

SVEN: An Alternative Storyline Framework for Dynamic Graph Visualization

Dustin L. Arendt^(✉)

Pacific Northwest National Laboratory, Richland, USA
dustin.arendt@pnnl.gov

1 Poster Abstract

The world is a dynamic place, so when we use graphs to help understand real world problems the structure of such graphs inevitably changes over time. Understanding this change is important, but often challenging. Techniques for general purpose dynamic graph visualizations generally fall into one of two broad categories: animation or timeline based techniques [2]. Simple approaches using animation or small multiples experience challenges with change blindness and “preserving the user’s mental map” [1]. Storyline visualization techniques [5, 7] hold promise, though these techniques were not originally designed as general purpose solutions for dynamic graph visualization.

There are well established criteria for drawing aesthetically pleasing storylines, which are to minimize (1) line crossings, (2) line wiggles, and (3) white space [5]. Past work has approached this problem by using evolutionary or quadratic [3, 6] optimization techniques, developing complex ad-hoc solutions [5], or not addressing all of the established aesthetic criteria [7]. Our contribution is a framework that divides the overall storyline drawing problem (including addressing the three aesthetic criteria mentioned above) into relatively simple sub-problems having well-known solutions. We refer to this framework as “Storyline Visualization of Events on a Network” (SVEN).

Input for SVEN can take the form of a contact sequence, which is a list of edges and associated time stamps. Edges in a contact sequence are assumed to represent instantaneous interactions and can repeat at different times. This data is transformed into “interaction sessions” [5] by discretizing time into several windows and finding communities that partitions the nodes into densely connected groups for each time window, similar to [7]. These groups are represented as nodes in a directed acyclic graph whose edges represent the flow of nodes between communities in adjacent time windows. We employ Graphviz’s “dot” algorithm, a directed graph layout technique, to determine an ordering for all groups of storylines that has few crossings. Determining which lines will be straightened (without changing the order of groups) is framed as a maximum weighted independent set problem and solved using a simple greedy algorithm [4]. Effective use of whitespace is found by defining the previous ordering and straightening properties as inequality and equality constraints in a linear program. The linear program’s objective is to minimize the sum total distance between groups and an optimal solution is found quickly using an off the shelf solver.

To date, we have demonstrated SVEN by generating visualizations of several benchmark movie datasets: *Star Wars*, *Inception*, *The Matrix* (see [6]). A comparison of the runtime performance of our framework against previous work will be important to evaluate the efficiency of the proposed framework. We note that the available literature on storyline visualization leaves much room for further evaluation of the scalability of the algorithms and techniques for storyline visualization, both in terms of usability and runtime performance. For future work, we could employ random dynamic network models to thoroughly evaluate our proposed method.

We believe that scalability challenges inherent to storyline visualizations can be mitigated partially through established interactive visualization patterns such as effective overviews, zooming (temporal), and degree of interest filtering of nodes. Along these lines, we are currently building a standalone web-based application around SVEN that includes capabilities to zoom in on an arbitrary time window, filter out uninteresting nodes, and obtain details about a particular node's interactions over time. The interface also provides alternate views of the data which include node-link and adjacency matrix representations of the interactions within a given time window. We also plan to extend this framework for visualizing many other types of data that can be described simply as "changing group membership."

References

1. Archambault, D., Purchase, H., Pinaud, B.: Animation, small multiples, and the effect of mental map preservation in dynamic graphs. *IEEE Trans. Visual. Comput. Graph.* **17**(4), 539–552 (2011)
2. Beck, F., Burch, M., Diehl, S., Weiskopf, D.: The State of the Art in Visualizing Dynamic Graphs. *EuroVis, STAR* (2014)
3. Liu, S., Wu, Y., Wei, E., Liu, M., Liu, Y.: StoryFlow: tracking the evolution of stories. *IEEE Trans. Visual. Comput. Graph.* **19**(12), 2436–2445 (2013)
4. Sakai, S., Togasaki, M., Yamazaki, K.: A note on greedy algorithms for the maximum weighted independent set problem. *Discrete Appl. Math.* **126**, 313–322 (2003)
5. Tanahashi, Y., Hsueh, C.H., Ma, K.L.: An efficient framework for generating storyline visualizations from streaming data. *IEEE Trans. Visual. Comput. Graph.* **6**(1), 1–1 (2015)
6. Tanahashi, Y., Ma, K.L.: Design considerations for optimizing storyline visualizations. *IEEE Trans. Visual. Comput. Graph.* **18**(12), 2679–2688 (2012)
7. Vehlow, C., Beck, F., Auwärter, P., Weiskopf, D.: Visualizing the evolution of communities in dynamic graphs. *Comput. Graph. Forum* **34**, 277–288 (2015)