07221 Abstracts Collection
Information Visualization - Human-Centered Issues in Visual Representation, Interaction, and Evaluation
— Dagstuhl Seminar —

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Abstract. From 28.05.07 to 01.06.07, the Dagstuhl Seminar 07221 "Information Visualization – Human-Centered Issues in Visual Representation, Interaction, and Evaluation" was held in the International Conference and Research Center (IBFI), Schloss Dagstuhl. During the seminar, several participants presented their current research, and ongoing work and open problems were discussed. Abstracts of the presentations given during the seminar as well as abstracts of seminar results and ideas are put together in this paper. The first section describes the seminar topics and goals in general. Links to extended abstracts or full papers are provided, if available.

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

07221 Executive Summary – Information Visualization

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, state of field, evaluation challenges, etc. This document briefly summarizes the event.

Dagstuhl Seminar Proceedings 07221
Information Visualization - Human-Centered Issues in Visual Representation, Interaction, and Evaluation
http://drops.dagstuhl.de/opus/volltexte/2007/1136

Joint work of: Kerren, Andreas; Stasko, John T.; Fekete, Jean-Daniel; North, Chris

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2007/1135

How Best to Evaluate Information Visualisation Interfaces

Keith Andrews (TU Graz, A)

As the information visualisation (infovis) community matures, the evaluation of information visualisation techniques is becoming more prevalent. However, the word "evaluation" encompasses many different kinds of evaluation techniques and sometimes results in confusion about which technique is appropriate in which situation. This paper organises various evaluation techniques according to their purpose and use of representative test users and discusses their applicability to infovis interfaces.

How to promote the use of InfoVis?

Gennady Andrienko (Fraunhofer IAIS - St. Augustin, D)

Although there are many examples of how visualisation can stimulate insight into data and underlying phenomena, interactive visual displays are not widely used for practical data exploration and analysis. One of the reasons is that very few potential users are familiar with the ideas and methods of InfoVis. In one of our research projects, we made an attempt to introduce a group of forest specialists to the concept and principles of exploratory data analysis and to the use of visualization for systematic and comprehensive data exploration. For this purpose, we performed an exploration of a non-trivial dataset provided by the foresters and reported the procedure and the principles applied, the techniques used, and the findings made. The reaction of the forest experts indicated that the lack of knowledge is not the only and, perhaps, not the main reason of the low use of analytical visualisation. The main obstacles to wider use of it seem to be the following:

- Visual analysis of complex data is an inherently complex process. It requires multiple views and complementary tools, which are difficult to master, to choose, and to combine.
- Visual analysis brings no material results but only ideas in analyst's mind, which are hard to capture, represent, and communicate. Therefore, the work of an analyst is difficult to report, to trace, and to evaluate.
- The results have a flavour of subjectivity and do not produce a solid impression, unlike outcomes of statistical methods. Moreover, apparent simplicity and visual appeal of graphical tools may promote their incompetent use, which may lead to misinterpretation of data. This harms the reputation of graphical tools among domain experts and contributes to their reluctance to use visualisation.

We suggest some ideas concerning possible solutions and call upon the community to join efforts in solving these problems.

Joint work of: Andrienko, Gennady; Andrienko, Natalia

What Is Lacking in InfoVis Theory?

Natalia Andrienko (Fraunhofer IAIS - St. Augustin, D)

Questions to think about:

- Is InfoVis a science or an art?
- Why people use statistics for data analysis but do not (widely) use visualisation?
- What is the difference between the statistics and InfoVis?

Let us look at some titles of statistics textbooks:

- Introduction to the Practice of Statistics
- Statistics Informed Decisions Using Data
- Statistics for Business and Economics
- Statistics for the Behavioral Sciences

. . . and many others. Can the InfoVis community write textbooks entitled like

- Practical Guide to Analytical Visualization: Understand Your Data
- Visualization Informed Decisions Using Data
- Visualization for Business and Economics

and so on?

It appears that the state of the InfoVis theory does not allow this yet. We need a testable theory with predictive power. A possible approach to creating such a theory could be the following. We assume that most of the InfoVis researchers can agree that the main goal of analytical visualization is to help the user to discover patterns in data. Hence, the theory must include

- a definition of the concept "pattern";
- a typology of patterns;
- methods to discover each type of pattern, including graphical techniques, interaction techniques, data transformations, and visually controlled computational techniques.

The theory should tell how, given an arbitrary dataset, to predict what types of patterns can be discovered in the data and what method(s) can effectively help in this (we mean not specific tools or systems but generic techniques). We plan to have a poster presenting our efforts in this direction.

Joint work of: Andrienko, Natalia; Andrienko, Gennady

Evaluation and Information Visualization

Sheelagh Carpendale (University of Calgary, CA)

An important starting point is to consider what we are trying to gain from our evaluations. Do we intend to better understand humans, or our visualization tools and their usage, or the impact these tools have on insight? If our intentions are to shed light on our cognitive and social processes as augmented by visualization, then these processes could exist between humans, between humans and technology, or between humans through technology. These types of studies are complex. Assessing whether insight occurs, or whether such an occurrence was aid by a visualization seems near to impossible. However, we are not alone in our desire to improve our understanding of complex processes. It is possible the characterizations of this problem in other fields may aid our exploration. One example is Kay et al. (1999) description of complex adaptive systems as non-linear, holarchical, self-organizing, dynamic, and often resulting in unexpected outcomes.

Considering just one of these factors, non-linearity, indicates that the behaviour of the system comes from the whole. That is, the system cannot be understood by decomposing it into its component parts, which can be then reunited. In practice this means that studying parts can lead to incomplete knowledge and that studying the whole is extremely difficult. As a result we often try studying parts while whole is in operation, which leads to messy studies and or to studies which make use of observational techniques to minimize intrusion. Examples of these kinds of techniques include: observing in context, shadowing, considering artifacts used, contextual interviews, pile sort, collage or concept maps, and acting out scenarios.

Studies can play an important part during the whole process. Studies conducted before design can provide insight into tasks, process, and task variations leading to more informed design. Studies conducted during design and development can influence and improve outcomes. Studies conducted of results can evaluate and result in summative guidelines.

Visual Data Mining in Software Archives

Stephan Diehl (Universität Trier, D)

In this talk, I briefly showed how visual data mining can be used to detect patterns in data stored in software archives. Once interesting patterns have been found, specific tools like the ROSE recommendation system can be built to support the software developer. Finally, I concluded that while software visualization has been a test bed for many infovis techniques, visual analytics has not yet reached software visualization

Keywords: Software visualization, information visualization, visual analytics, data mining

Full Paper:
http://www.st.uni-trier.de/ diehl/pubs/softvis05.pdf

Situating Geovisualization

Jason Dykes (City University - London, GB)

InfoVis is the geometric representation of abstract information without physical or geometric correspondence. Maps are defined as the graphic representation of the geographic setting. As such cartography and InfoVis appear to be mutually exclusive, but both have applications that require particular forms of interaction for exploration and the disciplines may benefit from sharing knowledge and approaches.

Geographic space has a number of characteristics that have been studied at length in its graphic representation through cartography. These include uncertainty, known error and tacit knowledge about the transformations and inherent information loss. These characteristics can be considered through a transformational view of static cartography focusing on the transformation from real world phenomena, to data model, map and internalized map image.

Geographic Information Science is a discipline that has developed a gamut of approaches for modeling and managing spatial information at all stages in this process. Geographic Information Systems are software applications that implement much of this science. Geovisualization draws upon GIScience to develop interactive maps that enable direct manipulation with graphics to support the thought process. Such software enables those analyzing geographic information to change views interactively as they browse and explore spatial data sets. Interactions can be developed that help users assimilate information, see through the transformations and use ancillary data to support the thought process and deal with the limitations of their models.

Several software examples and associated spatial views and interactions are introduced including : cdv, panoraMap, LandSerf, geowigs and tagMaps. The software demonstrates how informal domain knowledge may be used to inform exploratory analysis and leads to consideration of the roles of tacit knowledge and gestalt analysis in geovisualization.

Space has an important role in visualization. Whilst it appears to provide a useful framework for visual data synthesis it is less clear whether is . . . special? difficult/messy? particularly appropriate for prediction? These remain open questions, but readers from the domain of Information Visualization are encouraged to consider a number of core contributions in GIScience that may provide some insights.

Human-Centered Visualization of Personal Document Spaces

Achim Ebert (TU Kaiserslautern, D)

Human thinking and knowledge work is heavily dependent on (sensing) the outside world. E.g., it is well-known that our visual knowledge disclosure - that is, our ability to think, abstract, remember, and understand visually - and our skills to visually organize are extremely powerful. We are envisioning an individually customizable virtual world (comprising a users document-centred Personal Information Space), which inspires the user's thinking, enables the economical usage of his perceptual power, and adheres to a multiplicity of personal details with respect to his thought process and knowledge work. We strive to realize this vision by designing methods to present and visualize data in a way that integrates the user into his artificial surroundings seamlessly and gives him/her the opportunity to interact with it in a natural way. In this connection, we introduce a holistic context and content-sensitive approach for information retrieval, preattentive visualization, and navigation in manipulative virtual environments.

Keywords: Human-Centered Visualization, HCI, Visual Analytics

Arguing for the Value of Visualization

Jean-Daniel Fekete (INRIA Futurs - Orsay, F)

As Information Visualization practitioners, we need to introduce our domain to various audiences. We present a collection of slides collected from several attendants to the seminar used to quickly present Information Visualization.

Visualization for Investigative Analysis

Carsten Görg (Georgia Institute of Technology, USA)

Investigative analysts who work with collections of text documents connect embedded threads of evidence in order to formulate hypotheses about plans and activities of potential interest. As the number of documents and the corresponding number of concepts and entities within the documents grow larger, sense-making processes become more and more difficult for the analysts. We have developed a visual analytic system called Jigsaw that represents documents and their entities visually in order to help analysts examine reports more efficiently and develop theories about potential actions more quickly. Jigsaw provides multiple coordinated views of document entities with a special emphasis on visually illustrating connections between entities across the different documents.

Keywords: Visual analytics, investigative analysis, intelligence analysis, information visualization, multiple views

Joint work of: Görg, Carsten; Stasko, John; Liu Zhicheng; Singhal, Kanupriya

Is 3D-Visualization useful for Software Visualization?

Hans Hagen (TU Kaiserslautern, D)

There are quite some 3D visualizations which were developed in the context of software visualization. But the question is whether those are really useful for software engineers used in every days tasks.

Keywords: Software visualization, 3D visualization

Joint work of: Hagen, Hans; Zeckzer, Dirk

Interactive Visual Analysis of Large Sets of Functional Data

Helwig Hauser (University of Bergen, N)

Using interactive visualization for the exploration and analysis of large sets of data which are given in a functional form, i.e., tens of thousands of data series $f_i(x_j)$ or $f_i(x_j, x_k)$, etc., discretely given at many x_j (and x_k, respectively), is a major challenge for today's visualization technology. In this talk we briefly address the challenges which not at the least arise due to inherent limitations of human perception.

Keywords: Interactive Visual Data Analysis

Joint work of: Hauser, Helwig; Matković, Krešimir

Voyagers and Voyeurs: Supporting Asynchronous Collaboration around Interactive Visualizations

Jeffrey Heer (Univ. of California - Berkeley, USA)

Information visualization leverages the human visual system to support the process of sensemaking, in which information is collected, organized, and analyzed to generate knowledge and inform action. Though most research to date assumes a single-user focus on perceptual and cognitive processes, in practice, sensemaking is often a social process involving parallelization of effort, discussion, and consensus building.

This suggests that to fully support sensemaking, interactive visualizations should also support social interaction.

However, the most appropriate collaboration mechanisms for supporting this interaction are not immediately clear.

Our research explores mechanisms for asynchronous collaboration in the context of information visualization, recasting visualizations as not just analytic tools, but social spaces. We contribute the design and implementation of sense.us, a web site supporting asynchronous collaboration across a variety of visualization types. The site supports view sharing, discussion, graphical annotation, and social navigation and includes novel interaction elements. User studies of the system found emergent patterns of social data analysis, including cycles of observation and hypothesis, and the complementary roles of social navigation and data-driven exploration. Informed by this study and prior research, we also contribute design considerations for asynchronous collaboration in visual analysis environments, highlighting issues of work parallelization, communication, and social organization. These considerations provide a guide for the design and evaluation of collaborative visualization systems.

Full Paper:
http://vis.berkeley.edu/papers/sense.us

Teaching the Science of Information Visualization

T. J. Jankun-Kelly (Mississippi State Univ., USA)

A science is built upon, propagated, and sustained in three ways: By its practice, by its development via research, and by its continuation via education. The educational component is vital for the sustained activity of a science—such efforts establish common practice, provide the foundation of the field, and provide guidance for future use or development. Thus, any formalization of a "science of information visualization" must address how and what is being taught to our future users, practitioners, and researchers. In this talk, I will share my continuing experiences with forming a foundation for a visualization pedagogy, outline thoughts and where this might be going, and solicit discussion on where are field is going in information visualization education.

Keywords: Information visualization, science of visualization, pedagogy

Visual Analytics: Mastering the Information Age

Daniel A. Keim (Universität Konstanz, D)

Never before in history data has been generated at such high volumes as it is today - and most of the data is instantly available on the web. Analyzing the vast volumes of data has become increasingly difficult. Visual Analytics - the science of reasoning facilitated by interactive visual displays - can help to deal with the flood of information, since it combines the power of today's computers with the perceptual abilities of the human visual system. The core of Visual Analytics research is to integrate state-of-the-art data analysis technology with advanced interactive visualization techniques, helping to understand the data, fostering new insights, and encouraging the formation and validation of new hypotheses. The presentation discussed the differences between information visualization and visual analytics and also presented the newest information on funding opportunities in the field.

Keywords: Visual Analytics, Information Visualization, Data Mining

Visualization Criticism: One Building Block for a Theory of Visualization

Robert Kosara (University of North Carolina at Charlotte, USA)

In the search for a theoretical and scientific foundation for visualization, we need to start looking at ways in which theories are not just developed, but tested and improved. Criticism is used in education and practice of art, design, architecture, and others. It has also recently been incorporated into computer science courses, after being successfully applied in visualization classes. Criticism is a highly interactive and human-centered way of designing things.

We propose the idea of visualization criticism, and lay out rules for it. Criticism is the practical application of theory, and an important tool in embedding new work in existing research. It also guides the view away from implementation details and single mouse clicks to the meaning of a visualization.

Tired of Parallel Coordinates?

Kwan-Liu Ma (Univ. of California - Davis, USA)

Parallel coordinates is probably the most widely used technique for visualizing multidimensional data. It has been extended in several ways and from time to time adopted for new applications. While there are other techniques introduced for visualizing multidimensional data, parallel coordinates visualization seems to be the most intuitive and easiest to implement. In my talk, I will provide

several examples of using parallel coordinates in the context of scientific data analysis and visualization. My goal is to show the need and value of information visualization techniques in understanding the abstract, non-geometric, and non-spatially referenced data also generated in the course of large-scale scientific investigations.

I would also like to take this chance to discuss if parallel coordinates meet our need, and if it is possible and needed to extend/improve parallel coordinates.

Should we start looking for a new approach to multidimensional/multivariate data visualization?

Keywords: Multidimensional data, multivariate data, parallel coordinates, information visualization, scientific data analysis

When To Walk Away: Questions To Ask In Infovis Projects

Tamara Munzner (University of British Columbia - Vancouver, CA)

I will discuss several questions that I recommend asking before an infovis project starts, and re-asking at intervals throughout the lifetime of the project. In this talk, I will not focus on technique questions, such whether a technique is novel or whether a chosen visual representation actually communicates the desired structure.

Instead, these questions are concerned with process issues. What flavor of collaborators do I have - real users, or fellow tool builders? Is the problem solveable: Is there a real need for my new approach/tool? Am I addressing a real task? Does real data exist and can I have it? I will give examples of several past projects, with outcomes along the range from successful to not so successful, where these questions mattered. In many cases, it did not occur to me to ask these questions when starting the projects, even if they seem obvious in retrospect.

Informal Insight and the Value of Visualization

Chris North (Virginia Polytechnic Institute, USA)

There are two types of insight, formal and informal. Formal insights, such as correlations and outliers, are easily describable. Informal insight is difficult to describe, because of its informal nature. In fact, when people attempt to verbalize their informal insight, they usually formalize it. While formal insight is a value of visualization, other disciplines can claim it too. Hence, I think that informal insight is where the greatest value of visualization rests. But how do we justify visualization based on something that we cannot describe?

Two main arguments can help clarify informal insight, and perhaps make it more measurable. First, the 'usability' argument states that visualization's informal insight helps guide people to greater formal insight in an efficient manner. Second, the 'hypothesis generation' argument states that visualization enables

people to connect formal insight to their existing domain knowledge to gain greater informal insight. Thus, visualization establishes a circular self-feeding cycle, between informal and formal, of insight production.

Keywords: Visualization, value, insight

Graph Drawing Empirical Studies

Helen Purchase (University of Glasgow, GB)

Over several years, I have conducted empirical studies on the visualisation of graphs (node-arc diagrams), with a view to guiding the design of automatic layout algorithms so that their output best supports human comprehension.

This seminar will briefly outline the aims of the overall project, describing examples of the experiments that have been run, including graph layout aesthetics, graph drawing algorithms, UML diagrams, social networks, and recent work on dynamic layout algorithms. It includes detail on experimental methodology and graph-based tasks.

Keywords: Graph Drawing, Empirical Studies, Human Comprehension

Are we nearly there yet? - 6 Challenges for Exploratory Visualization

Jonathan C. Roberts (University of Kent, GB)

Exploratory systems are used in many domains, from web searching, geovisualization for spatial statistical analysis, to exploring and steering simulation data. Such systems permit users to explore complex and diverse datasets. We can do a lot with current systems. They are often highly interactive, display the results quickly and permit large quantities of data to be displayed. But, current systems are lacking in many ways. Datasets are continuing to increase in the size, complexity and diversity and there is a need to fuse information from multiple remote sources. We need to see where the challenges lie and look to the next generation of exploratory visualization interfaces.

The goal of exploratory systems is to allow the user to investigate and try-out scenarios. It is often the case that users do not necessarily know what they are looking for. They wish to explore the data and find information that appears to be interesting and relevant to their discovery. Hence, it is often through the exploration process itself that the user gains a better understanding of the information. In fact, during the exploration the user develops new ideas and directions for their exploration and as a result they may change their mind and explore in a completely different direction, hence users often create long and in depth explorations. Consequently, users often find it difficult to know where to

go next, understand how to use the interface to perform a specific task, understand in advance what the consequence of a particular action would be, work out whether something has been seen already, present what has been learnt, and understand how that exploration was achieved.

Bridges and Gaps between SciVis and InfoVis

Michael Schlemmer (TU Kaiserslautern, D)

There have been lots of discussions on the integration of SciVis and InfoVis. But there are still issues that need closer inspection. Besides the various "bridges" between SciVis and InfoVis, there are also "gaps". Not taking care of those gaps might result in misleading visualizations. The goal of the talk is to point out the importance of a combined usage for specific applications, but also to make aware of possible pitfalls when combing methods from SciVis and InfoVis.

Keywords: Scientific Visualization, Information Visualization

Communicating the Value of InfoVis

John T. Stasko (Georgia Institute of Technology, USA)

By its very nature, information visualization seems most suited to helping people with browsing and exploration, two activities that are difficult to evaluate quantitatively. We need to develop better ways to communicate the value of information visualization and to show people all the different benefits it can provide.

Keywords: Information visualization, evaluation, exploration, browsing

Problems Solved in InfoVis?

Martin Theus (O2 - Germany - München, D)

InfoVis is a discipline that borrows from many neighboring fields. Depending on the problem to visualize, knowledge from HCI, cognitive science, StatGraphics, GeoVis, etc needs to be combined to generate insights with a visualization. Being such a broad field, InfoVis can hardly be captured in an axiomatic theory. Nonetheless, subgroups of application like GeoVis, DataVis, graph drawing often have their theoretical foundations, which also can be used to formalize what is done in the visualization part. Lacking an overall theory does not at all reduce the value of InfoVis methods, but should be taken as a strong indication that research in InfoVis should always be fueled by real application problems.

Curiosity Driven Visualization

Jarke J. Van Wijk (TU Eindhoven, NL)

In a recent Vis Viewpoint (Bridging the Gaps - IEEE CG&A 26(6), 2006) I have thought aloud about our relation as visualization researchers with domain experts. Two gaps exist: a knowledge gap and an interest gap.

Various ways to bridge these gaps were discussed. In my presentation I will defend the last and most controversial one: Curiosity driven visualization; in order to make the discussions livelier and not too politically correct. The idea is to focus on just one user: The researcher him/herself, satisfying his curiosity. I will illustrate this with a recent example, where I attacked one of the oldest and best studied visualization problems. A video with strange visualizations will be shown.

Keywords: Visualization curiosity roles

Information Bandwidth - Measuring the Power and Effectiveness of InfoVis Tools

Matthew Ward (Worcester Polytechnic Institute, USA)

Information visualization can be likened to a communication channel, moving the values and relationships from a dataset through the human perceptual system for use in analytical reasoning. To this end, it should be possible to find analogies to the mechanisms by which communication channels are measured, such as bandwidth, channel capacity, and information loss, for use in evaluating information visualization tools. However, for information visualization, we need to be concerned not only with the rate of information flow, but also its underlying quality, value, or significance. In this talk, I will elaborate on some issues involving the characterization and measurement of the communication that results when an analyst uses visualization in tasks such as pattern detection and anomaly detection.

While I admit I do not have a complete solution to this problem, or even a detailed framework, I think it is certainly worth discussing the important attributes that should be involved in such measurements as a focus for current and future research.

Keywords: Evaluation metrics

Street Vis: What Lies Between Expert and Casual Visualization?

Chris Weaver (Pennsylvania State University, USA)

Curiosity-driven visualization appears to be a significant departure from traditional visualization, in terms of purpose and complexity (rather generally) and in goals, tasks, form, and content (somewhat more specifically). Is casual vis an indication of a scientific desire to explore the boundaries of vis usage, trailblazing from our well-developed region of technical application (serious exploration by experts) into clearly distinct areas? If so, is there a gap in "seriousness" between supposed "expert" and "casual" visualization, a middle ground of semi-serious/hobbyist/"street" visualization design that has yet to be explored? Because I can't resist the opportunity for shiny demos, I will offer up as fodder for discussion three example visualizations that target primarily curiosity-driven exploration by broad(er) audiences in education, sports, and entertainment, but that also attempt to support armchair analysis and perhaps even encourage evolutionary design.

Massively Collaborative Visualization - IBM's Many Eyes project

Frank van Ham (IBM TJ Watson Research Center, USA)

Most current information visualization research focuses on providing single user tools that can handle the ever increasing data sizes the real world presents us with. These tools often focus on the exploratory side of information visualization. We decided to focus on the expressive side of information and wondered what would happen if, instead of the data, we scale the audience of a single visualization.

This has led to Many Eyes (www.many-eyes.com), an online site where end-users can create information visualizations of their own data, annotate them, and discuss and share them with others. In this talk I will present the ideas behind Many Eyes, give an overview of its design and present some preliminary findings as to its usage.

Keywords: Collaborative Visualization, End-user visualization

See also:
http://www.many-eyes.com