

# Storyline Visualization with Force Directed Layout

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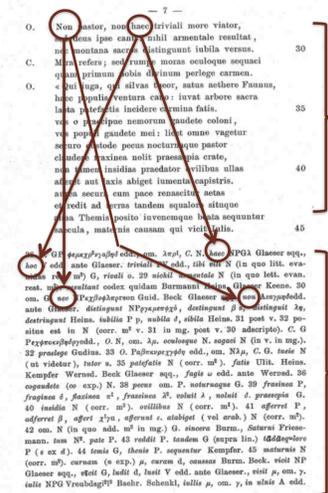
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Figure 1: Text reconstruction in printed edition

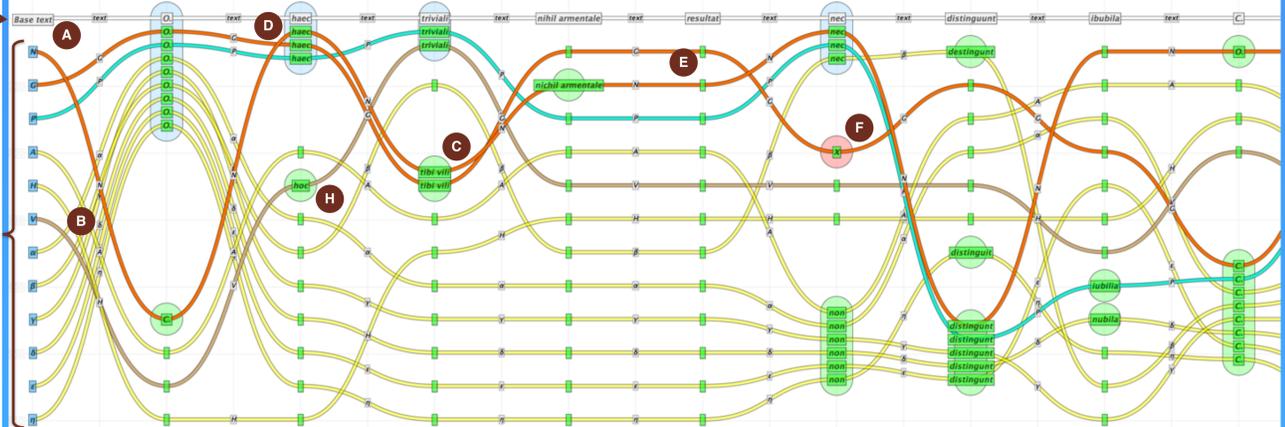


•Figure 1 shows the reconstructed original (base) text from a Latin poem in print format.  
•In Figure 2, the topmost line of the storyline equally spaces the words in the base text as light gray nodes from left to right (A).  
•Lower lines represent source manuscripts.

•Green blobs represent textual variation of an original text in a source; for instance, the line for manuscript V (B) uses *hoc* (H) as a variant reading for *haec* (D).  
•Blobs enclose intersecting lines to show when manuscripts share a common variant; for instance, manuscripts N and G both use the variant reading *tibi vili* (C) for *tiviali*.

•Blue blobs group manuscripts that agree with the reconstructed text. For example, N, G and P agree with *haec* (D).  
•Red blobs (F) indicate that an omission in an original text is suggested by the source.  
•An empty box (E) indicates that there is no textual variation for the word *resultat* in G.

Figure 2: Storyline layout for Giarratano's reconstruction of the classical Latin poem Calpurnius Siculus



## Application to Classics

Latin texts were mostly preserved by scribes, who copied the original text to a manuscript by hand, introducing **textual variations** and **transcription errors** in the process.

Original text—which is often lost—can be reflected in a variety of **manuscripts** that differ from each other substantially.

**Textual variations** usually appear at the bottom of the **printed edition** of a Latin text (Figure 1), in a **highly abbreviated** form that requires substantial training to read.

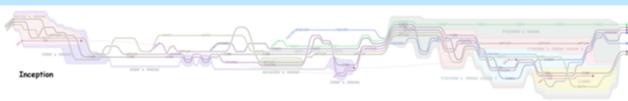
With our **storyline** approach, we aim to create an **alternative representation** of **textual variation** in Latin texts that is useful to scholars but also **accessible** to students and other novice readers.

## Related Work

Storyline visualizations represent interactions between **entities** in a story and how entity **relationships** evolve over time.

There is growing interest in **automating** the visual layout of data using storylines.

Existing storyline techniques support **limited** or **no user interaction** due to the **high cost** of layout [1][2].



[1] Y. Tanahashi and K.-L. Ma. Design considerations for optimizing storyline visualizations. IEEE Transactions on Visualization and Computer Graphics, 18(12):2679–2688, December 2012.

Typical design considerations for storyline layout include **minimizing line crossing** and **line wiggling**—NP-hard and NP-complete problems.

**Interactive** generation of layouts, such as in **response to dynamic querying**, is a substantial **performance challenge**.

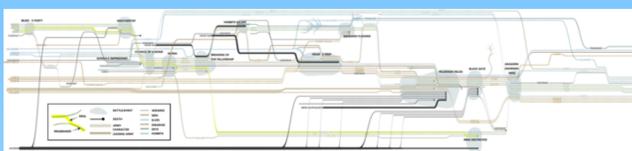
Current state-of-the-art storyline techniques do not produce layouts in **real time**, making them generally unsuitable for use with common **interactive querying** including **dynamic filtering**.

## Visualization Contribution

Here we present work in progress on a new approach that uses **force directed layout** to **dynamically** position storyline elements in an agile, legible fashion in **real time**.

We hypothesize that the characteristics of our model will allow for **graceful response** to a wide variety of **interaction types**, **speeds**, and **patterns**.

This interactive behavior will in turn greatly facilitate the flexible design of **coordinated multiple view** visualizations that include storyline views for a variety of domains.



[2] S. Liu, Y. Wu, E. Wei, M. Liu, and Y. Liu. StoryFlow: Tracking the evolution of stories. IEEE Transactions on Visualization and Computer Graphics, 19(12):2436–2445, December 2013.

## Layout Algorithm Overview

We implemented a prototype of our layout algorithm and visualization by adapting the existing general-purpose graph view in **Improvise** to the **special case graph topology** of storylines.

We use a modified version of the Fruchterman-Reingold model that has been extended to include hyperedge forces.

In our force model, **nodes** represent **textual variation** of a word at a particular point in the text.

**Edges** represent connections between **textual variations** within a **manuscript**.

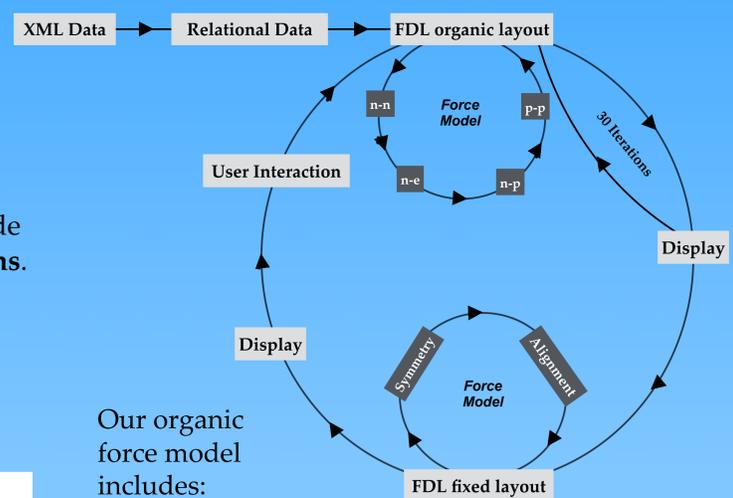
**Packs** (blobs) represent sets of **manuscripts** that share a common **textual variation** of a word.

Our layout algorithm consists **two major steps**.

In the **organic step**, we apply a force directed algorithm for 30 iterations to converge toward a minimal-crossing topological layout.

In the **fixed step** (31<sup>st</sup> iteration), we apply strong local **symmetry** and **alignment forces** to improve the **aesthetics** of the storyline layout.

## Layout Algorithm Details



Our organic force model includes:

**node-node (n-n)**, **node-edge (n-e)** attraction and **repulsion** forces using a vertical inverse-squared force with equilibrium distance. This **groups** and **separates** textual variations in each word slot.

**node-pack (n-p)** attraction and **pack-pack (p-p)** repulsion forces that **cluster** occurrences of each textual variation for a given word and **reduce overlap** between packs in a vertical slot.

We apply these forces **iteratively** and **continuously**, including during **navigation** and **dynamic query interactions**. In each iteration, we combine the forces to achieve a good balance. This results in **convergence** to **reasonable layouts**.

## Ongoing Work

We are incorporating the storyline visualization into our application for browsing Latin texts.

The **dynamic query capabilities** of our storyline layout help scholars **analyze relationship** between manuscripts based on their **similarities** in contributing **textual variation**.

They will also **select** textual variations to **explore** an editor's word choices in a printed edition.

Scholars will **filter** manuscripts based on date, location, source, authorship, etc. to **analyze** how manuscripts **vary** and **co-occur** throughout a text.

Our software workbench for creating visualizations is called **Improvise**. To see more, visit [www.cs.ou.edu/~weaver/improvise](http://www.cs.ou.edu/~weaver/improvise)

