07221 Executive Summary

Information Visualization –
Human-Centered Issues in Visual Representation,
Interaction, and Evaluation
— Dagstuhl Seminar —

Andreas Kerren[1], John T. Stasko[2], Jean-Daniel Fekete[3], and Chris North[4]

[1] Växjö University, SE
andreas.kerren@vxu.se
[2] Georgia Institute of Technology, US
stasko@cc.gatech.edu
[3] INRIA Futurs, FR
Jean-Daniel.Fekete@inria.fr
[4] Virginia Tech, US
north@vt.edu

Abstract. Information Visualization (InfoVis) focuses on the use of visualization techniques to help people understand and analyze data. While related fields such as Scientific Visualization involve the presentation of data that has some physical or geometric correspondence, Information Visualization centers on abstract information without such correspondences.

One important aim of this seminar was to bring together theoreticians and practitioners from Information Visualization and related fields as well as from application areas. The seminar has allowed a critical reflection on actual research efforts, the state of field, evaluation challenges, etc. This document summarizes the event.

Keywords. Information Visualization, Visualization, Human-centered Aspects, Evaluation, Visual Analytics, Interaction, Exploration, Human-Computer Interaction

1   Introduction

Information Visualization (InfoVis) is a relatively new research area that focuses on the use of visualization techniques to help people understand and analyze data. While related fields such as Scientific Visualization involve the presentation of data that has some physical or geometric correspondence, Information Visualization centers on abstract information without such correspondences, i.e., there is no possibility to map this information into the physical world in most cases. Examples of such abstract data are symbolic, tabular, networked, hierarchical, or textual information sources. The ever increasing amount of data

generated or made available every day confirms the urgent need of InfoVis tools. There are many possible visual representations but only a fraction are helpful for a given task or application domain. As prerequisite for building a successful visualization, InfoVis combines several aspects of different research areas, such as Scientific Visualization, Human-Computer Interaction, Data Mining, Information Design, Cognitive Psychology, Visual Perception, Cartography, Graph Drawing, and Computer Graphics. Also, aesthetic aspects play a more and more important role: the First Workshop on Computational Aesthetics 2005 in Girona, Spain, and the resulting Dagstuhl Seminar 06221 emphasize such aspects not only in the InfoVis area.

One main goal of this seminar was to bring together theoreticians and practitioners from the addressed research areas as well as from application areas, such as Bioinformatics, Finance, Geo Sciences, Software Engineering, Telecommunication, etc. There are several international conferences that include information visualization topics. Each of them have a slightly different high-level objective. In this context, a consolidation within one seminar appeared to be very beneficial.

1.1   Seminar Topics

- Human-Centered Aspects
- Human-Computer Interfaces
- Visualization Techniques and Models
- InfoVis Aesthetics
- User Interaction
- Multimodal Visualization
- Usability
- Scalability
- Quality Measures
- Perception and Cognition (Psychology Backgrounds)
- Prior Knowledge of the Users
- Education and Training
- Large or Mobile Displays
- Novel Visual Representations
- Visual Analytics
- Domain Specific Visualizations
- Evaluations and Empirical Studies

The seminar has allowed a critical reflection on actual research efforts, the state of field, evaluation challenges, etc. Participants also were encouraged to perform system demonstrations of prototypes and environments relevant to the seminar topics.

2   Participation and Program

About 40 people from 11 countries participated in this seminar. Most attendees were from the US and from Germany, but others came from Canada, Australia, and other European countries.

The program aimed to generate lively discussions. Thus, we had 11 different sessions, each on general problems that fit into the seminar theme. The presenters were asked NOT to give talks about their own research work. Instead, the organizers started the seminar by collecting interesting and important themes that should be discussed in later sessions. Then, the attendees could give talks within these different sessions. Such a talk could, for example, illuminate a specific aspect of the session theme, indicate open problems/difficulties, formulate concrete questions that should be discussed, and so on.

3   Discussions and Outcome of the Seminar

As mentioned before, the program included some organizational and 11 topic sessions. We will briefly describe the topic sessions below.

Collaborative InfoVis (Speakers: Jeff Heer and Frank van Ham). The speakers described projects in the area of collaborative InfoVis, especially projects at IBM. Discussions brought out that the collaboration discussed in both talks was asynchronous (Asynchronous Distributed Collaborative Visualization – ADCV). It seems that not many people are working in the area of synchronous collaboration in InfoVis. Advantages and disadvantages were also discussed. Many points are closely related to prior research in CSCV, but obviously there are many unexplored spaces in collaborative InfoVis.

Theoretical Foundations of InfoVis (Speakers: Matt Ward, Robert Kosara, T.J. Jankun-Kelly, and Natalia Andrienko). The aim of this session was to discuss theoretical foundations in InfoVis: Is there already a real InfoVis theory? If not, what would it look like? What are the important issues? The speakers illuminated several varying aspects of these questions including models and teaching issues to the point of visualization criticism. The discussion centered on several difficulties in generating a theory of InfoVis, e.g., a theory must be user-centered, a predictive theory is probably not possible because of the fact that InfoVis is a kind of cognitive externalization, and that InfoVis allows the user to discover unexpected findings/correlations.

Value of InfoVis (Speakers: Jean-Daniel Fekete, Chris North, and John Stasko). Here, the speakers initiated the interesting problem of how to better communicate the value of InfoVis and how InfoVis can be better disseminated. Many people may think about InfoVis for browsing and searching, but InfoVis is much more. It is not only about problem solving; it helps people to ask better questions! Another issue discussed is that InfoVis researchers have difficulty quantifying the value of their systems and tools because explaining insight (one of the main aims of using InfoVis tools and techniques) is very challenging.

Evaluation (Speakers: Keith Andrews, Sheelagh Carpendale, and Helen Purchase). The main topic of this session was to discuss different evaluation approaches that are suitable for InfoVis techniques and tools, including prerequisites, advantages, and disadvantages. Different forms of testing scenarios, experiments, or observational techniques can be used. Choosing one of them is often not simple. As an application example, empirical studies in graph drawing were illuminated in more detail. A lively discussion whether *each* good InfoVis paper needs an evaluation led to the result that this cannot be the aim for many works, for example, if a completely new visualization technique is introduced.

Interaction (Speakers: Jonathan Roberts and Helwig Hauser). Interaction and exploration are two of the most important properties of information visualization. The speakers exemplified the need of interaction techniques by means of very large data sets and how interaction can greatly facilitate the exploration. In addition, the audience was broken into smaller groups of about six people. Each group discussed and listed what they thought were open problems or challenges faced in interaction and then categorized these challenges into one of 17 categories from a scheme proposed by Roberts. The category receiving the largest number of items was "Exploration State" (history of interaction).

Visual Analytics (Speakers: Daniel Keim, Carsten Görg, and Stephan Diehl). The aim of this session was to clarify what Visual Analytics (VA) really means and how it differs from InfoVis. What we have now is data mining and visual data exploration. What we need is the tight integration of visual and automatic data analysis methods with data base support, i.e., the data-mining process and the visual-exploration process need to be brought together (guide the algorithms and steer the process). This is the core of VA. Also the direction of VA in Europe and in the US was discussed. In this context, two examples were observed in more detail: VA of large documents spaces as well as of software systems.

Good Paper Breakout (Speakers: Tamara Munzner). The Good Paper Session had a very pragmatic aim, to determine what makes a good InfoVis paper. Different types of papers were discussed: system, model, evaluation, technique, and design study papers. The audience was divided into groups, each discussing one of the various paper types. At the end of the session, the groups presented their findings. The benefits of videos for illustrating how highly interactive techniques and systems function also was discussed.

Integration (Speakers: Kwan-Liu Ma, Michael Schlemmer, Jason Dykes, and Hans Hagen). The integration of InfoVis into other related field, such as SciVis (Scientific Visualization), GeoVis, BioVis, etc., was the focus of this session. The speakers talked about the need of InfoVis in SciVis, for example, to visualize abstract data generated by scientific experiments, as well as about bridges and gaps between these two fields. In addition, GeoVis was situated against/with InfoVis. The discussion produced lively comments and disagreement: it remained unclear what is integrated where or if there are really differences, e.g. between GeoVis (even though spatial) and InfoVis.

Human-centered InfoVis and Broader Use (Speakers: Jarke van Wijk, Achim Ebert, Chris Weaver, and Gennady Andrienko). Each speaker considered a very specific subtopic: (1) Bridging the gap between visualization and domain experts as well as between new innovative techniques and useful tools. Four different approaches for possible solutions were introduced including a curiosity-driven approach that really addresses no specific problem or domain. (2) User-centered document management systems using stereoscopic views or useful metaphors. (3) The question "what is between expert and casual visualization?" generated much discussion and debate. (4) The last discussion point was on promoting the use of InfoVis in general. A common problem seems to be complexity. Several possible solutions arose, but none was a clear winner.

Teaching InfoVis (Speaker: Keith Andrews). In advance of this session participants completed a short questionnaire about their InfoVis teaching activities: course length, attendees, materials used, examinations, assignments, practical work, etc. Results were discussed, for example: most classes do not used a fixed textbook; students typically have to prepare a short presentation about a research paper; and the majority of courses were at graduate level. We noted that a nice public collection of images and videos would be very helpful for instructors.

State of the Field (Speaker: Martin Theus). This session covered the current state of the field and solved problems. One important point in the discussion was that we need to look inside and beyond the current community. Fair, constructive criticism is necessary and important. We need to look to our users.

Outcome (Speakers: Andreas Kerren and John Stasko). The organizers and participants decided to publish a book that should document and **extend** the findings and discussions of this Dagstuhl Seminar. Beforehand, the organizers gained the agreement of Springer Press to publish an LNCS State-of-the-Art issue on the seminar theme. The book will cover the problems discussed in the various sessions in detail. An extended seminar report also is planned to be sent to the *Information Visualization Journal (IVS)* published by Palgrave.

Acknowledgments