StoryPrint: an Interactive Visualization of Stories

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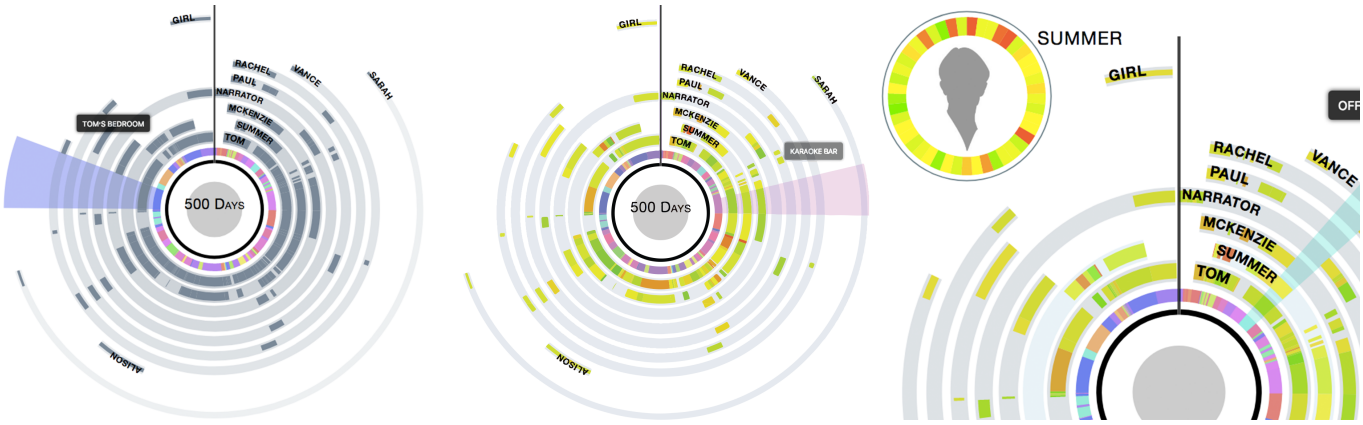

Figure 1. StoryPrint is an interactive visualization of script-based stories that plots scenes, character presence, and character emotion around a circular time axis.

ABSTRACT

In this paper, we propose StoryPrint, an interactive visualization of creative storytelling that facilitates individual and comparative structural analyses. This visualization method is intended for script-based media, which has suitable metadata. The pre-visualization process involves parsing the script into different metadata categories and analyzing the sentiment on a character and scene basis. For each scene, the setting, character presence, character prominence, and character emotion of a film are represented as a StoryPrint. The visualization is presented as a radial diagram of concentric rings wrapped around a circular time axis. A user then has the ability to toggle a difference overlay to assist in the cross-comparison of two different scene inputs.

We evaluated our visualization tool with two different user study groups. A larger group study consisting of 15-minute interviews of 100 naive users tested usability and intuitiveness of design while a smaller group study consisting of hour-long interviews with expert users tested both usability and usefulness as a tool for the writing process and industry. Naive users found the visualization tool to be effective in its portrayal of emotion, characterization, and setting. In addition, naive users showed that the difference overlay was a better visualization for comparative visual analytics than the traditional side-by-side comparison. In the expert study, 4 out of 5 experts supported the use of StoryPrint as a tool during the writing process, and all five found the tool useful for comparing scripts. We conclude that this tool effectively fills the gap in the interactive visualization of individual and comparative analysis research and could introduce a useful tool for writing and comparing scripts for users of all types of experience.

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INTRODUCTION

The format in which information is presented influences the information's comprehension, making data visualization a powerful tool. An effective visual can drastically reduce the amount of time needed to understand a complex or large data set. In this paper, we demonstrate how the form of our visualization tool can present an improvement for analysis functions prevalent in the creation of films.

Films are an important example of creative storytelling that afford complex, multi-faceted data sets through their scripts. Often, the comprehension of this information is made unwieldy by its limited means of raw consumption. Without processing, the reading and viewing of scripts and videos are quite time-intensive. On the contrary, condensations of both forms, such as film synopses and movie trailers can be too vague – the latter of which can be intentionally misrepresentative and sensationalistic. These disadvantages make these representations unsuitable for analyses deeper than comparing the general plots of different films. This motivates the development of visualizations for films.

For a more complex comparison of film structures, experts will often watch and re-watch films. While this method is useful for understanding a film's general plot, it is less effective when analyzing a film's structure. A film's structure goes far beyond just a solid grasp of a plot, and how each character is involved in the plot. Structure may include but is not limited to: relative scene length, character prominence, setting changes, and emotional shifts over the course of the film. Analyzing these aspects across different films may require either reading each script or watching each film in its entirety.

Finding an effective visualization for film plots would facilitate an in-depth structural analysis, and a visual analytic tool for both film fans and experts could allow for a broader understanding of this data and story format. Ideally, users should be able to readily identify thematic or structural patterns from the visualization. Such a visual tool could be used during the screenwriting process for comparing original and revised scripts. Other uses include comparative media analysis, or as a tool for helping an audience decide which media they want to consume by quickly communicating information about different episodes or films without spoiling the plot.

While there are existing storyline visualizations, most focus on a single aspect of a film, such as character interactions (Section 2.1). Other methods are useful for analysis on a film-by-film basis, but are less effective, visually, for film comparison. As it stands, there is no method for visualizing the many structural components of a film plot, including character presence, setting, and emotional shifts. Thus, in this paper we propose StoryPrint, a uniform-sized, interactive visualization of film metadata, constructed to make both individual and comparative analyses easier.

Figure 1 shows three different visualizations, based on an input of the film *500 Days of Summer*. An individual visualization, as shown, facilitates the analysis of the chosen film's structure by showing the breakdown of scenes, setting distribution, character presence, and the character's estimated emotional experience in each scene (polar, from negative to positive). As detailed later in the paper, our application also allows for cross-comparisons between different scripts, by either aligning them side-by-side or displaying a difference overlay between the two scripts.

To evaluate the effectiveness of our approach, we conducted two user studies: hour-long interviews with five screenwriters, and fifteen-minute surveys with 100 naive participants. Four out of the five screenwriters stated they would use StoryPrint as a tool during the writing process, and all five found the tool useful for comparing scripts. While some naive users struggled more than others, a majority were able to answer questions about script structure quickly and, according to their self-reports, easily.

Section 3 contains a design overview of StoryPrint. Section 4 contains a technical overview of the system. Section 5 explores comparisons of stories of different script genres, with a focus on film, television, and draft versions of a script. Section 6 describes our evaluation method and results. The contribution of this paper is two-part. The first is an automated method for the structural visualization of script-based media, using only text-based, script input. The second, is an interactive design that facilitates cross-comparison of script-based media through both a side-by-side layout and an automated difference overlay.

RELATED WORK

Radial data visualizations of storylines is a continuation of Storyline Visualization, Visual Analytics, and Radial Data Visualizations. In the following section we explore a variety of research perspectives that contribute towards the development of our platform.

2.1 Storyline Visualization

Recent research efforts have broadened our understanding of effective mechanisms for extracting and visualizing narratives. For the visualization of preexisting narratives such as film, various papers have taken inspiration from Randall Munroe's "Movie Narrative Charts,"[12] wherein he visualizes character interactions by plotting character presence along a time x-axis and setting y-axis. In the resulting graph, each line bundle is representative of a character interaction in the film. While Munroe's visualizations were hand-drawn, this visualization was automated by Ogawa and Ma in 2010 [14].

Tanahashi and Ma [18] took this automation and used evolutionary computation to significantly improve visualization aestheics and legibility. In 2013, Liu et al. [8] developed an efficient optimization approach to storyline visualization that handles the hierarchical relationships between entities over time. Gronemann et al. [5] delved further in to the storyline visualization problem by modeling the crossing minimization as a multi-layer crossing minimization problem with tree constraints.

Storyline visualization platforms often use their visualization techniques to attract new ways of human interaction. StoryCake[16] provides a hierarchical plot visualization to highlight structure within discontinuous and nonlinear stories.

VizStory[7] generates series of images from representative keywords to visually summarize text-based Fairy Tales. CARDINAL [11] uses 2-D and 3-D visualizations of a scripted narrative, as well as a timeline-based view that empowers scriptwriters to understand spatial perspective and overview of interactions. Murtagh et al. [13] used a modified tag cloud visualization of film script semantics and characterization.

2.2 Visual Analytics

Research in Visual Analytics has used multiple techniques and perspectives to explore both the ability of humans to interact and understand timeline and descriptive visualizations. Danone et al. [2] analyzed and presented visual summaries of text data based on comparative sentences extracted from customer reviews for an easy and intuitive understanding between a set of products. TIARA [19] uses topic analysis techniques to summarize documents and then uses several visualization techniques to explain the summarization results.

Time-based data visualization for visual analytics often takes the name "river" for the stream visualization technique. EvoRiver[17], a time-based visualization, allows users to explore coopetition-related interactions and to detect dynamically evolving patterns, as well as their major causes. EventRiver [9] integrates event-based automated text analysis and visualization to reveal the events motivating the text generation and the long term stories they construct. ThemeRiver [6] depicts thematic variations over time within a large collection of documents with thematic changes shown in the context of a time-line. While our approach does not use this technique, its wide availability leaves an opening for other visualization techniques.

2.3 Radial Data Visualization

Plotting information around a circular axis or within a circular field predates the advent of computer technology. The benefits, challenges, and efficacy of radial design have been addressed in a survey by Draper et al.[4] and by Burch and Weiskopf[1].

An abundance of radial visualizations are outlined in present-day literature, having gained popularity as a design choice in recent years. Spiraclock [3] bridges the gap between static calendar displays and pop-up reminders with a continuous and non-intrusive feedback in an analog clock. Chroring [20] presents multiple visualization views for a multi faceted approach to displaying time-based personal information of famous writers. StarGate [10] is a novel system for visualizing software projects for the purpose of studying the development process. Peltonen et al. [15] presents rapid information comprehension of search result data by embedding high-dimensional keyword representations into angles on a radial layout.

STORYPRINT

3.1 Overview

We present a new visualization method for script-based media (television and film). The target user-base for this visualization are amateur and professional film creators, specifically those involved in the screenwriting or production process. The goal for this tool is to quickly communicate information about a film. This goal is accomplished by facilitating the discovery of patterns within a single script and between multiple scripts.

Figure 2. The above image depicts the default view for the *500 Days of Summer* StoryPrint. This view emphasizes the scenes for which characters have spoken lines. The highlighted scene, which takes place in Tom's Bedroom, shows that only Tom is speaking during the scene.

Our system extracts metadata from film scripts and outputs an interactive visualization based on this metadata, producing a type of visual summary of film structure. More specifically, our software visualizes the following (for each scene in the film): setting, character presence, character prominence, and character emotion.

The visualization consists of concentric rings wrapped around a circular time axis. This type of circular diagram has been shown to be preferable for highlighting relationships and patterns within data [4], which is why we elected the radial design. An additional benefit of this design choice is that most facets of the visualization are normalized about the circumference of the circle, meaning that works can be compared regardless of differences in length. Potential drawbacks include: the difficulty of interpreting radial diagrams compared to traditional linear diagrams and visual distortion of the data. We address these drawbacks in Sections 3.6 and 3.3 respectively.

3.2 Scene Delineation and Setting

The innermost ring is partitioned into segments, which are ordered chronologically. Each segment corresponds to a scene in the film, and its relative length along the ring's circumference is dependent on the length of the scene normalized with respect to the entire film's duration. A segment's color is dependent on the setting of the scene. If the same setting appears in multiple scenes, then the color will be used consistently. Hovering over a segment displays the corresponding setting and highlights the scene for each outer ring, showing where the outer rings line up with that particular scene (Figure 2).

This scene ring was chosen as the innermost ring instead of the outermost ring, because it intuitively functions like a time-axis for the outer rings. This functionality is more evident in the experimental or alternative, "unrolled" design (Figure 6).

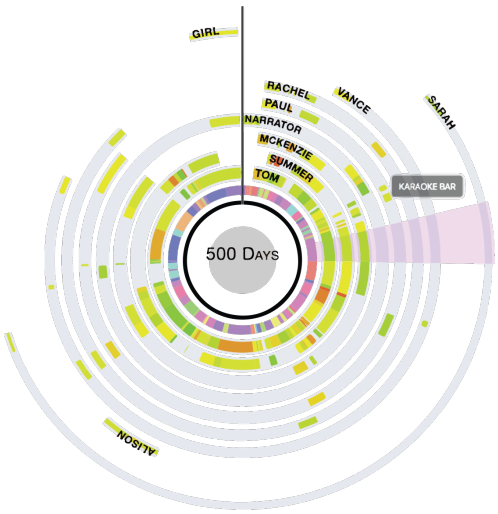

Figure 3. The above image shows the emotion overlay for the *500 Days of Summer* StoryPrint. Unlike the default view, this overlay emphasizes the range, from positive (green) to negative (red), of characters' emotional experiences on a scene-by-scene basis.

Unlike the outer arcs, this innermost ring must be connected around the circle, because it always contains the first and last scenes. If the first and last scenes were not touching at the top of the ring, the empty space would be left unutilized by every ring, because metadata before the first scene and after the last scene is not considered.

3.3 Character Arcs

Outer arcs represent different characters in the film. The order of these arcs is determined by the number of lines spoken by each character over the course of the film, radiating outwards in descending order. This implies that characters whose arcs are closer to the center likely play a more prominent role in the plot.

Each character arc is labeled with the character's name and is aligned with the scene partitions of the innermost ring. The arc begins and ends with the character's first and final scenes. Along this span of time, the arc is filled with light-gray (Figure 2). The light-gray color is not indicative of the character's presence in a scene. It simply serves to connect the scenes in which the character has spoken lines, which are filled in with dark-gray. Without this light-gray arc, the dark-gray segments would be more difficult to follow.

In this type of radial diagram, focus is drawn to those arcs furthest from the center circle, as their larger circumferences are more prominent. To counteract this effect, the width of each arc decreases moving from interior to exterior.

3.4 Character Emotion

The default view shows a character's scene presence through dark-gray segments. However, a user can toggle a colorful overlay by clicking on the inner circle beneath the title (Figure 3). This overlay, which lies atop the dark-gray segments, maps the estimated emotional experience for a character in each scene to a hue between red and green, where red indicates a negative experience and green indicates a positive experience. These emotional experience values are determined using sentiment analysis for the character's lines on a scene-by-scene basis.

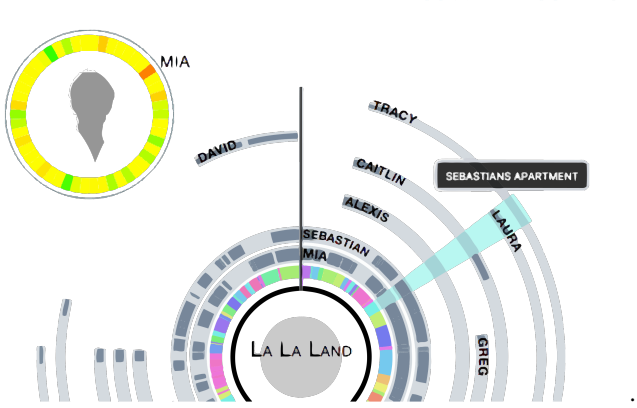

Figure 4. The above image depicts the character, Mia's emotion summary for the *La La Land* StoryPrint. The emotion summaries are ideal for character-to-character comparisons, because they distill the emotion information from the emotion overlay (Figure 3).

To see a summary of a character's emotional experience over the course of the film, a user can click on a character's arc, which toggles a wheel of fixed size (Figure 4). This wheel, which is read like a clock, consists of the different estimated positive or negative experiences of the character throughout their scenes. The main benefit of the emotion summary over the emotion overlay is that it facilitates character-to-character comparisons better. To elaborate, although the emotional experiences of each character are visualized simultaneously in Figure 3, comparing two agents that have disjoint arcs or appear in different scenes is unwieldy. Instead, with only the relevant scenes normalized around the wheel, the comparison is made much easier.

3.5 Difference Overlay

To better facilitate the cross-comparison of scripts, a user can toggle a difference overlay, illustrating which scenes are different between two different script inputs. In this case, the light-gray silhouette maps to the silhouette of the first script input. The inner ring shows how the scenes or settings are different. If the scene contains the same characters and setting in both scripts, that segment of the setting ring will be light blue – denoting no change. For any segment in which characters have been added or removed, the setting has been changed, or a scene has been added or removed, the segment will be shaded in with a different color. For a scene in which a character has been removed or added, the corresponding segment in their character arc also has its color changed (Figure 9). If a character has been added to a scene, a green segment is placed on their arc for that scene. If a character has been removed, a red segment is placed on their arc for that scene.

3.6 Design Alternatives

Previous representations of a storyline have used a event stream timeline. Popularly referred to as a 'river' [6, 9, 17], these timelines focus on plot events and scenes. This may

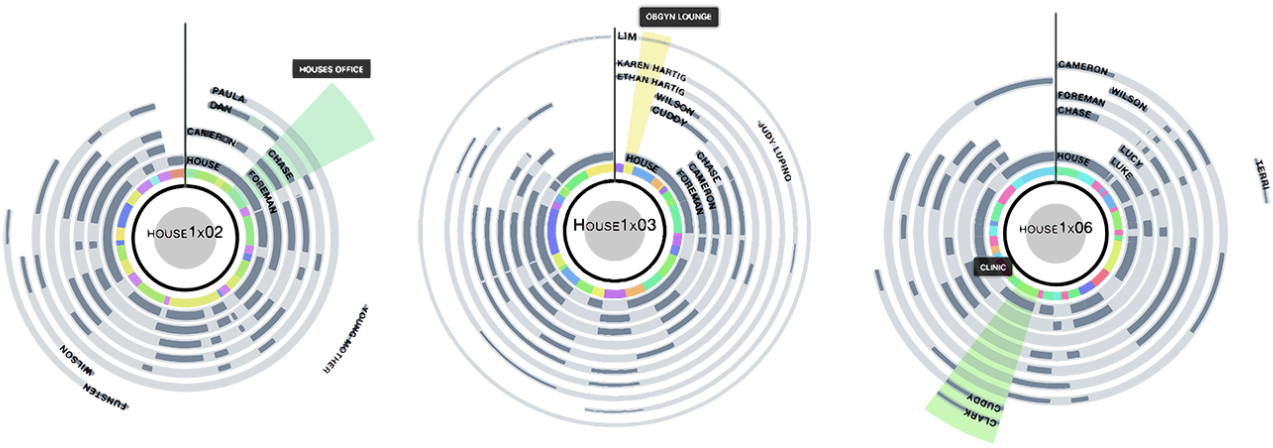

Figure 5. The StoryPrints above are of three different episodes from the first season of *House, M.D.*, from left to right: Episodes 2, 3, and 6. For films that are connected, StoryPrints allow for quick comparisons to be made; e.g., Episode 6 subverts the expectation of Chase, Cameron, and Foreman playing more prominent roles.

severely limit the ability of the visualization due to its simplicity. And while its possible to introduce a novel style of color-coding to help bring an analysis alive, the dissemination of information, and efficient use of visualization space is not the same. We represent two stories in this design in Figure 6.

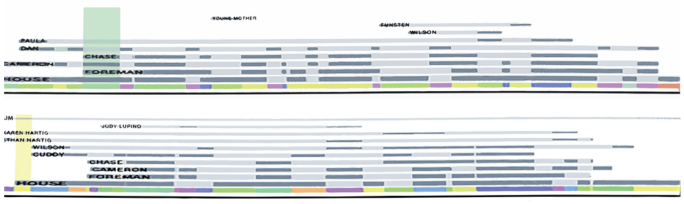

Figure 6. The two stories visualized above use an alternative design that "unrolls" their StoryPrints. Although these visualizations depict the same information as StoryPrints, they make poorer use of space, resulting in more cumbersome user-interactions.

Other representations include clouds and radial diagrams [3, 10, 15, 20]. We have chosen the radial diagram as our method of visualization. The cloud and radial diagram efficiently use space by orbiting relevant information around important concepts, and by ranking important information from closest to the core concept, to furthest, as is the most logical. In addition clouds and radial diagrams are fairly easy to compare when a unit size is enforced. We have chosen to implement a timeline as a radial diagram for StoryPrint because of its ability to combine several representations of the timeline, to rank important information such as character activity, emotion, and setting. In addition, StoryPrints will be easy to compare due to their enforced atomic size and shape.

STORY COMPARISONS

5.1 Overview

A goal for this visualization is to facilitate comparative analysis between script-based media. This goal motivated the visualization's initial design. The most obvious design influenced by this goal is the default structure of the visualization, which consists of two fingerprints side-by-side. Within this framework, the user is able to elect whether these fingerprints show the parts of the same script, allowing for cross-comparison within the same story, or two different scripts, allowing for cross-comparison between different stories.

Our hope with using a radial diagram was to tap into the user's pattern recognition abilities. If two stories are similar, but one introduces the supporting characters right at the beginning, and the other doesn't introduce the supporting characters until a quarter into the film – the visualization of the latter will have a significant chunk of whitespace that clearly contrasts with a visualization of the former, which would have very little whitespace at the beginning. In general, patterns of character introductions and removals, trends of emotional experiences, and patterns of setting changes can all be captured by this visualization.

5.2 Comparison of Different Films

Figure 7 presents a side-by-side comparison of StoryPrints that represent two Harry Potter films. The films being compared are the second (*Harry Potter and The Chamber of Secrets*) and third (*Harry Potter and the Prisoner of Azkaban*) installments in the Harry Potter film series. This side-by-side comparison shows some of the more pertinent differences between the films. As the protagonist, Harry Potter is easily identified by the center ring as the driving force of both stories. His friends, Hermoine and Ron, share in the adventures of Harry Potter, with differing levels of activity, depending on the film. Reoccurring characters such as Dumbledore and Hagrid are important in helping Harry Potter throughout his adventures, just as Draco, a reoccurring antagonist, is important in contributing to conflict.There are also secondary characters specific to each of the films, that are less important and can be found on the outer rings of the StoryPrint.

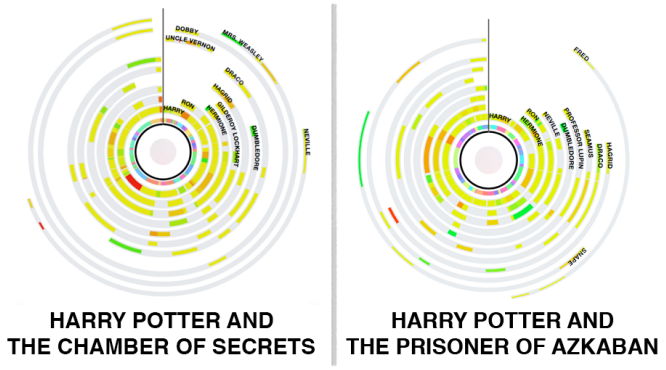

Figure 7. The StoryPrints of two Harry Potter films reveal that Draco, a reoccuring antagonist, tends to leave the plot, while characters, such as Hagrid and Dumbledore, supporting the protagonist tend to stay until the near end.

5.3 Comparison of Different Television Episodes

In Figure 5, there are three *House, M.D.* episodes in a side-by-side comparison. In this comparison we can see three atomic visualizations of the same scale. The largest outer circles are not uniformly sized between the visualizations, because this would make it more difficult to discern the different quantities of characters between the episodes. Using the same scale, it is evident that the second episode has the most characters.

Characteristics of the scene segments in each StoryPrint share the same color and serve to highlight the recurrence of settings across the three episodes. The innermost ring in each StoryPrint distinguishes Dr. House as the most prominent character, while middle rings rank other members of the central cast (Foreman, Chase, Cameron, and Wilson) by the amount of their activity in the episode. Reoccurring characters and secondary characters are easily identifiable in the side-by-side comparison of each episode as well as the underlying format of the television series.

Figure 8. Side by side, comparing the original *Wizard of Oz* script and an edited *Wizard of Oz* script is made easy by using StoryPrints. However, less obvious changes can be difficult to spot without the help of difference overlays (Figure 9).

5.4 Comparison of Original and Revised Script

Figure 8 shows two scripts: *The Wizard of Oz* on the left, and an edited version of *The Wizard of Oz* on the right. In the original script, Dorothy returns home to her family and life in Kansas at the end of the film. In the edited version on the right, the last scene has been changed such that Dorothy remains permanently in Oz.

There are a few visual differences between the two, some obvious, others subtle. One of the more obvious differences is that the character arcs of Dorothy's family members no longer extend to the end of the film, as the family reunion scene has been removed. The removal of Dorothy's family from this last scene also pushes Glinda's arc closer to the center, as she now has more spoken lines than Dorothy's family.

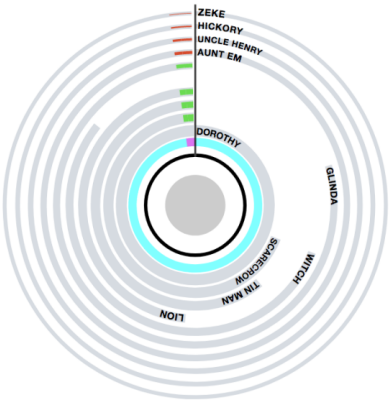

Figure 9. The above difference overlay shows the changes made to the original *Wizard of Oz* script by the edited version in the form of a StoryPrint. It is evident which characters have been removed from scenes (in red) and which have been added (in green). This particular difference overlay reveals an alternate ending as well.

5.5 Difference Overlay, Original and Revised Script

An alternate method of comparison can be seen using the difference overlay (Figure 9). Based on the color scheme described in Section 3.5, it is evident that towards the end of the script, there is a change in setting. The character arcs for Zeke, Hickory, Uncle Henry, and Aunt Em show that their lines from the last scene have been removed, and that new lines have been added for the Scarecrow, Tin Man, Lion, and Glinda (all of whom interact in the same scene). The visualization depicts changes made to the former work (in this case, the original) by the latter work (in this case, the edited version) on top of the latter version's ordering of character arcs. This is implies that the latter work has the most up-to-date lines for the story.

EVALUATION

6.1 Introduction to Approach

We evaluated our visualization tool with two different user study groups: a larger group of naive users, and a smaller group of expert users. The large-scale study tested usability and intuitiveness of design in the hand of a casual and naive user. The small-scale study also tested usability, but focused more on the usefulness of StoryPrint as a tool for film experts in the writing process and collaboration.

In order to nullify the bias that comes from a user's familiarity with a film, visualizations were anonymized to keep from influencing their answers or feedback during testing. Our process for anonymization involved changing all character names, as well as any specific setting or string of settings that could be identifiable as belonging to a certain franchise or film. The only exception to this anonymization step was the introductory *La La Land* StoryPrint example that was used as introduction to the tool and never used in the testing environment.

6.2 Naive Users

6.2.1 Study Design

This study takes the format of a fifteen-minute, online survey. The user is asked to read through a written and visual description of the visualization, using *La La Land* as input. After reading this description, they are presented with five groups of questions with twelve questions total. These twelve questions can be found in Table 1.

The first group of questions focus on gauging who the main characters are, and relative character prominence – who of two characters has a larger speaking role. The second half focuses on the setting, and seeing if the user can accurately pinpoint the setting of a scene and how may characters are present within that scene. The third group tests comprehension of the emotional overlay, while the fourth asks comparative questions of two films shown side-by-side. The fifth and final group of questions test comprehension of the difference overlay visualization.

Following these questions, the users are asked to fill out a short demographic survey. We recruited 100 users from Amazon Mechanical Turk (AMT) to complete this survey, only pulling from those users who have at least a 95 percent approval rate, with at least 100 approved HITS.

6.2.2 Results

Accuracy results for each question in Table 1 can be found in Table 2. While users were given 15 minutes to complete this task, the average time of completion was less than the alloted time at 529 seconds (about 9 minutes), with a standard deviation of 157.0 seconds. While users did well with questions involving emotion, setting, and character prominence, naive users struggled with the fourth and fifth question groups. Naive users were not expected to score high in these comparative analyses sections because of the nature of questions asked. Users found story comparison using the side-by-side comparison more difficult the difference overlay as is evident in the average rating of the task, and the higher scores for each of the questions.

These results show that our system accomplishes the task of visualization of prominence, setting, and emotion in scripted stories, and is proof that the difference overlay is an effective visual analytics tool even for naive users in a short-term online environment.

6.3 Expert Users

6.3.1 Study Design

Our expert user study consisted of hour-long structured interviews with active screenwriters, five in total. As users were based remotely, the visualizations were shared with them over screen-share for the duration of the call. Users were instructed to signal if/when they wanted the proctor to move the cursor to a different part of the visualization, or click different components, for the duration of the call.

The structure of the interview is as follows. The interview begins with a five-minute overview of the visualization, followed by answering any clarifying questions asked by the interviewee. The proctor then switches over to a single, anonymized visualization of *500 Days of Summer*. For this section, the user is asked a series of structural, comprehension questions based on this single visualization – verbally directing the movement of the cursor as they see fit. The following section focuses on a side-by-side comparison of two, anonymized Harry Potter films. The user is then questioned on what similarities/differences, if any at all, they notice between these films based on the visualization alone. These questions go more in-depth than the short 15-minute user study, and focus on every facet of the visualization – setting, character prominence, and individual character emotion.

The third section is structured similarly, but instead of Harry Potter films, the user is shown a side-by-side of the original *Wizard of Oz*, and a version with scenes edited. Following this side-by-side script comparison, the user is presented with the difference overlay. The user is then asked to interpret the visualization, and expand on how easy or difficult it is to understand. The last fifteen minutes of the interview are more unstructured, with questions geared towards spurring conversation about what possible use-cases, if any, the user may use this visualization tool and other user feedback.

6.3.2 Results

All five users found the questioning in the first section easy to answer. All users were able to pinpoint the main characters (Steven, Julia), accurately describe differences in the emotional arc between the main two characters, and note that the story seemed to be very focused on the two central characters. Four out of five were able to pinpoint the scene with the most characters present (of those included in the visualization) was around 8 o'clock on the visualization. When asked how easy or hard these questions were to answer, one user stated that, "once you know the rules, it's relatively easy." Another user explored the visualization a bit more, and went further in their analysis of the film, stating that the film was likely "very character-driven, mid-budget, with simple locations."

For the comparative analysis between the two Harry Potter films, users were first prompted with an open-ended question to explain the similarities or differences, if any, they noticed between the side-by-side visualizations. All five successfully pinpointed that, in the right-side visualization, the film focuses more on the main character – with fewer character introductions at the beginning of the film. Four of five noted that the characters in the second and third ring switched places in the right-side film. When presented with the emotional overlay,

	Group 1: Prominence	Group 2: Setting	Group 3: Emotion	Group 4: Comparative Side-by-Side	Group 5: Comparative Overlay
Q1	Who is the last character to enter the film?	How many characters are present in this scene?	Which character has the most positive experience in the highlighted scene, according the the visualization?	Do any characters have less screen time? If so, who?	How many scenes have been edited?
Q2	Who is the main character, according to the visualization?	Where does this scene take place?	Is Elizabeth's experience of the scene strongly positive, neutral, or strongly negative?	Name all changes in setting, if any.	Name all places these changes have occurred, if any.
Q3	According the visualization, who is more prominent, Don or Josephine?	N/A	N/A	Which characters have scene additions, if any?	Which characters have scene additions, if any?

Table 1. Naive User Large-Scale Study Questions

	Group 1, Prominence	Group 2, Setting	Group 3, Emotion	Group 4, Comparative Side-by-Side	Group 5, Comparative Overlay
Difficulty Mean (1 to 5)	2.59	2.03	1.58	4.12	3.7
Std. Dev.	1.13	1.11	.91	.99	1.22
Q1 (% correct)	.72	.60	.92	∗	.41
Q2 (% correct)	.94	1.0	.90	.16	.47
Q3 (% correct)	.92	N/A	N/A	.24	.27

Table 2. Breakdown by Question Category

∗ **Data not available at time of paper submission, will be included in camera-ready paper.**

one user noted that there were "more hills and valleys on the left film," while "the conflict on the right-side (. . .) visualization is more level." Each user noticed at least one unique detail to each other in this section. With this section as well, all users found this type of analysis easy and intuitive given the visualization.

The results for the comparative analysis between the original and revised script were similar to the previous section. All users note that the ending had changed, four of the five noted that Josephine had been moved closer to a closer ring. However, no user noticed or mentioned the dream sequence scene addition in the revised script. All users felt it easy to cross-compare. One user stated, "right away, it's very easy," and that the first shift he/she spotted was that "Josephine was given a larger role, and comes back in the end."

When presented with the difference overlay, all five users immediately noted that there was a second scene change they hadn't previously noticed. When asked if the overlay were more helpful, less helpful or equally helpful in spotting differences between two script versions, all five stated that it was more helpful - though three elaborated, expressing interest in being able to toggle between the side-by-side and the overlay.

When asked about whether this type of tool would be useful during the writing process, four of the five stated yes – that users stated they would use it as a tool. One user found the visualization interesting, but had a difficult time seeing any practical use case. Of the four who would use it as a tool, three would use it in their personal and collaborative writing process, one would use it exclusively for collaborative work. Three of the five users mentioned that the tool could be useful in production, or as a tool for producers or those on the production team.

CONCLUSION

StoryPrint is an interactive visualization tool for creative storytelling that facilitates individual and comparative structural analyses. Presented as a radial diagram, it portrays setting, character presence, character prominence, and character emotion throughout the storyline. After being thoroughly tested in both a large-scale, naive user study and a small-scale, expert user study for completeness, we find the tool to work as intended.

From our evaluation, StoryPrint in the hands of the naive user is an effective tool for visualizing emotion, setting, and character prominence. And while naive users found comparison of StoryPrints a difficult task overall, our difference overlay was a consistently better visualization for the Comparative Visual Analytics task. In the expert study, 4 out of 5 experts supported the use of StoryPrint as a tool during the writing process, and all five found the tool useful for comparing scripts.

We conclude that this tool effectively fills the gap in the interactive visualization of individual and comparative analysis research and could introduce a useful tool for writing and comparing scripts for users of all types of experience.

Limitations & Future Work

This tool does have several limitations. StoryPrint is currently limited by the script parsing mechanism, which is reliant on scripts being formatted to industry standards. However, there are a large number of scripts that, while currently not supported by this visualization, would be supported if this issue were resolved. Another technical aspect to be improved upon is the sentiment analysis needed for the generation of the character emotional overlays.

As the emotional overlay is only a component of this larger visualization, rather than the main research interest, there is work to be done towards creating a more accurate visual mapping for each character's emotional journey. Furthermore, while this visualization method focuses on script-based media, this type of analysis could be useful for writers of other subfields as well, such as novelists or short-story writers, if future work expanded to incorporate other types of written work as input.

From a design standpoint, there are various qualities that could be improved upon. These include finding a way to mitigate

how much the visual distortion, caused by wrapping data around a circular axis, inaccurately influences the user's understanding of the data being shown. Another example would be finding a better way to facilitate cross-comparison of, say, dozens of scripts at once.

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