Elastic Tree Layouts for Interactive Exploration of Mentorship

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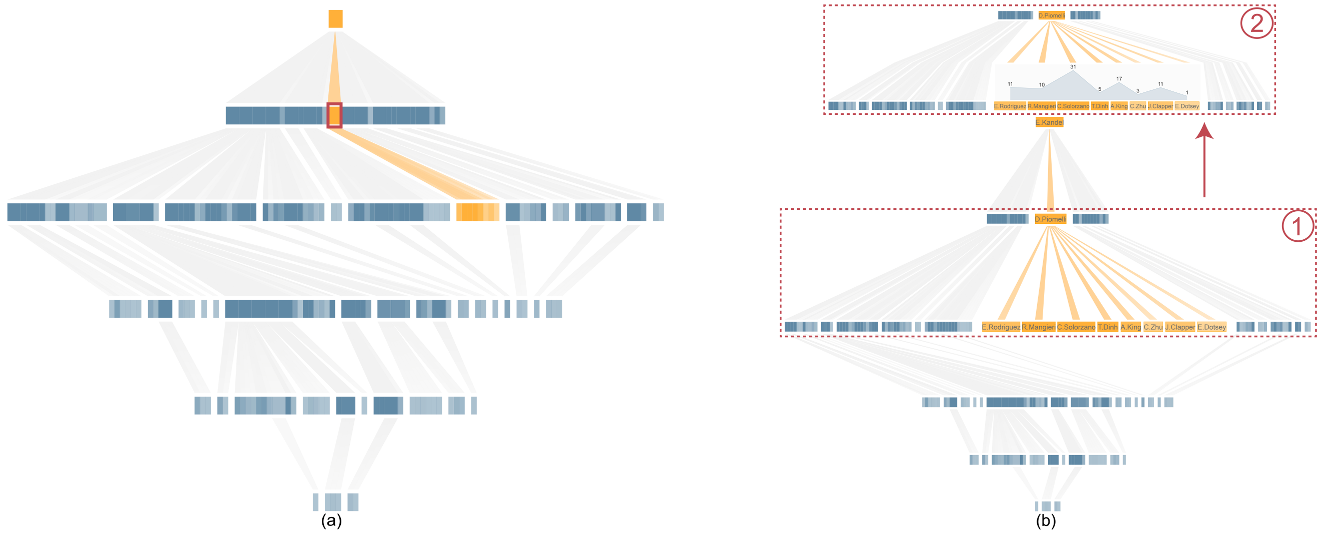

Figure 1: *Layouts of the elastic tree in interaction. (a) The initial layout with focus highlighted and node opacity encoded by citation. The lower part of (b) gives a focus+context display, in which area 1 can be further transited into area 2 via interaction to show more information.*

Abstract

Mentorship is an important collaborative relationship among scholars. The existing tools to visualize it mainly suffer from a waste of space, lack of overview representation, and less displayed attribute information. To solve these problems, we propose a novel elastic tree layout based on node-link diagrams, in which nodes and edges are represented as elastic rectangles and bands respectively. By stretching, compressing, aggregating, and expanding nodes and edges, we can: get a compact tree layout with high space-efficiency, display both the detailed subtree and compressed context in a single view, use labeling, charts, and node opacity to show multiple attributes. Besides, we designed various animated interactions to facilitate the exploration.

CCS Concepts

• ***Human-centered computing*** → *Visualization techniques; Visual analytics; Interaction design;*

1. Introduction

Mentorship is a kind of scholarly information [FHKM17], [LTW*18], that plays an important role in a scientist's career [MMU20], and recent projects such as the Academic Family Tree (AFT) [Aca20] attract increasing attention. AFT provides a tool to visualize the selected scholar (focus) and his/her mentors and mentees with node-link diagrams, where nodes are represented as labels. However, this tool has some drawbacks. First, intervals between nodes lead to space waste. Second, the overview is lacking, and only a sub-tree around the focus is provided. Third, sufficient attributes should be displayed apart from names and universities.

To solve these problems, we propose a novel elastic tree layout based on node-link diagrams for exploring the mentor-mentee relationship. Inspired by the features of elastic objects which can be

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stretched and compressed, nodes and links are represented as elastic rectangles and bands respectively. By default, mentees of the same mentor and their links are compactly arranged, thus improving space-efficiency; we expand the focus and his/her mentor and mentees and compress the context by deforming and separating the nodes and links, so that we can see both the detailed subtree and the compressed context in a single view; we display multiple attributes via labeling, opacity coding, and charts. Besides, we design various animated interactions to support the visual analysis.

We illustrate our design by applying it to the mentor-mentee tree with Prof. Eric Kandel as root, which contains 203 scholars from AFT and their academic attributes including publication, citation, and H-index from the Microsoft Academic Graph [WSH*19].

2. Related Work

Mentorship is a tree structure basically. Various tree layouts exist [Sch11], among which node-link diagrams are popular [RT81] as they are easy to understand via nicely placed nodes and visible links but suffer from scalability problems due to gaps between nodes. Space-filling methods such as TreeMap [JS91] excel at using space efficiently, but the tree structure is implicit as links are invisible. Our elastic tree is based on the former for its clear connections.

Tree interaction is also widely studied. TreePlus [BPP*06] focus on local exploration by expanding a tree from a node of interest, but at the cost of losing overview. Burch et al. [BSW11] introduced an indented tree browser that allows exploring big trees, but additional space is needed for detailed subtrees. Furthermore, these methods can only show labeling, which is not enough for multivariate data such as mentor-mentee relationships.

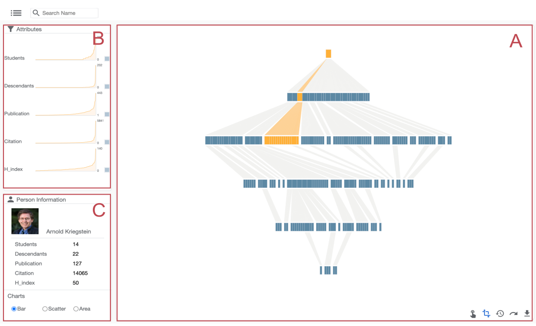

Figure 2: *The visualization tool interface has three panels. (A) Overview panel to visualize and interact with the tree layout. (B) Filter panel to change the opacity of the tree layout based on various attributes. (C) Personal panel to show information of the focus.*

3. Visualization and Interaction Design

Our design follows the principle of "overview first, zoom and filter, then details-on-demand" [Shn96]. As shown in Figure 2, we developed a visualization tool based on D3 and Flask to support the interactive analysis of the mentor-mentee relationship.

Overview. To generate the overview, we first calculate the node-link layout using [RT81], then draw nodes and links as elastic rectangles with a maximum compression degree and bands respectively, finally, mentees with the same mentor and relevant links are aggregated together, and a fixed gap is set between adjacent families to distinguish each other. Besides, considering the sparsity of mentorship, we compress leaf nodes to the narrowest to increase the scalability. Figure 1 (a) shows a compact overview of the tree.

Zoom and Filter. Panel A supports zoom-and-pan, and users can pan to read labels or zoom out to see the global when the layout exceeds the screen. Filtering is also allowed either by querying names or by selecting any numerical attribute on panel B, where the attribute value is linearly mapped to the node opacity (0.3-1), and the opacity of an edge changes gradually according to its connected nodes. After clicking on the node of interest, mentors and mentees of it also will be highlighted accordingly. Figure 1(a) shows a result after filtering based on citation and clicking a focus.

Details-on-demand. After clicking on the focus again, as shown in Figure 1(b), the highlighted subtree will be separated in the form of focus+context, which is obtained via three steps.

- Vertical Direction: The interval between adjacent layers is recalculated by the fisheye [SB92], so that intervals among the subtree are enlarged and the remaining layers are compressed.
- Horizontal Direction: More space is needed as the highlighted nodes are stretched into labels. The space could be preserved by compressing other nodes in this layer, if these nodes have been compressed to the narrowest, they move towards both sides until the reserved space is met.
- Centralization: For cases of edges with small slope due to the compact layout, we calculate the center of the subtree in the horizontal direction first, and then the highlighted nodes are translated towards the center as much as possible within a scope, the scope is defined by the length to which nodes can also be compressed in the translation direction.

The enlarged subtree makes it possible to show more information. Users can select a specific attribute in panel C, and the space between the focus and his/her mentees can be reserved by deforming links, and thus the attribute values of students can be depicted using various charts. Figure 1(b) where area 1 was replaced by area 2 shows the distribution of H-index of mentees using area charts.

Besides, users can switch the focus in any state of the tree. Focus change will restore the tree to the initial state first and then highlight the new subtree. And to preserve the visual consistency, all layout changes of the tree caused by interactions are animation transitions.

Scalability. As the overview is calculated offline and the subtree size is small, the scalability of the elastic tree is mainly limited by the screen space. While zooming can relieve this issue, to maintain good readability, we suggest visualizing trees within 8 layers and within 80 nodes per layer for the current interface.

4. Future Work

This work is still in progress, and we will visualize not just numerical attributes but categorical attributes [PSS*21]. We also plan to display more collaborations between mentors and mentees in the detailed subtree, such as co-authorship. Besides, we're trying to explore more feasible layouts for the mentees with multiple mentors.

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