Visualizing Alzheimer's Disease Research: A Classroom Collaboration of Design and Science

Associate Professor P. Mike Zender
College of Design Architecture Art and Planning
University of Cincinnati

Professor Keith A. Crutcher
College of Medicine
University of Cincinnati

1. Abstract

"There is a space of highly complex systems for which we lack deep understanding because few techniques exist for visualization of data whose structure and content are continually changing."
-Benjamin Fry, http://acg.media.mit.edu/people/fry/

As the quote suggests, there is a need for new techniques to visualize both emerging and accumulated data in complex fields such as the biological sciences. This paper reports on the early exploration of visualization techniques through the interdisciplinary development of a research data visualization tool at the University of Cincinnati. Undergraduate Digital Design students under the combined instruction of design and biomedical faculty formed collaborative teams to develop a prototype visual-verbal, web-based, dynamic information model (DISPLAY) for extracting, comparing and manipulating research findings related to Alzheimer's Disease (AD). Although the initial prototype focused on AD, the goal was to identify principles and techniques applicable to all types of biological data.

2. Problem

Increased specialization and an increased rate of data acquisition are taxing the human capacity for assimilation of data into knowledge. This is particularly acute in the biological sciences. As an example, over the past 30 years there has been an exponential increase in the number of papers published in the field of AD research, (Fig. 1). This explosion of data, combined with the inherent complexity of biological systems and the need to compare data from various fields and various levels of analysis, require improved techniques for understanding the data and developing new hypotheses.

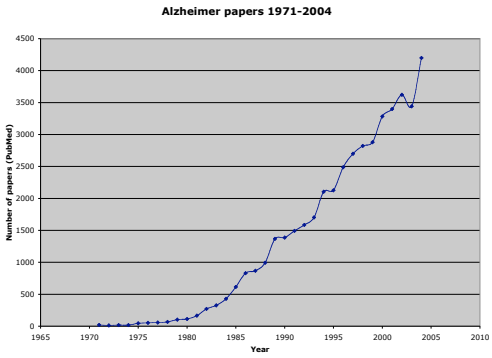

Figure 1.

One means for overcoming these problems is information visualization. Scientists, computer engineers, and programmers are entering the fields of bioinformatics to press visualization forward. However, one potential impediment is the relative paucity of collaborations between scientists and designers. The authors formed a collaboration to introduce design students to scientific approaches to information and to make scientists more aware of design principles for scientific visualization.

3. Collaborative Project

The authors, a designer and a biomedical scientist, created a course to integrate biological research with teaching in digital design, specifically dynamic information visualization. The class project, conducted with two classes of fifth year (Senior) Digital Design students at the University of Cincinnati, developed data visualization techniques to visualize hypotheses related to AD.

The initial collaboration focused on the presentation of scientific information and the need to develop a common vocabulary between design and science. One bridge concept used the analogy of language: with nouns being equivalent to biological entities at different levels of analysis such as "gene", "plaque", and "dementia", and verbs being equivalent to actions such as "cleavage", "deposition" or "infection".

Visualization tools and techniques were discussed at a similar conceptual level. Hue was identified as better indicating a qualitative difference, while value (dark to light) was better at representing quantity. Teams were assigned to apply visual principles to the solution of conceptual issues. One team focused on visualizing verbal concepts, (e.g.,fig. 2).

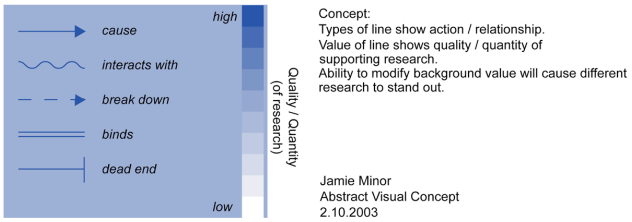

Figure 2.

Other teams explored techniques for visualizing other aspects of the problem. The result was a dynamic display, driven by XML data, of some of the concepts related to AD at various hierarchical levels. This ongoing collaborative teaching and research project is already impacting the educational infrastructure at the College of Design, Architecture, Art and Planning at University of Cincinnati and has grown into a series of grant proposals for information visualization.

4. Conclusion

This collaborative effort has demonstrated the feasibility and utility of interdisciplinary approaches to information visualization and is being written into the curriculum in the Junior and Senior years. With private and University support, the College of Design Architecture Art and Planning has formed a Design Research Institute with a core focus area on visualization. We anticipate equipping undergraduate and graduate students to pursue high-level collaborations in the sciences with hopes of having a significant impact on human understanding of data to enhance research efforts. To quote one NSF review panelist, "The idea of (scientists) collaborating with graphical design professionals is intriguing and if successful should be groundbreaking in science."