Geovisual Interfaces To Find Suitable Urban Regions For Citizens: A User-Centered Requirement Study

Chandan Kumar
University of Oldenburg
Oldenburg, Germany
chandan.kumar@offis.de

Wilko Heuten
OFFIS - Institute for
Information Technology
Oldenburg, Germany
wilko.heuten@offis.de

Benjamin Poppinga
OFFIS - Institute for
Information Technology
Oldenburg, Germany
benjamin.poppinga@offis.de

Susanne Boll
University of Oldenburg
Oldenburg, Germany
susanne.boll@uni-oldenburg.de

Daniel Haeuser
University of Oldenburg
Oldenburg, Germany
daniel.haeuser@uni-oldenburg.de

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Abstract
Geographic retrieval and visualization systems are essential to satisfy user's spatial information needs. However, the end users spatial information need is much more diverse and demanding in complex decision making scenarios such as: Persons moving to a new area need information about which place meets their individual demands. To analyze such requirements, we conducted a study with 18 users of different age group, knowledge, and expertise. In this paper we report the study methods, results, analysis and insights to build an end user-friendly geospatial decision support system.

Author Keywords
Geo-Visualization, Geographic Information Retrieval, Human-Computer Interaction

ACM Classification Keywords
H.5.2 [Information Interfaces and Presentation]: User Interfaces

Introduction
Geo-related information is one of the basic needs of citizens to understand the local infrastructure and to satisfy their spatial information requirements [1]. Nowadays, there are a lot of different services, like Google Maps, which provide a variety of different geo-related

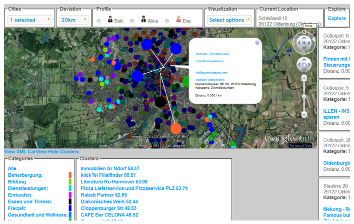

Figure 1: A screenshot of the demo prototype shown to experts

information and thereby aim to support the citizen. Until now, most of these services are only able to serve comparably simple requests such as 'Restaurants in Berlin'. However, in the current information age, the spatial information need of an end-user could be much more complex. This is particularly true for persons that are facing a complex decision-making task, e.g., somebody who has to move to a new place and is looking for a new flat. In this example the user will come up with a variety of different requirements and constraints, and the results provided by a system will lead to vital spatial decisions.

Visual analytics is a domain which aims to provide a better overview and exploration capabilities to support such decision-making tasks [2]. However, most of the visual analytical models support business-oriented decision-making, and existing interfaces come with specialized methods and interaction techniques to be operated by trained specialist. In this paper, we focus on the requirement analysis of geovisual interfaces with end-users. The more generic problem of user-centered analysis have been well investigated in visualization and human-computer interaction research [4, 2]. Lloyd et al. [3] reported requirement analysis of geovisualization tools with the team of research officers working in crime and disorder reduction. However, in this work we explore geovisualization needs for the multi-criteria search task of everyday users of local search applications. To do so we conducted two user studies with some multi-criteria spatial decision scenarios, where we gathered expert opinions and investigated the lay user needs.

User Study Methods

9 experts, of which 6 were male, participated in the first study. They were aged between 26 and 39 (mean 32.67, SD 4.33). All experts were working in our research lab or at the local university as HCI/Retrieval/Visualization researchers. 9 lay users (6M, 3F) participated in the second study, aged between 22 and 63 years (mean 33.33, SD 15.53). 6 users were full-time employed and 3 were students at the local university.

We met with the experts in an office in our research lab. We tried to cover as much potential end-user scenarios as possible. We asked each expert to name the important criteria and aspects if *a)* s/he would like to move to a different city, *b)* s/he would like to open up a business in a city, *c)* s/he would like to compare two different cities. Then we asked each of the experts on how an ideal user interface for these tasks could look like. Thereby, also non-stationary devices could be considered. Experts were allowed to draw sketches with pen and paper. We then asked them to reflect on how they use existing tools, like Google Maps, for these scenarios and if they fulfill their needs. Ultimately, we confronted them with an early prototype of our semi-functional decision support system (see Figure 1) and asked them to share their thoughts by thinking aloud.

The lay users were recruited from the personal environment of one of the authors. We gathered some basic information, like age and previous experiences with computers and the internet. We asked the lay users to imagine that they have to move to a new city. Then, we asked them to name and prioritize the criteria of relevance for finding a new home. We then asked how they would solve this task nowadays and with existing tools and services. Further, we were curious what would be of particular importance if someone decides to design and develop a support tool from scratch. Finally, we confronted them with two web-services, which support a similar task, i.e., Hipmunk (see Figure 2) and WalkScore

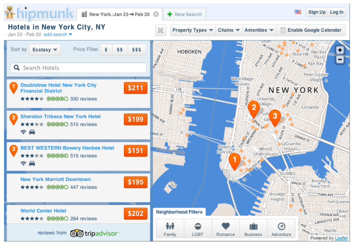

Figure 2: A screenshot of the Hipmunk hotel search.

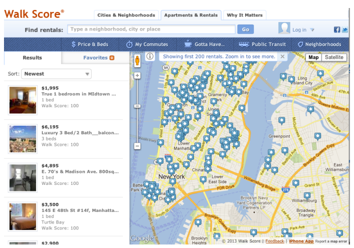

Figure 3: A screenshot of the WalkScore apartment search.

(see Figure 3), and asked what they liked and disliked in these systems.

User Study Results

We asked the lay users to state their most important criteria that they would consider if they had to move to a new city. In total we collected 48 different criteria. The five most frequent categories are visualized in Figure 4. The expert's requirements were also in parallel to the overall list of categories mentioned by the lay users, nevertheless the order or ranking of expert's criteria differs somewhat, e.g., public transport, medical facilities, shopping etc. Nowadays, 8 of the 9 lay users would consider either Google Maps or Google Earth to get an initial overview on where individual facilities, like supermarkets and bakeries, are located. 3 of them would go to the region of interest and have a look on their own. Also 3 users would ask friends who know the environment well or are living close to it.

We asked the lay users to give ideas on how an ideal geovisual information system should look like. Here, 8 of them said it is important to have an easy and intuitive interface. 5 users would like to have the application to be clearly structured and arranged. The experts did some useful sketching of their ideal interface, few experts especially wished context-biased and personalized results.

When the lay users were confronted with Hipmunk, 5 users instantly noticed and complained that the mouse wheel isn't used for any interactions. However, 5 of the 9 lay users used the so called 'neighborhood filters', which allow for a pre-selection after common criteria. When confronted with Walkscore, 5 participants were complaining about the huge amount of markers. However, they liked to add the various criteria to their search request and 4 participants thought that this would be handy in our to-be-developed system.

Discussion

The user study provided us with lots of inspiring ideas and insights for a geospatial decision support system. The user's requirements could be really diverse and dynamic as the participants had their very own criteria in mind while discussing the scenarios. All participants stated that existing tools and services are not sufficient to fulfill these tasks in a simple and easy way. We report our observations more specifically in the following subsections.

Information overload

One of the high points of our user study was the need for simplification in information representation, and most of the users wished for easy and simple visualizations. When the users were asked about the limitations of existing tools, they were concerned from overload of information from existing interfaces such as high density of markers and complexity of representation. The real-time geospatial data is high dimensional with multivariate and complex attributes so one of the basic need is to summarize this huge information via easy visualizations.

Categorical abstraction

One of the main observations of the study was that users tend to visualize the geo-attributes at low granularity. While being asked to list the important geo attributes for relocation, users mentioned the geo-relevance parameters with a categorical overview, e.g. shopping, education etc. The usual geo-data available to search systems are at the high granularity with the actual addresses of local entities. So the need is to represent the geovisualization of spatial databases with low level categorical abstraction to simplify the initial visualization for end users.

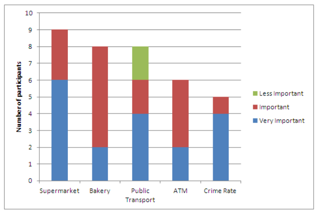

Figure 4: In total the lay users consider 48 criteria to find their new flat, of which the five topmost criteria are shown here. To live close to a *supermarket* was rated as most important criteria.

Social importance

Social importance of physically located entities could be one of the important factors of user's criteria selection for a geovisualization system. In several occasions users do not rely only on the editor's or website information of the local services and they would prefer to go through other community sources such as Tripadvisor, Wikipedia etc. to come up with a decision. They also considered that the opinion of friends and other people would certainly influence their decision making.

Designing for diversity

The requirements for individual users are diverse as their criterion of interest differs and especially how they weight these criteria. So the adaptability and dynamism of interface parameters would be important. The two variant study settings with expert and lay user groups had the general demand of simple and easy to use interfaces, however, the experts were much more relaxed (compared to lay users) about the complexity of information presentation. Experts do not mind more information and knowledge based support at the cost of simplicity. The other notable difference was experts' demand for 'context based support' when being asked on what is important to design and develop an ideal decision support system.

Conclusion

Existing end-user geo-information systems, like Google Maps, are unable to handle requests with complex constraints, e.g., if a user is looking for a new flat in walking distance to a supermarket and a kindergarten. There are expert systems, which could handle such requests for few static criteria, but these systems could only be operated after intense training. In this paper, we analyzed such multi-criteria information need of end-users through a user-centered study with 18 participants.

The participants agreed that existing tools and services often cause an information overflow and aren't able to satisfy their very individual information needs. Nevertheless, we found that the integration of multiple sources, particularly 'social platforms' would be helpful. Thus, the key challenge is to find suitable visualizations and interaction techniques that are informative and simplistic. We think that an information flow from low to high granularity, e.g., through pre-defined filter sets for certain end-user groups, could be helpful, and according interaction methods would be key to guide the end users through the facets of a decision-making process. In our future work we will use the gathered insights to design an end user-friendly prototype, which would eventually contribute to a geospatial decision support system.

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