VisArgue - A Visual Text Analytics Framework for the Study of Deliberative Communication

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Abstract

For the last two decades, deliberative democracy has been intensively debated within political science and other related fields. Only recently, deliberation research has experienced a computational turn. In this paper, we present a linguistic and visual framework for the study of deliberative communication. The framework includes a range of visual analytics approaches to support research into deliberation. In particular, we propose a range of visualizations for highlighting deliberative patterns over time, speakers, and debates.

1 Introduction

For the last two decades, deliberative democracy has been intensively debated within political science and other related fields. Deliberative democracy promotes a form of democracy that is based on normative rationality and public reasoning. The ideal deliberation aims to arrive at a rationally motivated consensus instead of majoritarian decision-making (Habermas, 1981; Gutmann and Thompson, 1996). At its core, the discourse should be inclusive and based on extensive reasoning. Following Habermas, stakeholders participating in the discourse should be willing to adhere to "the unforced force of the better argument".

While the empirical turn in deliberation research (Chambers, 2003; Bächtiger and Steiner, 2005) has led to an increased understanding of deliberative decision-making, previous approaches in political sciences rely on the application of manual coding schemes determining the deliberative quality within debates (Steenbergen et al., 2003; Hangartner et al., 2007; Lord and Tamvaki, 2013). However, analyzing deliberative processes through manual coding schemes are demanding and time-consuming resulting in a limited set of debate corpora. Moreover, the coding is often subjective making it subject to critical judgments of other researchers (King, 2009; Black et al., 2010; Dacombe, 2013). As a result, manual coding poses challenges with respect to both validity and reliability.

Only recently, the computational turn in deliberation research allows to analyze large quantities of debates. Previous studies, however, focus on single (visual) elements like topic structures (Nguyen et al., 2012; Prabhakaran et al., 2014; Lin et al., 2013) or cognitive complexity to proxy for debate quality (Wyss et al., 2015) but fail to provide a coherent framework for the exploration and interpretation of deliberative communication. With the VisArgue framework, we propose a novel linguistic and visual analytics toolbox to study deliberative communication in all its diverse aspects.

VisArgue is designed on the basis of comprehensible algorithms that also allow less experienced scholars to grasp the underlying logic of the visual tools. Due to the application of many visualization approaches to the same data, different perspectives in the data are highlighted supporting a detailed analysis of the data. In other words: the VisArgue framework provides a toolbox for opening the black-box of deliberative communication.

2 VisArgue framework

The VisArgue framework is based on a collaborative research initiative involving political science, computational linguistics, and information science and visualization engineering[1]. It is designed to support scholars of deliberative communication in various ways. First, we propose a visual tool combining higher-level thematic structures with a close examination of the content (section 2.1). Second, we introduce an approach to

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[1]For more information, please see http://www.visargue.uni-konstanz.de

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analyze speaker behavior patterns over topic and time (section 2.2). These two visual approaches mainly support the exploration of yet unknown texts and can be applied independently of the language. Finally, based on the theoretical foundations of deliberative communication, the VisArgue framework proposes a range of visualizations explicitly focusing on deliberative communication. These visualizations range from a rather simple statistical toolkit (section 2.3) to a visual analytics approach combining close and distant reading for the exploration of deliberative patterns (section 2.4). So far, only German communication data can be processed within these visualizations.

The framework is implemented using a client-server architecture. Users can access the tools using their internet browsers which makes installing extra software unnecessary. The web-client works independently of the user's operating system. The software architecture is based on a Java back-end and a JavaScript front-end. The processed data is saved in a database (MongoDB) and is then loaded into the user's cache – making cached data accessible to the visualizations without the need to process it multiple times. To tackle privacy issues, users have to use authentication to access the web-client. This ensures only authorized access to the data of each user.

In the following sections, we will provide an overview on some of the visual analytics tools. We will briefly describe the rationale and give examples of these visualizations. In order to provide a coherent picture, we rely on data on the arbitration on Stuttgart 21 (henceforth: S21). S21 is a railway and urban development project in Southern Germany. To reconcile conflicts between proponents and opponents, an arbitration procedure was established to discuss the facts of the project. The arbitration lasted for 9 sessions. Overall, this results in a corpus of around 9.100 turns with almost 70 speakers.

2.1 Lexical Episode Plots

The Lexical Episode Plots (Gold et al., 2015b) combine the logic of what Digital Humanities scholars call "distant reading" with the logic of "close reading". Primarily, the visual tool is used to explore yet unknown texts. In general, it can not only be applied to communication data, but also to any other (sequential) text data type. The contribution of this visual analytics approach is twofold: First, a novel text mining method to identify thematic clusters within a text is introduced. Second, these clusters are presented in an interactive visualization enabling an exploratory data analysis.

With respect to the applied algorithm identifying the clusters, we rely on a comprehensive method enabling less experienced users to grasp the mathematical foundations of the algorithm. The basic idea is based on the concept of lexical chaining (Morris and Hirst, 1991). Hereby, we attempt at extracting word-sequences that appear more densely than expected within a text segment given their count in the whole word sequence of the text. Hence, each extracted cluster represents a span of text in which the frequency of a specific term is significantly higher than its average in the document. The clusters are not only based on unigrams, but also on higher-order n-grams, i.e. two or more words that form an entity term (like "computational social science"). Additionally, based on a likelihood ratio test, for each term cluster, we compute its level of significance.

In a second step, the lexical episodes are visualized. The visual design follows the mantra: overview first, zoom and filter, detail on demand (Shneiderman, 1996). In general, each episode is visualized as a vertical bar to the left of the text. The bars span from the first to the last occurrence of the term within a cluster segment. Each bar is assigned a different color – bars that include the same term are assigned the same color. Scholars can visually explore the episode clusters, interactively. First, episodes can be filtered based on the level of significance. By interactively changing the significance level, users can control the number of episodes displayed in the visualization. Second, they can zoom in and out to switch between a distant and close reading of the textual data. Finally, by clicking on an episode bar, the terms are highlighted within the text representation.

Figure 1 shows the visualization of the Lexical Episode Plots. The visualization reveals the sequential structure of the arbitration on S21 and highlights the most important thematic clusters. For instance, in the first session, the members of the arbitration committee discussed the transport of goods (*Güterverkehr*), the switches (*Weichen*), and the emergency concept (*Notfallkonzept*). Moreover, the visualization reveals that Ms. Starke (*Frau_Starke*) was the most referred person in the beginning of the arbitration.

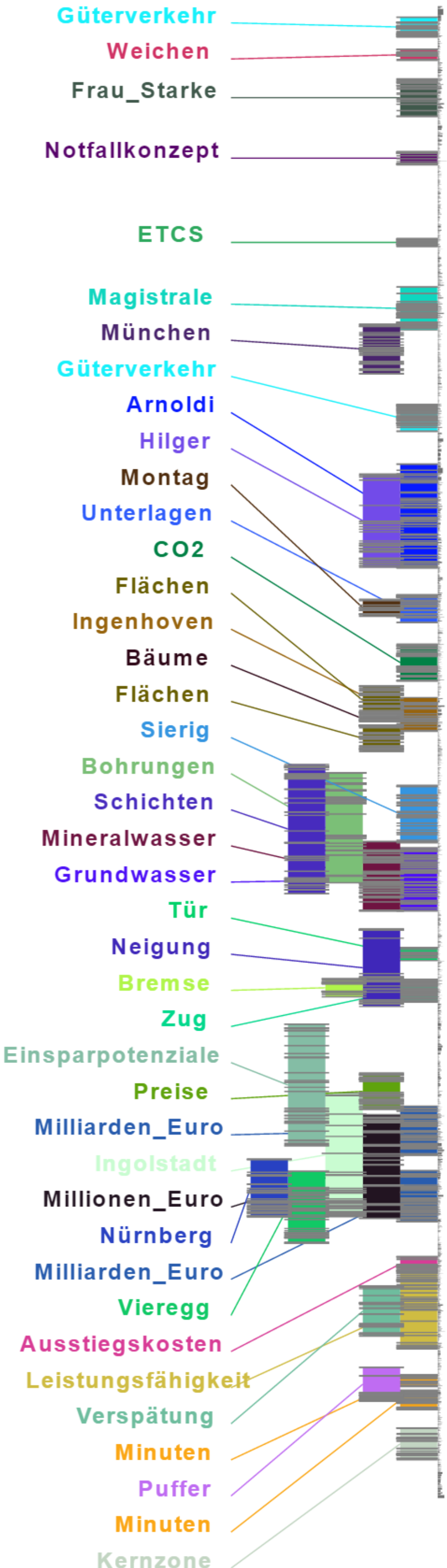

Figure 1: Lexical Episode Plots for S21

2.2 ConToVi

ConToVi (El-Assady et al., 2016), the Conversation Topic Visualization, was introduced to analyze speaker behavior patterns. ConToVi tracks the movement of speakers across the thematic landscape of a conversation. It is designed to explore the dynamics of conversations over time, highlighting speaker interactions and behavior patterns. Hence, compared to the Lexical Episode Plots, it adds a new dynamic layer to the analysis.

To uncover the topics in a given text, we utilize a hierarchical topic modeling algorithm that is developed to cope with the sequential structure of conversations (El-Assady, 2015). This algorithm was designed to specifically address the challenges with transcribed spoken data – namely more noisy data containing non-standard lexical items and syntactic patterns. Using the results of the topic modeling algorithm span a floor for the representation of speaker dynamics. In Figure 2, the movement of speakers in the topic space is shown. The topics are represented on the circular plot. Topics that are addressed more often are visualized by larger segments on the circular plot. With 16 topics shown, the movements and interactions of speakers over time can be visually tracked turn by turn. For instance, while in the previous turn the yellow speaker has addressed the topic on the left side, in this turn, the speaker moves to a different topic on the upper right side. Similarly, before the yellow speaker changed his or her topic, the light green speaker moved from a topic on the right side to the topic depicted at the bottom of the circular plot.

Beside demonstrating dynamics of speakers over time, ConToVi allows retracting the speakers' paths through the topic space. Since one of the main theoretical assumptions of deliberative communication requires speakers to listen and respond to each other, we assume deliberative debates to be characterized by overlapping paths. This is illustrated in Figure 3 for one session of the arbitration. The moderator of the debate moves back and forth addressing most topics in this session. In general, the moderator also addresses topics not related to the moderation of the debate but actively intervenes in the substantive issues of the debate. Speaker A and B are both less involved in the debate with Speaker A showing a tendency to the upper left topics – however, to some degree, the paths overlap.

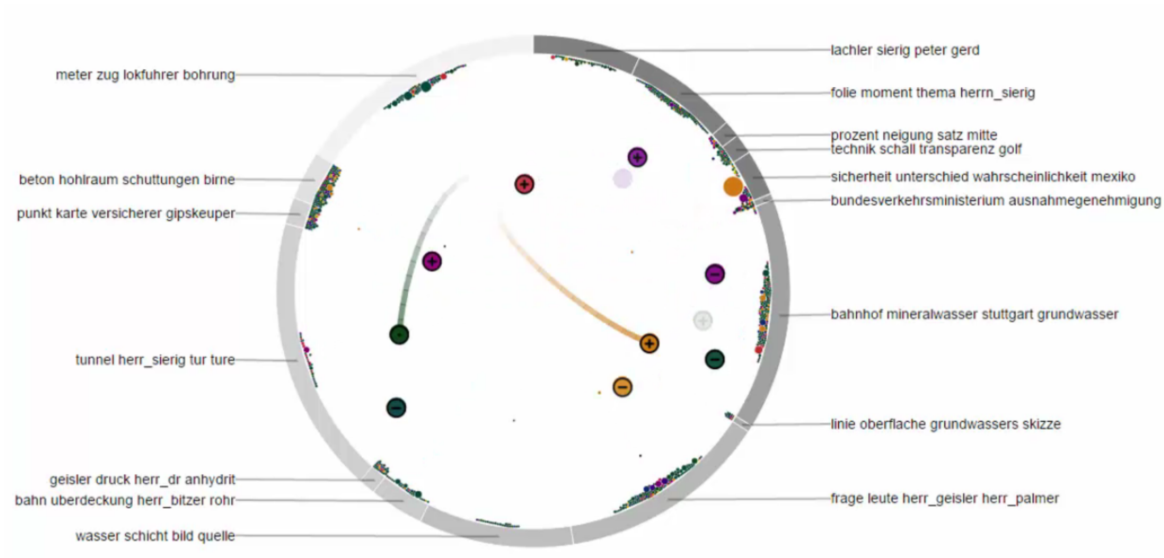

Figure 2: ConToVi Visualization

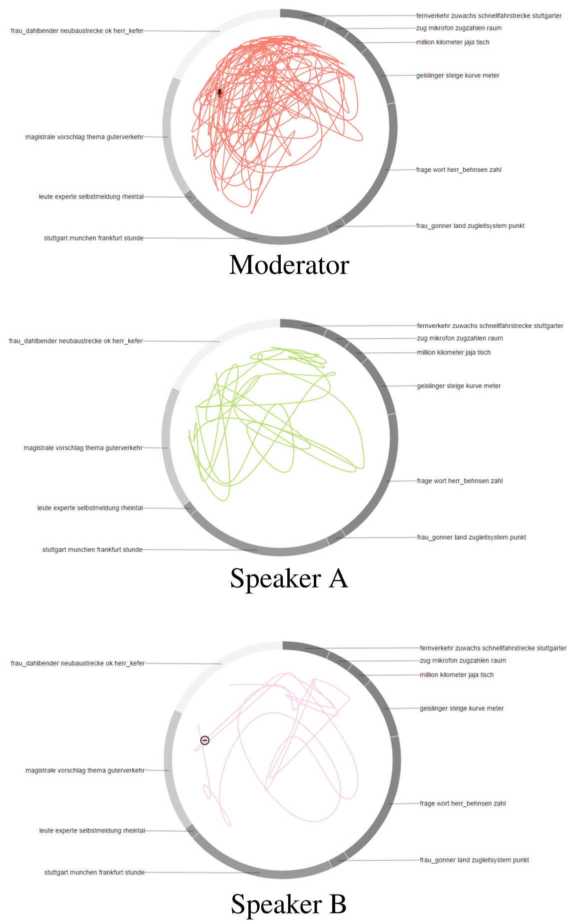

Figure 3: Speaker Paths

2.3 Deliberation Statistics

To arrive at a visual representation of deliberative communication, deliberation needs to be measured. As part of the VisArgue project, we propose a computational linguistic parsing system annotating the degree of deliberation for four dimensions: participation, respect, justification, and accommodation (Gold et al., 2015a; Gold and Holzinger, 2015). These four dimensions result from the application of natural language processing tools, unsupervised content extractions, dictionary applications, and statistical analyses. The four dimensions are further subdivided in different subdimensions belonging to similar theoretical concepts. For instance, within the broad dimension of justification, we determine the type and degree of reason-giving, the certainty with which information are exchanged, and the reference to norms. In total, the computational linguistic pipeline results in 53 individual measures of deliberative communication.

In order to support the analysis of deliberative communication, the VisArgue framework offers the possibility to quickly access descriptive statistics with respect to the 53 measures. In Figure 4, we demonstrate the general visual rationale for generating the statistics. Based on the type of measure, scholars can drag and drop the measures from the left side panel to the right panel. Besides specifying the x- and y-axis according to the scholars needs, they are provided the opportunity to name the visualization. After all is set, by clicking on the button, the visualization is created.

One of these visualizations is shown in Figure 5. It depicts the degree of reason-giving for

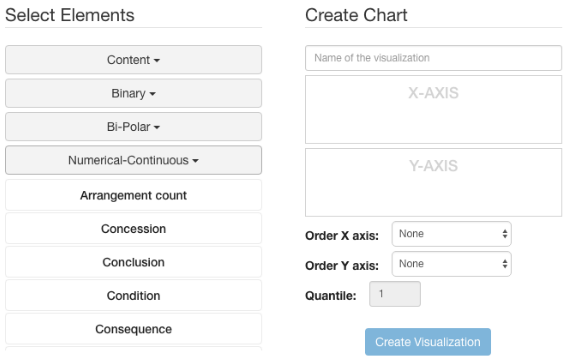

Figure 4: Statistics Visualization

each speaker in one of the sessions on S21, in relation to the mean level of reason-giving in this session. The green bars to the right indicate more reason-giving than on average, the red bars to the left less reason-giving, respectively. In general, we also provide the possibility to aggregate the statistics with regard to some metadata of the speakers, e.g. the position towards the project.

Figure 5: Degree of Reason-Giving per Speaker

2.4 Lexical Units

In order to explore and interpret the various measures of deliberative communication, we propose Lexical Units Visualization that is based on the annotation system but allows a distant reading of all annotations. Similar to the Lexical Episode Plots, the visualization combines the logic of close and distant reading and can be used to interactively explore the discourse.

For instance, in Figure 6, we demonstrate the visual approach for five deliberative annotations in one of the sessions on S21. The five annotations are visualized next to each other enabling a distant comparison of textual features. Again, similar to the Lexical Episode Plots, the text of the debate is shown in black and each segment is colored with its respective annotations. Each segment represents an Elementary Discourse Unit (EDU). Based on Marcu (2000), we assume the text between two punctuation marks to belong to the same event (Polanyi et al., 2004) and, hence, to be collocated in one EDU. The first bar in Figure 6 visualizes argumentation (red), the second bar conventional implicatures (blue), the third bar event modality (purple), the fourth bar information certainty (gree), and finally, the last bar emotions (yellow). The figure reveals overlapping segments of deliberative annotations and by providing zoom functionality, close reading can provide more insights into the debate and the reasons for these overlapping segments of deliberative behavior.

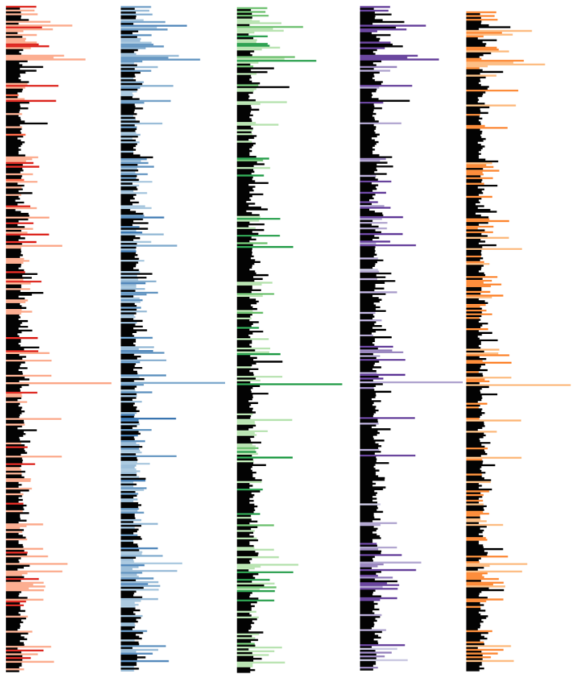

Figure 6: Lexical Units Visualization

3 Conclusion

In this paper, we introduce the VisArgue framework, a set of interactive visualization approaches to explore and interpret deliberative communication. These visual analytics tools are based on the result of a natural language processing pipeline combining various measurement approaches. We conclude that the turn in deliberation research towards computational analysis is the next step for analyzing large quantities of communication data.

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