A Survey on Animation in Visual Data Storytelling

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Outline

Introduction
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Introduction
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Background and Motivation

Why Storytelling?

For thousands of years, storytelling has been an essential part of our humanity.

Ancient storytelling
Analysis of the most popular 500 TED Talk presentations found that stories made up at least 65% of their content.
Why Data Storytelling?

Storytelling can be used to improve the understandability and engagement of data visualizations.

Enterprise

Journalism

Mr. Trump made large gains across rural America, helping to defeat Hillary Clinton and her urban supporters.
Why Animation?

Animation is an effective means of showing changes in data visualization due to its inherent nature of presenting temporal evolution over time.

Hans Rosling’s Gapminder presentation

https://www.youtube.com/watch?v=jbkSRLYSoho
Background and Motivation

Animation in Visual Data Storytelling

• Visual Data Storytelling
• Animation techniques
• Narrative

Narrative is a **series of connected events** transmitted in the form of spoken words, written words, or graphical representations.

• Data story

The data stories we focus on in this survey generally incorporate **data visualization** or **data dynamics**, display information, and enhance abstract data with capabilities to clarify salient differences, provide insights, and engage the audience.
• **Visual data storytelling**

Visual data storytelling is a method of telling a data story to aid understanding, describe relationships, and convey insights of **abstract data** through **visual representations**.
Visual Data Storytelling

Brief History

Taxonomy
In 2001, Gershon and Page were the first to notice the valuable contribution that storytelling could give to information visualization.

Nevertheless, their strategies for storytelling are unclear because they are based on map views and did not provide a description of actual visualization.

Later, in 2010, the theme sparked again when Segel and Heer reinvented the notion of using storytelling in visualizations and named it narrative visualization.

Visual narrative tactics
- Visual Structuring
- Highlighting
- Transition guidance

Genres of Narrative Visualization

Their work is valuable for communicating an intended message by using visualization techniques, but it failed to establish clear definitions of visual data stories and their compositions.

In 2013, Kosara et al. provided a general review of storytelling research. However, they only simply discussed a working model of story construction that is based on the working methods of journalists.

Lee et al. (2015) stated the use of attractive visualization as a storytelling medium has become increasingly prevalent in the visualization community. Nevertheless, the visualization community has yet to reach a clear consensus on the essential content of data stories.


Therefore, Lee et al. (2015) propose three characteristics that have to be present in visual data stories:
• A set of story pieces to support facts
• Annotations or narration to clearly highlight and emphasize the data
• A meaningful sequence of story pieces to reach the author’s communication goal
More recently, Stolper et al. (2016) identify and describe the storytelling techniques applied in the recent online data-driven stories. They classify 20 data-driven storytelling techniques into four high-level categories.

This paper extends the taxonomy by Segal et al. (2010) and consider newly emerging genres.
Brief History

Development of visual data storytelling
Taxonomy by Segel et al.

- **Visual Structuring**
  (e.g., Progress Bar, and “Checklist” Progress Tracker)
- **Highlighting**
  (e.g., Close-Ups, Motion, and Zooming)
- **Transition Guidance**
  (e.g., Viewer Motion, and Animated Transitions)

Although Segal et al. (2010) provided a nice framework that nevertheless misses several essential dimensions given that some aspects of data storytelling have changed (e.g., Scrollytelling).

Taxonomy by Stolper et al.

1. Communicating narrative and explaining data
   - Textual Narrative
   - Audio Narration
   - Flowchart Arrows
   - Labeling
   - Text Annotations on Visualizations
   - Tooltips
   - Element Highlighting

2. Linking separated story elements
   - Linking Through Interaction
   - Linking Through Color
   - Linking Through Animation

3. Enhancing structure and navigation
   - Next/Previous Buttons
   - Scrolling
   - Section Header Buttons
   - Menu Selection
   - Timeline
   - Geographic Map

4. Providing controlled exploration
   - Dynamic Queries
   - Embedded Exploratory Visualizations
   - Separate Exploratory Visualizations

• A wider range of genres (e.g., scrollers)
• Extending limited interaction to a high-level category

Taxonomy based on the Data Story Model

Freitag’s Pyramid
(adapted from Gustav Freytag’s Technik des Drams (1863))

- Exposition provides important **background information** to the audience.
- Rising action is series of events build **toward** the point of **greatest interest**.
- Climax is the greatest intensity of the **conflict**.
- Falling action makes its way **towards the resolution**.
- Denouement comprises events from the resolution to the actual ending scene.
Animation can be used to describe the data in the exposition stage.
Animation techniques in this category refer to visual strategies that build toward key findings.
The application of animation techniques to evoke emotions parallels the falling action toward resolution.
Variation of the Data Story Model
## Taxonomy based on the Data Story Model

<table>
<thead>
<tr>
<th>Category</th>
<th>Related Papers</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animation for Describing Data</td>
<td>(Huber &amp; Healey, 2005), (Akiba et al., 2010), (Scheepens et al., 2016), (Romat et al., 2018)</td>
<td>static data</td>
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<td>Encoding Data Attribute</td>
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<td>Animation for Revealing Insights</td>
<td>Data Transition (Dragicevic et al., 2011), (Chevalier et al., 2014)</td>
<td>temporal aspect</td>
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<td>(Peng et al., 2018)</td>
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Outline

Animation in Visual Data Storytelling

Animation for Describing Data
Animation for Revealing Insights
Animation for Evoking Emotions
Describing Data

Two types of animation techniques used to describe data:

- Encoding **object attribute**
- Encoding **stream data**

Research goal:
Applying animation **intuitively** to **present data**.
Animation is usually applied to help scientists in observing the objects’ complicated changes and interactions.

http://hint.fm/wind/
Romat et al. (2018) provides a systematic design space for generating animated network edge textures and applies dynamic particles to the network edges to increase the mapping capacity.
The three variables defining for dynamic behavior:

- Particle Pattern
- Pattern Frequency
- Particle Speed

Previous methods:
- Using static properties
- Animated texture in ad hoc manner

Encoding Object Attribute

- No delay
- Departure delay
- Arrival delay

Contribution: Widens encoding space
Limitation: Unclear interaction between variables

Huron et al. (2013) used the physical process of sedimentation as a metaphor and invented a visualization method to create data stream narration.

However, it may have some visual effect problems when dealing with bursty data streams because tokens aggregate depending only on the heuristic buffering strategy.

Describing Data

Encoding Stream Data

(Wang et al., 2013)

(Wang et al., 2016)

(Liu et al., 2016)

Two types of animation techniques used to describe data:

- Encoding object attribute (**static** data)
- Encoding stream data (**dynamic** data)
Revealing Insights

Three types of animations that aim at revealing insights:

• Animation for **visualization transition**
• Animation for **highlighting**
• Animation for **data transition**
Heer et al. (2007) proposed a framework, DynaVis, for creating animated visualizations between different charts.

Drucker et al. (2015) proposed a unifying framework and implemented the SandDance system for generating unit visualizations (e.g., unit charts, and scatterplots) and smooth transitions between different layouts.

Animation for visualization transition

Exploring the 2010 election. A: Colored by voting percent; B: Binned by longitude; C: Sorted by voting percent; D: Summed by total population; E: Binned by voting percent; F: Changed to 2 bins.

As the volume of data increases, the animated transitions will become *incomprehensible without more sophisticated bundling* techniques. Moreover, the units will become hard to display since the pixels of the screen are limited.

Animation for Highlighting

Attractive Flicker
causes minimal annoyance and provides effective visual guidance.

Waldner et al. (2014) considered human perception when designing a flickering effect, which is the cyclical variation of an objects appearance and disappearance that catches viewers’ attention.

Animation for data transition

Different temporal distortion strategies for animated transitions

Dragicevic et al. (2011) are the first to perform an empirical study and confirm that the slow-in/slow-out pacing is easier to follow than other temporal distortions in animations.

However, their conclusion is only suitable for single-object tracking.

Introduction

Visual Data Storytelling

Animation in Visual Data Storytelling

Conclusion and Future Work

Du et al. (2015) proposed a trajectory bundling approach for a group of adjacent objects that move in a similar direction.

Revealing Insights

Animation for data transition

The movement trajectories

Illustration of the complexity metrics

Before this work, little has been done for improving animated transitions from the spatial aspect.

Wang et al. (Wang et al., 2017) proposed a framework for creating animated transition of points along nonlinear paths with collision avoidance.


However, the vector field design in their work relies on the clustering of moving points with similar spatial positions and motions, which is a strong constraint of the proposed technique.
Evoking Emotions

- Emotion is one of the **key differences** between data story and data visualization.
- Emotive data stories are often more **memorable** and **enjoyable**.
- Evoking the audience’s emotions can also **help convey** the storytellers’ desired **messages**.
The animation produces an emotional data story with intense anxiety owing to the metaphor and the speed-up effect.

https://guns.periscopic.com/?year=2013
By considering the viewer’s mood and behavior data, Peng et al. (2018) opened up the design space and generated personalized animations that are emotionally engaging and motivated.

Conclusion and Future Work

Conclusion

Future Work
Conclusion

Data Story Model

Freitag’s Pyramid

Climax
Rising Action
Exposition

Falling Action
Denouement

Insight Revealing
Insight

Emotion Evoking
Next Steps

Description
Increase in audience awareness

Data Story Model
## Conclusion

### Animation in Visual Data Storytelling

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Challenges

Crafting good data stories is not easy. Data sometimes seems to be the antithesis of stories because stories are usually related to affectivity, while data are associated with objectivity. Moreover, a lot of contradictions have been found in animation research.
Future Work

Emotion of Data Story

Advantages:
• Memorability
• Persuasiveness
• Engagement

Challenges:
• Human’s mental states are hard to measure and evaluate

Opportunities:
• Personal data
• Speed
Future Work

Effectiveness of Animation

Advantages:
• Comprehensible
• Engaging

Challenges:
• Findings have indicated that similar and opposing opinions always exist

Opportunities:
• Techniques from cinematography
Thank You

Q&A