An Analytical Approach for the Creative Design of New Visualizations

1 Design-Feature Space

Motivation

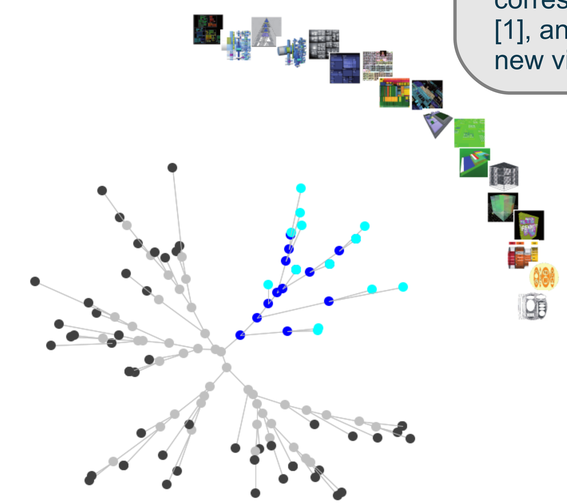
- Support creation of new visualizations with analytical “design by example” [3].
- Better understand the limits of current visualization techniques.

Dimensions Represent Design Attributes

- Every point in the design-feature space represents a unique combination of design attributes.

Attributes	Value A	Value B	StepTree
Number of visual dimensions in visualization *	two	three	three
How edges are shown in visualization *	implicitly through structure	explicitly as lines	implicitly through structure
Overall layout/orientation of visualization *	radial	axis-parallel	axis-parallel
Shape delineated by outline of visualization	irregular	regular polygon	regular polygon
Visualization is space-filling	yes	no	yes
Shape of nodes	rectangular	circular	rectangular
Nodes have evenly-distributed children	yes	no	no
Visualization is fractal	yes	no	yes
Tree depth is linearly encoded	yes	no	yes
Visualization is a fisheye	no	no	no
Visualization encodes weight of edges	yes	no	no
Are leaves collapsed?	all leaves always shown	some leaves obscured	all leaves always shown

* Feature used in [2].



Phylogenetic Tree of Visualizations Based on Design-Feature Distance

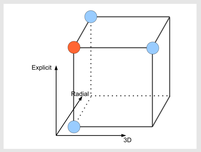
- Matrices M and N define points in the design-feature space (each row describes one feature for that point).

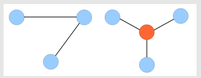
$$D_3(M,N) = \sum_{i=1}^{d} \left(\frac{1}{2} \sum_{j=1}^{k} |M_{ij} - N_{ij}| \right)$$

- Phylogenetic tree constructed using NJ [4].

Internal Nodes as Novel Visualizations

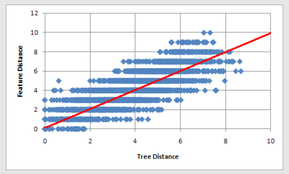
- Leaf nodes in the phylogenetic tree shown in the center of the poster are existing examples (blue).
- Tree structure implies that internal nodes (red) correspond to a point in the design-feature space [1], and thus internal nodes represent potential new visualizations.

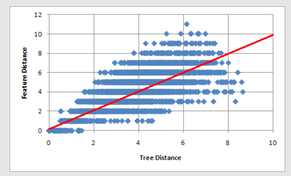




2 Quantitatively Describe New Visualizations

Compute Visual Attributes of New Designs



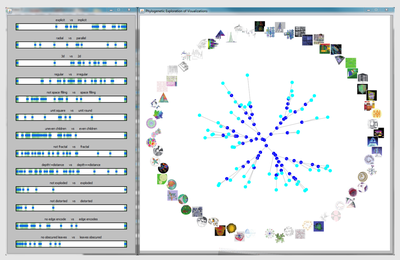


- Use tree structure and existing examples to compute design features of potential new visualizations.
- Brute force (left) and heuristic (right)

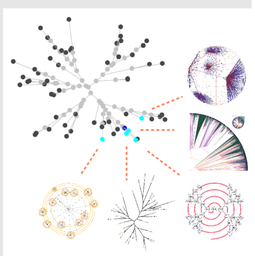
3 Support Creative Design Process

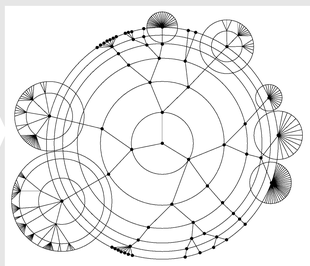
Design Tool

- Interactive exploration of existing examples and potential new designs.



Sample Use-Case with Domain Expert





- Task: design tree visualization to handle data with high branch factor near leaves.
- Artist used our tool to find examples with desirable attributes.
- Artist sketched novel visualization based on our computed design-features.

[1] Dıaz-Banez et al. El compas flamenco: a phylogenetic analysis. BRIDGES: Mathematical Connections in Art, Music and Science, pages 61–70. Citeseer, 2004.
[2] Jurgensmann et al. Poster: A Visual Survey of Tree Visualization. IEEE Information Visualization, volume 5, 2010.
[3] Lee et. al. Designing with interactive example galleries. CHI 2010. ACM.
[4] Saitou et. al. The neighbor-joining method: a new method for reconstructing phylogenetic trees. Mol Biol Evol, 4(4):406–425, 1987.

Garth Griffin gwg@cs.tufts.edu
Shaomeng Li samuelli@cs.tufts.edu
Connor Gramazio connor.gramazio@tufts.edu
Remco Chang remco@cs.tufts.edu

Tufts University, Medford MA

Future Work

- Improved evaluation metrics
- Refined design features
- Algorithmic visualization generation