

Designing across Human Abilities and Map Use Contexts

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ABSTRACT

This paper raises a number of research challenges with respect to the theme “designing across human abilities and map use contexts”, namely “context-aware visualization of spatial information”, “multi-sensory communication”, “advances in interface technologies”, “personalization and privacy issues” and “side effects”. We formulate important research questions within each challenge.

Author Keywords

Map Use; Visualization; Context-Awareness; Multi-Sensory interfaces; Side Effects

ACM Classification Keywords

H.5.1 Multimedia Information Systems: Hypertext navigation and maps; H.5.2 User Interfaces: Graphical user interfaces (GUI), User-centered design; H.5.4 Hypertext/Hypermedia: User issues

INTRODUCTION

Maps and geospatial technologies have become more and more ubiquitous in many aspects of our daily life, ranging from traditional fields like urban planning, resource management, and disaster management, to personal fields, such as activity planning in space over time, information seeking on the Web, decision-making, and entertainment and leisure. In recent years, we have also witnessed big companies like Google and Apple having a strong interest in map-related applications. This is not surprising, as many of our decision-making and activities are geo-related, and maps remain the most popular and powerful communication language of geo-referenced information.

On the one hand, this trend and increasing application demands of maps offer great opportunities to the discipline of cartography and GIScience, which make the discipline active, attractive, and relevant to the society. On the other hand, they also bring many challenges to the discipline. For example, currently, users of maps are not only professional and expert users anymore, but also general public, whose knowledge and abilities are diverse. In the meantime, with the rapid advances in Web and mobile communication technologies, the contexts maps are being used are far more diverse than before. Currently, maps have been used for different tasks and activities, e.g., from urban planning to personal navigation applications, and in different contexts, e.g., from stationary to dynamic mobile environments. Additionally, the output media or devices to render maps or

communicating spatial information are rapidly changing. In recent years, papers and desktop computers are not the only media anymore, instead mobile devices such as tablets, smartphones and wearable devices (such as smart watch, digital glasses) are becoming more and more popular, and even become the major platform for map applications. All these changes in users, map use context, and output media challenge the discipline of cartography to define and offer (improved or new) principles, rules, methods and techniques that can be used to design and create usable map applications meeting users’ information needs.

This position paper aims to provide a personal view on the research challenges relevant to this theme “Designing across human abilities and map use contexts”. We identify 5 essential challenges: 1) context-aware visualization of spatial information; 2) multi-sensory communication of spatial information; 3) advances in interface technologies; 4) personalization and privacy issues; and 5) side effects. The next section introduces each of these challenge.

SELECTED RESEARCH CHALLENGES

We argue that the main aims of maps or map-related applications (such as location-based services (LBS)) are to communicate spatial information to facilitate users’ decision-making and activities. To provide effective communication, it is essential to understand the users and their contexts, the technical constraints and opportunities brought by the interface media and devices, and the impact of these aspects on cartographic design.

The following list is not intended to cover all the research challenges within this theme. We put the focus especially on mobile applications to reflect the fact that mobile internet usage became dominant since February 2014[1].

Context-aware Visualization of Spatial Information

Due to the diversity of map users, map tasks and map use contexts, there is no more “one-for-all” solution for visualization of spatial information. In order to ensure the usefulness (utility and usability), maps and map-related applications should be adapted to their users, tasks, and the contexts maps are used. In other words, context-aware visualization of spatial information is needed.

To provide context-aware visualization, several essential issues should be addressed. Firstly, a systematic framework to study map users and map use contexts, as well as their information needs should be developed. There are still many open problems within this topic. For example, it is still unclear how map use contexts can be modelled and

described, how map users and their characteristics can be classified, as well as how far can map users' information needs be categorized and formalized. Secondly, techniques to provide context-aware visualization are needed. The overall question is "how can we transform users' information needs and other constraints (technical and cognitive) to cartographic design decisions". For this, it is important to understand "which map contents and presentation styles are relevant for which communication goals and which contexts" [3], as well as "which cartographic design patterns, techniques and rules are needed to implement these map design".

Multi-Sensory Communication of Spatial Information

While traditional cartographic products (i.e., maps) mainly communicate spatial information via human sense "sight", recently cartographers have started to explore the possibilities of using other human senses, e.g., hearing and touch (haptic), especially in the context of LBS. Furthermore, new forms of visualization, such as 3D, virtual reality and augmented reality, are being developed. However, a systematic understanding of strengths and weaknesses of these visual, sound, and tactile variables, as well as when they might be suitable to apply is still missing. Since they all have strengths and weaknesses, it is also essential to study which and how they can be meaningfully integrated to effectively communicate spatial information.

Advances in Interface Technologies and Devices

Recent years have seen a range of new interface technologies and devices being introduced for cartographic representation and communication of spatial information, such as smartphones, wearable devices like smart watch and Google Glass, haptic devices, and public displays. These kinds of devices often have their own characteristics, interaction modalities (e.g., voice, gesture, gaze based interaction), and technical constraints. To make use of these new technologies, conventional cartographic expertise (such as cartographic techniques, rules, and their relative priority), which was optimized for paper maps and maps on desktop computers, should be improved, updated, and even re-defined if needed. The rapid advances in interface technologies also bring challenges to usability studies, as new methodologies are often needed due to the different nature of interface technologies and devices.

Personalization and Privacy Issues

Recent years have seen an increasing interest in personalizing maps and map-related applications to individual users. Map personalization, i.e., tailoring maps to individual users' characteristics, preferences, and needs, is a very promising technique to effectively communicate spatial information, and increase users' satisfaction. Map personalization depends on the gathering and use of personal user information. From a technical perspective, to enable map personalization, questions like "how can user characteristics and preferences be inferred and modelled?" and "how should the appearance of maps be adapted to users' characteristics, preferences background, and

cognitive constraints?" should be answered. Furthermore, map personalization also brings some privacy concerns, as it relies on users' personal information. It is not surprising that many people are afraid to use the new Google search engine and Google Maps, as they contain lots of information about what people searched and browsed before, as well as where people have been before. How can we personalize maps while accommodating users' privacy concerns remains an open question.

Side Effects

Maps and map-related applications are becoming more and more popular and have entered into general public's daily life. For some of map-related applications, such as LBS and mobile navigation systems, we can see many people are relying on them when travelling around. While these kinds of applications facilitate people's daily activities and decision-making, they potentially bring some detrimental effects. As mentioned by [4], "technologies change how we think, often by reducing our ability to reason effectively without the technology". Therefore, there is a strong need to understand the potential side effects of over-reliance on these technologies. There are several initial studies towards this direction, and they show that over-reliance on navigation systems actually harm our spatial ability and spatial knowledge acquisition (see [2]). However, until now, a systematic understanding of these issues is still missing, and very challenging, as it requires long-term longitudinal empirical research. Another more important question is "how can we design technologies that facilitate people's activities and decision-making without harming their spatial abilities". This still remains an unexplored field.

SUMMARY

Recently, there is a trend towards designing maps and map-based applications to accommodate the diversity of map users, map tasks, and map use contexts. As introduced above, many research challenges exist within the theme. Many of them cover multi-disciplinary aspects, therefore it is important for cartographic community to work with other disciplines to address these challenges.

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