


Of Course it's Political! A Critical Inquiry into Underemphasized Dimensions in Civic Text Visualization

Eric P. S. Baumer,¹  Mahmood Jasim²,  Ali Sarvghad²,  Narges Mahyar² 

¹Lehigh University, Computer Science & Engineering, USA

²University of Massachusetts Amherst, Manning College of Information and Computer Sciences, USA

Abstract

Recent developments in critical information visualization have brought the field's attention to political, feminist, ethical, and rhetorical aspects of data visualization. However, less work has explored the interplay between design decisions and political ramifications—structures of authority, means of representation, etc. In this paper, we build upon these critical perspectives and highlight the political aspect of civic text visualization especially in the context of democratic decision-making. Based on a critical analysis of survey papers about text visualization in general, followed by a review on the status quo of text visualization in civics, we argue that civic text visualization inherits an exclusively analytic framing. This framing leads to a series of issues and challenges in the fundamentally political context of civics, such as misinterpretation of data, missing minority voices, and excluding the public from decision making processes. To span this gap between political context and analytic framing, we provide a series of two-pole conceptual dimensions, such as from singular user to multiple relationships, and from complexity to inclusivity of visualization design. For each dimension, we discuss how the tensions between these poles can help surface the political ramifications of design decisions in civic text visualization. These dimensions can thus help visualization researchers, designers, and practitioners attend more intentionally to these political aspects and inspire their design choices. We conclude by suggesting that these dimensions may be useful for visualization design across a variety of application domains, beyond civic text visualization.

CCS Concepts

• **Human-centered computing** → *Visualization theory, concepts and paradigms*;

1. Introduction

Critical orientations towards visualization lend alternative lenses to examining the process and practices of visualization. For instance, prior work has considered ethical [Cor19], feminist [DK20], critical theory [DFCC13], and rhetorical [HD11] perspectives on data visualization. Building on that work, this paper offers conceptual tools that help highlight the political aspects of visualization especially related to analyzing and utilizing text visualizations. By “political,” we refer to the ways that creating and using visualizations impact representation, delegation, interpretation, marginalization, and related processes in the exercise of power. This political aspect of visualization becomes particularly prominent in the context of public input for civic decision making. Often, public input is collected as free-form text, pertaining to public opinions, suggestions, requests, etc. Civic decision makers must read, understand, and incorporate such public input into decisions about the provision of social services, e.g., urban planning [MBX*16; MJN*18], health services [SOA*20], governmental procedures [Bra13], or environmental policy making [FO05]. Improving the public input process has become an important goal in the field of digital civics [MNC*19; VCL*16; OW15]. To that end, researchers and

practitioners have developed a variety of systems for, e.g., sharing public opinions [FBRG10], building consensus [KMF*12a; ZNB15], summarizing public input [19], or identifying people's priorities, reflections, and hidden insights [JHSM21].

Many of the aforementioned digital civics systems employ techniques drawn from work in text visualization [KMF*12a; ZNB15; FBRG10; 19; JHSM21; HC16b; ZVK17]. Text visualization is a well established research area, and at the time of this writing, KUCHER and KERREN [KK14] have documented 440 distinct text visualization techniques (see <https://textvis.lnu.se/>). Furthermore, not only have text visualization researchers written multiple survey papers [ŠB10; PSB10; AdOP12; SWLL13; GZL*14; NPW14; WSJ*14; LCWL14; KK15; JFCS15; CC16; FHKM17; JFCS17; KPK18; LWC*19; MS20], there is even at least one survey of surveys [AL19b]. Thus, rather than surveying techniques in text visualization, we examine how text visualization, both as a set of techniques and as a general orientation, has been applied in the inherently political context of digital civics.

This paper argues that text visualization acts for digital civics as a double edged sword. On the one hand, it provides a variety of tools

and techniques that help improve the tractability and efficiency of the public input process. On the other hand, the application of text visualization techniques treats the political process of public commenting as an exclusively analytic endeavor, leading to a variety of issues and challenges.

To make this argument, in Section 2 we clarify how our sense of the term “political” draws on prior work [Asa00; Bec02; BS99; Mou99; Mou13; Win80] and highlight how visualization can and often should be seen as a political process, one that grants representation and authority to some voices while potentially marginalizing others. However, using a critical literature review [a la BVSD07; BHP*12; BKM*14] of text visualization survey papers [ŠB10; PSB10; AdOP12; SWLL13; GZL*14; NPW14; WSJ*14; LCWL14; KK15; JFCS15; CC16; FHKM17; JFCS17; KPK18; LWC*19; AL19b; MS20], we find that text visualization research embodies a largely *apolitical* orientation that treats both the design and the use of text visualization systems purely as processes of analysis (Section 3). Then reviewing the status quo of civic text visualization [e.g., KMF*12a; ZNB15; FBRG10; 19; JHSM21; HC16b; ZVK17], we find that civic text visualization inherits this analytic orientation, implicitly casting the treatment of public input as an *analytic* process. In Section 4, we highlight how several issues and challenges that emerge in civic text visualization arise, at least in part, from this exclusively analytic orientation. For example, applying aggregate analysis to understand public sentiment can marginalize or ignore minority voices. In this way, the activities of civic text visualization—grouping similar individual comments, identifying salient topics, interpreting public opinion, etc.—should also be conceived of as much *political* as *analytical*. As we argue in Section 5, what is needed, then, are means by which to help researchers, designers, and practitioners in digital civics to shift from a purely analytic stance on text visualization to one that acknowledges and considers its political aspects. To this end, we contribute a series of conceptual dimensions that can help shift attention and account for these political aspects and all the subtleties that comes along with it (Section 6).

Our contribution in this paper is two-fold: we argue the importance of and offer means of accounting for political aspects of civic text visualization. This type of contribution differs somewhat from that of most papers in visualization publication venues [LIS*19]. It is perhaps best described as an argument or critique, similar to papers that have explored visualization through varied lenses beyond the purely technical [HD11; DFCC13; Cor19; DK20]. While the paper focuses on civic text visualization, it concludes by suggesting that many of the issues highlighted here, and thus the conceptual dimensions by which to address them, may apply quite broadly across a range of visualization systems.

2. Data Visualization as Political

Our use of the term “political” draws on prior work to analyze power differentials in the practices of visualization and to highlight how the status quo can be challenged and changed. For instance, we draw inspiration from the assertion that participatory design is less a design method and more a political process [Bec02] [also see Asa00]. For BECK [Bec02, p. 78], “political means concern about dominance patterns,” i.e., the means and structures by which some

groups of people exert power or influence over others. BOWKER and STAR [BS99] also show how the design of classificatory systems, such as the international classification of diseases, embodies commitments about categories that are then used to exercise authority. Similarly, according to MOUFFE [Mou99; Mou13], “the political” pertains to aspects of disagreement, tension, and differences of opinion that emerge in any human society. DiSALVO [DiS12] makes a compelling argument for applying Mouffe’s broader political theory, referred to as agonism, to understanding the general activity of design. Perhaps most notably, WINNER [Win80] argues that some technologies (e.g., railroads, nuclear power, sailing vessels) are highly compatible with, or may even require, certain arrangements of power. He shows how design decisions, both about what functionalities to include in a technology and about which technologies to build in the first place, are concomitant with decisions about the organization of authority within society. That is, design decisions are often simultaneously political decisions.

Such political questions—about representation, authority, interpretation, marginalization, etc.—closely resemble processes involved in data visualization. Design choices regarding datasets, visualization techniques, interactivity, and other aspects influence the conclusions that a viewer can reach [HD11]. However, the “tendency to view [visualization] work as the mere reporting or structuring of objective fact” [Cor19, p. 2] obscures how data are neither neutral nor objective [DK20]. Rather than a “view from nowhere” [Nag86], visualizations and the data they present are always a view from some situated perspective [Har88; Har91].

In this way, it is perhaps obvious that civic text visualization is political. And yet, relatively little visualization research closely attends to the interplay between design decisions and political ramifications. To understand the origins of this disconnect, we now turn a critical eye toward the broader research on text visualization.

3. A Critical Review of Text Visualization Research

The review in this section focuses on prior text visualization survey papers, due both to the volume of text visualization research [KK14] and to the existence of numerous prior surveys [AL19b]. To find these survey papers, we searched scholarly repositories (e.g., IEEE Xplore, ACM Digital Library, Google Scholar) with the queries “text visualization survey” and “text visualization review.” Doing so identified 17 survey papers [ŠB10; PSB10; AdOP12; SWLL13; GZL*14; NPW14; WSJ*14; LCWL14; KK15; JFCS15; CC16; FHKM17; JFCS17; KPK18; LWC*19; MS20; AL19b], all of which are reviewed here.

Our orientation continues a line of recent work on decentering the notion of the “user” in HCI [BB17; CBD19; Tay15; For18]. In particular, the analysis is guided by two inter-related questions. First, what are the kinds of activities these visualizations are meant to support? Second, who is envisioned as engaging in these activities? These two questions served as sensitizing concepts [Bow06]—rather than being the only questions we asked, they were used to guide our attention to important assumptions made in this body of work.

To address these questions, each of the above survey papers was

analyzed using an iterative, inductive approach drawn from qualitative methods [GS67; LSAL05; Cha06] and from previous critical literature reviews [e.g., BHP*12; BKM*14; BVSD07]. In brief, this approach involves mapping thematic patterns, determining the implicit assumptions driving a body of work as revealed by those patterns, and interrogating the consequences of those assumptions.

3.1. Who Is the User and What Are Their Tasks?

Across the 17 survey papers reviewed [ŠB10; PSB10; AdOP12; SWLL13; GZL*14; NPW14; WSJ*14; LCWL14; KK15; JFCS15; CC16; FHKM17; JFCS17; KPK18; LWC*19; MS20; AL19b], visualizations were consistently described as supporting primarily *analytic* activities that are engaged in by some sort of *analyst*. For instance, ŠILIC and BAŠIĆ [ŠB10, p. 39] explicitly describe text visualizations as being designed for “media analysts, historians and other scientists from all fields.” As another example, JÄNICKE, FRANZINI, CHEEMA, and SCHEUERMANN [JFCS15, p. 1] focus on “humanities scholars [...] interested in the analysis of related texts or text passages.” Other surveys name the intended users less specifically. Analogous to BRYNJARSDÓTTIR, HÅKANSSON, PIERCE, et al. [BHP*12], some of these surveys were not expressly or solely about text visualization. For instance, LIU, CUI, WU, and LIU [LCWL14] provide a general survey of information visualization, with a large section devoted specifically to text visualization. Similarly, FEDERICO, HEIMERL, KOCH, and MIKSCH [FHKM17] survey visualizations for scientific literature and patents, with a significant portion of the survey focused on text data.

Despite these slight variations, all surveys clearly (if implicitly) framed the **user as an analyst**. Visualizations are meant “to aid users in exploring, understanding, and analyzing data” [LCWL14, p. 1373]. They “enable users to visually explore [...] large sets of documents” [GZL*14, p. 29], and they are intended “to support exploratory analysis of document collections” [AdOP12, p. 480]. Several of the surveys present taxonomies of the various “analytic” tasks that a user might perform [e.g. KK15; KPK18; JFCS17; FHKM17]. This phrasing implicitly suggests the tasks a user might perform with the visualization are primarily analytic. Some surveys go so far as to explicitly refer to the user as an “analyst” [GZL*14; WSJ*14; SWLL13; AdOP12; FHKM17].

To some extent, this emphasis is perhaps unsurprising. As a field, visualization is concerned with “the process of transforming data, information, and knowledge into visual form” [GEC98, p. 9]. It “seeks to augment human cognition by leveraging human visual capabilities to make sense of abstract information” [HCL05, p. 421] [citing CMS99]. Such definitions, which inherit from HCI’s seminal rhetoric of enhancing user cognition [CNM83; CB95], explicitly set up information visualization as concerned with exactly the kinds of questions that arise when framing the user as an analyst. At the same time, this orientation has particular consequences in terms of shifting attention during the design of text visualization.

3.2. What Are the Consequences of an Analytic Orientation?

Framing visualizations as primarily analytic results, among other things, in *emphasizing the visualization itself*, thereby drawing attention away from potential audiences or contexts of use. The ma-

jority of each survey is spent describing various aspects of visualization design and implementation. For instance, JÄNICKE, FRANZINI, CHEEMA, and SCHEUERMANN [JFCS17] talk about several aspects of data transformation, such as the “pre-processing steps to transform the given textual data into the visualization’s input format” [JFCS17, p. 230]. CAO and CUI [CC16] devote separate chapters to topics such as the underlying data model (bag-of-words, n-grams, entity relations, etc.) and the use of different visual representation techniques for presenting document content (word clouds, frequency plots, animations, stream graphs, etc.). ALENCAR, de OLIVEIRA, and PAULOVIČ [AdOP12] describe the use of metadata to create visualizations that support network analysis of documents. FEDERICO, HEIMERL, KOCH, and MIKSCH [FHKM17] highlight visualization techniques expressly focused on analysis of temporal patterns. In such ways, these surveys (and the research they summarize) place more emphasis on the visualization itself than on the intended audience(s) or context(s) of use.

Relatedly, KUCHER, PARADIS, and KERREN [KPK18] provide far more parameters to describe the visualization itself (the data source, the application domain, the variables of interest, etc.) than on the analytic tasks a user might perform. LIU, WANG, COLLINS, et al. [LWC*19] link specific visualization techniques (charts, timelines, spatial projects, etc.) with specific analytic tasks (information retrieval, classification, exploratory analysis, etc.). Indeed, most of these analytic “tasks” more closely align with the functions that a computational *model* is performing (e.g., cluster analysis, natural language processing) rather than with the variety of possible goals that various audiences might have while engaging with the visualization in specific contexts.

Furthermore, this emphasis on analysis draws attention away from the variety of ways that people might engage with such visualizations. While some audiences may be analysts, others are certainly not, such those people who are the source of the data being visualized [BB17; Tay15]. Giving the people who thusly provide such data a voice in how those data are represented and interpreted, and involving them in decision-making, is necessary for participatory democracy [MHAG06]. Additionally, it may provide further benefits, from ensuring accuracy to avoiding co-optation. However, the analytic framing of visualization as a largely apolitical tool makes it difficult to see, let alone to account for, such myriad complex relationships.

3.3. What Are Alternative Approaches to Text Visualization Beyond Analysis?

It is informative to contrast this analytic emphasis with other evolving discourses in information visualization. The prior work reviewed above illustrates a few alternative orientations, including rhetoric [HD11], feminism [DK16; DK20], ethics [Cor19], and others [DFCC13; VW08]. As a further example, work on visualization evaluation [SP06; IZCC08; LBI*12] has emphasized the importance of close attention to the various contexts in which a visualization will be applied. Interestingly, some of the survey papers reviewed here comment on the need for detailed evaluations of text visualization systems with diverse users in real world settings [AdOP12; SWLL13; LCWL14; JFCS17]. However, these aspects do not emerge in the research summarized in the survey pa-

pers, but rather as important directions for future work. Thus, this kind of holistic approach seems to have gained traction in the information visualization community's approach to *evaluation*. However, it seems to have had less of an influence specifically within text visualization, especially with respect to *design*, either in terms of developing novel visualization techniques and or of assembling a confluence of existing techniques into a particular arrangement for a particular purpose.

To clarify, we *do not* argue that text visualization is never analytic, simply that it may also be otherwise, especially in civic text visualization. Framing text visualization as an exclusively analytic enterprise, hinders our ability to be aware of and design for other types of engagements. To elaborate on this point, the next section turns to considerations of text visualization that arise specifically in civics.

4. Issues and Challenges in Digital Civics

This section returns to this paper's core argument: either intentionally or unconsciously, *civic text visualization has inherited the analytic orientation found in text visualization research*. The public are essentially treated as a source of data to be collected, processed, visualized, and analyzed. To demonstrate this point, this section reviews existing literature on civic text visualization. We first searched scholarly repositories (e.g., IEEE Xplore, ACM Digital Library, Google Scholar) with the queries "civic text visualization," "public opinion visualization," and "digital civics." The resulting titles and abstracts were examined to find papers that present ideas, theories, design guidelines, or examples of text visualization tools or systems in civics. Snowball searching of the reference lists in each paper identified further work. Of the potentially relevant work, this section focuses on the 17 most relevant and representative papers [MNC*19; MJS20b; KRH17a; JKW*21; JHSM21; HC16b; ALND17; 19; FBRG10; Sav15; MJN*18; AJM21; CRMH12; GHWM20; JSHM20; KMF*12b; DRRD12]. Reviewing this work shows how an analytic orientation gives rise to a collection of interconnected issues and challenges. Some of these issues are not entirely unique to civics but apply to data analysis or visualization in other domains where decisions are high-stakes. The rest of this section introduces and discusses these issues in detail.

4.1. Providing an Environment for Collaborative Sensemaking

Civic text analysis can be an expensive, time consuming, and labor intensive task [MNC*19; MJS20b]. Decision-makers—who are responsible for gathering, analyzing, and making policy decisions based on public-generated civic text—often outsource the analysis of public input to analysts in an attempt to mitigate the complexity and distribute the tasks [MNC*19]. In order to mitigate analyst bias [WBF17; KRH17a], they desire that multiple analysts would identify, converge, and confirm the insights from civic text.

Prior works suggest that analysts use a variety of tools to synthesize and make sense of civic text. Some analysts use an assortment of spreadsheet applications and text editors [MNC*19; JKW*21]. Others use qualitative data analysis tools such as NVivo [21], Dedoose [20a], or atlas.Ti [ACM19]. Some tools provide both compu-

tational and visualization features. For instance, CommunityPulse provides a scaffolding for multifaceted public input analysis using visualizations [JHSM21], and MultiConVis enables multilevel exploration and analysis of threaded conversations [HC16b].

However, these tools and techniques are designed primarily for an individual analyst, and the functionalities they provide are not necessarily suitable for collaborative analysis. This aspect of the design represents a disjuncture from the desires of civic leaders to support collaboration among multiple analysts. Furthermore, the emphasis on a single analyst reaching conclusions belies the plurality and contention involved in political processes [Mou99; Mou13]. To be truly democratic, such collaboration should occur not only among multiple analysts but also in participation with numerous diverse stakeholders.

4.2. Integrating Participatory Approaches

In participatory democracy, the involvement of all stakeholders is critical. Decision-makers, analysts, community envoys, and the general public [MNC*19] each have different roles, responsibilities, and relationships with the data [JHSM21]. Civic leaders—who include community envoys and decision-makers—engage the public to gather data to inform decision-making are keen to leverage these relationships to gain a holistic understanding of people's perceptions and dispositions towards civic issues.

Researchers in HCI and digital civics have begun to explore methods to improve the analysis capabilities of visual analytics tools [JHSM21; MJS20b]. Although the broader community of visualization researchers acknowledges the importance of designing for varied levels of expertise [Mun14; GTS10; SNHS13], existing work on text analytics in general, as well as civic text visualizations in particular, focuses research efforts towards designing for analysts. Less effort has been put on designing and developing text visualization for non-experts—people who are not trained in or have had limited exposure to visualization and analytics. These people, who often have local knowledge and deep expertise in areas outside visualization and analytics (e.g., planning or urban design), constitute an integral part of the participatory democracy equation [Hea07; MNC*19; Nel19].

Despite their central importance in the civic engagement process, members of the general public are not necessarily involved in the analysis process. Hence, they are often left out of the loop when designing civic text visualizations—their requirements, aptitudes, knowledge, etc. are not given central consideration. Integrating participatory approaches in civic text visualization could pave the way not only for more inclusive analysis but also for leveraging the general public's knowledge to gather richer insights.

4.3. Presenting Rich and Interpretable Data

Civic leaders often demonstrate a strong preference towards gathering rich qualitative input as opposed to quantitative statistics [CL18b; CL18a; ALND17; MNC*19]. They want to move beyond aggregated measures of public preference (e.g., surveys, voting, or polling) to understand people's priorities and viewpoints [JHSM21; MNC*19]. Previous work has used various computational approaches to identify people's sentiments [HC16b]

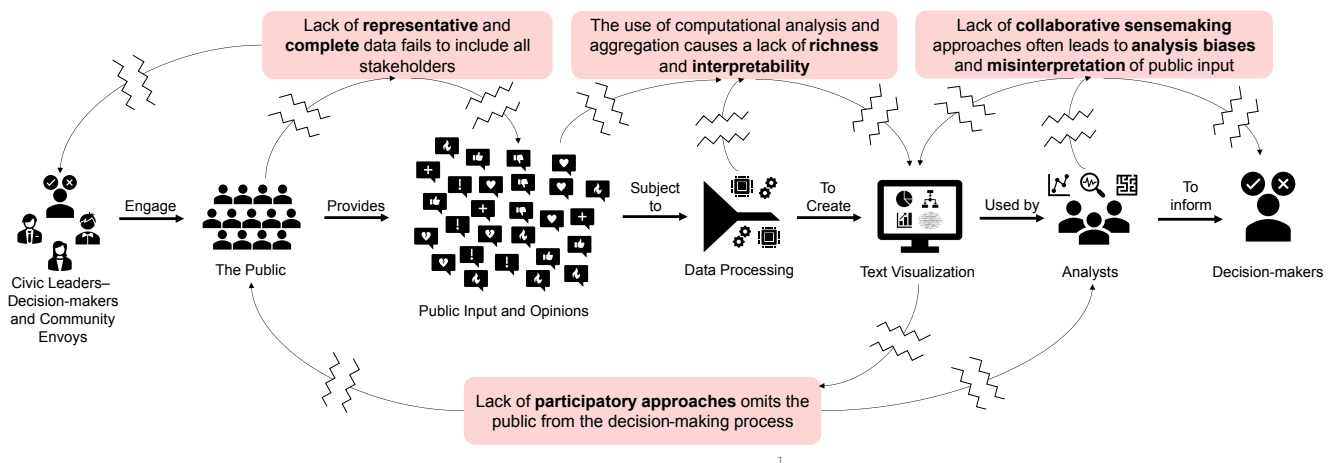


Figure 1: The status quo of civic text visualization is predicated upon a mostly linear pipeline (horizontal left-to-right arrows): civic leaders engage the public to provide input and opinions that go through data processing to create text visualizations used by analysts to inform decision-makers. However, our review highlights how, in practice, numerous disconnects emerge (broken curved arcs). Decision makers lack means for collecting representative data from all stakeholders. The public has little means of participating in the analysis of their inputs. Computational analysis reduces the richness of public input data. Analysts lack environments and tools to support collaborative sensemaking. Civic text visualization thus becomes susceptible both to misinterpretation of public opinion and to marginalization of minority viewpoints.

and extract the main discussion topics [JHSM21; HC16b]. Some have used clustering methods to group together similar opinions from the general public [19; FBRG10]. Others have used finer-grained categorization of text to identify public emotions from civic text [JHSM21; Sav15].

However, some of these tools rely on some form of aggregation or summarization to provide an overview. While useful for providing high-level understanding, such overviews are susceptible to being misinterpreted as the underlying text data themselves [PAE19; Cai19]. That is, the fact that aggregation or summarization were used is not always readily apparent, nor is it always obvious the effects that those processes have on the resultant visualizations. Furthermore, summarizing or aggregating civic text can result in missing key comments [JHSM21; MNC*19]. Such oversights in turn inhibit the civic leaders from gathering rich and representative insights from civic text. For example, civic leaders often want to know whether minority opinions are being suppressed by aggressive comments, or an unpopular but thought-provoking insight is obscured by support for popular ideas. Methods to enable civic leaders to combat oversimplification and decontextualization of unpopular or marginalized opinions remain an under explored issue in the civic domain.

4.4. Ensuring Representative and Complete Data

Civic leaders are keen on broadening their outreach to ensure that they gather both a diverse and a representative set of opinions [MNC*19; JKW*21]. This necessity stems from their desire to include every voice of opinion on civic issues and achieve a complete understanding of the general public's perspectives without discrimination. To that end, civic leaders have adopted both in-person and online civic technologies to gather public input.

Previous work has introduced several online engagement platforms to enable the public to asynchronously provide their comments, ideas, and feedback around civic issues [19; 20b; MJN*18]. These engagement tools have used micro-tasks [MJN*18], visualizations [19], and forum-like discussions [20b] to engage disconnected and disenfranchised populations [MNC*19]. Others have proposed technologies to promote in-person engagement of reticent participants during town halls [JKW*21] and public meetings [LLS] using clicker-like devices.

However, these methods of engagement introduce their own challenges to representivity. For example, using clicker devices in face-to-face town hall meetings generates data that are easy to analyze, but doing so simultaneously limits participants' expressivity to a handful of options without a chance to unpack the reasoning behind their opinions [JKW*21]. The online engagement methods are often difficult to disseminate, especially to people who do not have access to or are not comfortable using online technology [AJM21]. Furthermore, these methods often lack mechanisms to identify and track demographic information, which is critical to understanding the origin of public input and to ensuring representivity in the collected data [MNC*19]. While collecting demographics is beneficial for civic leaders, people often prefer to make anonymous contributions in online civic discussions to maintain privacy [MJN*18]. In addition to impacting representivity, such tensions and tradeoffs also have implications for bias and for uncertainty in the interpretation of the general public's perspectives.

4.5. Accounting for Bias and Uncertainty

Bias and uncertainty, which can be detrimental to the civic decision-making process [MNC*19; TK74], may manifest inadvertently in the civic domain due to challenges involved both in

data collection and in analysis [MJS20a]. For example, even when using online and offline channels to collect public input, the collected opinions can be biased representations of false consensus or perspectives of a vocal minority [JKW*21]. Even if perfectly representative data were collected, there is a risk of injecting analysts' personal biases into the analysis process unknowingly [WBF17; WAGJ19]. Furthermore, many visual analytics tools use computational methods and prediction models to categorize and label public input [JHSM21; HC16b]. These computational methods can have inaccuracies [CRMH12] that occur unevenly across different demographics [BS16], especially in the civic domain where there is a scarcity of labeled data to train prediction models [JHSM21]. Coupled with the bias present in the data, such uncertainties might lead to a biased analysis HOFMAN, GOLDSTEIN, and HULLMAN [HGH20], which is an incorrect interpretation of the underlying public input [GHW20]. In various domains other than digital civics, researchers have shown great interest in visualizing uncertainties and incompleteness to support transparency in matching user expectations from prediction models [KKHM16] and to support cognitive and meta cognitive processes in reasoning [ZC07]. However, looking back at the existing literature in civic text visualization, we observe a paucity of research on methods that experiment with how to combat biased analysis of public input and to visualize inherent uncertainty [Hul19]. Data feminism [DK20] has brought attention to how the data is neither neutral nor objective. Others have argued that bias may infiltrate and jeopardize the interpretation of data [WBF17]. These issues demand more attention in the civics as data is seldom representative or inclusive, it is data collected from a self-selected participants and can be subject to misinterpretation as well as analysis biases.

4.6. Synthesizing the Issues

Looking across the literature in civic text visualization reveals how the status quo implicitly organizes a particular set of relationships among specific entities (see Figure 1). These entities and relationships include: 1) Civic leaders—community envoys and decision-makers—who engage the public to gather data to inform decision-making; 2) The Public, who are the primary source of the text data gathered in the digital civics domain; 3) Public Input and Opinions, which consist of comments, critiques, new ideas, and disposition towards civic issues; 4) Data Processing, which transforms raw public input text into data suitable for feeding into visualization systems; 5) Text Visualizations, which depict the results of the data processing and the trends thereby identified in the data; 6) Analysts, who use the visualizations to analyze the public input data, identify patterns, make inferences, and generate reports; and 7) Decision-Makers, who solicit public input, assess and examine analysis reports, and leverage their position and expertise to make decisions that significantly impact the public's lives.

Although never explicitly stated, the civic text visualization research reviewed above implicitly adheres to this unidirectional, linear flow from the public to decision makers. To some extent, this linear, sequential process resembles the software development waterfall model [PWB09]. The input of each phase depends on the output of the previous one, corresponding to a specialization of tasks. Numerous cases in software engineering have demonstrated

the vulnerabilities of this model, especially around its rigidity and inability to adjust to dynamic requests when multiple stakeholders are involved [PWB09; AA13]. Similarly, this section highlights numerous disconnects that occur in practice, as depicted in Figure 1. Some work in software engineering, HCI, visualization, and other areas offers examples that move beyond a linear model and adhere to a more human-centered approach [Boe88; JHSM21]. However, the linear, stage-based model still seems dominant in civic text visualization. The above review of text visualization research helps explain the origins of the implicit single-directional flow from the public to decision-makers: work in civic text visualization has inherited the primarily analytic orientation that dominates text visualization research.

5. Combining Analytic Task and Political Process

To reiterate this paper's central claim, civic text visualization should be treated *not only* as an analytic task *but also* as a political process. The definition of the term "political" in Section 2 shows how many of the analytic tasks involved in text visualization—as described in Section 4—are simultaneously political processes.

This point can be seen by referring back to Figure 1. For instance, to say that the public provides input and opinions glosses over important details. It would be more accurate to say that civic leaders collect input and draw opinions from certain groups via particular sampling methods. In order for the process to be seen as legitimate, these leaders need to be able to claim that the data thusly collected speak on behalf of some broader population. That question—who gets to speak on behalf of whom—is fundamentally a question about political representation. However, *the current orientation in civic text visualization instead treats public input as a process of data acquisition*. As another example, numerous decisions must be made when processing public opinion data to create visualizations: what categories of people or opinions will be used, how will those categories be labeled, who or what belongs in each category, etc. In civic text visualization, these decisions are made via computational means for identifying topics, sentiments, clusters, etc. *Treating such decisions as steps in an analytic process downplays how the crafting of such categories establishes power structures [BS99]*, thereby again drawing attention away from the political nature of this process.

Essentially, treating civic text visualization as an entirely analytic task, rather than acknowledging and accounting for its political nature, gives rise to disjunctures among the various entities involved. These disjunctures are evidenced in the various desiderata [JSHM20] identified in prior work on civic text visualization (Section 4). The desire for tools and environments that support collaborative sensemaking (Section 4.1) occurs because of a disjuncture across the visualizations, which are designed for a single analyst, and decision makers, who want multiple analysts to provide different perspectives. The need for participatory approaches (Section 4.2) serves as evidence of a disjuncture between text visualizations and the public whose data and opinions are being represented. That is, the public are neither involved in the data processing and creation of the visualizations that represent them, nor do they contribute to interpreting what those visualizations mean and how they should be used to inform decision making. The lack

of rich and interpretable data (Section 4.3) occurs because of disjunctures across ways that data about public opinion are collected and the ways that those data are represented in text visualizations. Although data processing and text visualizations seek to make data more comprehensible, they also introduce the potential for biases and uncertainty (Section 4.5), both of which are not always readily apparent. As a whole, this analytic orientation separates decision-makers and other leaders from the public about whose opinions those leaders gather, represent, and reflect on (Section 4.4).

To reiterate, Figure 1 highlights these disjunctures. Each step in the visualization process involves numerous design decisions. These decisions impact the processes of assigning groups and labels, of choosing representative data points to speak on behalf of others, of delegating authority—essentially, the political processes—in civic text visualization. The conceptual orientation applied here [Mou99; Asa00; Bec02; Mou13] highlights how each of these steps, rather than being a smoothly applied analytic task, embodies the conflicts and tensions inherent in a political process.

6. Proposed Conceptual Dimensions

Having analyzed the origins and consequences of a primarily analytic framing for civic text visualization, this section focuses on means for moving beyond that framing. The user-as-analyst framing does not manifest in any single step in the visualization process. For this reason, interventions that seek to alter one or more of the activities, or to bridge one or more of the disconnects, depicted in Figure 1 will likely fall short of changing the overall analytic orientation. Indeed, the analytic orientation is what causes these activities to be conceived of in a mostly linear fashion. What is needed, then, are not changes in visualization techniques or data manipulation processes, but conceptual dimensions that can help shift the field's overall orientation toward civic text visualization.

To that end, this section offers a series of two-pole dimensions that can help those working in this area to step outside of an analytic orientation (summarized in Figure 2). These dimensions were identified by taking assumptions identified in our critical review (Section 3) and considering alternatives. For each dimension, we start by explaining how one pole represents the status quo of civic text visualization, illustrated via examples drawn from the literature. We then describe the opposite pole of that dimension. For some dimensions, examples are available to illustrate this second pole, though they may come from other bodies of literature beyond text visualization or digital civics. Using this description of the two poles, we show how intentional positioning along each of these dimensions can help balance one's orientation to acknowledge both analytic tasks and political processes.

6.1. From Data and Metadata to Provenance and Paradata

It is perhaps unsurprising to note that most current approaches to civic text visualization emphasize data and/or metadata. For example, tools such as ConsiderIt [KMF*12b] and CommunityPulse [JHSM21] prominently feature specific comments from members of the public (i.e., the data). Such visualizations also provide means for organizing those comments by specific attributes, such as sentiment toward a particular proposition or metadata about

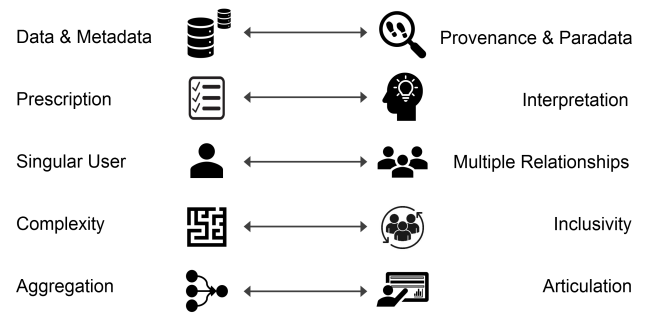


Figure 2: Each conceptual dimension captures shifts between an analytic orientation (left) and a political orientation (right).

the commenter. While often informative, presenting data and metadata alone may not be sufficient to engage the public effectively.

Visualizations focused on data and/or metadata implicitly draw attention away from the origins of those data and the processes used to collect them. Such concerns are sometimes referred to as provenance information or as paradata. Within information visualization, provenance “broadly includes consideration for the history of changes and advances throughout the analysis process” [RESC16, p. 31], such as “subsetting, data merging, formatting, transformations, [...] button pushes, view manipulations, query executions” [RESC16, p. 34-35], and others. We argue that what is missing here is the notions of provenance from database research, which “accounts for the origin of a piece of data (in a database, document or repository) together with an explanation of *how* and *why* it got to the present place” [Gup09, p. 608, emphasis added]. A related concept also occurs in statistical survey research. Although originally focused on byproducts of computer-aided survey data collection, the concept of paradata [Cou17] later expanded to include any data that are collected or generated as a byproduct of the survey process, as well as data that help us understand that process of data collection. This formulation of paradata differs from the concept of paradata in digital humanities [Sam11] that draws on the notion of paratext [Gen97]. Examples of paradata range from records about contact attempts, to researchers’ observations about the neighborhood where a particular respondent’s data were collected, to the time spent by researchers on various data collection tasks [BOL*21].

Such points about the origins of data and the processes of their collection are a key factor in civic text visualization. Indeed, a shift to emphasizing paradata can help draw attention to the representativeness of data.

Consider how systems such as MutiConVis [HCI6b] and CommunityClick [JKW*21] provide visual representations to help the viewer understand the structure and content of conversations. Such visualizations do less to expose the provenance or paradata of those conversational data. The CommunityClick interface, for instance, shows timepoints in community meeting transcripts where organizers indicated a “good point,” a “topic shift,” or a “main issue.” At the same time, this interface makes less visible the physical iClicker tools used to collect the data, the bodies for which such tools are and are not designed, the uncertainty a participant may have felt

about pushing or not pushing one of the relevant buttons, or the question of who is able to attend such meetings and who is not.

These points are not intended as criticism, neither of CommunityClick in particular nor of the broader class of similar systems [LLS; HC16b]. It would be nearly impossible for any single visualization to expose all such paradata or provenance information, at least while remaining usable. The point here is to highlight what is not being shown in the visualization [cf. DFCC13; DK20]. Who is included and excluded? Who is represented and not represented? What are the processes by which that inclusion and representation happen? Thus, instead of pure criticism, this example helps illustrate how an emphasis on paradata can shift attention toward more political aspects of representation and inclusion. Furthermore, the provision of such paradata can influence interpretations of what the visualized data actually means.

6.2. From Prescription to Interpretation

Many extant systems in digital civics make prescriptive statements about what the data they present mean. For example, MultiConVis [HC16b] makes prescriptive statements not only as to the sentimental valence of individual conversations but also as to the topics that each conversation is about. Similarly, ConsiderIt [KMF*12b] asks participants to place individual statements as either supporting or opposing a given ballot proposition. Although ConsiderIt does not make this pro/con determination on behalf of participants, it still presents each statement as clearly in support of or clearly in opposition to the given ballot proposition. In these and other examples, text visualizations can be designed in a way that prescribes a single, canonical meaning to the data being shown.

As an alternative, systems can be designed to reveal patterns and trends in data but leave their interpretation up to users. For example, Reflxt [BCD*14] identifies statistical associations between nouns and verbs [Res96] in political news coverage. As an example, in one corpus, the term “contraception” might be more likely to occur as the direct object of “cover” and “access,” while in another corpus it occurs as the direct object of “oppose” and “ban.” Reflxt does not assign an explicit meaning to these differences, but rather leaves the user to interpret what these patterns mean. Relatedly, [SG06] describe The History Tablecloth, which indicates how long objects in a home have been in a specific place by providing a slowly increasingly glow underneath stationary objects. This design “suggests that whether objects are stationary or moving may be interesting to think about. It does not, however, suggest what the implications of this might be” [SG06, p. 103]. As another example, work in the digital humanities often explicitly emphasizes the interpretation both of texts themselves and of computational analysis thereof [Ram03; Joc13; Und14; BSM*20]. While JÄNICKE, FRANZINI, CHEEMA, and SCHEUERMANN [JFCS17] describe this relationship between close and distant reading, it is not well represented in the broader text visualization literature.

Work tending toward each of these two poles thus takes opposing approaches to meaning. Systems more aligned with the first pole provide specific, prescriptive meanings for data. In doing so, such designs effectively background the political dimensions of that process. That is, the decisions made during the design process become

embedded in a proverbial black box [Pas16; Mol17], making them both more inscrutable and seemingly more objective. These decisions, however, can impact how the public and their opinions are represented to, and interpreted by, analysts and decision makers. As noted above, such questions of representation are fundamentally political in nature [Bec02; Mou99; Mou13].

In contrast, systems more aligned with the second pole provide visualizations as a resource for interpretation. Such systems are designed to draw attention to specific patterns in text data, suggesting that those patterns may be worth thinking about without making commitments as to what exactly those patterns mean. Civic text visualizations similarly designed to foreground interpretation could help make clearer who is making these interpretive decisions, thereby highlighting the lack of neutrality and objectivity in data [DK20]. If the system does not explicitly say what a given result or pattern means, then it becomes more obvious when a given stakeholder makes a claim about what that result means or, moreover, what should be done based upon the result. Such a design approach can also make clearer when and where disagreements occur about the meanings of specific patterns in public comment data.

In line with Mouffe’s points about agonism [Mou99; Mou13], foregrounding these interpretive processes and decisions will not necessarily cause a consensus or common ground to be reached. Nor will doing so establish for stakeholders which interpretations are more or less valid. However, designing to foreground interpretation can support stakeholders in addressing these differences by calling attention to them. Put differently, a design approach that emphasizes interpretation, rather than prescription of meaning, can help draw attention to the political dimensions of civic text visualization. It can also help draw attention to questions of who is performing that interpretation.

6.3. From Singular User to Multiple Relationships

In much the same way that many designers are encouraged to ask themselves “who is the user?” [SD09], civic text visualizations are usually designed with a particular user in mind. Tools such as ConsiderIt [KMF*12b] or Opinion Space [FBRG10] are designed specifically for the public. In contrast, tools such as CommunityPulse [JHSM21] or CommunityClick [JKW*21] are focused more on supporting community leaders and decision makers.

In such ways, the design of current civic text visualization systems tends to take a *monolithic view of “the user.”* That is, the design of any given system is predicated on a specific type of user. The user is not the same for every system, but most systems tend to be designed with a single user in mind.

In contrast, we could consider designing explicitly for multiple users. Doing so requires more than designing for different levels of expertise (see the following subsection for more on expertise) or designing for collaborative use, though both those things may be valuable in their own right. Rather, this dimension encourages accounting for the different types of relationalities that users may have with a system [cf. BB17]. These considerations include not only the kinds of relationships that different users might have with the system itself but also how the system mediates relationships among various users.

Consider, for instance, the roles described above (in Section 4.6) that are involved in many public input processes: the public, analysts, and decision makers. One could approach designing for these different roles and their relationships among one another in a variety of ways. For example, perhaps all users should have access to the same data, but different visual representations of that data should be presented to different users; visual representations specifically intended for the public may differ from representations intended for analysts. Alternatively, there may be data to which some users (e.g., decision makers) should have access while other users (e.g., the public) should not. Further still, a system could provide similar visual representations using similar data but allow different users varying analytic capabilities. For instance, if the kinds of questions that the public may wish to explore differ from the questions asked by analysts, then these different types of users may require different analytic tools or underlying models of the data to address their respective questions.

This shift—from a monolithic view of a single user to explicitly designing for a variety of relationalities—can draw attention to the political aspects of civic text visualization. In particular, it highlights power structures among the various groups of actors involved. Different actors in different roles will have different kinds of authority. There are things decision makers might be able to do that the public cannot (e.g., enacting policies), and there may in fact be things that the public can do but analysts or decision makers cannot (e.g., making claims about how and whether the data represent them). At the same time, people such as analysts or decision makers are, in most cases, simultaneously a subgroup of the public. When holding office as a decision maker or when playing the role of an analyst, one does not forgo their citizenship status. Why, then, do we not refer to such people as analyst-citizens, or perhaps as members of the public with decision-making authority?

The conceptual dimensions contributed by this paper are not intended to answer such questions. Rather, they offer concrete means of drawing attention to such questions. For instance, while it might be quite sensible to design certain visual representations, data manipulations, etc. with specific roles in mind, one need not constrain the use of those manipulations or representations to people in those roles. Perhaps, for example, certain aspects of a visualization might be intended for use by analysts, but all members of the public could have access to them. Because of differences in skill, expertise, time, etc., providing such access would not alone eliminate the power differentials between decision makers and members of the public. However, echoing points made above, the goal in designing civic text visualization should not necessarily be to remove such power imbalances. Instead, systems should be designed to foreground and account for these kinds of power structures. Designing for multiple relationships, rather than for a single user, provides one means of doing so. Such an approach can also highlight how an individual's expertise may mediate their interactions with a visualization.

6.4. From Complexity to Inclusivity

Prior work has highlighted the importance of careful consideration about the balance between complexity and simplicity in visualization design generally [Mun14; IHBD18]. Text visualizations span between very complex to simple, each serving their own analyti-

cal purposes and target audiences. Complexity usually abounds in public-generated text data due to high dimensionality, lack of structure, and ambiguity inherent in natural human language [AL19a], which can impact how text visualizations of such data are generated. However, in the context of civics, careful consideration is needed to decide on the level of complexity that a visualization should offer. One might argue that complex visualizations could be beneficial for surfacing actionable insights, identify patterns, visualizing uncertainty [PKH20] and incompleteness [DK16] in the data. Others might opine that such complex visualizations might exclude people with limited visualization literacy [BBG19], disengaging them from further exploration and analysis of civic input. For instance, visual analytic systems such as MultiConVis [HC16b] use multiple connected views to enable analysts to filter and explore text data at multiple levels. However, even some civic leaders, let alone the members of the general public, might not be comfortable working with such complex systems due to limited visualization literacy [MJS20a; MNC*19].

On the other side of the spectrum, some tools elide certain details in the data in favor of providing a “simpler” representation of otherwise complex data. For example, CommunityPulse [JHSM21] uses common, simple visualizations and iconography, such as bar charts and emojis, to provide overviews of people's emotions towards civic agendas and ideas. Similarly, ConsiderIt [KMF*12b] uses bar charts to visualize people's stance towards ballot measures. These two systems tend toward simpler interfaces that gloss over some of the complexities in the data. However, they do not provide information around the uncertainty and incompleteness present in the data, which could be beneficial in understanding people's rationale and disposition in civic inputs.

As an alternative to choosing between simplicity and complexity, we suggest that choices about complexity are simultaneously choices about inclusivity. Choosing a more complex visualization, for example, may provide accurate and detailed information and additional functionalities to investigate data at different levels to gather deeper insights. Indeed, MultiConVis [HC16a] and CommunityClick [JKW*21] support deriving insights that would be difficult, perhaps impossible, to derive from simply reading conversation transcripts. The choice to make visualizations complex also enables the designers to be transparent and avoid biases by adding explanations to visualized elements [KRH17b]. At the same time, such complex visualizations assume that users have relevant training and experience, implicitly alienating segments of the population who may lack such skills or expertise [GFM*13].

On the other hand, moving towards simplicity can accommodate a broader range of users [Mun14] and increase engagement [HHC*08]. Such simple visualization can inform the public about civic issues and pave the way for broader participation. However, the elision of certain aspects of the data in the interest of simplification distills meaningful nuances, thus watering down the impact, complexities, and dynamics inherent in the public input. Such simplification may also may open doors for human biases and marginalization of minority opinions [JHSM21].

Essentially, this dimension suggests recasting visualization design decisions about complexity to instead focus on inclusivity. Rather than asking whether complexity is warranted in a certain

element of the visualization, design decisions can instead consider how specific types of complexity may include or exclude certain users or audiences. For instance, one could design visualizations to provide multiple views with different kinds of complexity for different audiences [e.g., [FBL*10](#)]. A member of the public whose family has lived in a given neighborhood for generations may have intimate understandings about the history of properties, relationships among different residents, etc., while a government analyst may understand the neighborhood in terms of zoning regulations, building codes, etc. Neither of these understandings is necessarily less or more complex; each is complex in their own different way. Furthermore, systems could be outfitted with interactive functionalities that enables users to start either from simple visualizations or from complexities with which they are familiar and, through their interactions, gradually learn how to use other functionalities associated with different types of complexities [e.g., [BLN07](#); [FBL*10](#)]. At the same time, such learning should be optional, enabling the visualization to prove useful even in the most simplified views.

Thus, this conceptual dimension does not suggest favoring simplicity over complexity, nor vice versa. However, it helps draw attention to the ways that choices about complexity simultaneously constitute choices about inclusivity in terms of who can use and understand a visualization, and who cannot. It also highlights the limitations of approaches to design visualization by adhering to the “one size fits all” policy where a single design is used for multiple varied audiences [[DK16](#)]. Furthermore, considerations about inclusivity apply not only to the users and audiences of a visualization but also to the people whose data are being visualized.

6.5. From Aggregation to Articulation

Many extant text visualizations have predominantly focused on high-level aggregation of data such as summaries of topics discussed [[JKW*21](#)], collections of representative keywords [[JHSM21](#)], or statistics about sentiments [[HC16b](#)]. Such aggregation can provide civic leaders with a visual summary to help understand various facets of public input.

At the same time, aggregation tends to highlight common and popular opinions over nuances and often unpopular ideas [[MHAG06](#); [MNC*19](#)]. Even when visualizations combine overviews and details [[Shn96](#)], the summary statistics or overviews provide high-level information at a granularity that often inadvertently discards information that might represent unpopular or marginalized opinions. This can result in what has been termed the “tyranny of the majority” [[dToc10](#), Pt. 2, Ch. 7, Sec. 2], wherein a majority of the population forces their opinions upon various minority groups. Indeed, prior work shows how *summaries can suppress “minority viewpoints”* and miss some critical information as “not all the information is captured in the [summaries] due to imperfections” which might result in “losing the visions that are actually embedded into the [individual perspectives]” [[MNC*19](#)].

On the other side of this spectrum, at the detail level, articulating nuanced information present in raw text data can enable civic leaders to peruse and sublimate critical insights. Despite civic leaders’ preference for reading actual text over aggregate statistics that allows them “to make their [own] specific inferences” [[JHSM21](#)],

there are few examples of prior systems that articulate the space of differing views, perhaps due in part to high dimensionality of text data. Furthermore, there are often no specific mechanisms for detailed analysis at individual levels [[DRRD12](#)], which demonstrates a scarcity for computational and design approaches to mitigate this gap in granular information dissemination from text data.

This dimension, then, highlights how choices between visualizing aggregate trends and articulating a space of myriad opinions has political ramifications in terms of who or what is represented (and not represented). When designing civic text visualizations, one might ask “*At what granularity should civic text be aggregated?*” Rather than suggesting that any one application has a single, proper granularity, this conceptual dimension highlights the political nature of these choices that might otherwise seem purely analytic.

7. Conclusion

This paper argues that, in the context of civics, text visualization is a political activity and process just as much as it is analytic. However, prior visualization research has placed less emphasis on this political aspect, framing text visualization only as an analytic task. The implications of treating civic text visualization as solely analytic manifest throughout the visual data analysis pipeline. Examples include collecting unrepresentative and biased data, missing minority voices in aggregation, and designing analyst-oriented tools that exclude the public from the process. Drawing on political theory and participatory design [[Asa00](#); [Bec02](#); [Mou99](#); [Mou13](#)], we offer a series of conceptual dimensions that can assist researchers, designers, and practitioners in attending more intentionally to the political aspects of civic text visualization. Most of these dimensions involve gauging and balancing the tension between two poles, such as between prescription and interpretations of meaning, between aggregating trends and articulating exceptions, and between designing for a singular user and designing for multiple relationships. We suggest that attending to these dimensions can aid in consciously navigating the balance between civic text visualization as an analytic task and as a political process.

The argument put forth in this paper, and the conceptual dimensions offered, come from specifically examining the use of text visualization in the domain of civics. At the same time, we suspect the conceptual dimensions contributed by this paper could be extended to a variety of different application domains, from demographics and census data, to scientific visualization, to visualizing uncertainty. Indeed, the core activities that we argue characterize political processes—defining groups and categories, choosing representations, identifying aggregate trends, selecting prototypical examples, etc.—lie at the heart of many visualization systems. Put differently, the conceptual dimensions offered in this paper can help future work acknowledge how politics is not the only thing that is political.

Acknowledgments

For comments on previous drafts, thanks to Ethan Zuckerman, Dominic DiFranzo, members of Lehigh’s Human-Centered Social Computing group, UMASS HCI-VIS Lab members, and the anonymous reviewers.

References

- [19] *Pol.is*. <https://pol.is/gov>. Accessed: December 2019. 2019.
- [20a] *Dedoose*. <https://www.dedoose.com/>. Accessed: September 2020. 2020.
- [20b] *Free open-source participatory democracy for cities and organizations*. <https://decidim.org>. Accessed: January 2020. 2020.
- [21] *NVivo*. <https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home>. Accessed: January, 2021. 2021.
- [AA13] ADENOWO, ADETOKUNBO AA and ADENOWO, BASIRAT A. "Software Engineering Methodologies: A Review of the Waterfall Model and Object-Oriented Approach". *International Journal of Scientific & Engineering Research* 4.7 (2013), 427–434.
- [ACM19] ACM. *ATLAS.ti*. <https://atlasti.com/>. 2019.
- [AdOP12] ALENCAR, ARETHA B., de OLIVEIRA, MARIA CRISTINA F., and PAULO VICH, FERNANDO V. "Seeing beyond Reading: A Survey on Visual Text Analytics". *WIREs Data Mining and Knowledge Discovery* 2.6 (2012), 476–492. ISSN: 1942-4795. DOI: 10.1002/widm.1071.
- [AJM21] ARAGÓN, CAROLINA, JASIM, MAHMOOD, and MAHYAR, NARGES. "RisingEMOTIONS: Bridging Art and Technology to Visualize Public's Emotions about Climate Change". *Creativity and Cognition*. 2021, 1–10.
- [AL19a] ALHARBI, MOHAMMAD and LARAMEE, ROBERT S. "Sos textvis: An extended survey of surveys on text visualization". *Computers* 8.1 (2019), 17.
- [AL19b] ALHARBI, MOHAMMAD and LARAMEE, ROBERT S. "SoS TextVis: An Extended Survey of Surveys on Text Visualization". *Computers* 8.1 (Mar. 2019), 17. DOI: 10.3390/computers8010017.
- [ALND17] ASAD, MARIAM, LE DANTEC, CHRISTOPHER A, NIELSEN, BECKY, and DIEDRICK, KATE. "Creating a Sociotechnical API: Designing City-Scale Community Engagement". *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. ACM. 2017, 2295–2306.
- [Asa00] ASARO, PETER M. "Transforming Society by Transforming Technology: The Science and Politics of Participatory Design". *Accounting, Management and Information Technologies* 10.4 (2000), 257–290.
- [BB17] BAUMER, ERIC P. S. and BRUBAKER, JED R. "Post-Userism". *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI)*. Denver, CO: ACM, 2017, 6291–6303. ISBN: 978-1-4503-4655-9. DOI: 10.1145/3025453.3025740.
- [BBG19] BÖRNER, KATY, BUECKLE, ANDREAS, and GINDA, MICHAEL. "Data visualization literacy: Definitions, conceptual frameworks, exercises, and assessments". *Proceedings of the National Academy of Sciences* 116.6 (2019), 1857–1864.
- [BCD*14] BAUMER, ERIC P. S., CIPRIANI, CLAIRE, DAVIS, MITCHELL, et al. "Broadening Exposure, Questioning Opinions, and Reading Patterns with Reflex: A Computational Support for Frame Reflection". *Journal of Information Technology & Politics* 11.1 (Jan. 2014), 45–63. ISSN: 1933-1681. DOI: 10.1080/19331681.2013.872072.
- [Bec02] BECK, EEVI E. "P for Political: Participation Is Not Enough". *Scandinavian Journal of Information Systems* 14.1 (2002), 1.
- [BHP*12] BRYNJARSDÓTTIR, HRÖNN, HÁKANSSON, MARIA, PIERCE, JAMES, et al. "Sustainably Unpersuaded: How Persuasion Narrows Our Vision of Sustainability". *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI)*. Austin, TX: ACM, 2012, 947–956.
- [BKM*14] BAUMER, ERIC P. S., KHOVANSKAYA, VERA, MATTHEWS, MARK, et al. "Reviewing Reflection: On the Use of Reflection in Interactive System Design". *Proceedings of the ACM Conference on Designing Interactive Systems (DIS)*. Vancouver, BC: ACM Press, 2014, 93–102. ISBN: 978-1-4503-2902-6. DOI: 10.1145/2598510.2598598.
- [BLN07] BAILLY, GILLES, LECOLINET, ERIC, and NIGAY, LAURENCE. "Wave menus: improving the novice mode of hierarchical marking menus". *IFIP Conference on Human-Computer Interaction*. Springer. 2007, 475–488.
- [Boe88] BOEHM, B. W. "A Spiral Model of Software Development and Enhancement". *Computer* 21.5 (May 1988), 61–72. ISSN: 1558-0814. DOI: 10.1109/2.59.
- [BOL*21] BURNS, ALYXANDER, ON, THAI, LEE, CHRISTIANA, et al. "Making the Invisible Visible: Risks and Benefits of Disclosing Metadata in Visualization". *2021 IEEE Workshop on Visualization for Social Good (VIS4Good)*. IEEE. 2021, 11–15.
- [Bow06] BOWEN, GLENN A. "Grounded Theory and Sensitizing Concepts". *International Journal of Qualitative Methods* 5.3 (Sept. 2006), 12–23. ISSN: 1609-4069. DOI: 10.1177/160940690600500304.
- [Bra13] BRABHAM, DAREN C. *Using crowdsourcing in government*. IBM Center for the Business of Government, 2013.
- [BS16] BAROCAS, SOLON and SELBST, ANDREW D. "Big Data's Disparate Impact". *California Law Review* 104.3 (2016), 671–732. DOI: 10.15779/Z38BG31.
- [BS99] BOWKER, GEOFFREY C. and STAR, SUSAN LEIGH. *Sorting Things Out: Classification and Its Consequences*. Cambridge, MA: MIT Press, 1999.
- [BSM*20] BAUMER, ERIC P. S., SIEDEL, DREW, MCDONNELL, LENA, et al. "Topicalizer: Reframing Core Concepts in Machine Learning Visualization by Co-Designing for Interpretivist Scholarship". *Human-Computer Interaction* 35.5-6 (Apr. 2020), 452–480. ISSN: 0737-0024. DOI: 10.1080/07370024.2020.1734460.
- [BVSD07] BOEHNER, KIRSTEN, VERTESI, JANET, SENGERS, PHOEBE, and DOURISH, PAUL. "How HCI Interprets the Probes". *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI)*. San Jose, CA: ACM, 2007, 1077–1086. DOI: 10.1145/1240624.1240789.
- [Cai19] CAIRO, ALBERTO. *How Charts Lie: Getting Smarter about Visual Information*. WW Norton & Company, 2019.
- [CB95] COOPER, GEOFF and BOWERS, JOHN. "Representing the User: Notes on the Disciplinary Rhetoric of HCI". *The Social and Interactional Dimensions of Human-Computer Interfaces*. Ed. by THOMAS, PETER J. Cambridge: Cambridge University Press, 1995, 48–66.
- [CBD19] CHANCELLOR, STEVIE, BAUMER, ERIC P. S., and DE CHOUDHURY, MUNMUN. "Who Is the "Human" in Human-Centered Machine Learning: The Case of Predicting Mental Health from Social Media". *Proceedings of the ACM on Human-Computer Interaction* 3.CSCW (Nov. 2019), 147:1–147:32. DOI: 10.1145/3359249.
- [CC16] CAO, NAN and CUI, WEIWEI. *Introduction to Text Visualization*. Paris: Atlantis Press, 2016. ISBN: 978-94-6239-185-7 978-94-6239-186-4. DOI: 10.2991/978-94-6239-186-4.
- [Cha06] CHARMAZ, KATHY. *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis*. London: SAGE Publications, 2006.
- [CL18a] CORBETT, ERIC and LE DANTEC, CHRISTOPHER A. "Going the Distance: Trust Work for Citizen Participation". *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. ACM. 2018, 312.
- [CL18b] CORBETT, ERIC and LE DANTEC, CHRISTOPHER A. "The Problem of Community Engagement: Disentangling the Practices of Municipal Government". *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. ACM. 2018, 574.
- [CMS99] CARD, STUART K., MACKINLAY, JOCK D., and SHNEIDERMAN, BEN. *Readings in Information Visualization: Using Vision to Think*. San Francisco, CA: Morgan Kaufmann, 1999.
- [CNM83] CARD, STUART K., NEWELL, ALLEN, and MORAN, THOMAS P. *The Psychology of Human-Computer Interaction*. Hillsdale, NJ, USA: L. Erlbaum Associates Inc., 1983. ISBN: 978-0-89859-243-6.

- [Cor19] CORRELL, MICHAEL. "Ethical Dimensions of Visualization Research". *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI)*. Glasgow: ACM, May 2019, 1–13. ISBN: 978-1-4503-5970-2. DOI: [10.1145/3290605.3300418](https://doi.org/10.1145/3290605.3300418).
- [Cou17] COUPER, MICK P. "Birth and Diffusion of the Concept of Paradata". *Advances in Social Research* 18 (2017), 14–26.
- [CRMH12] CHUANG, JASON, RAMAGE, DANIEL, MANNING, CHRISTOPHER, and HEER, JEFFREY. "Interpretation and trust: Designing model-driven visualizations for text analysis". *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 2012, 443–452.
- [DFCC13] DÖRK, MARIAN, FENG, PATRICK, COLLINS, CHRISTOPHER, and CARPENDALE, SHEELAGH. "Critical InfoVis: Exploring the Politics of Visualization". *Extended Abstracts of the ACM Conference on Human Factors in Computing Systems (CHI EA)*. Paris: ACM, 2013, 2189–2198. ISBN: 978-1-4503-1952-2. DOI: [10.1145/2468356.2468739](https://doi.org/10.1145/2468356.2468739).
- [DiS12] DISALVO, CARL. *Adversarial Design*. Cambridge, MA: MIT Press, 2012.
- [DK16] D'IGNAZIO, CATHERINE and KLEIN, LAUREN F. "Feminist Data Visualization". *Workshop on Visualization for the Digital Humanities, at IEEE VIS Conference*. Baltimore, MD, 2016.
- [DK20] D'IGNAZIO, CATHERINE and KLEIN, LAUREN F. *Data Feminism*. Cambridge, MA: MIT Press, 2020.
- [DRRD12] DÖRK, MARIAN, RICHE, NATHALIE HENRY, RAMOS, GONZALO, and DUMAIS, SUSAN. "Pivotpaths: Strolling through faceted information spaces". *IEEE transactions on visualization and computer graphics* 18.12 (2012), 2709–2718.
- [dToc10] De TOCQUEVILLE, ALEXIS. *Democracy in America*. Ed. by NOLLA, EDUARDO. Trans. by SCHLEIFER, JAMES T. Indianapolis: Liberty Fund, 1835 (2010).
- [FBL*10] FRANCONI, JÉRÉMIE, BAILLY, GILLES, LECOLINET, ERIC, et al. "Wavelet menus on handheld devices: stacking metaphor for novice mode and eyes-free selection for expert mode". *Proceedings of the International Conference on Advanced Visual Interfaces*. 2010, 173–180.
- [FBRG10] FARIDANI, SIAMAK, BITTON, EPHRAT, RYOKAI, KIMIKO, and GOLDBERG, KEN. "Opinion Space: A Scalable Tool for Browsing Online Comments". *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI)*. Atlanta, GA: ACM, 2010, 1175–1184.
- [FHKM17] FEDERICO, PAOLO, HEIMERL, FLORIAN, KOCH, STEFFEN, and MIKSCHE, SILVIA. "A Survey on Visual Approaches for Analyzing Scientific Literature and Patents". *IEEE Transactions on Visualization and Computer Graphics* 23.9 (Sept. 2017), 2179–2198. ISSN: 1941-0506. DOI: [10.1109/TVCG.2016.2610422](https://doi.org/10.1109/TVCG.2016.2610422).
- [FO05] FEINDT, PETER H and OELS, ANGELA. "Does discourse matter? Discourse analysis in environmental policy making". *Journal of Environmental Policy & Planning* 7.3 (2005), 161–173.
- [For18] FORLIZZI, JODI. "Moving Beyond User-Centered Design". *Interactions* 25.5 (Aug. 2018), 22–23. ISSN: 1072-5520. DOI: [10.1145/3239558](https://doi.org/10.1145/3239558).
- [GEC98] GERSHON, NAHUM, EICK, STEPHEN G., and CARD, STUART. "Information Visualization". *Interactions* 5.2 (Mar. 1998), 9–15. ISSN: 1072-5520. DOI: [10.1145/274430.274432](https://doi.org/10.1145/274430.274432).
- [Gen97] GENETTE, GÉRARD. *Paratexts: Thresholds of Interpretation*. Cambridge: Cambridge University Press, 1997.
- [GFM*13] GOODMAN, MADELINE, FINNEGAN, ROBERT, MOHADJER, LEYLA, et al. "Literacy, Numeracy, and Problem Solving in Technology-Rich Environments among US Adults: Results from the Program for the International Assessment of Adult Competencies 2012. First Look. NCES 2014-008." *National Center for Education Statistics* (2013).
- [GHWM20] GELMAN, ANDREW, HULLMAN, JESSICA, WLEZIEN, CHRISTOPHER, and MORRIS, GEORGE ELLIOTT. "Information, incentives, and goals in election forecasts". *Judgment and Decision Making* 15.5 (2020), 863.
- [GS67] GLASER, BARNEY G. and STRAUSS, ANSELM L. *The Discovery of Grounded Theory*. Oxon and New York: Routledge, 1967.
- [GTS10] GRAMMEL, LARS, TORY, MELANIE, and STOREY, MARGARET-ANNE. "How information visualization novices construct visualizations". *IEEE transactions on visualization and computer graphics* 16.6 (2010), 943–952.
- [Gup09] GUPTA, AMARNATH. "Data Provenance". *Encyclopedia of Database Systems*. Ed. by LIU, LING and ÖZSU, M. TAMER. Boston, MA: Springer US, 2009, 608–608. ISBN: 978-0-387-39940-9. DOI: [10.1007/978-0-387-39940-9_1305](https://doi.org/10.1007/978-0-387-39940-9_1305).
- [GZL*14] GAN, QIHONG, ZHU, MIN, LI, MINGZHAO, et al. "Document Visualization: An Overview of Current Research". *WIREs Computational Statistics* 6.1 (2014), 19–36. ISSN: 1939-0068. DOI: [10.1002/wics.1285](https://doi.org/10.1002/wics.1285).
- [Har88] HARAWAY, DONNA. "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective". *Feminist Studies* 14.3 (1988), 575–599. ISSN: 0046-3663. DOI: [10.2307/3178066](https://doi.org/10.2307/3178066).
- [Har91] HARDING, SANDRA. *Whose Science? Whose Knowledge? Thinking from Women's Lives*. Ithaca, NY: Cornell University Press, 1991.
- [HC16a] HOQUE, ENAMUL and CARENINI, GIUSEPPE. "MultiConVis: A Visual Text Analytics System for Exploring a Collection of Online Conversations". *Proceedings of the ACM Conference on Intelligent User Interfaces (IUI)*. IUI. Sonoma, CA: ACM, Mar. 2016, 96–107. ISBN: 978-1-4503-4137-0. DOI: [10.1145/2856767.2856782](https://doi.org/10.1145/2856767.2856782).
- [HC16b] HOQUE, ENAMUL and CARENINI, GIUSEPPE. "Multiconvis: A visual text analytics system for exploring a collection of online conversations". *Proceedings of the 21st international conference on intelligent user interfaces*. 2016, 96–107.
- [HCL05] HEER, JEFFREY, CARD, STUART K., and LANDAY, JAMES A. "Prefuse: A Toolkit for Interactive Information Visualization". *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI)*. Portland, OR: ACM, Apr. 2005, 421–430. ISBN: 978-1-58113-998-3. DOI: [10.1145/1054972.1055031](https://doi.org/10.1145/1054972.1055031).
- [HD11] HULLMAN, JESSICA and DIAKOPOULOS, NICK. "Visualization Rhetoric: Framing Effects in Narrative Visualization". *IEEE Transactions on Visualization and Computer Graphics* 17.12 (Dec. 2011), 2231–2240. ISSN: 1077-2626. DOI: [10.1109/TVCG.2011.255](https://doi.org/10.1109/TVCG.2011.255).
- [Hea07] HEAD, BRIAN W. "Community Engagement: Participation on Whose Terms?": *Australian Journal of Political Science* 42.3 (2007), 441–454.
- [HGH20] HOFMAN, JAKE M, GOLDSTEIN, DANIEL G, and HULLMAN, JESSICA. "How visualizing inferential uncertainty can mislead readers about treatment effects in scientific results". *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*. 2020, 1–12.
- [HHC*08] HEER, JEFFREY, HAM, FRANK, CARPENDALE, SHEELAGH, et al. "Information Visualization". Ed. by KERREN, ANDREAS, STASKO, JOHN T., FEKETE, JEAN-DANIEL, and NORTH, CHRIS. Berlin, Heidelberg: Springer-Verlag, 2008. Chap. Creation and Collaboration: Engaging New Audiences for Information Visualization, 92–133. ISBN: 978-3-540-70955-8. DOI: [10.1007/978-3-540-70956-5_5](https://doi.org/10.1007/978-3-540-70956-5_5). URL: http://dx.doi.org/10.1007/978-3-540-70956-5_5.
- [Hul19] HULLMAN, JESSICA. "Why authors don't visualize uncertainty". *IEEE transactions on visualization and computer graphics* 26.1 (2019), 130–139.
- [IHBD18] INDRATMO, HOWORKO, LEE, BOEDIANTO, JOYCE MARIA, and DANIEL, BEN. "The efficacy of stacked bar charts in supporting single-attribute and overall-attribute comparisons". *Visual Informatics* 2.3 (2018), 155–165. ISSN: 2468-502X.
- [IZCC08] ISENBERG, PETRA, ZUK, TORRE, COLLINS, CHRISTOPHER, and CARPENDALE, SHEELAGH. "Grounded Evaluation of Information Visualizations". *Proceedings of the Workshop on BEyond Time and Errors: Novel evaluation Methods for Information Visualization (BELIV)*. Florence, Italy: ACM, 2008, 6:1–6:8. ISBN: 978-1-60558-016-6. DOI: [10.1145/1377966.1377974](https://doi.org/10.1145/1377966.1377974).

- [JFCS15] JÄNICKE, STEFAN, FRANZINI, GRETA, CHEEMA, MUHAMMAD FAISAL, and SCHEUERMANN, GERIK. "On Close and Distant Reading in Digital Humanities: A Survey and Future Challenges". (2015). DOI: [10.2312/eurovisstar.20151113](https://doi.org/10.2312/eurovisstar.20151113).
- [JFCS17] JÄNICKE, S., FRANZINI, G., CHEEMA, M. F., and SCHEUERMANN, G. "Visual Text Analysis in Digital Humanities". *Computer Graphics Forum* 36.6 (2017), 226–250. ISSN: 1467-8659. DOI: [10.1111/cgfm.12873](https://doi.org/10.1111/cgfm.12873).
- [JHSM21] JASIM, MAHMOOD, HOQUE, ENAMUL, SARVGHAD, ALI, and MAHYAR, NARGES. "CommunityPulse: Facilitating Community Input Analysis by Surfacing Hidden Insights, Reflections, and Priorities". *Designing Interactive Systems Conference 2021*. 2021, 846–863.
- [JKW*21] JASIM, MAHMOOD, KHALOO, POOYA, WADHWA, SOMIN, et al. "CommunityClick: Capturing and Reporting Community Feedback from Town Halls to Improve Inclusivity". *Proceedings of the ACM on Human-Computer Interaction* 4.CSCW3 (Jan. 2021), 213:1–213:32. DOI: [10.1145/3432912](https://doi.org/10.1145/3432912).
- [Joc13] JOCKERS, MATTHEW L. *Macroanalysis: Digital Methods & Literary History*. Chicago: University of Illinois Press, 2013.
- [JSHM20] JASIM, MAHMOOD, SARVGHAD, ALI, HOQUE, ENAMUL, and MAHYAR, NARGES. "Towards Understanding Desiderata for Large-Scale Civic Input Analysis". *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*. 2020, 1–8.
- [KK14] KUCHER, KOSTIANTYN and KERREN, ANDREAS. "Text Visualization Browser: A Visual Survey of Text Visualization Techniques". *Poster Abstracts of IEEE VIS*. Vol. 2014. Paris, 2014.
- [KK15] KUCHER, KOSTIANTYN and KERREN, ANDREAS. "Text Visualization Techniques: Taxonomy, Visual Survey, and Community Insights". *2015 IEEE Pacific Visualization Symposium (PacificVis)*. IEEE, Apr. 2015, 117–121. DOI: [10.1109/PACIFICVIS.2015.7156366](https://doi.org/10.1109/PACIFICVIS.2015.7156366).
- [KKHM16] KAY, MATTHEW, KOLA, TARA, HULLMAN, JESSICA R., and MUNSON, SEAN A. "When (ish) is my bus? user-centered visualizations of uncertainty in everyday, mobile predictive systems". *Proceedings of the 2016 chi conference on human factors in computing systems*. 2016, 5092–5103.
- [KMF*12a] KRIPLEAN, TRAVIS, MORGAN, JONATHAN, FREELON, DEEN, et al. "Supporting Reflective Public Thought with ConsiderIt". *Proceedings of the ACM Conference on Computer Supported Cooperative Work & Social Computing (CSCW)*. Seattle, Washington, USA: ACM Press, 2012, 265–274. ISBN: 978-1-4503-1086-4. DOI: [10.1145/2145204.2145249](https://doi.org/10.1145/2145204.2145249).
- [KMF*12b] KRIPLEAN, TRAVIS, MORGAN, JONATHAN, FREELON, DEEN, et al. "Supporting Reflective Public Thought with ConsiderIt". *Proceedings of the ACM 2012 Conference on Computer Supported Cooperative Work*. CSCW '12. Seattle, Washington, USA: ACM, 2012, 265–274. ISBN: 978-1-4503-1086-4.
- [KPK18] KUCHER, KOSTIANTYN, PARADIS, CARITA, and KERREN, ANDREAS. "The State of the Art in Sentiment Visualization". *Computer Graphics Forum* 37.1 (2018), 71–96. ISSN: 1467-8659. DOI: [10.1111/cgfm.13217](https://doi.org/10.1111/cgfm.13217).
- [KRH17a] KIM, YEA-SEUL, REINECKE, KATHARINA, and HULLMAN, JESSICA. "Data through others' eyes: The impact of visualizing others' expectations on visualization interpretation". *IEEE transactions on visualization and computer graphics* 24.1 (2017), 760–769.
- [KRH17b] KIM, YEA-SEUL, REINECKE, KATHARINA, and HULLMAN, JESSICA. "Explaining the gap: Visualizing one's predictions improves recall and comprehension of data". *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. 2017, 1375–1386.
- [LBI*12] LAM, HEIDI, BERTINI, ENRICO, ISENBERG, PETRA, et al. "Empirical Studies in Information Visualization: Seven Scenarios". *IEEE Transactions on Visualization and Computer Graphics* 18.9 (Sept. 2012), 1520–1536. ISSN: 1077-2626. DOI: [10.1109/TVCG.2011.279](https://doi.org/10.1109/TVCG.2011.279).
- [LCWL14] LIU, SHIXIA, CUI, WEIWEI, WU, YINGCAI, and LIU, MENGCHEN. "A Survey on Information Visualization: Recent Advances and Challenges". *The Visual Computer* 30.12 (Dec. 2014), 1373–1393. ISSN: 1432-2315. DOI: [10.1007/s00371-013-0892-3](https://doi.org/10.1007/s00371-013-0892-3).
- [LIS*19] LEE, BONGSHIN, ISAACS, KATE, SZAFIR, DANIELLE ALBERS, et al. "Broadening Intellectual Diversity in Visualization Research Papers". *IEEE Computer Graphics and Applications* 39.4 (July 2019), 78–85. ISSN: 1558-1756. DOI: [10.1109/MCG.2019.2914844](https://doi.org/10.1109/MCG.2019.2914844).
- [LLS] LUKENSMAYER, CAROLYN, LYONS, SUSANNA HAAS, and SPEAKS, AMERICA. *21st Century Town Meeting*®.
- [LSAL05] LOFLAND, JOHN, SNOW, DAVID A., ANDERSON, LEON, and LOFLAND, LYN H. *Analyzing Social Settings*. Belmont, CA: Wadsworth, 1971 (2005).
- [LWC*19] LIU, SHIXIA, WANG, XITING, COLLINS, CHRISTOPHER, et al. "Bridging Text Visualization and Mining: A Task-Driven Survey". *IEEE Transactions on Visualization and Computer Graphics* 25.7 (July 2019), 2482–2504. ISSN: 1941-0506. DOI: [10.1109/TVCG.2018.2834341](https://doi.org/10.1109/TVCG.2018.2834341).
- [MBX*16] MAHYAR, NARGES, BURKE, KELLY J., XIANG, JIALIANG ERNEST, et al. "UD Co-Spaces: A Table-Centred Multi-Display Environment for Public Engagement in Urban Design Charrettes". *Proceedings of the 2016 ACM on Interactive Surfaces and Spaces*. ACM, 2016, 109–118.
- [MHAG06] MANSBRIDGE, JANE, HARTZ-KARP, JANETTE, AMENGUAL, MATTHEW, and GASTIL, JOHN. "Norms of deliberation: An inductive study". *Journal of public deliberation* 2.1 (2006).
- [MJN*18] MAHYAR, NARGES, JAMES, MICHAEL R, NG, MICHELLE M, et al. "CommunityCrit: inviting the public to improve and evaluate urban design ideas through micro-activities". *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. 2018, 1–14.
- [MJS20a] MAHYAR, N., JASIM, M., and SARVGHAD, A. "Designing Technology for Sociotechnical Problems: Challenges and Considerations". *IEEE Computer Graphics and Applications* 40.6 (Nov. 2020), 76–87. ISSN: 1558-1756. DOI: [10.1109/MCG.2020.3017405](https://doi.org/10.1109/MCG.2020.3017405).
- [MJS20b] MAHYAR, NARGES, JASIM, MAHMOOD, and SARVGHAD, ALI. "Designing Technology for Sociotechnical Problems: Challenges and Considerations". *IEEE Computer Graphics and Applications* 40.6 (2020), 76–87.
- [MNC*19] MAHYAR, NARGES, NGUYEN, DIANA V, CHAN, MAGGIE, et al. "The Civic Data Deluge: Understanding the Challenges of Analyzing Large-Scale Community Input". *Proceedings of the 2019 on Designing Interactive Systems Conference*. ACM, 2019, 1171–1181.
- [MoH17] MOLS, BENNIE. *In Black Box Algorithms We Trust (or Do We?)* <https://cacm.acm.org/news/214618-in-black-box-algorithms-we-trust-or-do-we/fulltext>. Mar. 2017.
- [Mou13] MOUFFE, CHANTAL. *Agonistics: Thinking the World Politically*. London: Verso, 2013.
- [Mou99] MOUFFE, CHANTAL. "Deliberative Democracy or Agonistic Pluralism?". *Social Research* 66.3 (1999), 745–758.
- [MS20] MARTIN-RODILLA, PATRICIA and SÁNCHEZ, MIGUEL. "Software Support for Discourse-Based Textual Information Analysis: A Systematic Literature Review and Software Guidelines in Practice". *Information* 11.5 (May 2020), 256. DOI: [10.3390/info11050256](https://doi.org/10.3390/info11050256).
- [Mun14] MUNZNER, TAMARA. *Visualization Analysis and Design*. CRC Press, 2014.
- [Nag86] NAGEL, THOMAS. *The View from Nowhere*. Oxford: Oxford University Press, 1986.
- [Nel19] NELIMARKKA, MATTI. "A Review of Research on Participation in Democratic Decision-Making Presented at SIGCHI Conferences. Toward an Improved Trading Zone Between Political Science and HCI". *Proceedings of the ACM on Human-Computer Interaction* 3.CSCW (2019), 1–29.

- [NPW14] NUALART-VILAPLANA, JAUME, PÉREZ-MONTORO, MARIO, and WHITELAW, MITCHELL. "Cómo dibujamos textos: Revisión de propuestas de visualización y exploración textual (How we draw texts: a review of approaches to text visualization and exploration)". *Profesional de la Información* 23.3 (May 2014), 221–235. ISSN: 1699-2407. DOI: [10.3145/epi.2014.may.02](https://doi.org/10.3145/epi.2014.may.02).
- [OW15] OLIVIER, PATRICK and WRIGHT, PETER. "Digital Civics: Taking a Local Turn". *interactions* 22.4 (June 2015), 61–63. ISSN: 1072-5520.
- [PAE19] PECK, EVAN M., AYUSO, SOFIA E., and EL-ETR, OMAR. "Data Is Personal: Attitudes and Perceptions of Data Visualization in Rural Pennsylvania". *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI)*. Glasgow: ACM, May 2019, 1–12. ISBN: 978-1-4503-5970-2.
- [Pas16] PASQUALE, FRANK. *The Black Box Society: The Secret Algorithms That Control Money and Information*. Cambridge, MA: Harvard University Press, Aug. 2016.
- [PKH20] PADILLA, LACE, KAY, MATTHEW, and HULLMAN, JESSICA. "Uncertainty visualization". (2020).
- [PSB10] PURETSKIY, ANDREY A., SHUTT, GREGORY L., and BERRY, MICHAEL W. "Survey of Text Visualization Techniques". *Text Mining*. John Wiley & Sons, Ltd, 2010. Chap. 6, 105–127. ISBN: 978-0-470-68964-6. DOI: [10.1002/9780470689646.ch6](https://doi.org/10.1002/9780470689646.ch6).
- [PWB09] PETERSEN, KAI, WOHLIN, CLAES, and BACA, DEJAN. "The waterfall model in large-scale development". *International Conference on Product-Focused Software Process Improvement*. Springer, 2009, 386–400.
- [Ram03] RAMSAY, STEPHEN. "Special Section: Reconceiving Text Analysis Toward an Algorithmic Criticism". *Literary and Linguistic Computing* 18.2 (June 2003), 167–174. ISSN: 0268-1145. DOI: [10.1093/l1c/18.2.167](https://doi.org/10.1093/l1c/18.2.167).
- [Res96] RESNIK, PHILIP. "Selectional Constraints: An Information-Theoretic Model and Its Computational Realization". *Cognition. Compositional Language Acquisition* 61.1 (Oct. 1996), 127–159. ISSN: 0010-0277. DOI: [10.1016/S0010-0277\(96\)00722-6](https://doi.org/10.1016/S0010-0277(96)00722-6).
- [RESC16] RAGAN, ERIC D., ENDERT, ALEX, SANYAL, JIBONANANDA, and CHEN, JIAN. "Characterizing Provenance in Visualization and Data Analysis: An Organizational Framework of Provenance Types and Purposes". *IEEE Transactions on Visualization and Computer Graphics* 22.1 (Jan. 2016), 31–40. ISSN: 1941-0506. DOI: [10.1109/TVCG.2015.2467551](https://doi.org/10.1109/TVCG.2015.2467551).
- [Sam11] SAMPLE, MARK. *The Poetics of Metadata and the Potential of Paradata (Revised)*. <https://samplereality.com/2011/03/22/the-poetics-of-metadata-and-the-potential-of-paradata/>. Mar. 2011.
- [Sav15] SAVOLAINEN, REIJO. "Expressing emotions in information sharing: a study of online discussion about immigration". (2015).
- [ŠB10] ŠILIĆ, ARTUR and BAŠIĆ, BOJANA DALBELO. "Visualization of Text Streams: A Survey". *Knowledge-Based and Intelligent Information and Engineering Systems*. Ed. by SETCHI, ROSSITZA, JORDANOV, IVAN, HOWLETT, ROBERT J., and JAIN, LAKHMI C. Lecture Notes in Computer Science. Berlin, Heidelberg: Springer, 2010, 31–43. ISBN: 978-3-642-15390-7. DOI: [10.1007/978-3-642-15390-7_4](https://doi.org/10.1007/978-3-642-15390-7_4).
- [SD09] SATCHELL, CHRISTINE and DOURISH, PAUL. "Beyond the user: use and non-use in HCI". *Proceedings of the 21st annual conference of the Australian computer-human interaction special interest group: Design: Open 24/7*. 2009, 9–16.
- [SG06] SENGERS, PHOEBE and GAVER, BILL. "Staying Open to Interpretation: Engaging Multiple Meanings in Design and Evaluation". *Proceedings of the ACM Conference on Designing Interactive Systems (DIS)*. University Park, PA: ACM, 2006, 99–108.
- [Shn96] SHNEIDERMAN, BEN. "The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations". *Proceedings of the IEEE Symposium on Visual Languages*. IEEE, 1996, 336–343.
- [SNHS13] SCHULZ, HANS-JÖRG, NOCKE, THOMAS, HEITZLER, MAGNUS, and SCHUMANN, HEIDRUN. "A Design Space of Visualization Tasks". *IEEE Transactions on Visualization and Computer Graphics* 19.12 (Dec. 2013), 2366–2375. ISSN: 1941-0506. DOI: [10.1109/TVCG.2013.120](https://doi.org/10.1109/TVCG.2013.120).
- [SOA*20] SHAHID, FARHANA, ONY, SHAHINUL HOQUE, ALBI, TAKRIM RAHMAN, et al. "Learning from Tweets: Opportunities and Challenges to Inform Policy Making During Dengue Epidemic". *Proceedings of the ACM on Human-Computer Interaction* 4.CSCW1 (2020), 1–27.
- [SP06] SHNEIDERMAN, BEN and PLAISANT, CATHERINE. "Strategies for Evaluating Information Visualization Tools: Multi-Dimensional In-Depth Long-Term Case Studies". *Proceedings of the 2006 AVI Workshop on BEyond Time and Errors: Novel Evaluation Methods for Information Visualization (BELIV)*. Venice, Italy: ACM, 2006, 1–7. ISBN: 978-1-59593-562-5. DOI: [10.1145/1168149.1168158](https://doi.org/10.1145/1168149.1168158).
- [SWLL13] SUN, GUO-DAO, WU, YING-CAI, LIANG, RONG-HUA, and LIU, SHI-XIA. "A Survey of Visual Analytics Techniques and Applications: State-of-the-Art Research and Future Challenges". *Journal of Computer Science and Technology* 28.5 (Sept. 2013), 852–867. ISSN: 1860-4749. DOI: [10.1007/s11390-013-1383-8](https://doi.org/10.1007/s11390-013-1383-8).
- [Tay15] TAYLOR, ALEX. "After Interaction". *interactions* 22.5 (Aug. 2015), 48–53. ISSN: 1072-5520. DOI: [10.1145/2809888](https://doi.org/10.1145/2809888).
- [TK74] TVERSKY, AMOS and KAHNEMAN, DANIEL. "Judgment under uncertainty: Heuristics and biases". *science* 185.4157 (1974), 1124–1131.
- [Und14] UNDERWOOD, TED. "Theorizing Research Practices We Forgot to Theorize Twenty Years Ago". *Representations* 127.1 (2014), 64–72.
- [VCL*16] VLACHOKYRIAKOS, VASILLIS, CRIVELLARO, CLARA, LE DANTEC, CHRISTOPHER A., et al. "Digital Civics: Citizen Empowerment With and Through Technology". *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*. CHI EA '16. San Jose, California, USA: ACM, 2016, 1096–1099. ISBN: 978-1-4503-4082-3.
- [VW08] VIÉGAS, FERNANDA B. and WATTENBERG, MARTIN. "Tag Clouds and the Case for Vernacular Visualization". *interactions* 15.4 (2008), 49–52.
- [WAGJ19] WALL, EMILY, ARCALGUD, ARUP, GUPTA, KUHU, and JO, ANDREW. "A Markov Model of Users' Interactive Behavior in Scatterplots". *2019 IEEE Visualization Conference (VIS)*. IEEE, 2019, 81–85.
- [WBF17] WALL, EMILY, BLAHA, LESLIE M, FRANKLIN, LYNDSEY, and ENDERT, ALEX. "Warning, bias may occur: A proposed approach to detecting cognitive bias in interactive visual analytics". *2017 IEEE Conference on Visual Analytics Science and Technology (VAST)*. IEEE, 2017, 104–115.
- [Win80] WINNER, LANGDON. "Do Artifacts Have Politics?": *Daedalus* 109.1 (1980), 121–136. ISSN: 0011-5266.
- [WSJ*14] WANNER, F., STOFFEL, A., JÄCKLE, D., et al. "State-of-the-Art Report of Visual Analysis for Event Detection in Text Data Streams". *Eurographics Conference on Visualization State-of-the-Art Report (EuroVisSTAR)*. The Eurographics Association, 2014. ISBN: 978-3-03868-028-4. DOI: [10.2312/eurovisstar.20141176](https://doi.org/10.2312/eurovisstar.20141176).
- [ZC07] ZUK, TORRE and CARPENDALE, SHEELAGH. "Visualization of uncertainty and reasoning". *International symposium on smart graphics*. Springer, 2007, 164–177.
- [ZNB15] ZILOUCHIAN MOGHADDAM, ROSHANAK, NICHOLSON, ZANE, and BAILEY, BRIAN P. "Procid: Bridging consensus building theory with the practice of distributed design discussions". *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing*. ACM, 2015, 686–699.
- [ZVK17] ZHANG, AMY X, VEROU, LEA, and KARGER, DAVID. "Wikum: Bridging discussion forums and wikis using recursive summarization". *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing*. 2017, 2082–2096.