Narrative Visualization: A Case Study of How to Incorporate Narrative Elements in Existing Visualizations

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Abstract

Stories have long been used to convey information, cultural values, and experiences. Narratives not only have been the main way people make sense of the world, but also have been the easiest way humans found out to share complex information. However, today we are confronted with the problem of the amount of information available, which sometimes is hard to cope with. Combining storytelling with visualization has been pointed out as an efficient method to represent and make sense of data, at the same time allowing people to relate with the information.

In this paper, we explore the benefits of adding storytelling to visualizations. Drawing on case studies from news media to visualization research websites, we identified possible strategies to introduce storytelling in visualizations such as adding short stories or narrative elements using annotations and using time to introduce the feeling of storytelling or story-flow.

Keywords—**Storytelling, narrative visualization, case study.**

1 Introduction

In recent years many have researched the potential of the use of storytelling in information/data visualization. Moreover the interest in the area has also sparked outside of the research community due to its prospect of use in areas such as journalism, marketing, or education. The challenge is not only discovering ways to highlight the potential stories that exist within the data but also to transform visualizations in such a way that they adopt several narrative characteristics and eventually become a form of storytelling itself.

If visualizations get successfully infused with narrative we can overcome both the limitations of textual and visual representation. Due to the explosion of information and knowledge we have been witnessing in the last few years, potentially sparked by the blooming of the open-data movement, it is imperative that we discover better ways to understand information and to reduce the complexity of the information available. The benefits in using visualization for supporting users in coping with the complexity in

knowledge- and information-rich scenarios has already been proven [9]. However there are still opportunities to make a contribution, specially in the sub-genre of narrative visualization (visualizations intended to convey stories [14]).

With the qualities associated with information visualization and storytelling, narrative visualization can become very successful. Establishing a correct balance between narrative and visualization however is vital. We have to maintain the rigor and accuracy associated with visualization and not introduce narrative elements that could hamper the apprehension and assimilation of the information.

Driven by questions such as *What elements of traditional storytelling can be embedded as part of the data-driven visualization? How do we balance the narrative flow of the visualization without disturbing the experience of discovery? What elements of design and interactivity help us to better tell these data-driven stories?*, in this work we examine the benefits of adding storytelling to visualizations and explore possible strategies to do so. We collected examples of professionally-produced visualizations and used them as case studies. We take an empirical approach, analyzing three visualizations, their use of narrative elements, and how they could be redesigned to better introduce storytelling elements. We explored three narrative strategies that could become relevant dimensions of narrative visualization: context, empathy, and temporality. In order to illustrate our approach we present three simple prototypes of the introduction of storytelling in the selected case studies. Finally, we discuss the implications of these strategies and pave the way to future research on the impact of these strategies and on the establishment of design conventions for narrative visualization.

2 Related Work

"Narrative is first and foremost a prodigious variety of genres, themselves distributed amongst different substances – as though any material were fit to receive man's stories. Able to be carried by articulated language, spoken or written, fixed or moving images, gestures, and the ordered mixture of all these substances; narrative is present in myth, legend, fable, tale, novella, epic, history, tragedy, drama,

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comedy, mime, painting (think of Carpacio's Saint Ursula), stained glass windows, cinema, comics, news item, conversation. Moreover, under this almost infinite diversity of forms, narrative is present in every age, in every place, in every society; it begins with the very history of mankind and there nowhere is nor has been a people without narrative. All classes, all human groups, have their narratives, enjoyment of which is very often shared by men with different, even opposing, cultural backgrounds. Caring nothing for the division between good and bad literature, narrative is international, transhistorical, transcultural: it is simply there, like life itself. [1]"

Storytelling is an ancient art deeply rooted in our common human culture. In spite of having thousands of different forms what still automatically springs to mind to most of us when we hear the term storytelling is the image of an elder narrating an old fairy tale to children [12].

Although it may not appear so, modern storytelling still maintains many of the characteristics of its traditional form. Technological advances are actually helping to introduce in modern storytelling more of these characteristics that we appreciate so much in traditional storytelling. For instance, the use of interactivity makes the user feel the joy of the moment of discovery typical of the live narration of a story.

2.1 Narratives and New Forms of Storytelling

There are basic elements for a narrative [6]: *situatedness* (discourse context or occasion for telling), event sequencing (structured time-course of events), world making/world disruption (disruption of a state of equilibrium), and what it is like (the feelings of living through the situation and a foregrounding of human experience).

Another notion typically associated with narratives is the idea of beginning, middle, and end [11]. In the beginning we have the set up or base reality, that may include background information and a change or conflict. The middle is usually composed of a struggle, complication, or development, pointing towards a climax. With the end comes the resolution and sometimes developments that are left open.

The medium shapes the information [5] and the way it is represented. Computation and the Internet are part of a *New Medium* that has given us the possibility to employ characteristics typical from other media, creating multimedia narratives more complex and sophisticated than ever. Interactive storytelling, for instance, is becoming very popular on news casting and documentaries, areas that were up until recently holding on to traditional forms of storytelling.

2.2 Using Visualizations to Tell Stories

The symbiotic relationship between information/data visualization and storytelling has revealed to be one of the more prevalent topics in visualization in the last few years [4, 7, 12, 14]. Gershon and Page [5] were the first to notice that storytelling could give a valuable contribution to the area of Information visualization, without however truly describing examples of actual information/data visualization and contributing with strategies *de facto* to introduce storytelling.

In 2010 the theme sparked again when Segel and Heer[14] re-approached it, naming it narrative visualization. The authors state that these *data stories* are an emerging class of visualizations. In addition to providing a typology for classifying visualizations and generalized advice for designing narrative visualizations, the authors also identified patterns and structures that news media use to introduce storytelling: Martini Glass Structure, Interactive Slideshow, and Drill-Down Story. These structures vary in terms of how much author-driven paths and how it is structured: the first beginning with an author-driven approach that opens up to a reader-driven stage once the author's narrative is over, the second being a completely linear path with some interactivity within the limits of each slide, and the last one being completely reader-driven. Segel and Heer also argue that most visualizations do not fit the author-driven (Explanatory) versus reader-driven (Exploratory) dichotomy, so commonly established among visualization creators, and are somewhere in the middle. Even narrative dense visualizations can include data that can be freely explored by users and let them draw their own insights.

There is an intense discussion [2] in the visualization area about whether or not introducing storytelling is beneficial. However most seem to agree that, when done right, it can be a powerful way to create a structured interpretation path [2]. Good narrative visualizations allow the user to engage with the data, makes the insight jump out, and helps users to cope with their short attention spans and lack of data literacy. Nowadays most visualizations depend on different media to provide explanations about the data, usually text. However, often people try to interpret the visualization by it self and do not care about the extra information necessary for its interpretation. Visualizations that are too exploratory with little author-driven guidance can undermine comprehensibility and engagement, resulting in a user that is under-informed or even misinformed. This does not imply that exploratory visualizations that are thoughtfully designed cannot be engaging, however the user is always a volatile variable. On the other hand, visualizations that are over-curated and too story-driven also tend to be boring, specially for proficient users.

Achieving a equilibrium between exploratory and expository is important if we want to have visualizations that are easy to interpret, appealing, and that still leave possibilities for exploration. Also, if we are able to successfully introduce storytelling we will be able to produce visualizations that can be entirely independent of other means of storytelling.

Even tough there is a considerable amount of literature on narrative structuring techniques for visualization [14], there considerably less on clear guidelines recipes that creators can use to find the best narrative strategies for different types of visualizations. Research [2] has already revealed that having flexible narratives with landmarks and spaces for the user to freely explore in-between is a good option. However, this research towards design strategies and rhetorical techniques is still much needed.

2.3 Narrative Strategies

Several narrative strategies have been approached by different researchers in the past years, particularly approaches closer to semiotics, critical theory, and journalism. Authors such as Segel and Heer [14] and Hullman and Diakopoulos [7] proposed narrative strategies for visualization based on visual rhetoric. Segel and Heer's approach aimed towards structure and generalized advice for designing narrative visualizations. Hullman and Diakopoulos go farther proposing an analytical framework for visualization rhetoric that cross editorial layers (data, visual representation, textual annotation, and interactivity) and a set of techniques for visualization rhetoric(omission, metonymy, data provenance, representing uncertainty, identification, obscuring, contrast, classification, redundancy, typographic emphases, irony, similarity, individualization, anchoring, filtering). Their objective went towards the constitution of a guide to how much visualization rhetoric should be used on the design of visualizations. They also give insights about the impact of these rhetorical aspects influence the user's interpretation of the original data.

In this paper we analyze three particular approaches that were previously discussed in this field of study: context (closely linked to annotation), empathy, and temporality (its relation with story-flow). All of these aspects will be approached in relation with interactivity.

2.3.1 Context and Empathy

Interactivity opened up the possibility of adding new layers of content to information visualization. Thanks to this additional layer of content, most of the times in the form of annotations, visualizations can, in addition to the data itself, provide content that is able to add context. This content has the potential to help a user make sense of the data [8]. In addition interactivity offers the possibility to show the content on demand, giving the user a sense of freedom.

The free exploration of the data and its context stories allows the user to follow just the information he/she is most interested in, also improving his/her enjoyability.

According to Hullman et al. [8] annotations are a promising way to complement articles since they have the capacity to add context that otherwise would be very difficult to provide. Annotations with context information are easier to assimilate than a dense article and can serve as little moments of storytelling. However the context does not need to always be in the form of storytelling, it can also be given in the form of external links and short annotations.

These moments of storytelling can add another dimension to the visualization: empathy. Empathy and emotion are concepts that were not often associated with information visualization, speacially because the first concept are usually associated with chaos and the last with objectivity. However emotive/empathic information visualizations revealed to be often more memorable [10] and even, at times, more enjoyable. This sense of empathy can be achieved by making the user relate to the topic or to the individuals represented in the data (by allowing the user to see him/her represented or by putting the user in other people's shoes).

2.3.2 The Relation Between Time and Narrative

Temporality is a major structural factor in our lives and it is closely related with narrativity[13]. Narratives are able to represent the human experience of time in its two different modes: the linear succession time (the sequence of minutes, hours, days) and the phenomenological time(the past, the present, and the future, which do not necessarily correspond to the linear structure of before and after, in other words, a narrative may begin with a culminating event or the temporality that is lived in the narrative may not concur with the time of the events the the story is said to depict).

Temporal structure is something that can give visualizations a sense of story-flow and this often appeals to users, because it gives them the ability to navigate their way to particular information. Structures such as timelines are very efficient in giving this temporal sequence feel. Nonetheless, this sense of temporality does not need to be expressed as a linear structure and stories are useful way to do so because they do not always have a linear temporal structure [10]

3 Case Study

Three case studies were used to demonstrate the strategies of storytelling approached in this paper. The first example, *How many households are like yours?*[1] highlights how it is possible to introduce short stories to add empathy. The second, *What does china censor online?*[2] illustrates how it's possible to add context. The last example, *Death penalty statistics, country by country*[3] demonstrates the benefits of time as a form to introduce the feeling of narrative.

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[1]http://www.nytimes.com/interactive/2011/06/19/nyregion/how-many-households-are-like-yours.html
[2]http://www.informationisbeautiful.net/visualizations/what-does-china-censor-online/
[3]http://www.theguardian.com/news/datablog/2011/mar/29/death-penalty-countries-world

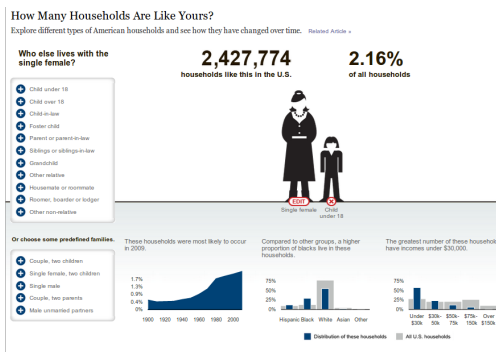## 3.1 Home Many Households are Like Yours?

Figure 1: Original How many households are like yours?

Accompanying the article *Baby Makes Four, and Complications* on the changing family dynamic, The New York Times published an interactive visualization that lets users explore different types of American households: *How many households are like yours?*, shown in Figure 1.

The user is first presented with the option to choose the primary residents of a household (married couple; male/female unmarried partners; single male; single female; male unmarried partners; and female unmarried partners), represented through pictograms. Afterwards the user can add secondary members of the household (child under 18; child over 18; child-in-law; foster child; parent or parent-in-law; siblings or siblings-in-law; grandchild; other relative; housemate or roommate; Roomer, boarder or lodger; and other non-relative), also represented as pictograms. The graphic updates on the fly and simultaneously shows how

the entered household compares to the rest of America's households. The visualization shows the total of households in the US that are like the one the user selected and the respective percentage. On the bottom there is a breakdown by time, race, and household income.

The user is presented with the possibility to choose any kind of household that he/she wishes however the visualization challenges the user to try his/her own family. This creates a sense of proximity between the user and that data.

In a previous research [3] we analyzed the different elements that compose this visualization. In terms of interactivity the New York Times visualization enables the user to click and hover details and filter the data. The narrative elements we identified in it were title, captions, annotations, introductory text, and accompanying article.

It is possible still to improve the sense of relatability that the user feels with the data if we introduce short stories about the different kinds of families instead of having only one long article about one type of family introducing the visualization. In Figure 2 we present how this can be done without changing the visualization too much. Basically, similarly to what happens with the graphics on the bottom of the visualization we propose that the visualization includes also a short article characterizing the type of family that the user selected. We used the main article that accompanies the original visualization as the example for household with a single female with a child under 18. Having stories for each type of household helps the user to see that data not just as a type of household but as real people.

Relatability is a factor that helps the user enjoy the visualization. It is one of the characteristics that makes it memorable [10] and one that is able to make the user feel
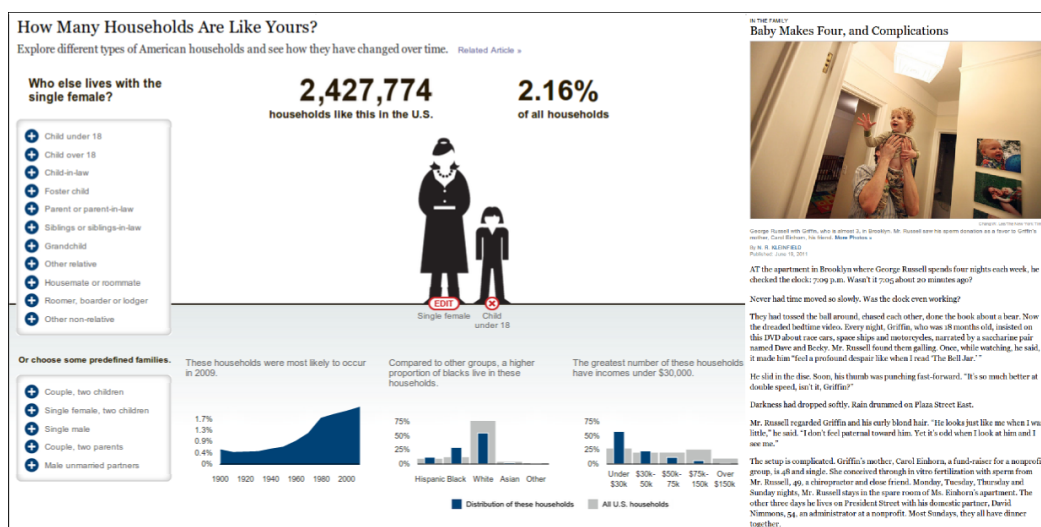

Figure 2: How many households are like yours? enhanced with storytelling

empathy with the subject or the individuals represented in the data, and which will probably make the visualization more successful.

Figure 3: Original What does China censor online?

3.2 What Does China Censor Online?

The visualization, by David McCandless, *What Does China Censor Online?*, shown in Figure 3, is a simple tag cloud that only has a title and text, in this case mere disconnected words.

The user is presented with a non-playable visualization that, although it is not visible at first, it is in fact a map. The tag cloud is shaped as a map of China.

This visualization would benefit greatly with the addition of extra information to add context. In Figure 4 we present how this can be done maintaining most of the origi-

nal design. We propose the introduction of small *tooltips* that pop-up when the user clicks on one of the websites censored. This would help the user realize the possible reasons for the censorship. There should also be external links to the actual websites.

Context information can work as little moments of storytelling. This kind of short stories can be more easily interpreted by the user than a dense article. Context could also be introduced as external links, for instance Wikipedia links or related articles, or short annotations.

This context information is beneficial for providing information that otherwise would be difficult to provide [8].
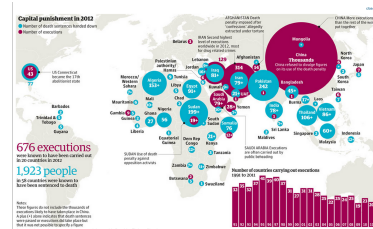

Figure 5: Original DPS, country by country

3.3 Death Penalty Statistics, Country by Country

Death penalty statistics (DPS), country by country, shown in Figure 5, is a visualization by The Guardian that accompanies an article about countries that maintain the death penalty.

Figure 4: What does China censor online? enhanced with storytelling

The map/diagram static visualization has bubbles of different sizes to representing the number of death sentences handed and executions in countries that are still carrying executions. On the bottom there is also a timeline representing the number of abolitionist countries for each year between 1991 till 2012. The timeline resembles a bar graph. Apart from the large article of which the visualization is part of, *Death penalty statistics, country by country* in terms of narrative elements only has an introductory text and captions that indicate the short information such as names of countries and dates.

This visualization would probably benefit if the timeline would actually function as a navigation and when the user clicks a certain year the map would show the number of death sentences handed and executions of that year. This representation of time and, specially the evolution of events, often appeals to users.

The use of interactivity elements such as hover or click details would also be useful on a visualization such as this one, because it could add extra information making the data more meaningful. In our prototype, shown in Figure 6, we propose adding *tooltips* with extra information about the executions and death sentences when the user clicks each countries' bubble. This *tooltip* could have general information about the subject for each country in a given year or a particular execution story to increase the empathy between the user and the data.

4 Conclusion

In this paper we explore the benefits of adding storytelling to visualizations and propose three strategies that still leave the way open for free exploration of the data: adding context, empathy, and temporal references. These techniques can be combined.
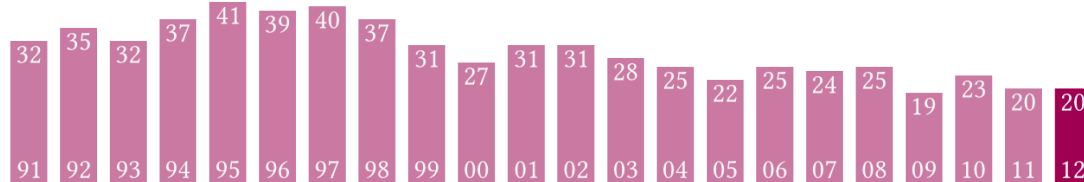
We take an empirical approach, analyzing three professionally-produced visualizations, their utilization of narrative elements, and how they could possibly be redesigned to better introduce narrative components. In order
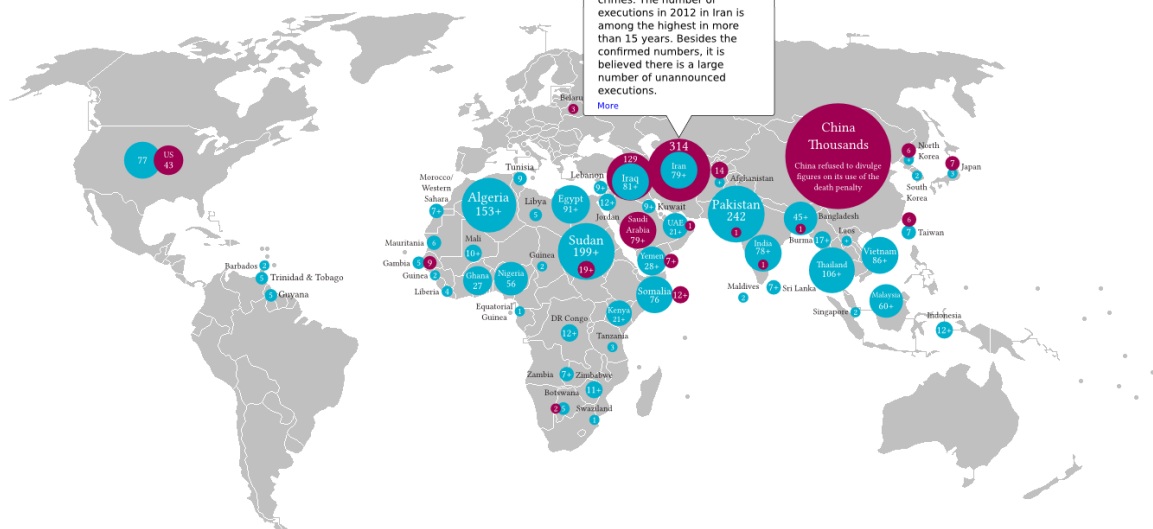
Figure 6: Death penalty statistics, country by country enhanced with storytelling

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to illustrate our approach we presented three simple prototypes of the introduction of storytelling in the selected case studies. This paper aims to be a contribution somehow between a design study and a model, therefore we discuss the implications of these strategies and try to shed a light on the impact they will have on the interpretation and level of enjoyability of the visualization. We were driven by the motivation to pave the way to future research on the impact of these strategies and on the establishment of design conventions for narrative visualization.

One of our main goals was to research techniques that add a story feel to the visualizations without however preventing the free exploration of the data. Narrative visualization shouldn't become a lean-back format, accordingly the quest to add storytelling has to be weighted so that it does not lead to a linear, too author-driven interpretation path for the user. Stories in visualization should be used as starting points for data exploration or short moments of insight about the data, rather than a predigested narrative.

Providing free access to the data seems to help address the need to expose the intricacy of the information, however this might be confusing specially for non-proficient users. Possibly narrative elements can help frame the inner contradictions of the data and lead the users to their own interpretations of the information, guiding their attention in subtle ways.

To make further progress on narrative visualization we still need to know:

- what makes it work;

- which of the narrative visualizations that are being produced in news media, advertising, research, education, etc. are having the desired effect on users;

- how and where should narrative elements be placed;

- how should the story be structured;

- what is the impact of these stories on the users.

We're at an inflection point where we understand the design dimensions enough to start working towards the construction of models for narrative visualizations. Once these are built they should be employed in the design of visualizations, tested, and maybe then we will achieve some answers to these questions. The systematic study of these narrative visualizations is the only way to further amplify our understanding on this subject.

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