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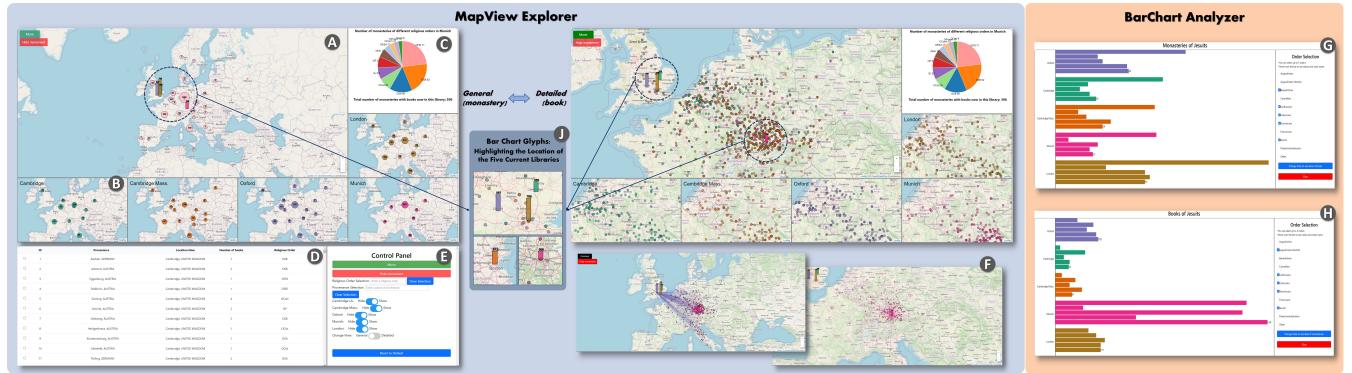
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# Unveiling the Dispersal of Historical Books from Religious Orders

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**Figure 1:** Two interfaces, **MapView Explorer** and **BarChart Analyzer**, are designed to visualize the historical dispersal of books using map-based layouts augmented with descriptive statistics information. The **MapView Explorer** offers two levels of observation, allowing users to see either an overview of monastery distribution or a detailed view of book distribution on the main map (A) and four synchronized mini-maps (B) displaying either monasteries or books in their current holding libraries. The bar chart glyphs (J) are used to distinguish the five current libraries on the map. Pie Chart (C) shows the proportions of books by religious order, while Table (D) displays book records with reordering, selecting, and highlighting functionalities. The Control Panel (E) enables hiding or displaying components and initiating the book movement animation (F). **BarChart Analyzer** displays the number of monasteries from various religious orders in current libraries using customizable Bar Charts, which allow users to adjust the order of religious orders as desired.

## Abstract

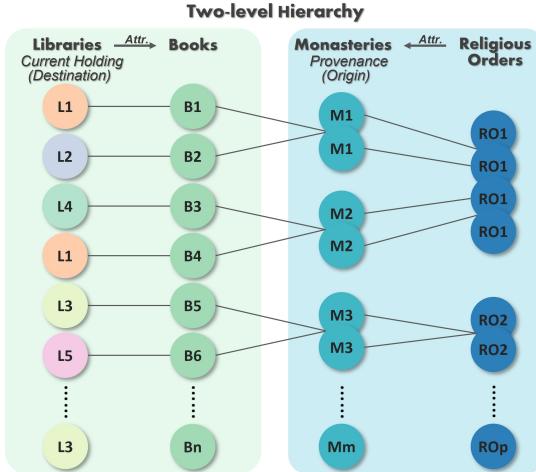
In this paper, we introduce a visualization prototype designed to assist domain experts in examining the dispersal of books from religious orders throughout Europe during the sixteenth century and beyond. The prototype is the result of a collaboration between visualization researchers and a historical book researcher, aiming to apply visualization techniques to address real-world domain challenges. Over two months, we engaged in an intensive collaboration with the domain expert to analyze domain issues and requirements and subsequently developed a prototype featuring two interfaces. Weekly discussions were held with the domain expert to ensure that the design and development process remained on track and to continuously evaluate the prototype. As the project is in its early stages, the prototype has demonstrated potential for improvement and scalability. Future work will focus on more formal and systematic evaluations of usability and practicality.

## 1. Introduction

The secularization of religious houses in Europe, driven by significant political events such as the reigns of Henry VIII, Joseph II, and Napoleon, as well as the Spanish desamortización (Spanish land and property expropriation) and the formation of the Italian State, led to the dispersal and partial destruction of vast quantities of early printed books. These events have shaped the landscape of libraries across Europe, with many books from secularized institutions forming the core of national and municipal libraries, while others found their way into the international antiquarian book market and became part of other countries' early printed heritage collections.

To address historical interest in mapping the dispersal of thousands of books, a collaborative project between a historian and visualization researchers resulted in the creation of an interactive visualization tool to quantify and analyze the extent of this phenomenon. By extracting information on the provenance of books from monastic institutions in major European collections, we uncover hidden patterns and connections between the original and current holding institutions.

The tool utilizes a multi-view approach, incorporating map-based representations, color encoding, and linked panels for intuitive exploration of the relationship between provenance and desti-



**Figure 2:** Two-level hierarchy of books and monasteries with embedded OD (Origin-Destination) feature.

nation. The current contributions include: 1) designing and developing a tool prototype; 2) proposing a visualization prototype for addressing domain challenges through map-based interactive interfaces with linked views that decompose the two-level hierarchical data (Figure 2); and 3) initiating a profound interdisciplinary collaboration with a historian. This interdisciplinary project highlights the potential of visual analytics to advance historical research.

## 2. Motivation, Domain Background, and Data

From the sixteenth century onward, vast quantities of early printed books have been displaced and partially destroyed because of the secularization of the religious houses of Europe. It is hard to find a library in Europe today that has not been affected by these political events. Historians have always tried to quantify the extent of the phenomenon and have managed to extract useful information from the provenance data of historical books, as they frequently change ownership throughout their lives, disseminating knowledge, ideas, and information [Don13]. Since 2009, the collaborative database Material Evidence in Incunabula (MEI) [CER15] has collected data on the former ownership and usage of 15<sup>th</sup>-century books, enabling the tracking of their circulation across Europe and the USA. In this project, the development of the tool is based on a dataset of 2,369 book records selected by domain experts from the MEI database, focusing on the impact of the secularization of religious houses on historical book dispersal. Figure 2 illustrates the data structure with a two-level hierarchy, comprising books and monasteries. Each book instance is accompanied by an origin-destination location pair, and each monastery is associated with its corresponding religious order. The Origin-Destination (OD) features [TC21], along with the hierarchical visualization and decomposition [BJGA98], have also garnered interest from visualization researchers.

## 3. Requirement and Task Analysis

Based on our discussions with the domain expert, we identified the following requirements to achieve the objective of *mapping the dispersal of books from religious orders*:

- R1 Display the locations of monasteries in Europe.
- R2 Illustrate the current locations of books and their movement.
- R3 Aggregate data by country, religious order, and current location.

To address these requirements, we developed the following tasks:

- T1 Use color encoding to emphasize the provenance-destination pairing and the current holding library.
- T2 Facilitate comparisons among books or monasteries.
- T3 Incorporate mini synchronized maps for aggregating books by their current location.
- T4 Enable extensive dataset exploration & manipulation via table.
- T5 Create visualizations to present descriptive statistics of the data.

## 4. Tool Description

The prototype features two interfaces, as shown in Figure 1, to address domain requirements. Both interfaces use a multi-view design to efficiently handle the two-level hierarchical data structure, allowing users to seamlessly switch between books or monasteries for comparison, exploration, explanation, or identification. A consistent color scheme is employed, encoding data with distinct colors for different holding institutions to facilitate intuitive comparison and differentiation of book origins and distributions.

In the *MapView Explorer*, map-based visualizations (Figure 1 A & B) emphasize the OD feature and intuitively display the dispersal of the book. They support the exploration of historical book distribution and offer insights into specific historical questions related to the secularization of European religious houses. The bar chart glyphs (J) on the map distinguish the five current libraries, indicating the number of books currently held in each library. Using small multiples [vdEvW13] for comprehensive data comparison, five synchronized mini-maps are specifically designed to highlight data pertaining to each individual library. Connected panels (C, D, E) supplement the map-based views by providing users with diverse perspectives, flexible options, and the ability to interact with the data for a deeper understanding.

The *BarChart Analyzer* provides an interactive bar chart visualization, enabling users to select up to five religious orders in a customizable order to compare the number of books (H) or monasteries (G) held in the five libraries.

## 5. Limitation and Future Direction

As the project continues to progress, there is substantial scope for refining the prototype, and it is essential to examine factors such as scalability and performance further. In future developments, emphasis will be placed on more formal and systematic evaluations of the tool prototype's usability and effectiveness, as well as incorporating innovative visualization techniques like parallel coordinates and heatmaps to enhance the representation of OD data within a hierarchical structure. It is noteworthy that our collaborating domain expert has already put the existing prototype to use in a teaching session for data presentation and evidence, offering initial confirmation of the tool's practical value. This interdisciplinary visualization project, therefore, underlines the potential of visual analytics in promoting historical research and teaching.

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