

# Enhancing Understanding of Constitutional Law through Visual Design

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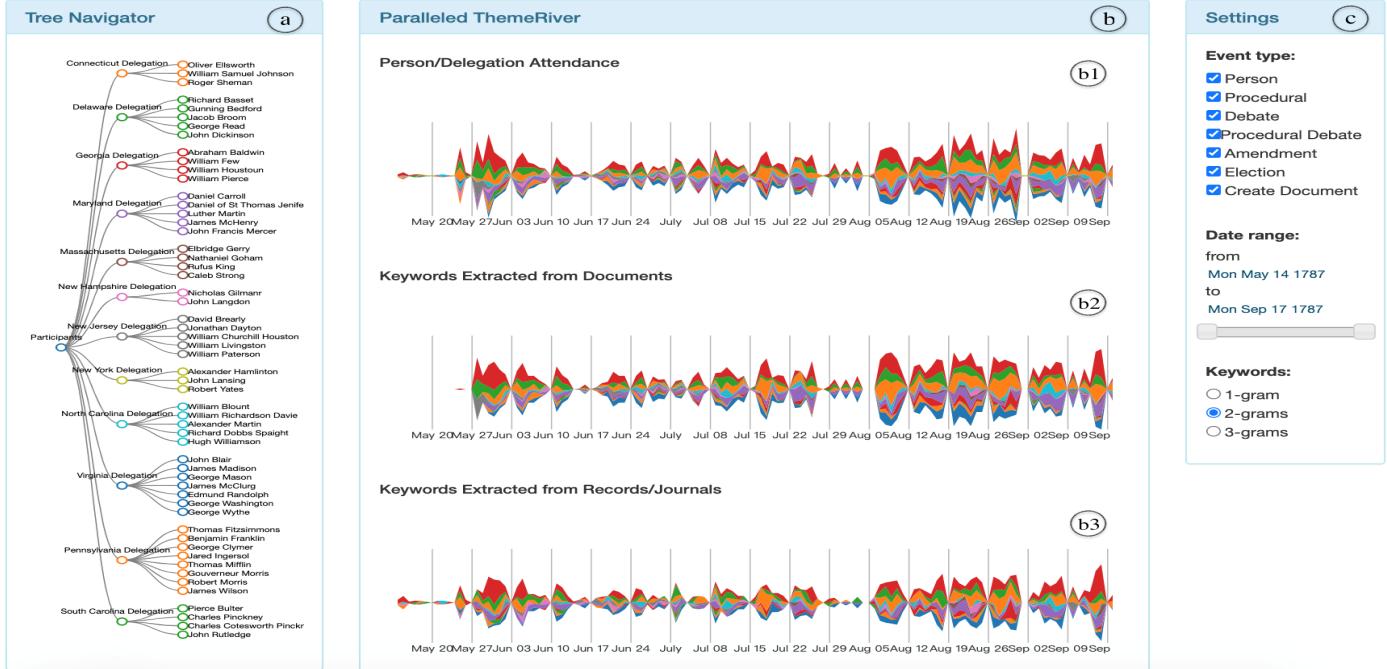


Figure 1: Prototype: (a) Hierarchy Tree to present the structure between people and delegations; (b) Paralleled ThemeRiver to illustrate the temporal evolution of participants' contribution in the whole process of the convention from three different angles; and (c) User-defined sets enable users to filter and select data on their own needs.

## ABSTRACT

In this paper, we present a work-in-progress visual analysis prototype to support domain experts in their understanding and analysis of constitutional law. In accordance with digital humanities domain, constitutional data is rich in relational, hierarchical, temporal, and text features. Data have complex implicit network structures and event-based dynamics and as such they have always posed a challenge to visualization. Through ongoing discussion with experts in constitutional law, we design a prototype with paralleled ThemeRiver and hierarchy tree to support the understanding of constitutional-convention data by showing the hierarchical structures and trends of selected attributes through their temporal development, and making values and trends of different attributes comparable simultaneously.

**Index Terms:** Human-centered computing—Visualization—Visualization design and evaluation methods

## 1 INTRODUCTION

This prototype is built on top of the Quill Platform [2]. Quill conducts research into the application of text analysis and data visualization to enhance domain experts' understanding of the modern world foundational legal texts and constitutional-convention process. Quill contains well-organized event-based datasets for different constitutional-conventions. The datasets concern the negotiation of legal texts during formal processes of negotiation and legislative drafting—most of the processes extended over months. They are complicated to present visually: the texts under discussion were the result of hundreds of amendments proposed by dozens of actors across an extended period of time. The data and model used by Quill tracks both the sequence of events and the hierarchical relationships

that connect proposals and decisions. The complexity of the datasets themselves provides significant challenges for visualization.

**The Quill Platform** Several visual tools have been implemented in Quill to illustrate the structure of the negotiation process together with text analysis tools providing close or distant reading to the legal texts [2]. To date, the main focus of the visualizations presented by the platform has been tools that allow the analysis of a particular moment in time – the relationship of a given proposal to text already agreed or other proposals already tabled. Visualizations that encompass the whole process of negotiation, allowing points of interest or trends within the discussions to be identified are less advanced.

**Datasets** The database is network-structured with multiple tables. Time is included in the ‘conventions’ and ‘sessions’ tables. Participants’ data is recorded in the ‘people’ and ‘delegations’ tables. Hierarchies also exist within tables, for example, ‘people’ is the sub-unit of ‘delegation’. Text data is stored in ‘documents’ related tables and are categorized into two. One is the text content of the constitution itself, the other is descriptive documents that model the process of negotiation. This large amount of descriptive text is drawn from journals and minutes of discussion, that record the text of proposals made, decisions taken, attitudes towards proposals. ‘event’ object is the basic unit in the dataset. ‘Event type’ – a categorical attribute is allocated to each ‘event’ and links the record of each event to the tables containing certain data based on its type.

**Research question** We define our research question as **enhancing the ability of domain experts to reason about the process of complex, multi-author negotiations through visual design**. To clarify the research question based on domain experts' needs, we split into three objectives:

- *The visualization requires to identify moments/trends of data that span events across months, while preserving the overall structure.*

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- A single view helps to compare different dimensions of the dataset using a common visual language is needed.
- The visualization should be developed as an exploration tool, giving a general view of several dimensions of data and covering the overall time span of a convention.

**Related work** We divide the related work into three parts: chronological data visualization, visualization of hierarchies, and topic model visualization. In terms of visualizing temporal and hierarchical data, there exist plenty of works, for example, the design of Timeline Trees [1] and Multistream [3], using a combination of tree structure and timeline visualization. Although the temporal visualization techniques are diversified according to the different characteristics of data, the hierarchy tree is widely used in presenting hierarchical structure. It can be well integrated with timeline visualizations and play a role of a navigator to a certain extent. In terms of showing topic and theme changes through time, the river metaphor is widely used such as the ThemeRiver [5]. The combination of hierarchy tree and ThemeRiver gives good result on visualizing hierarchical topic data in previous works such as HierarchicalTopics [4]. It is also applicable to our design. However, based on the complexity of our data, we consider not only text data but also attendance statistics. Therefore, we implemented a modified version of ThemeRiver to make it more suitable to our needs.

## 2 METHODOLOGY

### 2.1 Visual Design

Based on the research questions and domain experts' need, we devise following tasks to achieve by our future visual tool:

- To visualize the event data of three dimensions – people, constitution content, and descriptive text, with single visual encoding.
- Enable comparisons among temporal developments of different dimensions of the event data.
- Embedding hierarchical structure of data in the visual design.
- Allow user to explore the huge and multi-data typed dataset in a general view at a glance.

We follow the nine-stage methodology [6] when conducting the design study and use the *US Constitutional Convention 1787* to demonstrate our prototype. From the dataset, the people and documents events are extracted and aggregated based on their type and action time. With a mixture of numerical and text data, we apply basic keywords extracted methods to the text data, and count the frequency of keywords as a numerical feature illustrating how participants are involved in the process from the angle of document. A modified version of ThemeRiver is implemented to present the temporal evolution of attendance of people as well as the keywords features extracted from the original proposal text and descriptive text separately. We redefine *theme* in the original ThemeRiver prototype based on our research questions. Rivers represent the value associated with delegations, and the change of river over time reflects the participation and contribution of each delegation in the whole conventional process.

To visualize several temporal development simultaneously and provide feasibility for making comparisons, we place three ThemeRivers in parallel to show the attendance data, proposal text data, and descriptive text data in a single view. Same color encoding and certain interactive highlighting and labelling helps users identify delegation they focus on in each ThemeRiver. Sharing the same time scale provides feasibility for users to make comparisons.

To present the hierarchical structure, hierarchy tree is implemented to show the affiliation of participants and delegations. It is also designed as a navigator to the paralleled ThemeRiver, using the same color encoding to identify delegation information.

### 2.2 Prototype

Our prototype is shown in Fig. 1.

**User-defines sets** shown in Fig. 1(c), enable users to select events through intuitive interactive tools: **checkboxes** helps filtering certain type of events; **time range slider** helps focusing on a particular period; and **radio-buttons** allow users to choose the level of keywords.

**Tree structure navigator** in Fig. 1(a) shows the structure of how people and delegations are related. It also allows navigating through the hierarchical structure to the paralleled ThemeRiver. Association between the tree structure and the paralleled ThemeRiver are created through the consistency of color encoding. Whether in the tree or the rivers, nodes, and layers belonging to the same delegation are rendered in the same color.

**Paralleled ThemeRiver** in Fig. 1(b) generates an overview depicts the events in time at a high level of abstraction from three different angles: the attendance statistics, text features from the legal text, and text features from the descriptive text recording the negotiation process. This compression allows users understanding the process of the entire convention in a glance and making comparisons.

ThemeRiver in Fig. 1(b1) illustrates how people and delegations getting involved in the whole convention by the attendance statistics. The thickness of each layer represents the number of people of each delegation participating in the convention. While the thickness of the aggregated layers reflect the total number of people getting involved.

Sharing similar concept with Fig. 1(b1), but with text feature rather than numerical features, both Fig. 1(b2) and (b3) show the amount of keywords changes through time. The keywords for Fig. 1(b2) are extracted from the proposed documents and the keywords for Fig. 1(b3) are extracted from the descriptive text which record the process of the negotiation and debating in each session. Each layer represents a single delegation and the thickness of each layer represents the amount of keyword related to each one.

Three rivers shown in parallel allow the users to compare feature differences. For example, at one point, the thickness of Fig. 1(b1) and (b3) are high while in Fig. 1(b2) is quite low. This feature may indicates that although many people and delegations are involved in that session and the process of negotiation and debate are rich, the outcome shows in the proposed document itself may be poor.

## 3 CONCLUSION AND FUTURE WORK

We introduce a prototype for supporting the exploration and understanding of constitutional convention process. The prototype offers a multi-views visualization – combining the tree structure navigator and a modified version of ThemeRiver to present the temporal evaluation of the contribution of participants to the whole convention from different angles. Evaluation and user study will be conducted in the future. We will continue to improve the design of the prototype.

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