Focus Group Methodology for Evaluating Information Visualization Techniques and Tools

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Abstract

This paper proposes a structured methodology that uses focus group interviews to evaluate Information Visualization techniques and tools. Focus groups are particularly suitable for the collection of qualitative data from users, and allow researchers to uncover unexpected problems that cannot be identified through analytical evaluations or controlled experiments. The approach relies on open-ended questions to explore user attitudes, feelings, and beliefs, but also indicates a number of questions designed to explore specific cognitive tasks related to Information Visualization systems. We argue that focusing the discussion on cognitive tasks allows for the generation of user comments that are more effective than informal and unstructured interviews.

Keywords: **empirical evaluations, focus group.**

1. Introduction

Over the last decade, researchers have proposed numerous techniques and tools in the area of Information Visualization (InfoVis). A number of solutions (such as Spotfire and Inxight) have moved out of the research laboratories to become commercial products. However, the number of prototypes that had a follow-up into a real application, when compared with other disciplines, is extremely low. The reason for this difficulty in transferring an InfoVis solution to a commercial product could be related to the difficulty in conducting evaluations and judging the utility of visualization systems.

The evaluation of an InfoVis technique or tool is a challenging task. This is because it is often difficult to construct experiments or observations that give definitive quantitative answers regarding a particular visualization. Each newly proposed technique and tool should be evaluated with its intended users in mind. In assessing a system, we must determine what aspects of a visualization system provide a value, as well as how and why [12]. In fact, less than 20% of the authors of InfoVis systems report user evaluations [4], reflecting the level of difficulty for researchers in terms of conducting evaluations for this type of application.

The lack of a systematic approach to the evaluation of an InfoVis application was reported during the panel session of the IV04 Conference and also by a number of prominent researchers [2][11]. Recently, a workshop was dedicated to this thematic (BELIV'06, held in Venice on 23 May 2006 [1]), showing that, finally, researchers in the InfoVis domain acknowledged the need for standard, accepted evaluation techniques appropriate for this sort of application.

In this paper, we briefly present the most common evaluation methods undertaken with an InfoVis application and propose a systematic approach for evaluating the InfoVis tools' utility through the use of focus groups with some representative users.

2. Evaluation Methods

Current evaluation practices regarding InfoVis techniques and tools are based on methodologies established in Human Computer Interaction (HCI). They fall into two categories: analytic evaluations and empirical evaluations.

Analytic evaluation methods come from psychological models of human information processing and are based on studies of human cognition and behaviour. They are performed with expert-based methods such as *heuristics evaluations* (where an expert evaluates an interface and judges its compliance with recognized usability principles called "heuristics"), or *cognitive walkthroughs* (where an expert walks through a specific task using a prototype system, thinking carefully about potential problems that could occur at each step) [13]. They are also used to evaluate usability and accessibility issues. Analytic evaluations usually occur during the system's design and are oriented to identify problems and guide modifications during the development of a system.

Empirical evaluation methods (also known as *user studies*) involve real users in the study and allow designers to obtain qualitative and quantitative data. Usually they are performed with systems already implemented (in the form of prototypes or demonstrators), as they are suitable for making formal claims. Empirical evaluations can be further distinguished between quantitative studies and qualitative studies.

Quantitative studies consist of an analysis of determinate hypotheses tested through direct measurements [3]. Examples of such hypotheses can be the user's performance in relation to a specific task, or

the number of trials required in order to accomplish a specific task. This requires the definition of one or more variables related to the hypotheses examined and a metric associated with each of them. The evaluation is carried out usually by means of *controlled experiments* (also known as *experimental studies*) [7]. They consist of asking the user testers to run a task, performing some measurements using observation methods, and completing the study with questionnaires or interviews.

Qualitative studies can also be quite useful for the empirical evaluation of user-centred systems. Qualitative research involves the analysis of qualitative data, which may be obtained through questionnaires, interviews, and observations of users using the system, in order to understand and explain social phenomena. They are complementary to quantitative methods used in experimental studies for their ability to analyse phenomena from the point of view of the participants, which it is largely lost when textual or analytical data are quantified [8]. *Interviews* are a form of qualitative research that can be conducted with users, asking specific questions to elicit information about users' impressions and general comments. *Focus groups* [9][6][10] are another form of qualitative research that involve group interviews of individuals selected and assembled by researchers; they discuss and comment on, based on personal experience, the topic that is the subject of the research [5]. In InfoVis, both focus groups and interviews can be appropriate for detecting the users' opinions about the usefulness of the proposed graphical representations. These are less formal than in a controlled experimental study, but have the advantage of getting the user's viewpoint directly and "*may reveal issues which have not been considered by the designer*" [5](p. 431).

3. Focus Groups

A focus group is a powerful social interviewing technique that allows researchers to elicit several viewpoints from users at the same time. Users' comments can be obtained very quickly, and the social discussion allows participants to use, reflect on, and comment on the ideas of others. A focus group is conducted by bringing together representative users to discuss their issues and concerns about the features of the system being evaluated. The discussion is led by a moderator whose role is to facilitate the interaction between group participants and to keep them focused on the topic of investigation.

3.1 Why use focus groups?

This investigation technique is useful because "*attitudes, feelings, and beliefs ... are more likely to be revealed via the social gathering and the interaction which being in a focus group entails*" [5]. Compared to other investigation methods, such as observation, interviews, or surveys, focus groups are particularly suitable for the challenges specific to InfoVis, such as "*formulat[ing] and answer[ing] questions [users] didn't anticipate having before looking at the visualization*" [11] (p.111). With focus groups, evaluators have the opportunity to collect qualitative information that can be used to identify what worked and what did not, and more importantly, why.

3.2 Advantages, limitations, and issues of focus groups

Focus groups were first used in the world of marketing to evaluate potential customer response to new products. Now they are being adopted in other domains to identify user needs and feelings that might be missed through other methods of assessment. The main advantages of focus group are as follows:

- Focus groups provide qualitative data more quickly, and they are more cost-effective than other methods;
- Researchers may interact directly with participants and obtain rich data in the participants' own words. This also gives them the opportunity to clarify the responses, follow-up questions, and receive contingent answers to questions; and
- Focus groups allow respondents to react to other group members, and to generate new ideas that might have not been uncovered in individual interviews.

Although focus groups offer interesting advantages, they have some limitations as well:

- Responses from group members are not independent of one other. Also, the small number of participants may limit the generalisation of the research;
- A dominant member of the group may bias the result, and more reserved members may be hesitant to talk;
- The open-ended nature of the responses make the analysis of the result difficult; and
- A skilled and experienced moderator is needed for an effective research study.

4. Designing a focus group for evaluating InfoVis tools

In a focus group, a number of open-ended questions are asked in such a way to trigger discussion among the participants.

To help the researcher in adopting this technique and obtaining useful comments and feedback from users, we propose a structured process that will be described in the following sections.

4.1 Preparing for the interview

Like other evaluation techniques, an effective focus group requires thorough preparation. In particular, it includes the following steps:

- Establish the research objectives.
- Identify and recruit participants.
- Design the questions to be used in the study.
- Plan the sessions.

Research Objectives

The first step of the process is to define the research objectives. As the focus group is powerful in obtaining qualitative information on the attitudes, feelings, and beliefs of the users, some possible research objectives could include the evaluation of the functionality and the usefulness of an InfoVis application. A good evaluation elicits both open-ended, unstructured user comments and user opinions on questions distilled by the moderator. Also, InfoVis applications have some specific tasks that might be worth exploring. For this reason, we suggest structuring a focus group into two parts. The first part will be dedicated to exploring more open-ended, generic questions on the usefulness of the system, and the other part will be more oriented towards exploring the cognitive tasks of InfoVis applications. Details on the two parts are specified in the following sections.

Participants

Each interview should involve a number of representative users of the system. In the literature, there is no universal indication about the recommended number of people per group. Even though some authors give precise suggestions about group size (Krueger [9] recommends 7 to 10 participants, and Morgan [10] suggests a range of 4 to 12 participants), we have to acknowledge that a small number of participants per group might lead to a partial analysis, so we suggest having at least 6 participants per group. Each session should last between 1 and 2 hours, and should cover a range of 6 to 10 different key topics.

As a group with highly different characteristics might lower the quality of the data, we suggest conducting multiple interview sessions to get a cross-section of views from participants with different backgrounds and skills.

For instance, one session with the focus group may involve a discussion with the experts of the field in which our visualization will be used. It is important to involve experts who have extensive experience with the use of InfoVis. The second session may invite people with strong knowledge of the field of interest, but who are familiar with the use of graphical interfaces. It is useful to have a complete overview of the problems with the graphical representations and of any particular need the users may have.

Questions

To maximize the effectiveness of the evaluation, researchers need to focus the questions on the research objectives.

It is advisable to divide the interview into two parts. In the first part, the moderator will ask some questions regarding the participants' general impressions. He/She will ask a question about the benefits they may have when using the representations, and about the usability problems they might encounter when using them. The second part of the discussion will focus the discussion on a series of questions that concern specific cognitive tasks that are involved in InfoVis tools.

4.1 Part one: Introducing the focus group

The first few moments in a focus group discussion are critical. In a short time, the moderator has to create a thoughtful, permissive atmosphere. After an introductory explanation about the aim of the interview and about the purpose of the study and its role, it is very important to formulate some open questions to encourage debate. To this aim, the moderator will show the visualizations on a large screen and the participants will be asked to discuss that representation.

At this stage, the moderator may ask some questions about the possible use of the visualization (useful to better understand the needs of the users), or questions about the possible usability problems users may encounter when using that system.

The questions could include the following:

- What kinds of activities would you use this representation for?
- Do you find this representation useful? If so, why? Would you be interested in having this information displayed for some of your activities?
- What kind of information can you gather from these images?
- Do you think it should be presented differently? If so, how?

To help the researcher with the analysis of the discussions, it is advisable to record the sessions on videotape. This will provide a complete record of the session, and it will also capture all the verbal and nonverbal behaviours.

4.2 Part two

The second part the research aims to explore the cognitive tasks the user performs with InfoVis applications. Such tasks are well known, but only a few authors explicitly explore them in the evaluation of InfoVis applications. Weherend and Lewis [14] defined a number of domain-independent operations that a user might need to execute to analyse data. These operations will be used to keep the interview focused on specific cognitive aspects of InfoVis application. These are:

- Locate
- Identify
- Distinguish
- Categorize
- Cluster
- Distribution
- Rank

- Compare
- Associate
- Correlate

Each of these tasks will be presented with a description and sample questions that the moderator can ask the subjects during the discussion.

1. *Locate*

Description: the user is able to find something that he/she knows already and indicates it by pointing at it or describing it.

Examples:
- Can you identify a particular object that you knew before looking at this representation?
- What do you suggest to improve the identification of items in this representation?

2. *Identify*

Description: similar to locate, but the user is able to locate an item without previous knowledge of it.

Examples:
- Can you identify a particular object in this visualization that you didn't know before?
- Which graphical propriety helped you in identifying this object? Do you think this should be represented differently?

3. *Distinguish*

Description: the user is able to distinguish among the different items in the datasets.

Examples:
- Can you distinguish among the different objects in the dataset?
- What visual items are not clear in this representation?
- Is there any object that is not captured in this representation?

4. *Categorize*

Description: the user is able to identify divisions of item categories using visual objects.

Examples:
- Can you describe the object categories?
- What are the problems that you encountered in the categorization of the data?
- Do you think that this representation helped you to classify the data?
- What do you suggest to improve the categorization of data in this representation?

5. *Cluster*

Description: the user is able to find a cluster of items (if any). They can be identified by items that are linked or grouped together.

Examples:
- Are you able to identify any groups/clusters of data in this representation?
- What sort of problem do you think you will encounter in finding clusters with this graphical representation?
- What do you suggest to improve the understanding of clusters in this representation?

6. *Distribution*

Description: the user is able to characterize the distribution of an attribute's values over the set of data cases.

Examples:
- Do you think that this representation gives you a clear picture of the distribution of the objects and their values over the whole set?
- What are some of the problems that you might encounter when characterizing the distribution of the objects in this representation?

7. *Rank*

Description: the user is able to indicate the order of the items displayed according to some metric.

Examples:
- Can you see an ordering of the objects represented?
- Do you understand the metric according to which the objects are ranked?
- Would you like to have other instruments to rank the objects?
- Would you want to order the objects with a different criterion?

8. *Compare*

Description: the user is able to compare similar entities or different sets of items.

Examples:
- Do you feel that this representation gives you the opportunity to make comparisons between similar objects?
- Do you feel that this representation gives you the opportunity to make comparisons between different sets of objects?

- Do you feel that this representation allows you to have a clear picture of the relations between objects?
- Do you feel that this representation underlines the most important relationships?
- Do you have some suggestions to improve the comparison of objects in this graphical representation?

9. *Associate*

Description: the user is able to form relationships between the items displayed.

Examples:
- Can you identify the relations between the objects represented?
- Do you feel that this representation gives you the opportunity to better establish relationships between objects?
- What do you suggest to improve the understanding of relationships in this representation?

10. *Correlate*

Description: given two attributes of the dataset, the user is able to determine whether there is a relationship between the values of those attributes.

Examples:
- Is there any correlation between the values of these objects?
- Is there any relationship that can be gathered but is not captured very well in this representation?
- Do you feel that this representation gives you the opportunity to identify new relationships?

Conclusions

In this paper, we introduced a systematic approach to evaluating InfoVis applications using the qualitative data collected from focus groups. This interview technique is used successfully in marketing and social sciences, and can be adopted to evaluate some aspects of InfoVis applications.

The evaluation of an InfoVis technique or tool may address different criteria, namely: functionality, effectiveness, efficiency, usability, and utility. The most commonly used techniques (e.g., controlled experiments, heuristics, and cognitive walkthroughs) aim to evaluate the effectiveness, efficiency, and usability of the proposed representations. However, the users will have a real advantage over the graphical representations only if the information provided is useful to them. The focus group, and, to some extent, the individual user interviews may be appropriate to investigate this aspect. Focus groups may uncover potential problems and suggest improvements that would not have been revealed with other analytic and empirical evaluation techniques.

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