Assignment 1

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1 Find four different definitions of information visualization from the existing literature (using proper methods for quoting and referencing). Present your own view and comments on each of them.

1.1 Preliminary thoughts

In order to effectively examine the following definitions, information visualization has to be evaluated for its most relevant issues. A definition should try to cover all these issues with the minimum amount of words while at the same time being as simple and comprehensible as possible. Also, it should be defined abstract in order to be applicable to any kind of concrete scenario.

During the lecture no January 14th, information visualization was described as "the field of study that deals with the design and creation of visual representations of abstract data" [Hoeber, 2009] (lecture 1, slide 3). It was furthermore described, that by providing a visual presentation, data can be much more easily comprehended and processed by human beings (lecture 1, slide 6). Consequently, the following issues can be defined as relevant, based on the information provided within the lecture:

Scientific research Information visualization is a field of study. It is therefor an area for scientific research.

Visual Obviously, information visualization is based on visual perception. It concentrates on vision as the primary sense and tries to use it.

Data representation The primary task of information visualization is to display abstract data.

Knowledge gain Last, the ultimate goal of information visualization is to provide the user with the means to comprehend and process the abstract data.

From these four issues, the *scientific research* is probably the one least important. Information visualization could just as well be understood as an area where both scientific research ans practical application are relevant.

1.2 Definition 1

> Information visualization is... *"the use of computer-supported, interactive visual representations of data to amplify cognition."* [Card et al., 1998]

This is a very concise, and generalizing definition. It covers the visual issues as well as both the data representation and the knowledge gain. It is brief, simple, easy to comprehend and can be applied to every kind of scenario. All requirements for a good definition are therefore met. The word "amplify" allows information visualization to be considered as part of a greater process of cognition. It does not, however, define information visualization as a field of study. Instead it indicates with the word "use" information visualization to be some kind of "best practise". In my personal opinion, this is a flaw in the definition. Furthermore, it restricts its utilization on computer aided systems, thus limiting its applicability. It allows all kind of data to be used for representation, not just abstract data. I believe that this is actually correct, since cognition of non-abstract data can be aided by a visual representation just as well (for example displaying the poverty level of countries).

1.3 Definition 2

> (Information) visualization is... *"a graphical representation of data or concepts,"* ...that is either an... *"internal construct of the mind"* ...or an... *"external artifact supporting decision making."* [Ware, 2004] (page 2)

This definition extends the object in question that is to be displayed to include concepts. Even though it is brief, it is more difficult to comprehend. Both the scientific issue and the knowledge gain are not touched by it. Ware only talks about *supporting decision making*. Cognition in general, however, does not necessarily require a decision to be made. The goal might simply be to extract some information that is of interest or to discover patterns that are not as obvious in non-visual representations. The lack of cognitive issue is a critical flaw that substantially reduces the quality of this definition. Since the definition is intended to work for both internal and external visualizations, it does not require a computer to be present. Ultimately, this definition covers the visualization of information in a much broader sense then the one we are seeking for. We, however, concentrate purely on computer-based information visualization. Since the objects need to be described by data in order to be processed by a computer, the benefit of including concepts is not relevant. Consequently, I believe that all advantages this definition provides are irrelevant to our context. Since the definition still has disadvantages over Definition 1, it is less fitting to our context.

1.4 Definition 3

> *"Information visualizations attempt to efficiently map data variables onto visual dimensions in order to create graphic representations."'* [Gee et al., 2005]

Just like Definition 2, this one does not cover the scientific nor the cognitive issue. The lack of the cognitive issue is a critical flaw of the definition. The described mapping of data variables to visual dimensions is very intuitive and well formulated. Since color, position, and dimension are all visual

dimensions, the data can really be understood to be mapped to those. However, there is one other non-visual dimension that is of interest for mapping data variables: time. Visualizations can very well be animations (for example when showing the spreading of a particular disease). The chronological dimension should therefore be considered as well. Just like Definition 2, it applies to a broader sense of visualizations, but, following the same logic, this does not create any benefit for our context. Consequently, I believe that Definition 1 is better suited for our context.

1.5 Definition 4

> Information visualization is... *a method of presenting data or information in non-traditional, interactive graphical forms. By using 2-D or 3-D color graphics and animation, these visualizations can show the structure of information, allow one to navigate through it, and modify it with graphical interactions.* [UIUC, 1998]

This definition again does not talk about either scientific utilization or cognitive gain. Instead, it introduces a new trait: *non-traditional*. When applying on different scenarios, it becomes obvious, that *non-traditional* limits the number of appliances substantially. All scenarios where information is traditionally displayed visually is hereby excluded (i.e. maps or signs). Instead of describing the benefit in knowledge gain, it states that information visualization can show the structure of information. In the terms of pattern recognition this might be true. It does, however, not include the recognition and evaluation of proportions of non-related data sets. The term "knowledge" is much wider then "structure" and therefore allows a broader application of a definition. Because of that, and because of the lengthy formulation, this definition is in my opinion less efficient then the other ones.

2 List the major conferences in the field of information visualization. For each conference, provide links to the Web sites for next and previous conferences, and a link to where papers from past conferences can be downloaded.

2.1 Primary conferences

IEEE Conference on Visualization

- URL: http://vis.computer.org/VisWeek2009/vis/index.html
- Proceedings:
  - until 2007: http://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1000796
  - since 2008: published as part of the Transactions on Visualization and Computer Graphics (http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=2945)

IEEE Conference on Information Visualization

- URL: http://vis.computer.org/VisWeek2009/infovis/index.html

- Proceedings:
  - until 2006: http://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1000371
  - for 2007: http://ieeexplore.ieee.org/xpl/tocresult.jsp?&isnumber=4376125
  - since 2008: published as part of the Transactions on Visualization and Computer Graphics (http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=2945)

ACM Conference on Human Factors in Computing Systems

- URL: http://www.chi2009.org/
- Proceedings: http://portal.acm.org/browse_dl.cfm?linked=1&part=series&idx=SERIES260&coll=ACM&dl=ACM

2.2 Secondary conferences

IEEE International Conference on Information Visualization

- URL: http://www.graphicslink.co.uk/IV09/
- Proceedings http://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1000370

Conference on Visualization and Data Analysis

- URL: http://vw.indiana.edu/vda2009/
- Proceedings: http://vw.indiana.edu/vda2009/past.html

IEEE/WIC/ACM International Conference on Intelligent Agent Technology

- URL: http://www.wi-iat09.disco.unimib.it/IAT09/IAThome.htm
- Proceedings: http://ieeexplore.ieee.org/xpl/conhome.jsp?punumber=1000386

3 List the major journals in the field of information visualization. For each journal, provide a link to the journal home page and a link to where articles can be downloaded.

3.1 Primary journals

IEEE Transactions on Visualization and Computer Graphics

- Homepage: http://computer.org/tvcg/
- Articles: http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=2945

ACM Transactions on Graphics

- Homepage: http://tog.acm.org/
- Articles: http://portal.acm.org/browse_dl.cfm?idx=J778

3.2 Secondary journals

Communications of the ACM

- Homepage: http://cacm.acm.org/communications
- Articles: http://portal.acm.org/browse_dl.cfm?idx=J79

Information Visualization

- Homepage: http://www.palgrave-journals.com/ivs/index.html
- Articles: http://www.palgrave-journals.com/ivs/archive/index.html

Parsons Journal for Information Mapping

- Homepage: http://piim.newschool.edu/journal/
- Articles: http://piim.newschool.edu/journal/issues/

4 List eight distinct research topics in the field of information visualization. For each, provide a brief description.

Interactive InfoVis systems In order to allow the user to fully utilize visualizations, it is necessary to provide him with the means for interacting with the system. Current research evaluates different methods for interacting with InfoVis systems, focusing on different kinds of visualizations and appropriate means for interaction. Notable papers in this area are [Tu and Shen, 2008, Lam, 2008]

Geographic Visualization By applying geographic data to visualzations, data sets can be geographically weigthed, thus providing information about geographical distribution and local anomalies. Current research concentrates on generating this geographical weight. For this, data sets have to be mapped to geographical locations. The generation of geographic data, however, is non trivial and depends on the scenario. Notable papers in this area are [Dykes and Brunsdon, 2007, Fisher, 2007]

Reusability of visualizations Visualization systems typically deal with a predefined set of scenarios. Applying them beyond those scenarios is not feasible. One topic of research is to identify means on how visualizations and InfoVis systems can be reused for other scenarios in order to reduce development and implementation effort. A notable paper in this area is [Humphrey, 2000]

InfoVis for ranking and ordering data One very powerfull application of information visualization is to use it for sorting data. Especiall web search engines can profit greatly from the appliance of InfoVis technology. A visual ordering and sorting allows users to quickly identify the data entries that are most relevant to their query. Furthermore, it provides a sophisticated approach for clustering data. Notable papers in this area are [Kidwell et al., 2008, Freiler et al., 2008]

Multi-dimensional visualization When constructing a visualization, it is important to evaluate the different dimensions both of the provided data set and of the constructed visualization. Current research trys to find out how the dimensions data sets can be mapped to those of the visualization, and in which cases the number of dimensions should be reduced or increased. It furthermore concentrates on the presentation on multi-dimenional visualizations. Notable papers in this area are [Hanson and Cross, 1993, Yang et al., 2003, Riazati et al., 2007, Peng et al., 2004, Artero et al., 2006]

Distributed and/or collaborative visualization When working with larger data sets or complex structures, the process of recognition can be distributed amongst a set of human clients. These clients need to communicate and cooperate with one another thus increasing the overall process of recognition to an optimum. It is a current issue of research, how different clients can interoperate with oneanother under the prospect of efficiency optimization. Furthermore, classical InfoVis systems perform all preprocessing and transformation at a single point. Since in a collaborative scenario information is accessed from multiple clients, and since those clients typically require only a subset of the data pool, it is possible to distribute the computation amongst those clients thus resolving the need for a single high-end server and minimizing the costs of computation. Notable papers in this area are [Zhao et al., 2007, Anupam et al., 1994, Heer et al., 2007, Johnson and Elvins, 1998, Balakrishnan et al., 2008, Bajaj and Cutchin, 1999]

Scalability of information visualization Hardware capabilities such as resolution and display size are rapidly increasing. While this allows InfoVis systems to display an equally bigger the amount of information, the human capablities for recognition are limited. It is a current topic of research to identify the means, potentials, and limitations to scalable InfoVis systems in order to exploit the new capabilities as effective as possible. Notable papers in this area are [Yost et al., 2007, Ball and North, 2005]

Text document visualization Especially large text documents often require a considerable amount of work in order to fully comprehend the content, its logical structure, and consequences. Furthermore, putting text documents into relationships with oneanother is both difficult. Since there is no scientific approach on capturing the concept and content of a text document, connections must often be made on instinct of the reader. By applying information visualization, it is hoped to gain knowledge about the structure of single documents and the relationship between different documents more easily. Notable papers in this area are [Weber, 2007, Huang et al., 2005, Rohrer et al., 1998, Wattenberg and Viegas, 2008]

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