From Theory to Usage: Requirements for successful Visualizations in Applications

[Extended Abstract]

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ABSTRACT

Visualizations are a powerful tool to solve various tasks in different applications. Although a huge variety of visualization techniques are constantly published, only a few of them end up being used in real world day-to-day operations. To identify the reasons for this observation, this work aims at summarizing the criteria, that promote a real world application of a visualization tool.

Keywords

Requirements Design, User-centered Visualization

1. INTRODUCTION

Various visualization techniques are constantly published in the visualization community. Although some of them became very popular in the academic world, very few of them are used in real world scenarios. In addition to that, there exist applications where visualization techniques are used that are clearly outdated or are proven to provide suboptimal results compared to recently published techniques.

Although the distribution of a visualization is also dependent on various economic factors, the question this work tries to answer is: *What requirements need to be fulfilled by a visualization in order to be used in real world applications?* This work shows examples on how visualizations are used in real world scenarios and combines this knowledge with existing requirements for suitable visualizations. As a result, this paper provides a list of requirements and its contributing factors that need to be fulfilled to use visualizations in real world applications.

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2. METHODS

To develop a list of requirements a short questionnaire (see Appendix A) was handed to users in six different application domains. The questionnaire provided questions regarding the type of visualization that is used in the domain and how well it is perceived. Based on the feedback (see Appendix B) and the collection of state of the art knowledge on successful visualization design [5, 9, 12, 3], it was possible to identify five groups of requirements and their components (see Figure 1). The following section will explain in detail what the implications of each of them are with respect to visualization.

Usability.

Usability [11, 2] refers to a low degree of difficulty for using a visualization. Therefore, the visualization has to address the workflow that is common in a given scenario [4]. In addition, the usability increases if the number of input parameter is low or ideally zero. Daily usage of a visualization requires efficient use which is not compatible with a significant amount of time spent on adjusting input parameters. Furthermore, the visualization has to avoid clutter to be usable. Additionally, the approach needs to be interactive in order to introduce a high degree of usability. At last, visualizations need to allow a collaborative use to be applied to team or demonstration tasks.

Efficiency.

Efficiency [7] means a low consumption of resources which covers computational time, memory usage and usage time. As resources can be very costly, this is an important property. In addition to that, hardware solutions in application have usually lower capacities as research setting, which needs to be addressed by the visualization.

Correctness.

The correctness [6] of a visualization means the accurate visual representation of the used dataset as well as the possibility to express their quantitative properties. In addition, the communication of uncertainty is required to achieve a

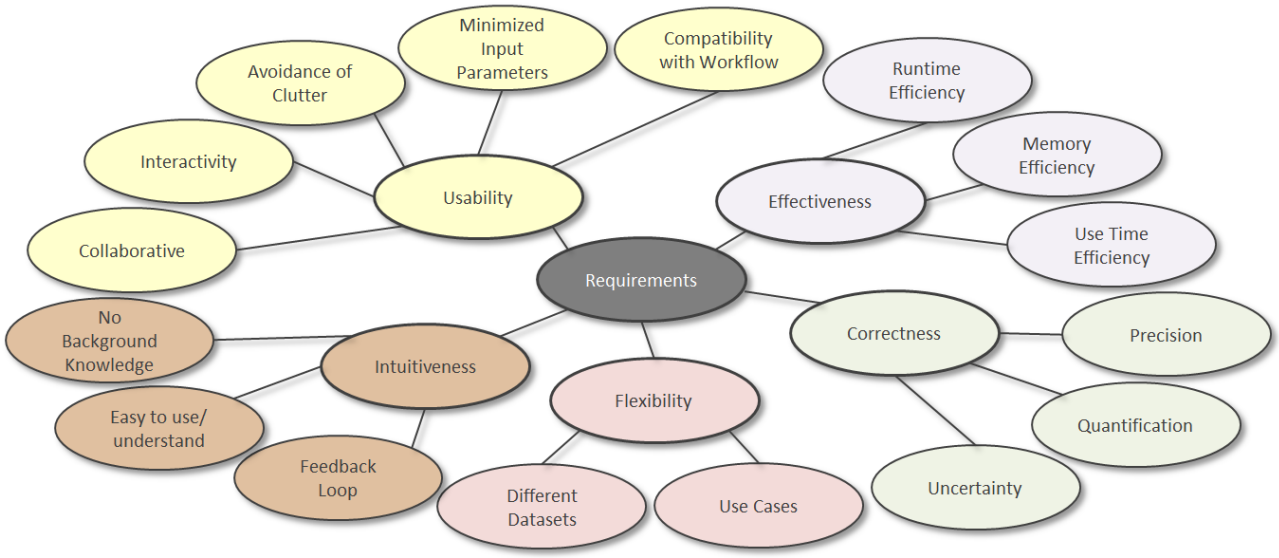

Figure 1: Requirements for successful visualizations in applications. They are categorized into 5 groups: Intuitiveness, flexibility, correctness, effectiveness and usability. Each of them contains several components that contributes the requirements.

high user acceptance [1].

Flexibility.

To make a visualization flexible [8], it needs to be applicable to different tasks of an application. In addition to that, the visualization requires the ability to visualize the common type of datasets in the targeted application.

Intuitiveness.

To make a visualization intuitive [10], a user needs to be able to understand it without the need for deeper background knowledge about the visualization procedure. Consequently, this directly implies that the visualization needs to be easy to understand. In daily solutions, new visualization will not be applied, if the initial learning time is too long. In addition to that, intuitiveness requires a feedback loop between the input dataset and the resulting visualization.

3. CONCLUSIONS

In summary, this paper states a list of requirements, that need to be fulfilled in order to achieve a real world use of a visualization techniques. To identify these requirements, users from different applications were invited to participate in an evaluation. The resulting list of requirements was completed with known requirements for high quality visualizations. Although there exist further factors that influence the decision of users for visualizations, the presented list is a initial set of properties that have to hold for a successful application of visualizations in daily scenarios.

4. ACKNOWLEDGMENTS

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APPENDIX

A. QUESTIONNAIRE ON USED VISUALIZATIONS IN DIFFERENT APPLICATIONS

The following questionnaire was handed to users from different applications, in order to identify requirements for for successful visualization in applications.

The goal of this evaluation is to investigate the fashion different users of various applications are making use of visualization techniques. The question that we want to answer is: which tasks are solved with which visualizations and why was a specific type of visualization chosen. Please note, that your data is anonymized and only used for this study. Thank you for participating.

1. General Information
   (a) In which field are you working?
   (b) How long are you working in that field?
   (c) How much knowledge do you have about visualization techniques (basic, intermediate, advanced)?
   (d) Is visualization a common tool to solve your tasks?
2. The use of visualization in your field
   (a) What kind of tasks are you solving with visualization*?
   (b) What type of visualization are you using?
   (c) Have you been involved in the choice of the visualization?
   (d) What are the benefits about the visualizations you are using?
   (e) What are the drawbacks?
   (f) What would a new visualization have to make better to replace your current one?

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* With visualization we refer to any kind of visual representation of data, which covers images, graphs, networks, tables, timelines etc.

B. RESULTS OF THE QUESTIONNAIRE

The following section presents the answers that where stated by participants of the questionnaire.

Table B presents the results of the first part of the questionnaire. The questionnaire was answered by 6 persons from different applications, covering medicine, teaching, engineering, architecture, product service management and physics. All applications differ from computer science and especially the visualization area. Therefore, this gives an impression how visualizations are used in real world scenarios. Most of the participants work in their field for more then 10 years. Except for person E, all users claim, their experience as medium or basic. Interestingly, except for one case visualizations seem to be a common tool, although the users claim not to be experienced with visualizations.

Table B presents the answers received from the questionnaire. The tasks users are trying to solve are varying and therefore, the used visualizations alter depending on the application. The questions 2 a), b) and c) targeted to understand the fashion on how users apply visualizations in real world scenarios. The answers of the participants show, that the presented requirements are an important factor when it comes to the choice of a visualization. The different requirements are colorcoded according to the scheme from Figure 1 in Table B. It can be observed, that the five groups of requirements are mentioned by the participants of the study, therefore hinting their correctness.

	a)	b)	c)	d)
1	Orthopedic surgery	15 years	Basic	Yes
2	Language teaching	15 years	Basic	Yes
3	Training and support of computer aided design	11 years	Advanced	Yes
4	Architecture	10 years	Intermediate	Yes
5	Product-Service Systems	3 years	Basic	No
6	Neutrino physics and satellite based experiments	3 years	Basic	Yes

Table 1: Results for the first part of the questionnaire.

	a)	b)	c)	d)	e)	f)
1	Complex fracture treatment	Computed tomography scan	No	Deeper knowledge of data, more views	Higher image quality means higher ray doses	Better visualization while having lower dosis
2	Teaching tasks	Charts, timeline	Yes	Intuitiveness	Missing standardization	Higher effectiveness, higher quality
3	Demonstration tasks	Collaborative visualizations	Yes	Share knowledge	No	None
4	Design analysis, communication	Images, videos, models, graphs	Yes	Usability	Slow computation	Incorporate new media, easier access, easier to understand
5	Modeling of a production process, present quality gaps, results of a survey, show trends	Graphics and timelines	No	Easy and fast to use	None	More information in one visualization and higher usability
6	Analysis of simulation results	Graphs	Yes	Easy to understand, fast use	No uncertainty addressing, no importance highlighting	Different scales

Table 2: Results for the second part of the questionnaire. The answers given for questions d), e) and f) are visually highlighted according to the requirement that was addressed.