

Using Visual Metaphor in Interactive Visualization to Improve Navigation of Complex Data Sets

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Abstract

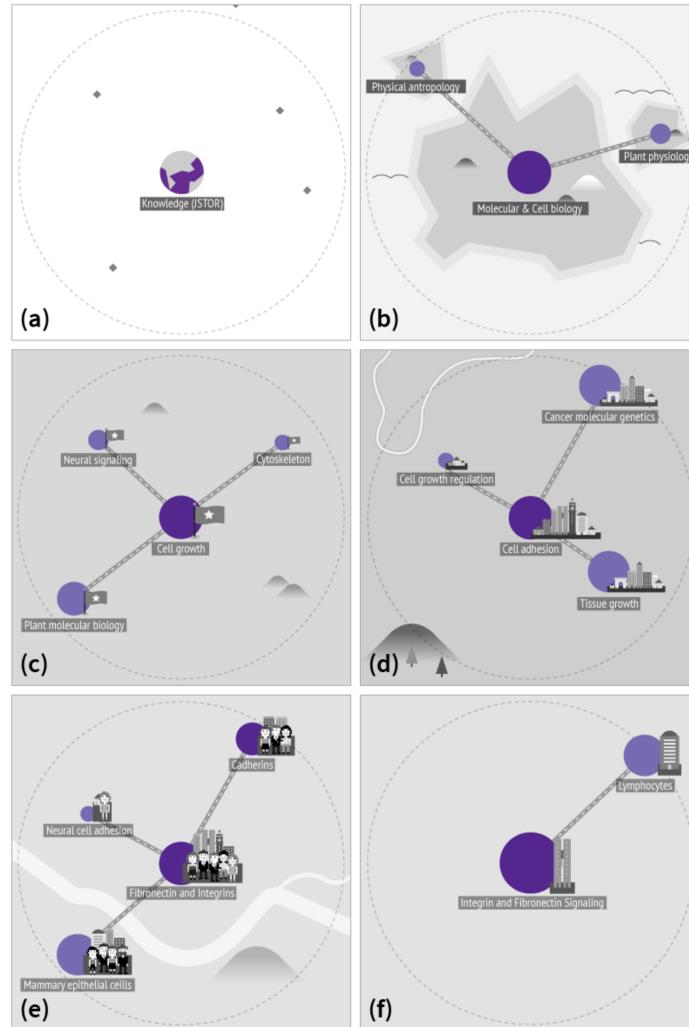
Metaphor enables us to align novel concepts with ones we already understand, and is the primary means by which we assimilate new knowledge. Designers of visual interfaces have long been interested in using metaphorical presentations to provide users with such cognitive shortcuts, yet a systematic method for building effective metaphorical interfaces remains elusive, especially for very large and complex data sets.

We build upon theoretical foundations laid by Bertin, Mackinlay, and Shneiderman for the creation of effective visual mappings and Lakoff and Johnson's image-schematic theory of metaphor to present a systematic process for the creation of effective visualizations of abstract data utilizing metaphor. We provide examples of visualizations created using our process on a complex hierarchical network, and present the results of a pilot study evaluating visualizations created using our approach with a focus on the effectiveness of metaphoric congruency and embodiment.

Research Contribution

The primary contribution of this work is, Firstly, to lay the groundwork for a generalized design process for leveraging metaphor in the design of complex, interactive interfaces.

Secondarily, we demonstrate and test the method on an extremely large and complex real-world data set and conduct a pilot study to evaluate its effectiveness.

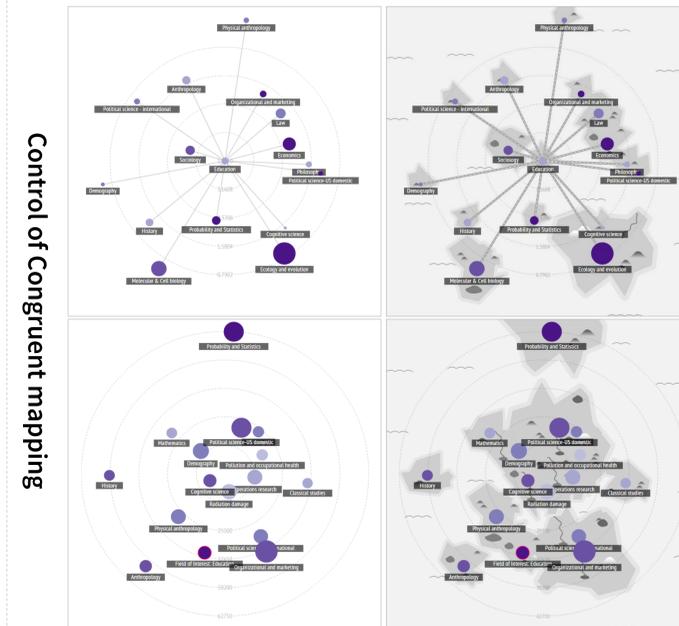


Visualization for the hierarchically structured data set with the metaphor of landscape

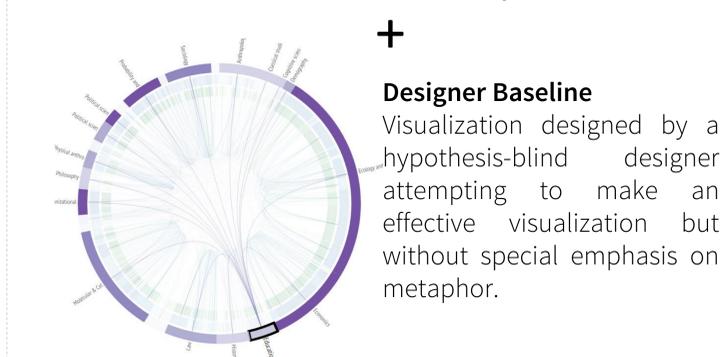
The first six levels of a metaphorical visualization of hierarchical data. As the user zooms in from world (a), to continent (b), to country (c), to city (d), to neighborhood (e), to building (f), s/he progressively enters a more specialized subfield, descending here from Molecular & cell biology to Cell growth to Cell adhesion.

Experimental Design

We implemented five different visualizations of the same large, complex, hierarchical data set. To assess the contribution of schema-alignment, we created a second tool identical to the landscape visualization described above but with all data properties mapped onto alternative, schema-incongruent elements. Next we transformed each of our landscape tools (congruent and incongruent) into equivalent abstract versions.



Control of Abstract / Embodied representation



Designer Baseline
 Visualization designed by a hypothesis-blind designer attempting to make an effective visualization but without special emphasis on metaphor.

Result

Engagement
 : 32% of participants who were assigned to abstract tools dropped out of the study before completing the tutorial. (c.f. landscape tools: 14.8%)

: The average enjoyment score* of landscape tools was 3.6 (SD = 1.0), as compared to 3.2 (SD = 1.2) for the abstract tools.

Usability
 : Landscape Congruent (LC) condition had the highest average task accuracy** and the lowest variance of all conditions.

Comprehension
 : The Landscape Congruent tool had the highest mean** (M = 36.4, SD = 6.82) among all tools.

Idea Generation

	Abstract	Landscape
Congruent (generative / total comments)	13.3% (8 / 60)	21% (13 / 60)
Incongruent (generative / total comments)	15% (9 / 60)	23.3% (14 / 60)
Total	14.2% (17 / 120)	22.5% (27 / 120)

Conclusion

We proposed a novel systematic method for designing effective metaphorical. Results of the study indicate that a systematic design process utilizing metaphoric image schemata shows promise for visualizing large and complex data sets and is worthy of further study.