StoryNext : A visualization tool for Visual Storytellers & Writers

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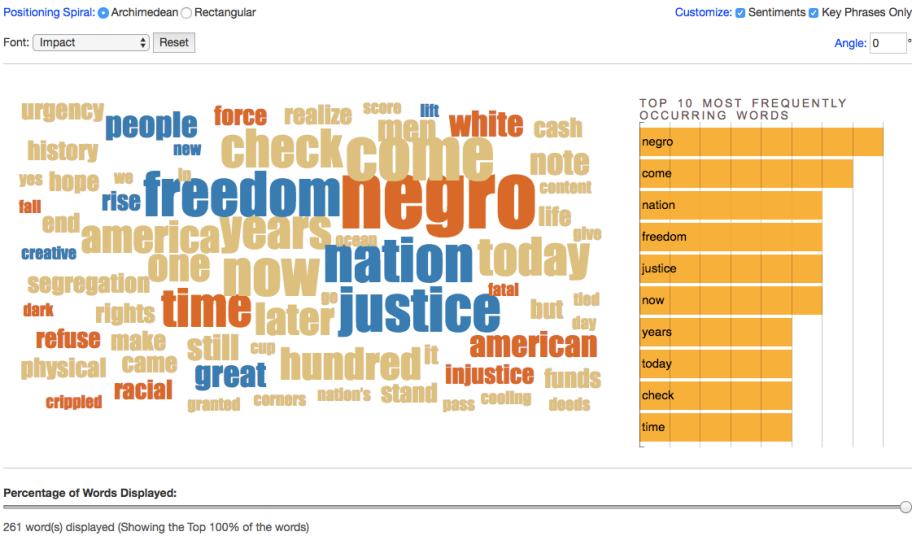

Fig. 1. Sentiment cloud for the first half of the "I Have A Dream" speech by Martin Luther King Jr delivered in 1963 at Washington, D.C.

Abstract—Lorem ipsum dolor sit amet, consectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat. Ut wisi enim ad minim veniam, quis nostrud exercitation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in vulpu-tate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blan-dit praesent luptatum zzril delenit augue duis dolore te feugait nulla facilisi. Ut wisi enim ad minim veniam, quis nostrud exercitation ullamcorper suscipit lobortis nisl ut aliquip ex ea commodo consequat. Duis autem vel eum iriure dolor in hendrerit in vulpu-tate velit esse molestie consequat, vel illum dolore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio dignissim qui blan-dit praesent luptatum zzril delenit augue duis dolore te feugait nulla facilisi.

Index Terms— script wrting, story, visualization, storymap, virtual reality, text, word frequency, word cloud, sentiment analysis

1 Introduction

StoryNext aims to provide interactive visualization tools for story-tellers and content-writers to help them in the process of content generation and also content management stakeholders to streamline the process of asset acquisition needed to realize any creative piece in production. This solution is aimed to be the visual analytical tool for a larger *Virtual Reality* solution (which converts text/stories to 3-D virtual-reality (VR) content in real-time). The larger VR project generates real-time viewable VR content from text/story entered on a web-browser. It dynamically creates animated 3D characters, models, objects, scenes (background) coupled with a background music based on the actions in the scene and mood of the story plot entered. This entire experience is viewable on a inexpensive VR device like Google® Cardboard. Hence, apart from this VR content generated, StoryNext aims to help authors get more context and perspective on their writing; not only through the VR medium, but during the writing using data visualizations which dynamically evolve as the story evolves.

The intended audience for the visualizations are story tellers, script writers, directors/producers and creative leads. The idea is to empower authors to write more engaging, relevant and imaginative stories and will help stake-holders (directors, producers) better plan resources to move to production.

The motivation for the project comes from the idea of making story-writing/telling more insightful and context-driven. In the numerous interviews I had with story-tellers and writers, I realised that there are very few tools for story-writers to visualize their content easily before the story moves to production or a draft is finalized for an artist to take it over and work on. To sum up my motivations in some core questions, I asked the following:

- What if there were more tools to help story-writers and authors better understand and contextualize what they write about?
- How do we make story-writing more exciting, other than, perhaps, adding music and 3D scene visualization in VR?
- What are the ways can we help story-writers and content writers using data-driven insights and visualizations?
- Can visualizations aid the process of creative writing, by showing not-so-obvious trends and implicit assumptions which the authors may not themselves realize while writing a piece?

In the quest to find answers to the above questions, I started working on this project to use data visualization as tool to assist content generators and writers better visualize their stories. This will empower authors to write more engaging, relevant and imaginative stories and will help stake-holders (directors, producers) better plan resources to move to production.

2 Existing Work

There have been many who have tried to come up with visualization tools for story-writers, however, most of them have been static visualizations and more targeted towards the scientific community, than, say the script-writer of a publishing house or a film/theatre production company. Particularly notable is the work by Tom Liam Lynch, who visualized the flow of sentiments across the paragraphs of

E.M. Foster's novel "A Room with a View"[1]. The idea was to determine positive and negative sentiments for literature, which can act as a great tool for a writer to understand subtle highs and lows in their stories.

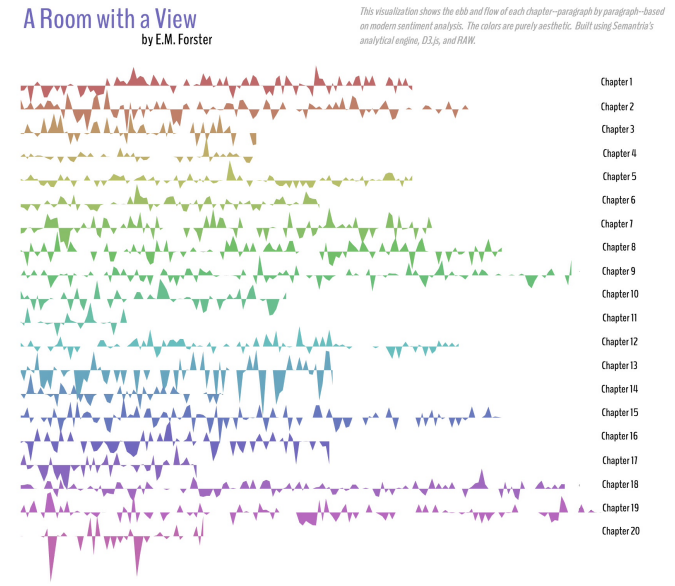

Fig. 2. Sentiment flow across paragraphs of E.M. Foster's 'A Room with a View' by Tom Liam, hosted at edspace.co.

Another popular related work I found was by Francesca Giannett from the 'Data Mining in the Humanities' group of Rutgers University. Her word cloud visualization 'A Distant Reading of Anna Karenina'[2] was a great example of visualizing text. Distant reading is not understanding a text by physically reading each and every word, but rather by analysing huge amounts of data and drawing information and conclusions from such analyses. She used many scientific techniques like Dunning Log Likelihood algorithm and Ngram viewer to better understand and visualize the novel.

Fig. 3. This is a word cloud generated by the Meandre Tagcloud with Cleaning[3] algorithm. This visual makes more frequently used words bigger to shed some light on significant themes and subjects discussed in the novel.

3 Process

As a part of my background research, I had interviews with the following a couple of writers and story tellers in the Boston area and spoke at length about how do they think technology can help them write better stories. Fortunately, the interviewees were really invested; spending more time than planned sharing ideas, which indicate that there was substantial interest in the topic and the idea. To summarize, the following were the key take-away from the discussions:

- Word clouds can give good indication of the semantic setup of text.
- Word clouds when clubbed with perceived emotion or sentiment can help gauge the big picture.
- Ability to scale time in terms of difference stages of script writing can give insights. This needs storing of visualization data over time and later retrieving to get a better picture.
- Sentiment flow can be an effective tool only in some cases and may not be truly indicative. Question of ethics, manipulation and lack of context/perception of a machine are barriers.
- Sentiment flows are better if segmented by chapters/acts rather than sentences/paragraphs.
- Historical context or usage of words can be a good tool for exploration for certain types of scripts where a particular time or audience is the target.
- A visual story around *characters* is more exciting than story around words/sentences.
- Initial story visualizations can sometimes be shared with the audience to generate advertisement, interest and promote the story even before production.

There were some insightful surprises in the discussions as I came across new avenues of how textual data can be organized or shown. What emerged out of all the discussions is that authors would love if the visualizations are around the characters in the text/story rather than other words/objects in the story. Further, it would be of great interest if they can see how the characters grow and transform through the text, like a journey. However, I believe this aspect of the project is complex and hence, is something I am taking up as a long term project, working continually in the future.

The overall response was very good and it was a consensus that word cloud analysis and sentiment flow can be of great help to the author while writing and hence can be used as the candidates for visualization. While the motivating questions have indeed remained the same, the interviews gave me better idea what things authors want and how do they want to see the data about their creations. This will help me tweak the visualization to appeal better to the users of my project, i.e. the authors.

3.1 Data & Cleanup

Based on the numerous interviews and data exploration, there were broadly 2 types of data which were identified in the data acquisition phase:

(a) Plain-Text User Input: this is the main story or text to be analyzed for the visualization and is directly input by the user/author into a web interface. This will be used mostly by script-writers and story authors who generate their own content on the go and want to get an idea about their story in real time. This is the raw unstructured data and will not be used directly in the visualizations. However, various text-extraction methods and computing logic will have to operate on this data for it to be usable.

Acquisition medium: Web Page/HTML
Format of Data: Plain text
Complexity of Data Clean-up: Medium

(b) Sentiment Data/NLP Processed Data: this is the machine generated data generated by the NLP methods and programming code, which will be visualized using various visualization techniques. This data will be in different formats and mostly unstructured as different Machine Learning algorithms provide different outputs and metrics. This is the processed data which will be used in the visualization.

Acquisition medium: API Call
Format of Data: JSON/JS Objects/Unstructured text
Complexity of Data Clean-up: High

Extensive data clean-up required is to extract the relevant information from the JSON file to usable data structures to enable analysis. A lot of JavaScript code along with complex data-handling scripts are needed to process the data. Also, there is a need to filter low-confidence data from the API output and dynamically modify this data in real time as the user interacts with the visualization.

Additionally, after exploring preliminary data, the important thing to consider is that the data complexity increases with the length of the text and hence, there is a need to come up with reference points or clustering techniques to split the original data into manageable segments.

3.2 Task Analysis

Based on the principles on visual design, the discussions I had with writers and my motivations in the space, I was able to identify the various *tasks* or *actions* the user intends to perform using the visualization and the *targets* for those tasks. Based on the inferences from the interviews and discussions, the primary actions can be noted as the following:

- *Analyse & Consume the data*: the visualization should present the data in a more intuitive manner providing new insights.
- *Search & Explore the data*: search through the visualization to find the most dominant words.
- *Query & Compare the data*: identify key words and compare the usage of words across the literary piece.
- *Summarize large amounts of data*: summarize a lot of data into a simple infographic highlighting key subjects and trends.

On the other hand, upon delving deeper into the expected outcomes of the visualization, the following were the possible targets the visualization should aim to address and resolve:

- *Distinguish Extrema/Outliers*: effectively show the most widely used words and the most widely evoked emotion of the text.
- *Expose Trends*: show the change and flow in emotion patterns and its distribution.
- *Network Data/Topography/Paths*: show how emotions flow through the various parts of the text as the story progresses.

Upon tabulating the same, I can summarize the tasks and its abstraction as follows:

Domain Tasks	Generic Abstractions
Identify the most widely used words and the most widely evoked emotion of the text.	Find *outliers* among all data.
Get the overall gist/central idea of the text.	*Summarize* Correlations.
Observe the change and flow in sentiment patterns and its distribution	Identify *Trends* in sentiment data.

The above structuring now gave me a clear idea as to what should I focus on and what should be the primary goals of the visualization.

3.3 Design Ideas and Sketches

Based on the tasks, the motivations and the timelines of the project, I worked on a couple of ideas to visualize the data, which I will briefly introduce below.

(ii) ***Sentiment Flow Plot***: the motivation for this came from discussions with actors and creative content writers, Zena[5] & Benjamin[6]; as well as from the existing work by Tom Liam Lynch[1] I talked about before. The objective/target for this design was to observe trends by following the flow emotions from one paragraph to another. The most intuitive choice was of a line graph, perhaps using colour as a redundant encoding to show rise and fall of sentiments. Implementing brushing and linking across similar sections of each of the paragraphs would make it more interesting and engaging. Also, annotations and pop-up labels when clicking on points on the graph can help users derive and produce insights.

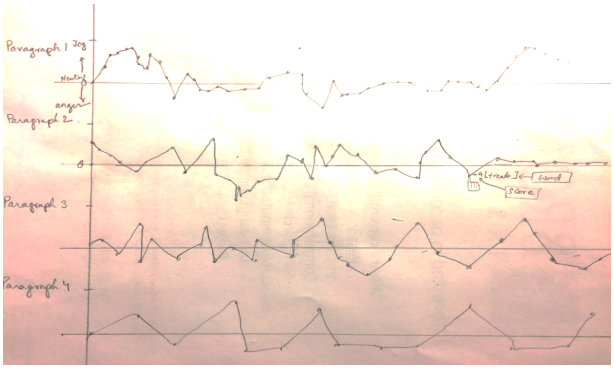

Fig. 4. A sentiment flow plot showing the progression of positive and negative sentiments across paragraphs.

(i) ***The Character Graph***: the motivation for the graph came from my discussion with one of the story-writers, Matheus[4], who suggested it would be really great if one could establish relationships between characters and each character can have its own attributes. Hence, with respect to task abstraction, it was obvious that the target was network data (where characters are laid out in a connecting graph) and action was to search and discover. Using size as the medium to encode the actors was intuitive as it would better display which actors/characters are more connected and influential. Choosing to add interaction to help the user navigate, select and establish connections was important to condense many actors in a single visualization and also give the user a bird's eye view of the plot.

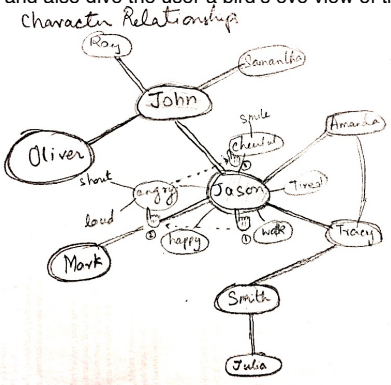

Fig. 5. A character graph of a story which shows a person named Jason being the central character and how other actors like John, Oliver, Amanda etc. are related to each other. Clicking on a particular actor brings up their personality traits.

(iii) ***The Word Cloud***: the motivation for this visualization was from the fact that the project's data was essentially text; so, it was intuitive to think of showing text in a visualization where we can see what words are most frequently used. Additionally, giving the user control to select how many words they want to see was needed to engage the user. Choosing size as a way to encode word frequency was driven by the fact that the goal here is mostly finding outliers. Also, it was necessary to have interactions which dynamically update the visualization as per changes in user data.

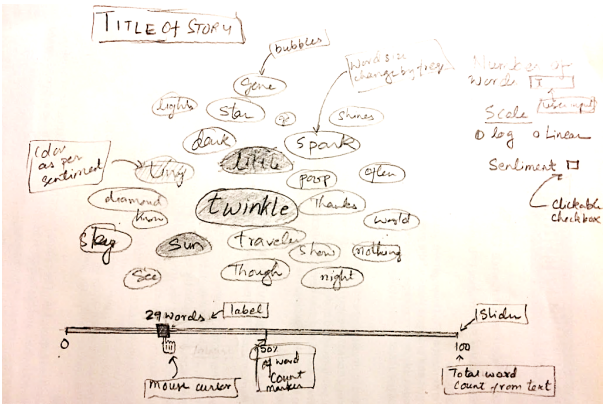

Fig. 6. a word-cloud of words for the children's lubbaby 'Twinkle Twinkle Little Star' from the 19th-century English poem by Jane Taylor.

4 Design

The final visualization I chose to visualize is the enhancement of the word-cloud, clubbed with a dynamic list on the right and a linked slider at the bottom. The slider can be used to choose how many words are to be visualized in the word cloud. As already explained before, I chose a word-cloud as the visualization type as the primary purpose of the visualization is to analyse text in the script and get a big-picture of the text, its usage and context. On the top panel, the user can choose the word's spiral orientation for plotting the cloud and also define if sentiment analysis is needed or not (Fig. 8). The visualization fits well into the *Query* and *Analyse* actions which were identified during task abstraction. It can also be noted that the targets for the task are multiple elements and identification of extrema/outliers among all data.

Fig. 7. The final word cloud visualization showing the text analysis of Martin Luther King Jr's 'I have a Dream' speech.

Encoding by the Size was an obvious choice as words can easily be sized, giving a pop-out effect (Fig 7). The sentiment portion of the task requirements is an ordinal measure and hence Colour seems to be a good encoding choice for it (Fig 8). It particularly is a good candidate for the diverging colour map.

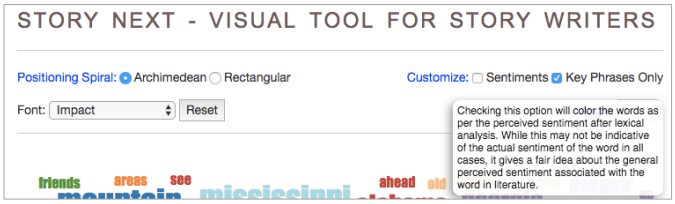

Fig. 8. The various options for the user to change the positioning to better suit smaller and larger texts, change the font, enable sentiment-colouring and filtering only key-phrases out.

Finally, the brushing and linking (shown in Fig. 9) using the slider can not only give a coherent picture and add interactivity, but it will also let the user choose how much data they want to see. This is particularly important if the text/stories being analysed are huge.

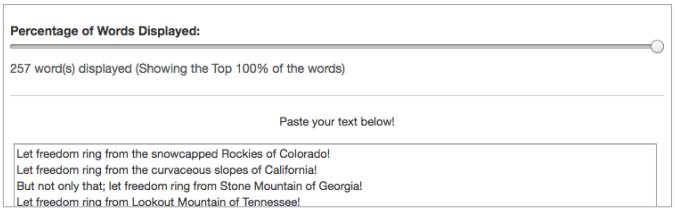

Fig. 9. Brushing and linking implemented through the slider to choose only the most important words, eliminating less frequent words.

An additional dynamic list on the right gives the highlights of the data being shown in the word-cloud by showing the most prominent occurrences of words. All user selectable options are explained by clear tool-tips to carefully laid out not to overlap important data. The colour-scheme used for the sentiment graph has been picked using a colour-blind friendly palette from colorbrewer.org[7] by Cynthia Brewer.

5 Discussion

The visualization enables a number of task evaluations and insights into the data:

- Evaluate what are the most commonly used words in the text and easily find any excessive use of particular words in the text.
- Get a big picture of the story or text by having a single glance at the cloud and get the common theme of the story/text.
- Get a semantic perspective of how positive or negative the story is by checking the sentiment heat map, i.e., if the sentiment cloud is more red, it possibly implies that a lot of negative words have been used. Similarly, a bluer cloud implies the overall usage of positive words are more in the text; whereas a more mellow yellow/off-white tone represents neutral/undetermined sentiments.
- Filter the less relevant words from the visualizations by using the slider as and when required. E.g. while analysing large paragraphs and chapters of a story, the author can use the filter to focus on the most commonly used words.
- Use the 'Font' function to choose the font they want to render so that the visualization can be better suited for print and other mediums (by using True Type fonts).
- Use the Top 10 list on the right of the visualization to instantly get an idea of what are the top most used words at any time, without having to count or look in the large cloud.

The interesting insights one can perceive out of the data is the inherent effect words play in telling story. E.g. if we take the 'I have a Dream' speech by Martin Luther Jr, we can observe that the first half of the speech is more about the problems and issues, hence the sentiment map is more red (Fig 10). However, if we observe the sentiment-cloud of the second half, its more bluish with more hopeful words which are more frequent (Fig 11). This gives a great idea of the shift of sentiments and focus across the text, without even reading the speech in full.

6 Conclusion

StoryNext aims to provide authors and story-tellers more insights and perspective to their writing, thereby attempting to enable better story-writing. The solution is planned to be developed further to include more features and enhancements to increase the relevance of the solutions proposed in this project. Additionally, the vision is that StoryNext evolves into a more sophisticated Machine-Learning enabled tool, which can make informed predictions to pre-empt authors regarding word usage and cultural sensitivity. Currently, the solution has many limitations which are planned to be covered in the subsequent versions of the project. Some of the notable limitations which ware being worked upon now and will be worked upon the near future are:

- *Synonyms appear as different words*: club words which are synonyms together and show them as one word. This will help understand usage of similar words in different forms, however, convey the same meaning.
- *Sentiment is binary*: make sentiment non-binary by having a range of sentiments between positive and negative.
- *Brushing limited by the slider*: make brushing more interactive by adding the ability to brush over the cloud by dragging a selection rectangle over the cloud.
- *No word search capability*: include the ability to search words by clicking on a word, which highlights all occurrences of the word in all views. Also, enable user to input a word to search for it.

6.1 Future Work & Scope

There are a number of future work avenues which I plan to take up in the future. Some of the notable ones are:

- Improving the sentiment analysis by using custom code for machine learning and adding context information. Using crowd-sourced APIs for lexical analysis.
- Implementation of the paragraph wise Sentiment Graph as shown in one of the sketches (Fig. 4).
- Addition of the character growth graph as visualized in one of the sketches (Fig. 5).
- Ability to manually define characters by the author and then tracking the same.
- Use PCA techniques to do topic detection and make a story-map using techniques such as Prof. Beauchamp's plot-mapper[8].
- Add ability to look for culturally sensitive information in the text and warn/prompt the writer of potentially conflicting usage of words in different geographies. E.g. tattoos are considered very culturally violent and insensitive in Japan (as they are associated with gang-wards and violence), however, the same reference in Unites States is not so negative and is more of a form of expression of one's personality.

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[2] Benjamin Peck (San Francisco): Software Engineer, Lucasfilms Ltd.: www.ben-peck.com/

[3] Zena Wood (NYC): Producer/Director/Actor: www.linkedin.com/in/zenaproducer

[4] Heather Albano Jackson (Boston): Freelance writer of fiction and roleplaying games: www.linkedin.com/in/heather-albano-jackson-7763301

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