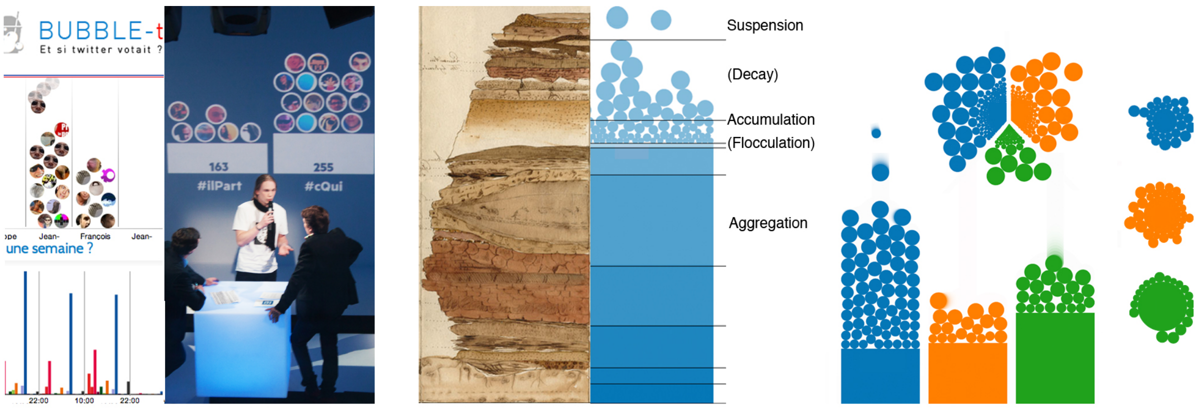
Towards Visual Sedimentation

Samuel Huron*
IRI and INRIA

Romain Vuillemot†
INRIA

Jean-Daniel Fekete‡
INRIA



(a) (b) (c)

Figure 1: From left to right: (a) Our two case studies (Bubble-t and Bubble-TV), (b) illustration of sedimentary rocks [1] compared to our visual sedimentation process, and (c) three types of visual sedimentation charts: bar chart, pie chart and bubble chart.

Abstract

We present *Visual Sedimentation* (**VS**), a new design metaphor for visualizing streaming data inspired by the geological process of sedimentation. Our work started by early experiments visualizing political Twitter streams during the French 2012 presidential elections, and social interactions during a TV show. In both cases, the positive feedback we received expressed an unexpectedly high level of engagement from users, guiding our generalization of the metaphor.

This article explores **VS** and describes a new generative design space for Information Visualization. Geological sedimentation is our inspiration as it smoothly aggregates falling objects by compacting them into strata. We use this idea to visualize changing information in a new way by providing continuity between the representation of new and older data. The metaphor preserves an overall visual encoding while making it suitable for monitoring streaming data generated at unpredictable rates.

Keywords: Design, Information Visualization, Incremental Visualization, Data Stream, Social TV.

1 Introduction

Visualizing streaming data, such as Tweets, is challenging. Among many reasons, the constant and unpredictable data updates make it difficult to allocate an optimal portion of the screen. Reflecting changes at different temporal scales, while keeping the visual mapping continuous for the viewer, is required to support such tasks as monitoring. Animation is probably the most common technique to convey updates, but it requires user attention, thus may not support real-time changes or emphasize enough recent and past updates.

2 Case Studies

In this section, we present two prototypes of real-time micro-post visualizations based on early experiments. After assessing these two prototypes, we discuss a new design space that manages updating visualizations progressively.

2.1 Tweet Monitoring for Presidential Elections

Tweets can provide an informative pulse of what is being said on various public subjects. Even though tweets are short messages, their quantity, rhythms, and conversational structures are a way to understand a general opinion. One challenging aspect for monitoring near real-time updates is that we need to visually integrate the incoming data in the visual representation of data that has already arrived. This challenge arises for example during a meeting or a TV show, but also during a major event like presidential elections.

To visualize Twitter streams during one such events, the 2012 French presidential election, we developed a web-based visualization called Bubble-t [3]. It addresses the challenges of real-time visual update by using a particle system to fill in a bar chart (Figure 1 (a)). Each particle is a new piece of information that we refer to as a “token” (in this context, a Tweet). Each bar corresponds to a presidential candidate. Therefore, once a tweet is sent about a candidate, it is transformed into a token that is thrown into the candidate’s bar. By accumulation, the columns are progressively filled in by the tokens. When a column is full, the *n* tweets that first arrived are flushed out of their column. We mapped the Twitter user’s avatar to the token for additional informations and to further engage viewers. A static bar chart at the bottom captures all tweets during two different time periods (7days or 24hours).

The application received an award at the Google Dataviz 2012 challenge. Up to 81 273 *unique* visitors browsed the website in 6 months time. The average visit duration was 4min 21s, which is long. We received positive feedback from Twitter users with more

*e-mail: samuel.huron@inria.fr
†e-mail:romain.vuillemot@inria.fr
‡e-mail: jean-daniel.fekete@inria.fr

than 1 800 tweets embedding the URL. This work also received attention from some national and authoritative media such as newspapers and radio. We also informally observed unexpected reaction from users. When the visualization was publicly presented, the audience in the room sent tweets, not only to test the system but also to show or see their own avatar inside the chart.

Despite these successes we also identified several issues:**(p1)** The transition between the bar holding the tokens and the static chart at the bottom is not continuous (Figure 1 (a) left). **(p2)** The time windows in which the token remain inside the bar is short due to the limited amount of screen space. **(p3)** The exploration of detail for aggregated tweets (in bars) is currently not possible.

2.2 Live Visualization for Social TV

With Bubble-t's popularity, a national TV broadcaster asked us to adapt it to monitor another class of live data: live Twitter poll results during a TV Show (Figure 1 (a) right). This mixed use of TV and social media is refers to a trend called "Social TV" where social media becomes the backchannel of an audience's sentiment. We developed a new tool called Bubble-TV to address the shortcomings of Bubble-t and to take the requirement of social TV into account. At the TV show Bubble-TV was used as followed :

(1) At the beginning of the TV program, the presenters asked a question and the audience could reply by using Twitter with a specific hashtag. **(2) During the show,** every tweet sent by the audience was visually encoded into tokens which accumulated on top of the bar chart columns (Figure 1). The bar chart also encodes the aggregated values of the previous tweets. **(3) Integration :** The visualization was tightly integrated in the show: it was a part of the style of TV show's graphical elements. The TV show presenters frequently referred to the visualization to present trends, rather than reporting accurate numeric information. **(4) The TV show's community manager** also used it to monitor the Twitter activity and to present some tweets to the audience during the show.

This second iteration Bubble-TV differs from Bubble-t since a bar chart serves as a podium to structure the layout of tokens, trying to tackle **(p1)**. It provides an overview of all tweets and details of last tweets. The community manager reported, after the show, that it was a useful to relate real-time Twitter activity to the content of the show. Bubble-TV has also significantly increased the participation on Twitter for the TV show: the number of tweets sent (5 300) was more than twice as during the previous show (2 000).

The positive part is that, despite our iteration, we did not break the attractiveness. Some problems remained: **(p4)** The relation between the bar chart and the tokens was better in this version but they were still disconnected. We observed the need to design a better transition between tokens and their aggregated state. **(p5)** The lack of visual cues for showing the density of tweet aggregated.

3 Design Generalization

Trying to address the problems **(p4)** and **(p5)** from the previous section, inspired us to design a new framework for updating charts.

3.1 From Geological to Visual Sedimentation

Our assumption is that **VS** is highly familiar due to its physical equivalent (Figure 1 (b) left) that is referred as "sedimentation" and is defined in Wikipedia as: *"the tendency for particles in suspension to settle out of the fluid in which they are entrained, and come to rest against a barrier.*' This physical sedimentation surrounds us: mountains, hills or rivers are visible and familiar accumulations. The closest approach to ours is the use of the geological metaphor explored by Viegas et al. [2], to compress and display data as strata over time. As far as we know, the full exploration of the sedimentation metaphor from falling objects, due to gravitational forces, to their aggregation into compact layers over time (Figure 1 (b) right) is novel. Our case studies also show it has a low learning curve.

3.2 Visual Sedimentation Design space

We call the visual extension of sedimentation *Visual Sedimentation* **(VS)**. In its scope we defined three main states: *suspension*, *deposition* and *aggregation*; and two main transitions, *decay* and *flocculation* (Figure 2).

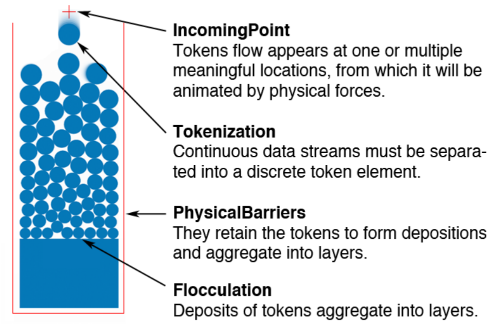


Figure 2: Details of the sedimentation process.

To create a visualization using **VS**, continuous data streams are separated into discrete token elements. *Barriers and walls* have to be set up to provide containers for the tokens and define the general layout (bar chart, pie chart, ...). Tokens encode *incoming data*. They fall during *suspension* and land on other tokens and remain there during the *deposition* phase. Over time, the *decay* process changes the size of individual tokens. Finally, the *flocculation* process fluidly transforms token deposits into the aggregated chart area where the tokens adopt the *aggregation state*.

3.3 Generative Design

Given the previous guidelines, removing walls, changing the decay function or the attraction forces allows to recreate classic data charts and to produce new ones (Figure 3):

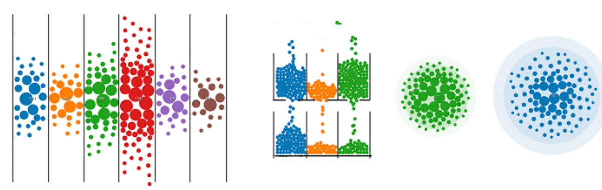


Figure 3: Example of generated visualizations (with their walls and barriers as black lines).

4 Perspectives

Throughout our case studies and our generalization, we presented a promising design space for aggregating streaming data using a smooth and continuous transition. Despite the positive user feedback we received, the technique still needs to be refined. Future work will consist in evaluating **VS**'s applications to real data set and testing it on different space filling visualizations during an updating process.

References

[1] G. C. et Alexandre Brongniart. Coupe théorique des divers terrains, roches et minéraux qui entrent dans la composition du sol du bassin de Paris, 1832. Bibliothèque nationale de France, Cartes et Plans, Ge D 14409.

[2] F. Viégas, E. Perry, J. Donath, and E. Howe. Artifacts of the presence era: visualizing presence for posterity. In *ACM SIGGRAPH 2004 Sketches*, SIGGRAPH '04, pages 19–, New York, NY, USA, 2004. ACM.

[3] R. Vuillemot, S. Huron, R. Velt, and Y.-M. Haussonne. Bubble T : Et si twitter votait ? http://dev.fabelier.org/bubble-t/.