NARRATIVE VISUALIZATION: SHARING INSIGHTS INTO COMPLEX DATA

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ABSTRACT

This paper is a reflection on the emerging genre of narrative visualization, a creative response to the need to share complex data engagingly with the public. In it, we explain how narrative visualization offers authors the opportunity to communicate more effectively with their audience by reproducing and sharing an experience of insight similar to their own. To do so, we propose a two part model, derived from previous literature, in which insight is understood as both an experience and also the product of that experience. We then discuss how the design of narrative visualization should be informed by attempts elsewhere to track the provenance of insights and share them in a collaborative setting. Finally, we present a future direction for research that includes using EEG technology to record neurological patterns during episodes of insight experience as the basis for evaluation.

KEYWORDS

Narrative visualization, Insight, Creativity support, Information visualization, Evaluation methods

1. INTRODUCTION

We are increasingly required to make sense and use of complex data. This is not only due to the successes of the open data movement and to companies such as Google releasing increasing amounts of information, but also to factors like the growth of social networking and social media. In addition, advances in personal and mobile computing power, allied to faster broadband speeds, allow us to collect, process and distribute datasets far larger than was previously practical. Alongside these developments, we have also witnessed major upheavals in the way media is produced and consumed, opening new avenues to reach people directly, whilst simultaneously disrupting existing models. A key challenge posed by these trends is the task of creatively engaging with the public, and one response has been *narrative visualization* [17] in which interactive data visualization techniques are incorporated into story telling. Examples of this can be found in the data journalism of The Guardian [25] and New York Times [26] websites, and it is further evidenced by events such as the *Telling Stories with Data* workshop at the VisWeek conference [27].

One of the distinguishing features of narrative visualization is the use of interactive exploratory techniques to enhance the communication of ideas and promote insight through discovery. It is our view that this combination of communication through narrative and discovery through exploration offers new opportunities for authors to successfully share insights with their audience. This is because the exploratory nature of interactive data visualization offers an opportunity for the end-user to experience a similar moment of insight to that which the author had experienced earlier. Crucially, however, the end-user is guided by the context of the narrative structure in which the visualization is presented and she is not required to take on the entire cognitive load of unguided discovery.

In order to exploit these opportunities we first need a better understanding of the nature of insight and how it can be shared. With this in mind, we present a two part model of insight derived from the Information Visualization (InfoVis), Cognitive Psychology and Neuroscience literature. We then go on to discuss how narrative visualization design can be informed by efforts to support insight sharing made elsewhere. We discuss this first from the perspective of authors sharing insight with end-users and secondly from the perspective of social collaboration between end-users. Finally, in the future research section, we discuss possible new approaches to evaluating narrative visualization using electroencephalography (EEG). The main contribution of this paper is to provide a theoretical background to communicating insights about complex data through exploratory visual narratives and to suggest novel methods for their evaluation.

2. INSIGHT

It is an oft repeated truth that *'the purpose of visualization is insight not pictures'* [2]. In this section we seek to improve our understanding of insight and present a two part model that, we hope, indicates how insights can be communicated and shared more effectively.

Within the InfoVis community there has recently been interest in using insight as an evaluation metric. Typically, this has resulted in a unitary description. For example, Plaisant et al [12] declare *'Insight can simply be defined as a non-trivial discovery about the data'* whilst Saraiya et al [15] define insight as *'an individual observation about the data by the participant, a unit of discovery'*. Such a view has obvious merit when discussing a metric for evaluation but appears somewhat limited. North [11] moves away from the unitary view when he lists the important characteristics of insight. Here, insight is *'Complex', 'Deep', 'Qualitative', 'Unexpected'* and *'Relevant',* although North retains the notion that insight is to a large degree the product or end-result of a task. Yi et al [23] extend this understanding, describing how insight is also likely to be the by-product of ongoing exploration and often serves as the starting point in theory creation. However, common to all these cases is the idea of insight as **something that is gained**.

The Cognitive Psychology literature, in contrast, speaks of insight as **something that is experienced**. Often described as an *'Aha!'* moment of sudden realization, insight is said to occur when an inappropriate representation is restructured to overcome a mental block, giving new understanding. For example, Schooler et al [16] describe insight as *'a transitional event in which a solver moves from an impasse state to a solution state'*. Similarly, Csikszentmihalyi & Sawyer [4] state that *'insight seems to involve (1) an existing state of mind or mental structures relevant to the topic and (2) a moment of realization, consequent to new information or a sudden new way of looking at old information, resulting in (3) a quick restructuring of the mental model, which is subjectively perceived as providing a new understanding'*. More recent work in the field of Cognitive Neuroscience [1, 10 & 14] has used neuroimaging techniques, electroencephalography (EEG) and functional magnetic resonance imaging (fMRI), to support this idea of insight as something experienced.

We take the view, following these descriptions, that the best way to understand insight is in two closely coupled parts. First, there is the insight experience as described by psychologists and second, there is the product of this experience, the changed mental model that represents new knowledge or understanding; this second part being closer to the way insight is discussed in the InfoVis community. It therefore seems appropriate that when attempting to communicate and share our insights, we do so not only via their products but also by attempting to reproduce the experience of having them. This, we believe, is the opportunity presented by narrative visualization.

3. THE DESIGN OF NARRATIVE VISUALIZATIONS

As Tufte [18 & 19] shows in his discussions of Minard's map of Napoleon's march on Moscow and John Snow's map of cholera cases in London, story telling has a long history as part of successful data visualization. However, it is this intention to tell a particular story that distinguishes narrative visualization from much current research in InfoVis. Hullman & Diakopoulos [9] address this intentional aspect, building on Segel & Heer's [17] design space categorization with an analysis derived from semiotics, critical theory, journalism, decision theory and political theory they call *visualization rhetoric.* Their aim is to show how

design choices can influence user interpretation of the original data and they provide a guide to how such visualization rhetoric may be used to positively inform those choices, therefore providing a narrative structure to support insight sharing. Elsewhere, Rojhas & Ju [13] show the potential of data visualization to engender empowerment and synthesize personal narratives. In each case, the authors' aim of sharing particular insights about data they find interesting through both exploration and story telling is clearly shown.

The field of social data analysis, in which data is visualized and discussed publicly online, is emerging roughly parallel with that of narrative visualization. Research on the use of websites and interactive applets such as Many Eyes [20] and NameVoyager [21] address important issues like democratising visualization technology, data handling with a lay audience and designing for asynchronous collaboration. Work by authors such as Heer & Agrawala [8] and Willet et al [22] extend these ideas into collaborative visual analytics looking at factors that support awareness, establish common ground and support sharing insights through hypothesis generation. In each case, there is clear evidence for the effectiveness of shared interactive visualizations in communicating and developing insights.

Research into recording and tracking insight provenance during visual analytics sessions is also illuminating, as it attempts to discover which factors regarding the visualization state, data transformations and patterns of user interaction are significant in effectively capturing and sharing insight. Gotz & Zhou [7] identify a tier of domain independent, semantically meaningful user *Insight Actions* which are *'performed by users as they discover or manipulate the insights obtained over the course of an analysis'* from which they attempt to infer a high level logical structure. Similarly, Gersh et al [6] introduce *rich information collections* in which the analyst's original information collection is augmented with *'an executable specification for finding similar information, and the annotation describing her insight'*. In each case, the visualization tool acts in a way Fischer et al [5] would term a *boundary object*, used to support distributed cognition in creative tasks. Understanding this role, and the techniques that best support it, are important in efforts to reproduce an author's insight experiences in the end-user audience through successful narrative visualization design.

4. FUTURE RESEARCH

Investigation should be made into the effect design choices have on the extent to which a narrative visualization is able to tell a compelling story whilst simultaneously facilitating data exploration and insight discovery. This should be guided by Segel and Heer's [17] design categorization and Hullman and Diakopoulos' [9] visualization rhetoric, and informed by discussions about the role of interaction in InfoVis [e.g. 24]. Such studies could be usefully enhanced by building on the neuroscience work of Bowden et al [1], Kounis & Beeman [10] and Sandkhuler & Bhattacharya [14]. This would involve undertaking evaluations that compare factors such narrative structure and data exploration techniques using EEG to record insight experiences. This should be carried out in conjunction with other techniques such as observation or self-reporting, taking further inspiration from the way Carroll & Latulipe [3] have combined these methods to measure creativity support. In this way, it may even be possible to record the pattern of neurological activity present when an author experiences insight during initial explorations and see if there is any correlation with patterns observed in end-users as they later interact with the narrative visualization product.

5. CONCLUSION

Narrative visualization is a creative response to the need to communicate effectively and share insights about complex data with a public audience. We believe that their combination of exploratory elements and narrative structure enable authors to communicate discoveries more successfully by reproducing something of the experience of finding them. A better understanding of insight, as both something that is experienced and also as the product of that experience, will further help authors to tell effective data stories. In addition, recording EEG data offers a novel approach to recognizing episodes of insight experience and studying the relationship between narrative structure and interactive data exploration, therefore providing new approaches to the evaluation of narrative visualization.

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