, the information panel contains links to in-depth articles on specific topics pertinent to the collection. The detailed events in the timeline are shown as soon as the user zooms into a particular period (see Figure 3). The timeline contains 40 events related to Frederick William

IV's life as well as historical events related to the political developments of the time. These events are positioned right below the yearly columns in order to facilitate the establishment of a connection between the personal and historical developments and the sketches that the King produced at the time.

## Technological implementation

In accordance with our aim to make the collection of drawings accessible and explorable by a broad audience, it was paramount for us to publish the visualization in a web interface. Given the size of the collection and its digital images, we had to develop an approach that would allow us to display the whole of the collection on a zoomable canvas, while at the same time be highly responsive and reduce the loading time. In order to be able to reconcile these objectives we developed new technological approaches. Knowing that waiting time while loading a website is crucial to the perceived quality of the user experience<sup>14</sup> it was one of our pronounced goals to instantly be able to not only display the first zoom level of the visualization, but to also allow for dynamic interaction right from the start. For this first state of display (the bird's-eye view) we employed a progressive loading approach which instantly loads a data layer with low level of detail. This first layer includes the metadata and thumbnail of each sheet.

This preliminary data is visualized in form of the list of keywords, the image plot, and the timeline. While the user is able to gain a first overview and filter the visualization by keywords, a second data layer is being transferred in the background, which holds a high-resolution version of each image. Each loading progress is communicated by a progress bar, which has been identified as being a good approach for reducing the perceived waiting time for the user.<sup>15</sup>

As soon as the thumbnail resolution is exceeded during the zoom interaction, the next level of detail is displayed with a version of the image with higher resolution. In order to be able to provide a fluid user experience during the zooming and reloading of images, a fast and efficient way of streaming the data was built. Conventionally, a website loads each image separately in a TCP request, which would in our case inevitably flood the user's connection and browser. To bypass this limitation, we clustered the images into chunks of data blocks. These data blocks have an approximate size of 7mb and hold up to 150 images. Those chunks are then streamed with a GZIP compression from a Content Delivery Network, which provides the fastest transfer speed, to the client's browser. After a chunk is received by the browser, the contained images are then pumped into the visualization as a detailed version of each entry. The data chunks are kept under a size of 10mb, which is the file size limit of cacheable objects in today's browsers. In order to bring the desired visual features together, we combined the web visualization library D3.js with the web graphics library pixi.

js. The list of index keywords that are used for filtering the visualization, as well as the timeline with the additional contextual annotations, are rendered in HTML with CSS3 animations and the area holding the images is rendered in a WebGL canvas. Consequently, we were able to combine the benefits of HTML5 features, such as interactive user interfaces and high performance CSS animations, with the performance of modern GPUs via WebGL.

## Qualitative insights from quantitative views

The collection subset used for the case study consists of approx. 1500 data records, or about 20% of the drawings executed by Frederick William IV which are preserved in the collections of the Prussian Palaces and Gardens Foundation. The first version of the online catalogue, launched by the SPSG in 2013, did not cover all subjects evident in the King's drawings to the same extent. Instead, specific compilations – e.g. drawings of Charlottenhof Palace within Park Sanssouci – were published almost entirely, while other series and subjects were only represented by singular sheets. In reference to the significance and gain of knowledge expected from the actual visualization, one must take into account that its data set is basically identical with the 2013 catalogue and will only successively be complemented with sheets missing so far. The tem-

poral arrangement and thematic filter functionality, complemented by supplementary biographical and historical information, creates highly interesting curve progressions, showing which subjects were most relevant for the king in a specific time or maybe readopted in later phases. A most significant example for this observation is provided by the sheets covering Charlottenhof Palace. A present to Frederick William IV by his father in 1825, Charlottenhof was supposed to be complemented with new structures and become transformed into a mediterranean villa. The curve progression along the timeline clearly shows the intensity with which the crown prince worked on his later executed designs. Frederick William IV reacted quite similarly to other biographical or political events. His intensive planning on the restructuring of his study and his apartment within the Berlin city palace has to be seen in close regard to his marriage, celebrated only one year before. And Frederick William's constant changes, improvements and alternative proposals for the construction of Babelsberg Palace, carried out for his brother in several phases, will also impressively become visible along the timeline. However, this requires the recognition of all 6,900 records to obtain exact results. Then it will be possible to see how the revolutionary events of the year 1848 left deep scars on the psyche of the King, for example visible in the frequent depictions of demons and devils within his drawings of the time. His journeys to Italy will probably

become just as evident on the timeline, showing how the king processed his impressions. It is especially here, that highly interesting insights may be expected for both the expert user and the interested layperson. Especially art and architecture historians will appreciate the ability to combine different index terms with each other. Presumably, it will be possible to obtain a more precise dating when combining findings on individual drawings executed on the same sheet. For example, some of the king's drawings depict the German piked helmet, only used by the Prussian Army since 1843. However, methodically it has to be remarked that the arrangement of the drawings along a timeline already represents the result of an art historical approach, taking into account the individual fixed datings and other biographical and historical corner points. Researchers will therefore have to be aware of circular reasoning; and yet, this new visualization may provide an effective and powerful tool to refine and verify previous findings, datings and examinations.

## Conclusion

With this first use case we were able to apply principles and concepts from visualisation research and interface design to a digitized art historical source and illustrated the potential of visualizations when implemented in an art historical context. The concept and functionalities were developed in an interdisciplinary co-creation process, thus ensuring the result to be well

grounded on the respective disciplines. During the next phase of our project, we will carry out thorough user-tests and additional empirical research in order to be able to validate some of the functionalities and investigate the potential of our model when used for art historical research as well as the applicability for a broader audience. Regarding the technology, a new framework for displaying collections of large image data has been successfully developed, opening up the potential to scale the number of images up to approximately 8000 images per canvas. The ability to fluidly combine a distant view with a detailed examination of the high-resolution images has already raised considerable interest among collecting institutions. We are now considering generalizing this specific visualization into a framework that may be applicable to other visual collections with e.g. a broader variety of visual qualities and higher contrast between the shapes and shades of images.

## Notes

1 Acknowledgements: We wish to thank the Editors of the *International Journal for Digital Art History* for the invitation to present our case study. We would like to acknowledge the German Federal Ministry of Education and Research (BMBF) for their generous funding of our research project *VIKUS–Visualising Cultural Collections*. We thank our project partners SPSP and Programmfabrik GmbH for the productive cooperation. We wish to thank Matthias Graf for his work on a previous version of the visualization and Dr. Jörg Meiner for his scientific consulting. We are grateful

for valuable ideas, continuous feedback, and support from our colleagues Sebastian Meier, Till Nagel, Stephanie Neumann und Jan-Erik Stange.

2 Herbartische Reliquien, ein Supplement zu Herbart's Sämmtlichen Werken, eds. v. [Tuiskon] Ziller, Leipzig 1871, p. 201. Cited after »Unglaublich ist sein Genie fürs Zeichnen« Friedrich Wilhelm IV. von Preußen (1795-1861) zum 150. Todestag, published on behalf of the Prussian Palaces and Gardens Foundation Berlin-Brandenburg by Jörg Meiner 2011, 8. (Translation by the authors)

3 cf. ICOM Code of Ethics for Museums, 2013

4 For a description of the framework for such a participatory workshop with collection maintainers and contributors cf. Chen, K., Dörk, M., & Dade-Robertson, M. (2014). Exploring the Promises and Potentials of Visual Archive Interfaces. In *iConference 2014 Proceedings* (735–741). doi:10.9776/14348

5 see e.g. the visualization of metadata of the DDB that provides experimental overviews of the temporal and spatial distribution of objects and the associated topics, people, and organizations, using the metadata of more than 7 million cultural heritage objects aggregated by the German Digital Library (DDB) Bernhardt et al (2014).: [http://infovvis.fh-potsdam.de/ddb/index\\_en.html](http://infovvis.fh-potsdam.de/ddb/index_en.html).

6 Johanna Drucker, "Is There a "Digital" Art History?" In: *Visual Resources: An International Journal of Documentation*, Vol. 29, No. 1-2 (2013), 7.

7 Benjamin Zweig, "Forgotten Genealogies: Brief Reflections on the History of Digital Art History." In: *International Journal for Digital Art History*, Issue 1 (2015), 39.

8 The exhibition »Friedrich Wilhelm IV. von

Preußen (1795-1861) zum 150. Todestag« was open to the public from 7 May until 31 July, 2011 and was accompanied by an exhibition catalogue.

9 The digital copies, metadata, and texts used in the visualization were created by Dr. Jörg Meiner (project lead), Dr. Catharina Hasenclever (project lead 2006-2008), Antje Adler, Astrid Fritsche, Klaus Dorst, Stefan Gehlen, Dr. Gabriele Horn, Dr. Andreas Meinecke, Dr. Gerd-H. Zuchold, Dr. Rolf H. Johannsen, Prof. Dr. Harry Falk, Dr. Rolf Th. Senn and Dr. Sepp-Gustav Gröschel. Editor: Dr. Carsten Dilba.

10 »Unglaublich ist sein Genie fürs Zeichnen« Friedrich Wilhelm IV. von Preußen (1795-1861) zum 150. Todestag, published on behalf of the Prussian Palaces and Gardens Foundation Berlin-Brandenburg by Jörg Meiner (2011)

11 Bederson, B. and Hollan, J. (1994). Pad++: a zooming graphical interface for exploring alternate interface physics. In *UIST 1994: Symposium on User Interface Software and Technology*, 17–26. ACM.

12 Hochman, N. and Manovich, L. (2013). Zooming into an instagram city: Reading the local through social media. *First Monday*, 18(7).

13 Manovich, L. (2015). Data science and digital art history. *International Journal for Digital Art History*, (1): 13–35.

14 cf. eg. Antonides et al. "Consumer Perception and Evaluation of Waiting Time: A Field Experiment". In: *Journal of Consumer Psychology*, 12(3) (2001); Egger et al. "Waiting times in quality of experience for web based services", *QoMEX*, IEEE (2012)

15 cf. Myers "The importance of percent-done progress indicators for computer-human interfaces". Presented at the *Computer Human Interactions*, Vol. 16, ACM (1985)

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## Linking structure, texture and context

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## Linking structure, texture and context

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The research project »VIKUS - Visualizing Cultural Collections« (Visualisierung kultureller Sammlungen, 2014 - 2017) brings together researchers from various fields such as information visualization, computer science, interface design, and the humanities to develop and evaluate graphical interfaces aimed at enabling interactive examination of cultural objects. The project liaises closely with cultural institutions (e.g., museums, libraries and foundations) as well as with developers of media databases. The VIKUS team approaches the area of digital cultural heritage by combining technological possibilities with cultural considerations in order to develop visualizations and interfaces that open up interesting and useful perspectives on digitized collections. Thereby, novel interaction techniques and representations are designed and evaluated for their suitability for different scenarios.

More information about the Urban Complexity Lab: [uclab.fh-potsdam.de](http://uclab.fh-potsdam.de)



## Linking structure, texture and context

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