

Visualizing complex narratives with parallel timelines

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ABSTRACT

This paper presents an interactive visualization system based on parallel timelines that is designed to make it easier for journalists and the general public to follow and understand long, complex, multi-plot narratives involving many interacting actors. To illustrate our idea, which combines a timeline visualization with interactive filtering tools and a network visualization of the actors and their relationships, we describe a proof-of-concept prototype based on the scandal involving meatpacking giant JBS and the Brazilian government.

KEYWORDS

Storytelling, Timelines, Visualization

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1 INTRODUCTION

Timeline visualizations have often been used in the media as storytelling devices, in the context of both news [17] and entertainment [4, 13]. Brazilian newspaper *O Estado de São Paulo* used a timeline-based slideshow (made with TimelineJS [19]—see Section 2) to narrate the chronology of the events related to the budgetary tricks employed by former president Dilma Rousseff that lead to her impeachment [17]. The *Washington Post* used a vertical, linear timeline accompanied by a character guide to summarize everything that happened in the Marvel Cinematic Universe movies before “Avengers: Infinity War” [13]. The *Australian Broadcasting Corporation* used horizontal, curved timelines with subway map-like junctions to depict character interactions in the

first six Star Wars movies [4], with color indicating who belongs to which “side of the Force.”

We developed an interactive visualization system based on parallel timelines that is aimed at making it easier for journalists and the general public to follow and understand long, complex, multi-plot narratives involving many interacting actors. The timeline visualization is paired with a filtering system and complemented with a graph visualization of the actors and their connections to one another. Our system is aimed at both finding stories and communicating them to an audience. It is thus also potentially useful to authors and students of fiction or of any other kind of narrative that involves complex networks of characters and interlocking, parallel subplots that evolve chronologically.

This work uses as a case study a prototype based on the scandal involving meatpacker JBS and the Brazilian government. With its multiple interwoven threads, its numerous plot twists, and its ever-expanding cast, the JBS story produced a long and highly complex narrative. Keeping track of the actors, events, and their relationships became a gargantuan task for both journalists and the general public. For most of 2017, every day brought a new revelation that spun the story into a new and unexpected direction—from plea deals to accidental recordings of compromising conversations.

2 RELATED WORK

Timelines and storytelling

Timeline visualizations have been a focus of research in storytelling. Screenplay analysis tool ScriptThreads [11] uses both interwoven and parallel timelines to depict character activity and scene co-occurrence, showing when characters are present or absent from scenes (their presence graph is particularly relevant to the work presented in this paper, as it has some similarities with our approach to visualize multiple plot threads). Inspired by xkcd’s handcrafted storyline infographic [9], some works [8, 10, 12, 14, 15] use a subway map-like timeline visualization to depict the structure of a story, with interwoven lines of different styles representing characters and even *McGuffins* (objects that move the story along, such as the ring in “Lord of the Rings”). Wook et al. [7] used multi-row timelines to visualize non-linear (i.e., out of chronological order) stories extracted from films, with colored lines representing different subplots that can share the same scenes (i.e., simultaneously advance). Brehmer et

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al. [2] presented a design space for storytelling with timelines, identifying 14 design choices characterized by three dimensions (representation, scale, and layout). In their design space, a timeline design can be described by a tuple of values, one from each dimension, with each design choice supporting different narrative points that can be combined to tell different types of stories. Brehmer et al.'s design space study served as a basis for Microsoft's Timeline Storyteller, an open-source storytelling environment that lets authors create timelines of many different styles [3].

Timeline creation tools and libraries

There are several web-based tools for timeline creation, some commercial [1, 6, 16] (with free options) and others completely free [19]. They either provide a complete authoring environment [1, 6, 16] or integration with other tools [19]. Most host the timelines themselves, often allowing them to be embedded in other websites [1, 6, 16], but some let users integrate them directly into their own pages [19]. All the tools offer some customization of visual attributes (e.g., colors, fonts, background images) and integration of different types of media (e.g., images, video, embedded documents, interactive widgets). Most use horizontal designs, featuring a time ruler or line that represents time [1, 16, 19]. Others feature vertical designs [6, 16], letting users scroll vertically through events, which are usually displayed as balloons around a central line. Notably, Tiki-Toki [1] also includes a 3D layout, in which the timeline axis faces the viewer, who advances by moving straight ahead along the line. Some visualizations display events all the time, as balloons [1, 6], while others show them on demand, as labeled balloons that can be clicked to display a popup [6] or labeled bars on the ruler that can be clicked to display the event as a slide in a presentation [19]. It is important to note that TimelineJS [19] and Tiki-Toki [1] provide some support for multi-plot stories by letting authors assign events to categories, which are displayed in different rows. However, this support is limited, as events can only belong to a single category at a time.

Timelines can also be created and more fully customized using libraries, such as Google Charts [5], which provides a simple API that lets authors create interactive horizontal, multi-row, bar-based visualizations, and vis.js [18], which also lets developers create interactive horizontal timelines, but provide even more features and flexibility.

3 CONTEXT: THE JBS SCANDAL

Wednesday, May 17th, 2017. Brazilian president Michel Temer was having one of his best weeks since taking office. The economy, which had been left in shambles by his impeached predecessor Dilma Rousseff, was showing signs of recovery after months of stupor. Not only that, but his ambitious reform agenda was moving forward in Congress. Despite

some missteps and the turbulence produced by operation Car Wash (a massive anti-corruption investigation that implicated many political figures), the government seemed to have found its groove, and Brazil looked set for a relatively smooth ride to the 2018 election. This did not last long.

Late that afternoon, *O Globo* journalist Lauro Jardim broke the story that businessman Joesley Batista had secretly taped Mr. Temer supposedly discussing hush money payoffs to Eduardo Cunha, the jailed former speaker of the lower house. Mr. Batista, one of the owners of meatpacking giant JBS, had made the tape as part of a plea bargain deal struck with then-prosecutor-general Rodrigo Janot. If the content of the recording were confirmed, it would have been an unprecedented scandal: for the first time in Brazilian history, there would have been explicit evidence of a president committing a crime while in office. No one had heard the tape, but talk of a premature end to Mr. Temer's government was widespread and speculation began of who could take his place.

The next day, the Federal Police launched an operation targeting not only Mr. Temer, but also senator Aécio Neves, a leading figure of the former opposition who ran for president against Dilma Rousseff in the 2014 election and barely lost. As part of his deal, Mr. Batista had also taped Mr. Neves supposedly requesting two million reais in bribes.

That evening, Supreme Court justice Edson Fachin lifted the secrecy of Mr. Batista's deal, making the content of the tapes public. The audio was not as bad as feared, but Mr. Temer's situation was still serious as the recording was made at a late-night secret meeting during which Mr. Batista nonchalantly admitted to the president to having committed several crimes. The president's situation was further aggravated by video footage of his close aide Rodrigo Rocha Loures running with a suitcase full of money, which he had supposedly received from one of Mr. Batista's associates. By the end of the day, Mr. Temer, Mr. Neves and Mr. Rocha Loures found themselves under investigation for corruption, obstruction of justice, and participation in a criminal organization.

The JBS plea bargain launched a long and complicated series of events and revelations that took the Brazilian political establishment by storm. Events that followed included attempts to bring down the government, investigation of criminal activities by politicians and businessmen, excessive judicial activism, unorthodox behavior by prosecutors, lawyers, and investigators, and maneuvering by politicians in desperate attempts to save their skins or take advantage of the situation, along with many "strategic" leaks to the press.

4 TECHNIQUE AND PROTOTYPE

The main idea behind our technique is to use a visualization of **parallel timelines** to make it easier to follow and understand a long, complex **narrative** made up of **events** belonging to different **plot threads** that may intersect.

Events are the main building block of the visualization. They are displayed chronologically and may feature one or more **actors**. An event consists of a label indicating when it took place, a short block of text describing what happened, and, optionally, an illustrative image (which may also have a descriptive caption) and a set of references (e.g., links to documents and news reports). Events are displayed alongside a visualization of parallel timelines, with each timeline corresponding to a plot thread. When an event belongs to a given thread, the corresponding timeline is displayed in its associated color; otherwise, the timeline appears in gray. To make events easier to follow, they can be grouped into **chapters**, which are displayed sequentially.

The complexity of certain narratives might make it interesting for users to focus on specific subplots or on a specific set of actors. Users can do this through filters that can be based on both threads and actors. They work by hiding all events that are not associated with what they want to see. Filters are thus also useful to discover connections between threads, actors, and events that might be difficult or even impossible to notice by simply following the story when displayed in its entirety. They are, as such, a potentially useful source of insight into the story.

Finally, the timeline visualization can be complemented by a **network visualization** of the actors and their relationships. These relationships can be computed automatically, based on the co-occurrence of actors in events, or manually, defined by the authors according to how they understand these relationships to be. They can also be built using a combination of both approaches: authors can first compute them automatically and then manually refine them to better reflect the story they want to tell.

Our Prototype: Visualizing the JBS Scandal

The inspiration behind our idea was the JBS scandal. Its long, intertwining, twist-filled parallel narratives and its large cast of actors made it difficult to follow even to the most avid news junkies. As such, although our technique can be applied or adapted to other lengthy multi-plot narratives—be they real or fictional—the prototype¹ we implemented was designed to tell the specific story of the events unfolding from and surrounding the plea bargain deal struck between Brazil’s prosecutor-general and the executives of meatpacker JBS.

As it is based on Brazilian sources, the prototype is in Portuguese. It covers events from January 2011 to August 2017. This is not the whole story, as events continued to unfold for a few months afterward, but resulted in extensive material (341 events divided into four chapters). As our prototype is a proof-of-concept and not a full-fledged work of journalism, this was enough to illustrate our idea.

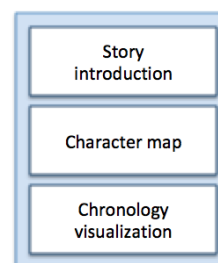


Figure 1: Layout of our prototype web application

The prototype was implemented as a web application. It follows a vertical, three-part layout, showing, in order: 1) a textual introduction summarizing the JBS scandal and describing the purpose of the application; 2) a character map, consisting of an interactive network visualization of the actors and their relationships; and 3) the chronology of the story, which consists of the parallel timelines visualization. This layout is shown in Fig. 1.

The character map (Fig. 2) uses a node-link force-directed visualization of the network of relationships of the actors involved in the JBS scandal narrative. We built the graph by hand using a custom-made authoring tool (described later in this section). Relationships represent meaningful co-occurrence of actors in events as well as family, professional, criminal, and other types of associations they may have with one another. By default, all actors are displayed in black and white as circles containing their pictures. A label below each circle shows the actors’ first and last names. Hovering with the mouse over an actor will highlight it as well as its neighbors, showing them in color. Clicking on an actor will display a popup containing an enlarged, color picture of the person along with a short biography and a few relevant facts related to the JBS scandal. Finally, by clicking and dragging the actors, users can move them around the character map’s work area, altering the layout of the visualization.

At the top of the chronology area, a fixed title bar displays the title of the current chapter. Below it, the parallel timelines visualization is displayed on the left and a fixed sidebar containing filtering options is shown on the right.

The visualization can be read like a three-column table, with each row depicting an event. The first column displays a label indicating when events took place. The second column contains the parallel lines that show which subplots events belong to (following the logic described in our description of the idea and, additionally, letting users hover with the cursor over each line to display a tooltip containing the name of its respective subplot). Finally, the third column shows events’ details, which may include textual descriptions, an image with an optional caption, and links to external websites and documents (shown as superscript numbers at the end of the

¹ Available at <http://www.inf.ufrgs.br/~spritzer/jbs>

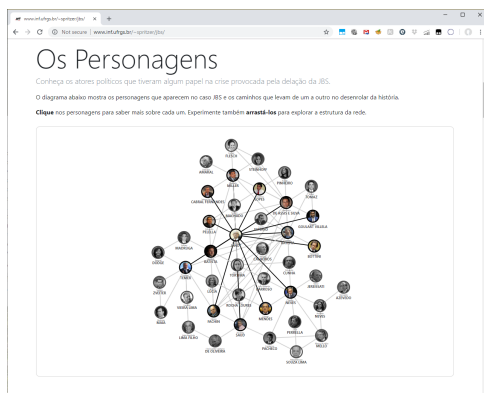


Figure 2: The Character Map shows actors and their relationships. Users can select an actor to obtain additional information in a popup.

descriptions). Users advance along the story by scrolling down, with chapters being progressively loaded as required.

Two types of filtering are provided: by topic (i.e., subplot) and by actor. The filtering-by-topic panel lists the titles of the story’s subplots, which are shown alongside their respective colors and thus work as a legend for the parallel timelines. The filtering-by-actor panel lists all the actors, displaying their names and pictures (the same ones used in the character map) to make identification easier. On both panels, filtering is activated and deactivated by clicking on an item. Multiple filters can be active at the same time, helping users find connections between different subplots and actors.

Authoring and implementation. The prototype was implemented in HTML5 and Javascript. The D3 library was used for the character map and jQuery was used throughout. The data for both the chronology and the actor network visualization were stored as JSON files.

To help authors work with the data, we developed two authoring tools: an actor network editor and a timeline editor.

The actor network editor lets authors create and edit the graph that will be used as the prototype’s character map. In it, authors can add, remove, and edit actors and their relationships, defining each actor’s attributes, such as first and last names, profile picture, and biography.

The timeline editor lets authors create and edit the timelines that will be displayed in the prototype’s chronology area (using the parallel timelines visualization). In it, authors can add, remove, and edit events, change the order in which events appear, and associate them with topics (i.e., subplots) and actors. For each event, authors must define some required properties, such as when the event took place, its duration (in days), and its description. They may also define optional properties, such as a label (to be displayed in place of the event’s date, on the chronology area), a picture (with

or without a caption), and a set of external references (i.e., links to websites and documents).

Like the prototype, both authoring tools were implemented using Javascript and HTML5 and generate compatible JSON files. We also wrote Python scripts to turn CSV files into the accepted JSON files and vice-versa, potentially streamlining the authoring workflow by letting users create and edit the data as tables in software such as Microsoft Excel or Google Sheets.

In our case study, the authoring process began by considering events surrounding the week the JBS story first broke and identifying in them an initial set of plot threads. We then scoured the available news reports and official documents up to August 2017, reconstructing the chronology, identifying actors and their relationships, associating actors and plot threads to events, and creating new plot threads as needed. Throughout this process, we crafted short summaries of each event and collected illustrative pictures (when available or necessary) and references to news reports and official documents. Sources included major Brazilian newspapers and websites, blog posts by renowned journalists, and official documents that were leaked or made public by authorities. To better organize the data and make the story easier to follow, we broke it into thematic, chronological chapters based on significant turning points. All event-data was recorded in CVS files, which were later converted to JSON files using the above mentioned Python scripts and further edited using our timeline editor. In parallel to the construction of the timeline, we wrote short biographies of the actors and, based on the unfolding of events and our knowledge of the actors’ roles in them, manually crafted the character map using the actor network editor. We decided to create the character map manually rather than by actor co-occurrence because co-occurrence was not always semantically significant (i.e., two actors being in the same event did not necessarily mean that they had a particularly meaningful connection in terms of the story) and some very meaningful relationships were not explicit in the story’s events.

5 CONCLUSIONS AND FUTURE WORK

Breaking stories often build on events that took place before, requiring a lot of previous knowledge to be properly understood. These stories also often reveal new information about the past, changing how we interpret it. Keeping track of evolving stories and knowing the full context in which they take place is therefore no easy task. Our technique was designed with this in mind.

There are many techniques for timeline visualization, but they rarely support multi-plot stories. When they do, events often cannot belong to two subplots at the same time. Our technique allows users to follow stories that are made up of multiple crossing subplots and that involve many characters.

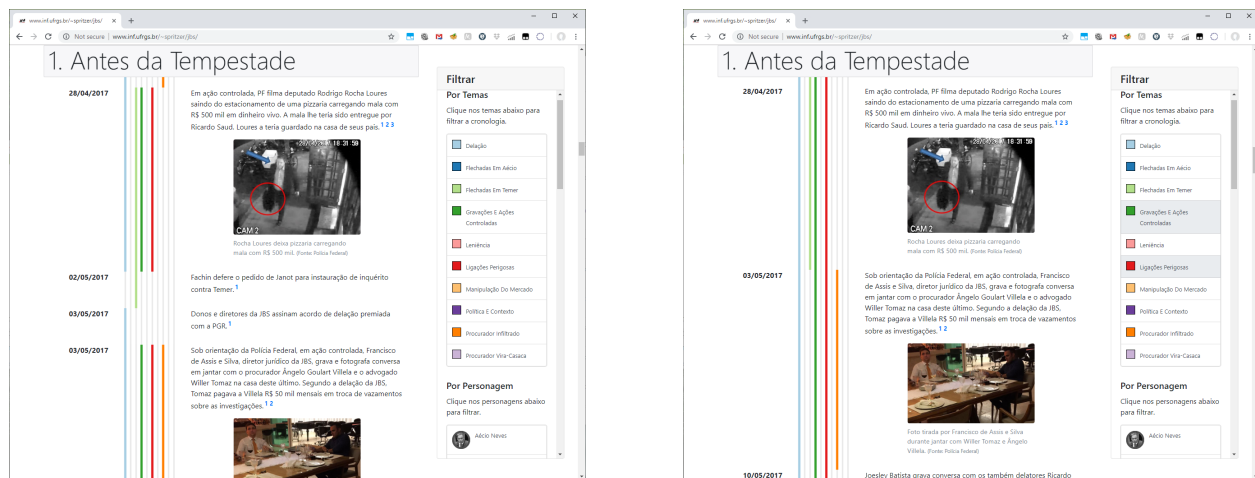


Figure 3: The chronology area, featuring the parallel timelines visualization and its interactive filtering tools. Left: no filters applied. Right: filters used to show only events that belong to both the dark green and red subplots/timelines

Thus, it can be useful to the general public and also to journalists, investigators, and even authors of fiction, who can use the colored parallel lines and the filtering tools to find previously unseen connections and gain new insight into the story and its subplots.

The prototype built around the JBS scandal helps show how our idea can work in practice and can serve as inspiration for new features or even for a full-fledged tool for timeline-based storytelling. Features that could be added include simple ones, such as support for more media types in event descriptions, and more complex ones, such as actor-centered visualizations, for example, presence/absence in specific events, interactions/co-occurrence through time, changing characteristics, etc., and more powerful filtering tools. Further tests may also be conducted to ensure both the public and journalists find the technique useful.

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REFERENCES

- [1] [n. d.]. Tiki-Toki Timeline Maker. <https://www.tiki-toki.com/>.
- [2] Matthew Brehmer, Bongshin Lee, Benjamin Bach, Nathalie Henry Riche, and Tamara Munzner. 2017. Timelines Revisited: A Design Space and Considerations for Expressive Storytelling. *IEEE Transactions on Visualization and Computer Graphics* 23 (2017), 2151–2164. Issue 9.
- [3] Matthew Brehmer, Bongshin Lee, Nathalie Henry Riche, Darren Edge, Christopher White, Kate Lytvynets, and David Tittsworth. 2017. Microsoft Timeline Storyteller. <https://timelinstoryteller.com>.
- [4] Katie Franklin, Simon Elvery, and Ben Spraggon. 2016. Star Wars: every scene from I-VI charted. *ABC* (2016). <https://www.abc.net.au/news/2015-12-16/star-wars-every-scene/7013826>
- [5] Google. [n. d.]. Google Charts. <https://developers.google.com/chart/>.
- [6] Thomas Ketchell, Steven Chiu, Yoran Brondsema, and Jonathan Ketchell. [n. d.]. Sutori. <https://www.sutori.com>.
- [7] Nam Wook Kim, Benjamin Bach, Hyejin Im, Sasha Schriber, Markus Gross, and Hanspeter Pfister. 2018. Visualizing Nonlinear Narratives with Story Curves. *IEEE Transactions on Visualization and Computer Graphics* (2018).
- [8] Shixia Liu, Yingcai Wu, Enxun Wei, Mengchen Liu, and Yang Liu. 2013. StoryFlow: Tracking the Evolution of Stories. *IEEE Transactions on Visualization and Computer Graphics* 19, 12 (Dec. 2013), 2436–2445.
- [9] Randall Munroe. 2009. Movie narrative charts. <https://xkcd.com/657/>. *xkcd* (2009).
- [10] Vadim Ogievetsky. 2013. PlotWeaver. <http://www.ogievetsky.com/>.
- [11] Kevin Ponto, Eric Hoyt, and Carrie Roy. 2014. Visualizing and analyzing the hollywood screenplay with ScripThreads. *Digital Humanities Quarterly* 8, 4 (2014).
- [12] Lu Qiang, Chai Bingjie, and Zhang Haibo. 2017. Storytelling by the StoryCake Visualization. *Vis. Comput.* 33, 10 (Oct. 2017), 1241–1252.
- [13] Sonia Rao and Shelly Tan. 2018. Everything that’s happened leading up to ‘Avengers: Infinity War’. *The Washington Post* (2018). <https://wapo.st/mcu-timeline>
- [14] Yuzuru Tanahashi and Kwan-Liu Ma. 2012. Design Considerations for Optimizing Storyline Visualizations. *IEEE Transactions on Visualization and Computer Graphics* 18, 12 (Dec. 2012), 2679–2688.
- [15] Makarand Tapaswi, Martin Bäuml, and Rainer Stiefelham. 2014. StoryGraphs: Visualizing Character Interactions As a Timeline. In *Proceedings of the 2014 IEEE Conference on Computer Vision and Pattern Recognition (CVPR ’14)*. IEEE Computer Society, Washington, DC, USA, 827–834.
- [16] Daniel Todd. 2008. Time Toast. <http://www.timetoast.com>.
- [17] João Villaverde, Adriana Fernandes, Regina Elisabeth, Marcos Muller, Fabio Sales, Carlos Marin, Renan Kikuche, Tiago Henrique, and Vinicius Sueiro. 2015. As ‘Pedaladas Fiscais’ do Governo Dilma. *O Estado de São Paulo* (2015). <http://infograficos.estadao.com.br/economia/pedaladas-fiscais/>
- [18] vis.js. 2015. Timelines. <http://visjs.org/>.
- [19] Zach Wise. 2015. TimelineJS. <http://timeline.knightlab.com/>.