Mapping the Avantgarde: Visualizing Modern Artists' Exhibition Activity

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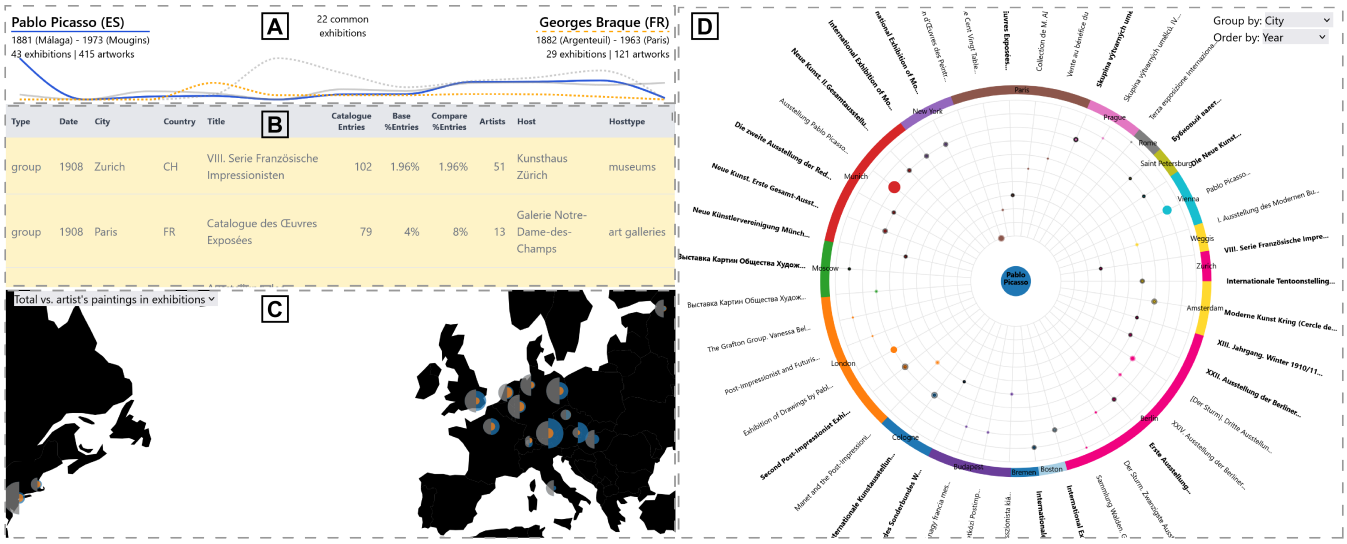

Figure 1: *Our proposed approach with comparison view. (A) Details about two artists, number of common exhibitions, and line charts displaying yearly averages of the base artist's exhibited artworks (blue line) and total artworks in the exhibitions (grey line), as well as dashed lines for the compared artist (dashed orange and grey lines). (B) The table displays details about all exhibitions and highlights common exhibitions in yellow. (C) The map shows per city the number of total artworks exhibited (grey half-circle), the number of the base artist's artworks (blue half-circles), and of the compared artist (orange half-circles). (D) The radial view indicates all exhibitions of the artist, highlighting common exhibitions in bold.*

Abstract

In this paper, we address a crucial challenge for art historians by proposing a visual analytics approach consisting of multiple views designed to facilitate exploration and comparative analysis of artists and their exhibitions. Existing tools to support art-historical research are scarce and lack analytical means to navigate and analyze artists' exhibition activities. Our approach addresses this gap by supporting the identification of geospatial and temporal patterns and offering insights into the multifaceted exhibition behavior of artists in the early 20th century. To demonstrate the efficacy and validate our approach, we present a case study conducted by an art historian in the form of an expert interview. The discussion presents details about insights that were obtained and valuable feedback about the utility of the visual encodings and interactions. By integrating geospatial and temporal facets along with features to perform comparative analysis our approach emerges as a valuable asset for art historians providing a comprehensive look into artists' exhibition histories.

CCS Concepts

• ***Human-centered computing*** → ***Information visualization; Visual analytics; Empirical studies in visualization;***

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1. Introduction

Art History (AH) is a discipline centered around examining visual arts in various forms, including the study of artistic movements and styles, exhibition behaviors and patterns, and how these have evolved over time. The exploration of patterns, both spatial and temporal, offers researchers in this domain invaluable insights into the exhibition practices of artists. The early 20th century marks a pivotal period of time where the breakthrough of the Avantgarde took place. This period of time serves as our primary focus and temporal context. While several databases exist and are accessible [BMB*20, MW21, CVC06, JPSRDS16] they lack Visual Analytics (VA) methods necessary to support researchers in unraveling the intricate relationships between exhibitions and artists. In this paper, we propose the design and development of a VA approach that supports art historians in exploring and identifying such patterns in the data, leading to new insights and knowledge about artists' exhibition practices and behaviors. Our main contributions are:

- Contextualizing and justifying the design rationales according to state-of-the-art spatio-temporal visualization and domain tasks (Section 3);
- Designing and developing a VA approach supporting insights and exploration and comparison of artists' exhibition activity (Section 4);
- Evaluating the approach by a domain expert case study, describing the insights and patterns obtained, supported by a discussion about the utility of the visual encodings and interactions (Section 5).

2. Background

The Database of Modern Exhibitions (DoME) [BMB*20] is, for a short period of time (1905-1915), the most comprehensive available art exhibition database. We therefore have chosen it for the development of this visualization. DoME contains over 13,200 modern European artists and information about over 1,300 exhibitions. For every artist, details about exhibited artworks and exhibitions they participated are included. Further details such as birth and death dates and places can be retrieved from linked norm data. DoME also contains details for every exhibition (countries, cities, exhibition venues), and each artwork (e.g. type–oil painting or watercolor). Additionally, the Artl@s database [JPSRDS16] visualizes global exhibitions of the 19th and 20th centuries on a map with the possibility to filter them. Fraiberger et al. [FSR*18] quantify the success and reputation of artists by exploring the exhibition behavior of nearly 500,000 artists between 1980 and 2016. They created a co-exhibition network of institutions and visualized artists' number of exhibitions per year as well as the auction prices of their paintings using line charts and scatter plots.

3. Design Considerations

During the design and development of our approach, our primary aim was to support domain experts (i.e., art historians) with a detail-oriented and interactive VA concept. Our design considerations and rationales follow the tasks outlined by the experts: extracting valuable art-historical insights by detecting patterns in the spatio-temporal exhibition data. Experts are particularly interested in identifying which artists exhibited together–how much, when, where, and with whom. In the following, we outline the research questions posed by the domain experts and abstract these into tasks supported by our approach.

(T1) Identifying geographical patterns: A specific research question posed by the domain experts is related to uncovering geographical patterns within an artist's exhibition data. In this sense, they expressed interest in seeing "hotspots" of exhibition activity and identifying the venues where an artist's exhibitions were concentrated.
(T2) Discerning temporal patterns: Another crucial aspect of interest is related to the temporality of the data. In this case, the experts need to recognize specific years marking a pivotal moment in shaping the careers of specific artists. This facet of the data provides meaning and context to an artist's trajectory within the Avantgarde movement.
(T3) Providing multiple perspectives: Exhibition data is intricate and has diverse properties (e.g., year, city, host name). Exploring multiple perspectives of an artist's exhibition activity (i.e., grouping or sorting by these properties) is considered valuable to identify patterns. To support this task, our approach provides interactions to reconfigure the visualization, resulting in unique patterns that can be discerned.
(T4) Comparative analysis: A central point of the experts' research is comparing artists' exhibition behavior. A distinctive feature we provide is the ability to perform a comparative analysis between pairs of artists. This enables comparing their spatial exhibition behavior (*where*), the temporal aspect (*when*), and the quantity (*how much*). We aim to support detail-oriented exploration of common exhibitions between two artists for insightful discoveries of similarities in their artistic careers.

To extract meaningful and insightful patterns from the exhibition data, we opted for multiple coordinated views. The views depict different aspects of the data and allow for seamless analysis between the single components. Supporting interactive links, we ensure that domain experts can gain a coherent understanding of the exhibition dynamics (spatial, temporal, and quantitative information–**T1 & T2**).

Concerning the geographical aspect and how our approach supports understanding spatial distributions of exhibitions and patterns that arise (**T1**), we explore map-based visualization techniques. Maps are the most widespread and often used visualization technique for geospatial data. For an extensive overview of the state-of-the-art of map visualization, we refer to the survey by Hogräfer et al. [HHS20]. Proportional symbol maps are used to visualize numerical data by placing scaled symbols, which are often circles or squares, on a map [CHVKS10]. Using different point symbol markers for visualizing quantitative data was extensively surveyed [BC98, Rot17, Nel00, GKSSP21]. Among them, circles were the most widely used symbol on proportional symbol maps and adjacent half circles were used for bivariate data comparison. Numerous examples displaying the use of proportional symbol maps with circles showing "hotspots" were investigated in related work [Gom17, Smi17, KAA06, TMFD*18, SCP04]. Related to iden-

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tifying temporal patterns (**T2**) and exploring artists' exhibition activity over time we investigate timeline visualizations. Time-series plots are very efficient and the most frequently used form of graphic design [Tuf01]. Brehmer et al. [BLB*16] surveyed different timeline designs with linear timelines being the most commonly used design choice, while spirals are deemed to be aesthetically appealing. For a comprehensive review of time-oriented data visualization we refer to Aigner et al. [AMST23].

Furthermore, an interactive radial representation of an artist's exhibition activity over time provides an engaging and compact representation of these data. Given the richness and diverse properties associated with exhibitions, we provide interactions that enable the domain experts to reconfigure this view by selecting different arrangements and grouping properties. This results in unique and distinct patterns showing multiple perspectives of the artist's exhibitions (identifying patterns–**T3**). Radial charts have been used to visualize data at least since the early 19th century [Pla01, Nig58]. Since then, radial charts have evolved and are still widely used in modern visualization approaches, among other purposes, to show similarity and temporal patterns in the data [KSS04, FSR*21, BD08, CK98, Spo04, TSMR03]. Further radial visualization approaches were extensively surveyed by Draper et al. [DLR09].

Finally, to facilitate a comparison of artists and their exhibition behavior, we provide the possibility of querying and selecting artists to be compared. This updates the individual views to highlight the common exhibitions. In this case, a different visual encoding is employed to discern between the individual artists and their common exhibitions. According to the terminologies by Javed and Elmqvist [JE12] and Gleicher et al. [GAW*11], we are using superimposition (i.e., overlaying multiple objects in one visualization) and explicit encoding, which helps with direct comparison between the artists. Facilitating a comparative analysis of the spatio-temporal exhibition behavior between artists supports answering questions such as "When/Where/How much did the pair of artists exhibit together?" and "What were the most common venues that both artists exhibited at?" (comparative analysis–**T4**).

4. Proposed Approach

In the following, we present our VA approach [TFK*23] (see Figure 1), discuss the views, interactions, and their connection to the tasks (Section 3).

4.1. Artist Details

Details about the artist are available at the top left (see Figure 1-A). We display the artist's nationality, their birth and death dates, their birth and death places, as well as statistics about the artworks they have exhibited and the exhibitions they have participated in. Furthermore, underneath, we encode their exhibition activity over time in a line chart, intending to provide an overview of their career trajectory: whether they were rising stars, had stagnant exhibition behavior, their career followed a fluctuating pattern, or faded away from the exhibition scene over time (**T2**). The average number of total artworks per exhibition per year is denoted as a grey line and the average number of the artist's artworks as a blue line. In the case of making a comparison with another artist, the other artist's lines are superimposed as dashed lines (see Section 4.5). These details present crucial information for the domain experts and provide context to support the further exploration of the artist's exhibition activity. For instance, to better understand the geographical aspects of an artist's exhibition activity (**T1**). Specifically, if the artist only (or mostly) exhibited in proximity to their birth or death places.

4.2. Exhibitions Overview

A comprehensive summary of an artist's exhibition history and involvement is presented in a structured tabular overview (see Figure 1-B). The table displays key details about each of the artist's exhibitions, such as the type (i.e., group, solo, or auction), the date, title, number of catalog entries, the artist's contribution (as a percentage), the number of artists, as well as the organizing host and their type (e.g., art gallery), the country, and city where it took place. Initially, the table is ordered by the date of the exhibition and can be resorted by any of the columns. The table and resorting feature assists art historians in locating exhibitions according to a certain property or identifying exhibitions sharing similar properties (e.g., finding all solo exhibitions of an artist). This provides multiple perspectives and context about the exhibition history of an artist and supports in-depth exploration (**T3**). Furthermore, such tabular representations have been utilized by the domain experts to identify missing or incomplete data related to any of the individual exhibitions.

4.3. Radial Exhibition View

The radial visualization component in our approach depicts the temporal and geographical dimensions of an individual artist's exhibitions (see Figure 1-D). The collective set of an artist's exhibition history is arranged around the circle, displayed alongside their title. The central node shows the current artist. Exhibitions are represented as rays emanating from the artist represented as timelines, with the innermost ring depicting the year 1905 and the outermost ring the year 1915. Each exhibition is placed on a ring that corresponds to the year when it occurred and is marked by two circles that encode further information. The two circles overlap and are depicted in different opacities, the transparent one (in the background) represents the total number of artworks exhibited (reflected in the circle's area). Overlaid on top is an opaque circle representing the artist's contribution to that exhibition (the percentage of their artworks exhibited compared to the total). This dual-circle encoding presents a visual indicator of the artist's involvement and contribution to each of the exhibitions (**T2**). If the opaque circle completely covers the transparent one, it means that all of the artworks in this exhibition were by the displayed artist and indicates that this was a solo exhibition. The colored segments along the outer ring function as indicators to group exhibitions according to different criteria, such as year, exhibition type, country and the city where it took place, the host's name, and the host's type. Within each of these segments, the individual exhibitions belonging to it can further be ordered according to other properties. This results in distinct temporal patterns that can be identified. Moreover, geographical patterns become discernible, when grouping by the country or city where the exhibition took place at (**T1**). By configuring the radial

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component to group according to the country or city and ordering the exhibitions within each according to the number of artworks exhibited, it highlights the primary locations where the artist exhibited more frequently. Chronologically ordering these exhibitions within each country or city respectively, allows to identify the key years or periods during which the artist was active in each location (**T1 & T2**).

4.4. Map View

While both the tabular and radial components reflect the geographical dimension of an artist's exhibition activity, neither of these is particularly suitable for conveying the spatial distribution of exhibitions, nor their geographical proximity to other exhibition venues. To address this task, we provide a map view (see Figure 1-C) that effectively conveys the spatial distribution of exhibitions further facilitating pattern identification (**T1**). Within the map, there are two different encodings for the markers (with a toggle to switch between them). Each exhibition is either encoded as a circle map marker or as two half circles, which are positioned according to their geographic coordinates (see Figure 2). The markers are depicted in varying sizes according to the number of the selected artist's artworks featured in each exhibition (encoded as the circle area). Transparency is used to manage occlusions between exhibitions whose venues coincide geographically, as well as, to support identifying geographical "hotspots". Cities with more opaque circles signify a higher number of exhibitions and cities with larger markers highlight that the artist exhibited a significant number of artworks there (see Figure 2-A). The half circles serve as summaries for all exhibitions that took place in the same city. Sizes of the half circles vary according to the total number of paintings in all exhibitions in the same city (grey half circles) compared to the number of paintings of the selected artist (blue half circles) (see Figure 2-B). Exploring the map provides insights related to the artist's exhibition activity. Specifically, if the artist predominantly exhibited in their home country (or within proximity to it) or globally and internationally.

4.5. Comparing Artist's Exhibition Activity

To support a comparative analysis of artists and enable an in-depth examination of their exhibition activity as well as similarities or differences, each of the aforementioned views incorporates enhancements to highlight the common exhibitions (see Figure 1). In the artist's detail panel, information about the compared artist is presented on the side, accompanied by metrics indicating the number of exhibitions the artists have in common. The line chart superimposes both artists' activity timelines enabling a comparison of their career trajectories (see Figure 1-A). The table is reordered to prioritize the display of common exhibitions, highlighted with a yellow background (see Figure 1-B). Additionally, a new column showing the prominence of the compared artist in each of the common exhibitions is presented (as a percentage similar to the base artist). In the radial component, common exhibitions are distinguished by bold font and a border around the circles (see Figure 1-D). This facilitates identifying which years the artists exhibited together or discovering if there were certain exhibition venues frequently featuring both artists. Finally, within the map view, the common exhibitions are highlighted by changing the color of the circle map markers to yellow (similar to the table background coloring) which supports identifying geographical "hotspots" related to the commonalities between both artists. For the half-circle markers, an orange half-circle shows the number of paintings of the compared artist alongside the base artist (see Figure 1-C). This facilitates identifying which of the artists exhibited more in certain cities. The provided comparison feature supports contrasting the geographical and temporal exhibition behavior of artists (**T4**). By integrating visual enhancements in each of the views, our proposed approach supports the domain experts in a comprehensive understanding of the geospatial and temporal exhibition activity of artists and their collaborative patterns.

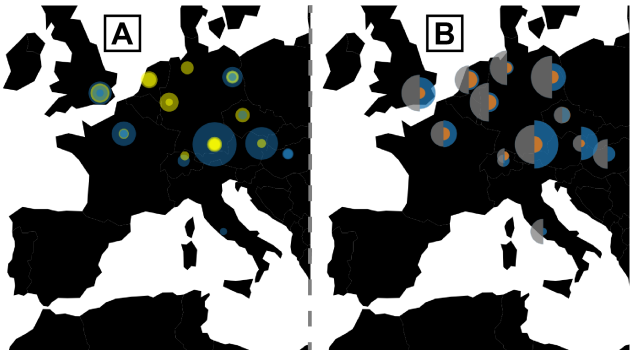

Figure 2: *The two different views for comparing artists on the map. (A) "Hotspots" showing overlaid circles. The more opaque the circles, the more exhibitions of an artist took place in this location. Circle sizes show the number of artworks exhibited by the artist. Yellow circles denote common exhibitions with the compared artist. (B) Half circles summarizing exhibitions per city showing the number of total exhibited paintings (grey), the number of the artist's exhibited paintings (blue), and the number of paintings the compared artist exhibited (orange).*

5. Case Study

We performed a case study with a domain expert in AH to ensure the utility and effectiveness of our approach, as well as to guarantee that the tasks listed in Section 3 are supported. After a short introduction to the different views, visual encodings, and interactions, the domain expert explored the data freely, generated their own data-driven questions, and subsequently answered them supported by our approach. Throughout the process, the domain expert explained what geospatial and temporal patterns they could identify in each of the views and why they were interesting from an art-historical perspective. For further details and insights obtained by the domain expert, we refer to our supplementary material.

The case study showed that the line chart is very helpful in reasoning about the career trajectories of individual artists and their change over time (i.e., the average number of exhibited paintings per year and number of exhibitions). However, it was remarked that they are hard to interpret without a legend and annotations of the years. The map was effective in conveying the geospatial distribu-

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tion of an artist's exhibition activity and highlighting "hotspots" that revealed the main cities and venues where certain artists were featured. Moreover, the map markers were considered to be appealing and the toggle to switch between the circle and half-circle markers (see Figure 2) was considered to provide interesting perspectives on an artist's exhibition activity. The map view was often used to figure out if an artist exhibited in many different countries or in proximity to their birth or death place (**T1**). The half circles on the map as well as the comparison view supported identifying the cities where an artist exhibited more than the one being compared (see **T4**). For the exploration of the temporal aspects, the radial chart was prominently used (see **T2**). The possibility to configure parameters such as the grouping and ordering of the exhibitions in this chart was utilized frequently to identify temporal patterns of exhibitions in certain countries or for certain host types (**T3**). Throughout the exploration, the table was used to inspect and compare certain details of the artists' exhibitions.

6. Conclusion & Future Work

Our proposed VA approach provides a significant step toward supporting research on identifying and analyzing geospatial and temporal patterns of artists' exhibition activities. The presented combination of views and interactions provides a comprehensive solution for art historians, offering a multi-faceted exploration of their exhibition histories and enabling their comparison. We evaluated our approach in a case study structured as an expert interview with a domain expert in AH. The evaluation aimed to assess the value and efficacy of our VA solution in a real-world research scenario. The discussion shows that this approach delivers promising results for supporting art historians in gaining new insights and delving deeper into the details of artists' exhibition activities. Our directions for future work are related to expanding the features and capabilities of the proposed approach to support a visual exploration and comparison of more than two artists' exhibition activities and further refining the visual encodings to effectively convey key metrics associated with the influence and prominence of artists.

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