Gestalt principles in graph visualization

1 Proposal

Information visualization concerns itself with presenting data so as to facilitate interpretation of it. In graph visualization, this information comes in the form of a graph, with the information typically organized as nodes (objects) and edges (the relationships between them). This still leaves open the evaluation of such a visualization. If the main factor is usability, then usability for what purpose? Do attractiveness and memorability play a role? Thus, the question of how aesthetics influences user interactions with and reactions to a given visualization is a core question in this field.

A basic assumption of that question is that it is known what it means for something to be aesthetically pleasing. In fact, this is the topic of much research in the area of gestalt psychology. There, many principles have been identified and investigated that help something to be perceived as a unified whole, or gestalt, more than the simple sum of its parts. For example, the principle of similarity states that people tend to perceive similar objects as parts of a whole, or the dissimilar object among a set of similar ones as the focus (see Fig. 1). It makes sense to build upon this research in asking how the individual gestalt principles contribute to a "better" graph visualization. Our hypothesis is that gestalt principles contribute to both aesthetic appeal and analytic performance in force-directed layout networks.

To evaluate this hypothesis, we must first conduct a survey of the literature in order to match gestalt principles to the graph layout heuristics, such as minimizing edge crossings, which have tended to be the focus of previous graph visualization research. We will perform this survey of the literature with the aid of the SurVis system, which allows sources to be tagged and searched in an intuitive manner [1]. Once the matchings between heuristics and gestalt principles have been identified, we plan to make a poster showing these and submit it to GD. At that point, we will have the information we need to choose the gestalt principles to test in our user study, and we will know which graph heuristics to use to generate graphs which do or do not follow these principles.

The user study will present subjects with graph embeddings following these gestalt principles to varying degrees. To ensure our answers are minimally biased, users will be asked to perform tasks and provide preferences instead of merely telling us which graphs are most aesthetically pleasing and "useful." Thus, each graph will have several questions associated with it, and as we would prefer a within-user study, the length and thus the number of test factors will need to be limited in order to retain the interest of our subjects. Fortunately, the principle/heuristic table will help us to do so. Finally, we will need to translate the responses to our questions into answers as straightforward as possible on which graphs are more aesthetically appealing and/or usable, and thus whether and which gestalt principles have the most impact.

Figure 1: "The figure on the far right becomes a focal point because it is dissimilar to the other shapes." (reproduced from [2])

2 Syllabus

2.1 Expected work

Phase 1

1. Survey of gestalt/graph visualization papers (Scan papers, decide most relevant, read those more in depth, discuss and compare)
2. Use the SurVis system to compile/organize what's there/what's relevant
3. Create a table where papers' findings of correlations between gestalt principles and layout heuristics are collected

Phase 2

1. Make a poster presenting the information from that table in an appealing way.
2. Use phase 1 work to update hypotheses/user study goals and choose the most relevant gestalt principles to test
3. Program visualizations, etc, to display graphs satisfying the gestalt principles we will test to varying degrees
4. Design tasks to gather usability and preference data from subjects

Phase 3

1. Conduct prototype study as test run and make any necessary modifications (make sure our design is likely to collect usable data)
2. Run the full user study

Phase 4

1. Analyze data (correlations, confoundings...)
2. Come to conclusions (yes/no to hypotheses?)
3. Write up paper/make figures

2.2 Expected meetings

1. At least once a week (on skype when in-person not possible)

2.3 Expected product(s)

1. Survey of existing literature organized using SurVis
2. Poster
3. Data from user study
4. Research paper

2.4 Criteria for evaluation

1. Work completed with reasonable thoroughness, best practices
2. Completed on reasonable timeline (Note: phases are not entirely sequential)

2.5 Aspirational learning outcomes

Gain skills in:

1. Reading papers
2. Making and submitting a poster
3. Designing/carrying out a user study
4. Writing a paper
5. Steps involved in publishing a paper in a peer-reviewed journal

3 References

[1] Beck, F., Koch, S., and Weiskopf, D. "Visual Analysis and Dissemination of Scientific Literature Collections with SurVis." In: IEEE Transactions on Visualization and Computer Graphics (2015) (to appear).

[2] "The Gestalt Principles." http://graphicdesign.spokanefalls.edu/tutorials/process/gestaltprinciples/gestaltprinc.htm