Converging Data Storytelling and Visualisation

Yangjinbo Zhang[(✉)]

Visualisation and Interactive Media Lab. (VisLab.), Curtin University,
Perth, WA, Australia
yangjinbo.zhang@postgrad.curtin.edu.au
http://curtin.edu/vismedia

Abstract. The goal of this paper is to discuss and review existing literature in the field of data storytelling and draw the relationship between data storytelling and visualisation. It also associates both domains, as well as it explores pathways how to better present and deliver data driven presentations. To associate data storytelling with visualisation will be a worth-studying and intriguing direction. We summarize in a brief discussion the convergence between visualisation and data storytelling by pinpointing to key theories, illustrating the potentia, and present both concepts as tool in data science, aesthetics and information visualisation.

Keywords: Data storytelling · Serious storytelling · Visualisation
Data visualisation · Narrative structure · Story · Media study · New media
Cognition

1 Introduction

The role of data in today's world is clear. With the increasing amounts of data, it's getting more and more important to find adequate ways to communicate, present, and make data understandable to individuals. Story telling has played a role as "message carrier" in human history for a very long time. In comparison with raw data – a narration is a more natural and smooth-understanding form of message. The convergence of both concepts – storytelling and data science – seems to be the next natural next step forward, in making data easier to comprehend, and to communicate.

Def. Visualization (Tufte 1983): According to (Tufte 1983), visualisation is visually present measured quantities with visual elements such as lines, shapes, colors, words, symbols and so on. It is the art and tool for reasoning data and information (Tufte 1983).

Def. Narrative (Chatman 1978): According to Chatman's idea (Chatman 1978), narrative is a whole with nature of both transformation (deliverable and expressible) and self-regulation (self-maintained and closed structure) and is constructed with discrete events and existents, and with a sequential composition, that function as a whole (Chatman 1978).

Def. Data Storytelling (Knaflic 2015): according to Knafilc's idea (Knaflic 2015), data itself is difficult to understand, but there are stories in data bringing it to life that

allow to communicate data in a much more efficient way. Data storytelling transforms data into a better form that can support decision making (Knaflic 2015).

In the way of exploration of how to better present and deliver data, how to make the process more vivid, convenient and plentiful. Within this paper, we discuss the multi-disciplinary facet of data storytelling, and it's basic theories.

2   Review of Basic Theories

A brief review of the relevant topics and literatures are shown as below (see Table 1).

2.1   Visualisation

In recent researches, visualisation as a research domain has considerably developed. There are a lot of important ideas and concepts being provided in many aspects. On visual efficiency, Tufte (1983, 1990) contributed an important concept: data-ink. Data-ink is the cord of an image that cannot be erased. If it is, the message will be incomplete. Maximising data-ink and minimising non-data-ink can dramatically improve efficiency (Tufte 1990). Tufte also cited efficiency as only one of the dimensions of visual design. Other dimensions include complexity, structure, density and beauty (Tufte 2006). So comprehensively consider the various dimensions of visualisation design will be a necessary way to improve the overall quality.

The principles of data analysis and presentation (Tufte 2006), are about the design principles are based on the fundamentals of human cognition and motivation. These are closely related to some basic human activities: decision, purpose, response, consequence, planning, and so on (Tufte 2006). It will be important to further understand and conduct a more comprehensive analysis of what aspects and elements are essential to create human centered visualizations, as e.g. discussed in (Lugmayr et al. 2016, 2017b). Research around visual cognition (Ware 2013), addresses aspects such as the working memory/long-term memory, knowledge formation/transfer, visual cognitive systems and visual thinking processes. Different frameworks have been researched, as well as a concept of sensory versus arbitrary symbols has been provided (Ware 2013). This concept provides a good guide to analyse the relationship between visual cognition and graphic symbolic elements. A important work in visualisation cognition and its information visualization cognition framework has been provided by (Patterson et al. 2014).

2.2   Storytelling and Narrative Structure

The purpose of visualisation is to translate a message into visual form for more convenience understanding. And in order to achieve even better understanding, the massage should be re-organised and re-edited before it is visualised. In the domain of storytelling, there are some theories and researches which can support for this.

According to Chatman's narrative structure research, narratives have two major parts: the story—which is depicted in a narrative—and the discourse—how a narrative is depicted. The story part has two subtopics: events (actions, happenings) and existents

Table 1. Overview of literature resources

Topic	Description	Aspects	Ref.
Visualisation			
Data-ink	Cord of an image that cannot be erased, and Maximizing data-ink, and minimizing non data-ink improves efficiency	Efficiency of visualisation	Tufte (1990)
Analysis and presentation of data	Design principles fundamental to human cognition and motivation, closely related to some basic human activities	Visualisation principles	Tufte (2006)
Visual cognition	Research in aspects such as the working memory/long-term memory, knowledge formation and transfer, visual cognitive system and visual thinking processes	Visualisation and cognition	Ware (2013)
Visualisation design	Ingredients of good visualisation form the perspective of designer, reader and data	Design of visualisation	Iliinsky and Steele (2010, 2011)
Cognitive Big Data	Framework for cognitive understanding of data, and categorizing the traits of Big Data as in	Psychological framework	Lugmayr et al. (2016, 2017b)
Data storytelling			
Storytelling with data	Guidelines for the use of storytelling in data presentation, and support cognition and decision-making	Data presentation	Knaflic (2015)
Serious storytelling	Story for serious purposes. How storytelling can be used for non-entertaining purposes, such as support decision-making and share knowledge	Serious story	Lugmayr et al. (2017c)
Information aesthetics			
Information aesthetics	It provides a unique thread to combine science and art. Research includes studies of sematic and aesthetic information and uncertainties in perceptions of symbols	Information study	Moles (1968)
Aesthetics theory			
Aesthetic response theory	Art can neither be fully identical with the work created by author, nor with the realisation by the viewer. It exists halfway between these two poles	Aesthetic response	Iser (1978)
Layered structure of art	Inner structure of art, phonetic formation, units of meaning, schematized aspects and represented objectives	Structure of art	Ingarden (1973a, 1973b)

Table 1. (*continued*)

Topic	Description	Aspects	Ref.
Story narration			
Narrative structure	Narrative parts and subfactors affecting narration: the story (depicted in a narrative); discourse (depiction of narrative)	Structure of story	Chatman (1978)
Characteristics of storytelling	Tell-ability of a story, characteristics of good storytelling and storytelling techniques	Storytelling techniques	Baker and Greene (1977)
Media studies			
Medium's affect to message	Content of a media is always another media, media as translator and carrier of information	Nature of media	McLuhan (1964)
Characteristics of new media	Numerical representation, modularity, automation, viability, and transcoding	Media characteristics	Manovich (2001)

(characters, setting). Many subfactors also affect narration (Chatman 1978). He sees story as a form of sharing massages has been tested by throughout centuries as a way of exchanging information easily to understand, and attractive for people. Therefore, the most obvious step is to link data with storytelling to make data understandable.

How to naturally combine the cord data into story units, meanwhile remain the clarity of the cord data. This is the aim and the direction. About how a story is present in the aspect of visual, Chatman also provided some guide in his research of visual space in cinematic narrative (Chatman 1978) and its digital production (Lugmayr et al. 2008). Visual factors such as scale, density, texture, position, colour, angle, size are the key elements that are presenting and telling the story in the aspect of sense of visual (Chatman 1978). In fact, this is sharing very similar principle with visualisation, and helps it's creation process.

In the research of characteristics of storytelling (Baker and Greene 1977), a central question is discussed: what makes a story tellable? Some of the characteristics are: a single and clear theme, dramatic appeal, characterization (Baker and Greene 1977). This provide a direction which is worth to think, when a message is reorganized and reedited into a story, how this story should like in order to being attractive and can catch people's attention. To explore how these characteristic elements fit in the context of data visualisation, will definitely help to improve the overall quality of cognition and understanding.

In terms of narratives in specific media, research into linguistic structure of comic narratives (Cohn 2014) also provide valuable ideas. In this research, it reveals three structures which are affecting in the visual aspect of comic. They are graphic structure, narrative structure and external composition structure. Through graphic structure, lines and shapes combine into image. Then with narrative structure, a series of images organise into a coherent message. Last with external composition structure, all the organised images fit into a specific media space. We also have to consider the 'medium' carrying the story – which we explore in the next section of the paper.

2.3   Media and Communication Studies

The media is not only the carrier of the information, but also part of the information. It affects how information is presented. "The medium is the message" as stated by McLuhan (1964). McLuhan's research also revealed that the content of a media is always another media. In fact, media plays the role of translator; it carries the information from one form into another form. When discussing the media, some very important parts will be the characteristic of medias, difference between medias, which aspects of message are being affected by the forms of media, and when in the translating form media to another media which parts of message will be changed because of the affection by different media forms. Manovich's research (Manovich 2001) into new media reveals that - compared to former media - new media in the digital age have many new characteristics. These are e.g. (Manovich 2001): numerical representation, modularity, automation, variability and transcoding. These affect how information is presented in new media. Today, media study theories extend towards smart media environments (Pogorelc et al. 2012; Lugmayr et al. 2009) and topics like personalization (Uhlmann and Lugmayr 2008).

2.4   Data Storytelling

In the field of data storytelling, there are many important contributions have been made. Knaflic (2015), provides a method to associate live narration with data figures. This combination provides a good idea to understand the application and context of data story telling. This research also provides a guideline to guide the use of storytelling to better present data and support cognition and decision-making (Knaflic 2015).

Recent research in this domain has produced valuable concepts such as e.g. serious storytelling and cognitive big data (Lugmayr et al. 2017a, 2017c). Questions like the difference between serious storytelling and entertaining storytelling are addressed. It also rethinks, if some methods and theories of traditional storytelling can support serious storytelling; and which domains or disciplines should be considered. These concepts are vital how data storytelling support cognition and human activities.

3   Discussion and Conclusion

Data storytelling and digital visualisation are relatively young concepts. To develop data storytelling, it is essential to intersect theories from multiple domains and disciplines. It is necessary to discuss and analyze which theories in each domains contribute to data storytelling. It will also require creative methods to create these (Lugmayr 2011). It is necessary to essential to explore different characteristics in different aspects and domains and distill the required ones to develop data storytelling as a discipline. In this paper, some key-theories contributing to data storytelling are explored and key-literature described. These need to be applied in concrete application scenarios and application domains to allow new insights into data and decrease the cognitive load of individuals exploring different aspects in data. This research paper is research in progress and is only a starting point for further investigation.

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