NarVis: How to Explain An Advanced Visualization Design

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Fig. 1. In the Clouds: Vancouver from Cypress Mountain. Note that the teaser may not be wider than the abstract block.

Abstract—nothing here

Index Terms—Radiosity, global illumination, constant time

1 Introduction

Advanced visualization techniques are effective for data analysis[][]. By introducing metaphors borrowed from nature [6, 15], applying carefully designed layout algorithms [7, 34], and sophisticatedly combining existing visualizations [36], novel visual presentations help people identify patterns, trends and correlations hidden in data. However, these advanced visualizations are usually not intuitively recognizable. Users need to go through some training, for example, reading a long and boring literal description, before they grasp the knowledge required to understand and freely explore a visualization.

What is more, even designers of these advanced visualizations suffer when they are required to introduce their design, especially when the visual encoding has complicated logic dependency, or when their audience have little prior knowledge about visualization techniques.

As a result, these advanced visualization technologies, in spite of the fact that their utility has been verified by domain experts from various fields, gain little exposure outside the visual community. Unaware of or unable to understand these advanced visualizations, main stream media is still dominated by nave visualizations, such as bar charts, pie charts and so on.

For a visualization, its design space can be described as the orthogonal combination of two aspects: graphical elements called marks and visual channels to control their appearance [25]. But why the explanation of these two things is so complicated?

This problem mainly arises from the great amount of information that an advanced visualization design attempts to deliver with visual encoding. First, it would overload an audience if we inundated them with all the information at one time. Second, even if we tried to explain it sequentially, considering the logic dependency existing among visual elements, an improper explanation could totally confuse the audience. For example, the topic streams of a theme river should be explained before the keywords mapping on them, otherwise, the audience would get totally lost. Third, when digesting such a considerable amount of information, audiences can easily get distracted or forget previous information. [ ].

Thus, a specific order of encoding explanation becomes necessary. Attention guidance and reminders are also needed to make sure that audiences are following order, not getting distracted or forgetting previous information.

Narrative, which means connected events presented in a sequence, has long been used to share complex information. As the data visualization field is maturing, many researchers have moved their focus from analysis to presentation, making narrative data visualization an emerging topic [20]. Many efforts have been made to define, classify, and provide design suggestions for narrative data visualization [11, 14, 31]. Some visualization systems have already incorporated narrative modules into their design [5, 10]. However, current work is mainly focused on communicating the conclusion of analyses, rather than guiding the audience how to read a visualization.

Here, we present a prototype to adopt narrative techniques to create a visual encoding explanation. Based on our analysis of the structure, logic dependency, and visual distraction existing in a visualization design, we develop an authoring tool to decompose a visualization, reorganize extracted visual elements, and explain their visual encodings one by one through animated transition in the form of slideshow. Through incorporating a narrative sequence, appropriate chunks of information, rather than all the information, is delivered to the audience at one time, effectively avoiding information overload. Reminders, such as questions, summarizations and repetitions are woven into the narrative sequence to enhance the audiences memory while visual attention guidance, such as flickering, highlighting, and morphing are

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used to lead their attention to newly added information. ()

To the best of our knowledge, this is the first attempt to explain visual encoding with narrative. We believe we make the following contributions: 1). Analysis of the structure, logic dependency, and visual distraction which exists in a visualization design. 2) A framework for explaining narrative visual encoding. 3) An authoring tool to generate and edit the narrative visual encoding explanation We conjecture our work can motivate and enable people to use more advanced visualization designs.

2 Related work

In this section, we provide an overview of prior research around the analysis of narrative structure in data visualization, animation in data visualization, and existing authoring tools for narrative visualizations.

2.1 Structure of Narrative Data Visualization

Narrative is as old as human history. [cite something] People in the fields of literature, comics [8] and cinema [30] have gone to great lengths to analyse the sequencing and forms of grouping used in a narrative, as well as how they affect the meaning a narrative tries to deliver.

Some people believe that work from other fields can inspire researchers in the visual data community. Amini et al [1] borrowed concepts from comics [8] to classify and analyse the structure of data videos. Wang et al [33] adopt two representative tactics, time-remapping and foreshadowing, from cinematographers to organize a narrative sequence for visualizing temporal data.

Other researchers, on the other side, focus on the narrative structures exclusively for data visualization.

Satyanarayan and Heer, through interviews with professional journalists [29] define the core abstractions of narrative data visualization as state-based scenes, visualization parameters, dynamic graphical and textual annotations, and interaction triggers. Hullman et al [14], by identifying the change in data attributes, propose a graph-driven approach to automatically identify effective narrative sequences for linearly presenting a set of visualizations.

These works, however, rarely discuss the narrative structures used for visual encoding scheme, which is fundamental to a visualization. We hope our work can fill this gap.

2.2 Animation for data visualization

There is a wide discussion about the effects of animation when used in a data visualization environment.

Animation can facilitate the cognitive process. Heer and Robertson [12] confirmed the effectiveness of animation when relating data visualizations backed by a shared dataset. Ruchikachorn et al [28], going a step further, design morphing animations which bridge the gap between a familiar visualization and an unfamiliar one, thus introducing a new visualization design through animation. Graphdiaries [3] use animation to help audiences track and understand changes in a dynamic visualization.

On the other hand, animation can be an effective tool to attract and guide visual attention. Huber et al [13] study the perceptual properties of different kinds of animation, as well as their effects on human attention. Waldner et al [32] focused on a specific animation: flicker. By dividing the animation into an orientation stage and an engagement stage, they strike a good balance between the attraction effectiveness and annoyance caused by flickering.

It is, however, noteworthy that animation, in spite of all the advantages mentioned above, can bring about negative effects when used improperly [27]. Our work is based on the results of these researches, which give us a guideline on how to implement animations in our system.

2.3 Authoring tools for narrative visualization

The extensive needs of data communication exist not only in the data visualization field but also in journalism, media, and so on. This has motivated researchers to investigate ways for authoring narrative visualization.

User experience is of great concern when utilising an authoring tool. Sketch story [21], with its freeform sketch interaction, provides a more engaging way to create and present narrative visualization. Dataclips [2]lower the barrier of crafting narrative visualization by providing a library of data clips, allowing non-experts to be involved in the production of narrative visualization.

However, it is the information delivery that is the core consideration of an authoring tool. Existing authoring tools usually choose a specific type of narrative visualization based on the information they want to convey. [2]Meanwhile, integrating an authoring tool for narrative visualization with a data analysis tool has become a trend since it effectively bridges the gap between data analysis and data communication. [5, 10, 22]

These tools offer inspiring user interaction design as well as good examples to implement narrative visualization. However, they treat visual encodings as cognitively obvious attributes that can be universally and immediately recognized without a formal introduction, making them inapplicable for our purpose.

3

4 Bibliography Instructions

- Sort all bibliographic entries alphabetically but the last name of the first author. This LaTeX/bibTeX template takes care of this sorting automatically.
- Merge multiple references into one; e. g., use [19, 24] (not [19] [24]). Within each set of multiple references, the references should be sorted in ascending order. This LaTeX/bibTeX template takes care of both the merging and the sorting automatically.
- Verify all data obtained from digital libraries, even ACM's DL and IEEE Xplore etc. are sometimes wrong or incomplete.
- Do not trust bibliographic data from other services such as Mendeley.com, Google Scholar, or similar; these are even more likely to be incorrect or incomplete.
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  - title
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  - volume
  - number
  - month of publication as variable name (i. e., {jan} for January, etc.; month ranges using {jan #{/}# feb} or {jan #{--}# feb})
- use journal names in proper style: correct: "IEEE Transactions on Visualization and Computer Graphics", incorrect: "Visualization and Computer Graphics, IEEE Transactions on"
- Papers in proceedings—items to include:
  - author names
  - title
  - abbreviated proceedings name: e. g., "Proc.\ CONF_ACRONYNM" without the year; example: "Proc.\ CHI", "Proc.\ 3DUI", "Proc.\ Eurographics", "Proc.\ EuroVis"
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- article/paper title convention: refrain from using curly brackets, except for acronyms/proper names/words following dashes/question marks etc.; example:
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  - will be typeset as “Marching Cubes: A high resolution 3D surface construction algorithm”
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5 Example Section

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6 Exposition

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Table 1. VIS/VisWeek accepted/presented papers: 1990–2015.

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2015	33	9	38	33	14	17	15	159	127
2014	34		45	33	21	20		153	133
2013	31		38	32		20		121	101
2012	42		44	30		23		139	116
2011	49		44	26		20		139	119
2010	48		35	26				109	109
2009	54		37	26				117	117
2008	50		28	21				99	99
2007	56		27	24				107	107
2006	63		24	26				113	113
2005	88		31					119	119
2004	70		27					97	97
2003	74		29					103	103
2002	78		23					101	101
2001	74		22					96	96
2000	73		20					93	93
1999	69		19					88	88
1998	72		18					90	90
1997	72		16					88	88
1996	65		12					77	77
1995	56		18					74	74
1994	53							53	53
1993	55							55	55
1992	53							53	53
1991	50							50	50
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sum	**1515**	**9**	**595**	**277**	**35**	**100**	**15**	**2546**	**2431**

6.2 Mezcal Head

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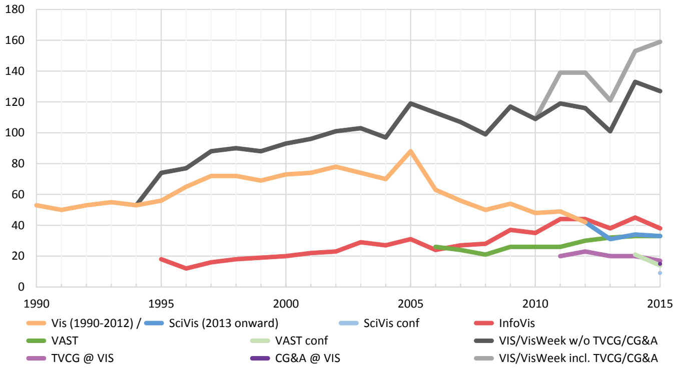

Fig. 2. A visualization of the data from Table 1. The image is from [16] and is in the public domain.

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7 Conclusion

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Acknowledgments

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