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Geographic Relevance in mobile services

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ABSTRACT

In this position paper we describe the concept of geographic relevance and its potential for mobile location-based services employing the mobile Internet. We argue that existing LBS have a too limited concept of location and its application for filtering geographic content. We propose an approach for geographic relevance that extends LBS and location-aware web applications and aims at better supporting mobile users' decision-making based on geographic information. After a short description of an ongoing project we discuss the different roles of location and the different conceptions of space that can be involved in assessing and representing geographic relevance. Finally we provide a few concluding statements that aim at stimulating a cross-disciplinary discussion about location and its importance for relevance.

Categories and Subject Descriptors

H.3.3 [**Information Storage and Retrieval**]: Information Search and Retrieval – *information filtering.*

General Terms

Human Factors, Theory.

Keywords

Geographic relevance, location-based services, context-awareness, adaptive geoservices.

1. INTRODUCTION

Location has lately seen an increasing interest in the Web, mainly the mobile Web. In this paper we predominantly intend to contemplate and discuss issues of space and place in the context of the mobile Internet and web based LBS from a *geographic perspective*, well aware that there are other perspectives that focus more on the aspects of formal representation of location. Here, we reflect on the role of location in mobile geographic information retrieval and the relevance of the retrieved information.

Mobile usage of geographic information has recently increased due to affordable and powerful mobile devices, widespread availability of mobile network connectivity, and provision of spatial data sets. Accordingly mobile services employing geographic information, such as location-based services (LBS) or mobile traffic and tourism related services have been developed and deployed.

However, the usage of such services is still problematic, users' acceptance is low, and usage numbers behind market expectations. I see several reasons for these usage problems: the costs of such services are still very high; most services provide simple, isolated solutions and lack interoperability with other services that could provide richer solutions; many services lack utility due to information mismatch, inadequacy or irrelevance of information; most services do not provide a presentation of information adapted to the mobile Internet and thus lack usability caused by an information overload; services apply established representation and portrayal methods from stationary, desktop or web applications; the general direction of service development is too technology-driven instead of need driven; the focus of most LBS is on location only and they employ often too simple spatial concepts (e.g. buffers around the user's position as a binary information filter).

Clearly missing in most services, including LBS is the concept of relevance. Relevance is mainly responsible for the utility of a service for a user, but this concept and its implementation as relevance filtering, as well as the representation and visualization of relevance of displayed information in its own right is still neglected in research.

2. STATE OF THE ART

In information science, mainly in information retrieval (IR), including pragmatics relevance is a key concept [1-3]. It is closely related, even dependent on context, as pointed out in [4, p. 206]: "The intention in expression of relevance always comes from a context and is directed towards that context – the matter at hand. Relevance cannot be considered without a context".

In GIScience relevance has not been extensively investigated so far and if so, not so much in a comprehensive way. The shortcomings of classic information retrieval methods for geospatial applications have recently been addressed in many research projects and have lead to an extension termed geographic information retrieval (GIR). [5] define it as "the provision of facilities to retrieve and relevance rank documents or other resources from an unstructured or partially structured collection on the basis of queries specifying both theme and geographic scope." Other research focused on the fitness for use or relevance of geospatial data sets (e.g., [6]).

However, in most of this work, relevance is generally reduced to binary relevance, relevance for web retrieval of documents, relevance of data sets for specific applications, or spatial relevance only. Context-awareness is often reduced to determining the current position. A broader perspective on relevance, mainly for mobile geospatial services, is missing so far. Apart from spatial relations there are several other factors and challenges in mobile usage situations originating from physical environmental states, temporal constraints, mobile users' information needs and activities, technical limitations and many more that give rise to contextual information needs or may require an adaptation.

Geographic relevance is associated with a geographic information need [7]. It is associated with a spatial problem to solve, a goal to be achieved, or an activity to be supported. [7] distinguishes two types of information need: an intentional "need to know information" and task-related "informational support" type. [8] propose the following relevance filters for geographic information delivered to mobile devices: spatial proximity, temporal proximity, speed-heading prediction surfaces, and visibility. Also related to geographic relevance are well established concepts from time geography that offer models of spatio-temporal characteristics of human activities, their interactions, constraints, activity patterns, and accessibility. The usefulness for LBS has been demonstrated by [9].

3. GEOREL PROJECT

In a current research project on geographic relevance in mobile applications (GeoRel) we address some of the missing building blocks and try to establish a theoretic foundation. Within this research project we extend the idea of current LBS in the following ways:

1. Shifting the location-based perspective to a relevance-based perspective, including the spatial, temporal, topical, and motivational dimensions.
2. Considering the relation of information needs with information objects within the mobile usage context.
3. Exploiting geography as a unifying framework for a broader understanding of relevance by the nexus of location (where), time (when), and objects (what), i.e. geographic relevance.
4. Employing more sophisticated spatial concepts for filtering content than simple distance-buffer selections.
5. Developing suitable representations of geographic relevance within mobile services or applications.

The objective of the project is the development of methods and metaphors for assessing the geographic relevance of geospatial features for a usage context and its effective representation and visualization in mobile services. This includes efficient representations of relevance as a property of single objects or as conceptualizations as new, synthesized features, as well as representations of spatio-temporal constraints of mobility and activities, and of accessibility within the space-time prism.

Geographic relevance is investigated under the perspective of activity theory, since activities offer a structured and useful framework for the mobile usage context involving geographic (spatio-temporal), structural, and perceptional (visual) context. Also, it is these mobile activities triggering geographic information needs, questions or problems that should be supported by the concept of geographic relevance by offering relevant geographic information objects answering the where, what, and when aspects.

4. THE ROLE OF LOCATION IN RELEVANCE

Our approach to geographic relevance is guided by a basic assumption derived from the first law of geography [11]. Other things being equal we assume the shorter the distance in any relevance dimension (space, time, property, etc.), the more relevant an information object is in a given usage context. This becomes intuitively obvious, if we think of the potential of nearer objects to be either perceived, reached (accessibility), fit into existing information, or efficiently used in solving a problem or to be supporting an activity.

Figure 1 illustrates this idea with an example of two users standing at the same location *P*. User A is riding a bike and needs a bike store for replacing some parts of his brakes, whereas user B is looking for bookshops to buy a Christmas gift. The circle represents a buffer with a radius of 250m around the location. In LBS you would get only the two objects 1 and 2 for A and B accordingly. However for A objects 3, 4, and 5 are also relevant. Objects 3 and 4 are less relevant, since they are more distant from *P* and object 5 is even less relevant although it is closer than object 3 and 4, but the bike store represented by object 5 is still closed for another 15 minutes. For B object 7 is about as relevant as objects 3 and 4 for B, although object 7 is closer to P than object 3 and 4. This is because object 7 is less accessible for A who has to walk on foot. Similarly objects 8 and 9 are much less relevant for A as objects 3 and 4 for B.

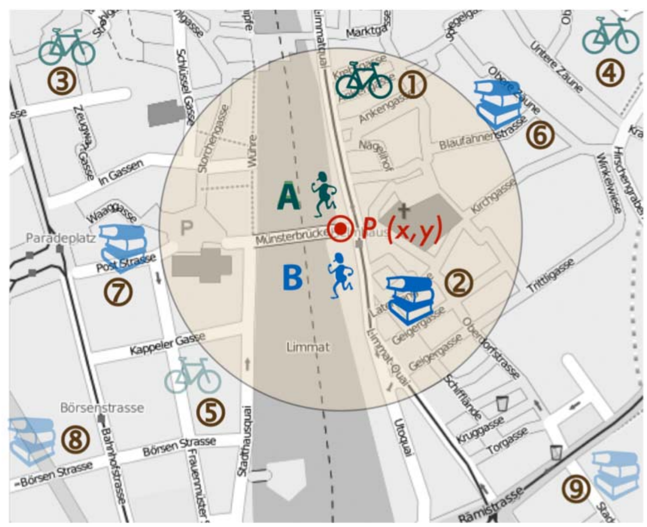

Figure 1. The role of distance for different users.

Since proximity is a crucial concept in geographic relevance, one major step in assessing geographic relevance is to find and establish appropriate distance functions and evaluate suitable methods for the integration of single relevance values (e.g. spatial, temporal, topical) into a compound that is holistic relevance concept for an information object. Previous work in that area has been done by [6, 8, 13].

Since location plays a central role in geographic relevance and particularly in defining appropriate distance functions it is important to contemplate the many aspects of location and the different conceptualizations of space (see Figure 2).

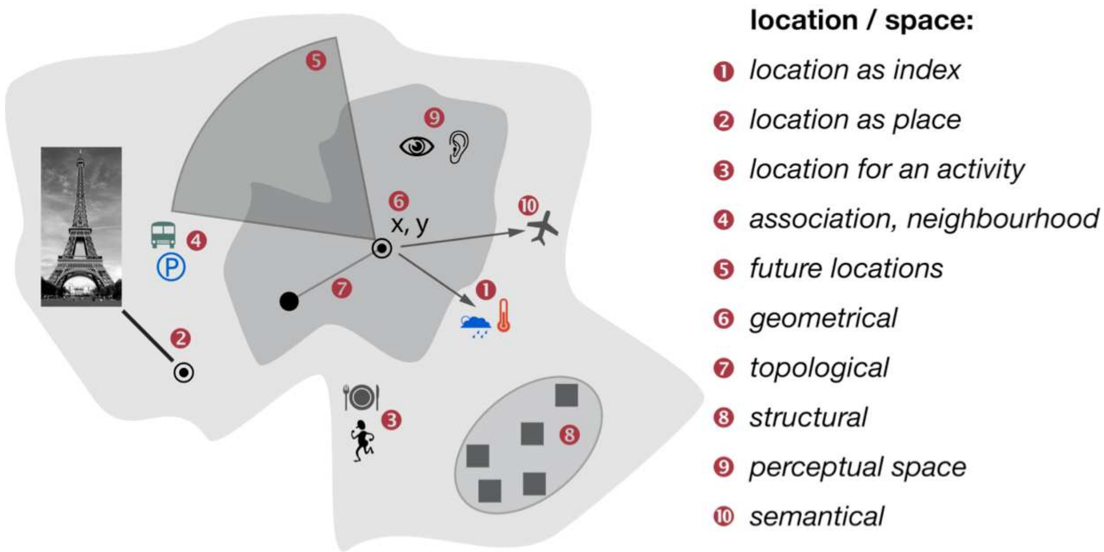

Figure 2. Different roles of location and conceptions of space.

4.1 Location as index

Location can act as an index to further context information that can be used to adapt a service and its information presentation. As illustrated in Figure 2 ❶ the location could for instance be used as an index to a weather service providing current weather data for that location.

4.2 Location as query parameter

Location can be used as one of the parameters of a mobile user query that can be handled by a location-aware web application or a LBS. Examples of interfaces to location are e.g. the W3C Geolocation API or the Open Geospatial Consortium OpenLS.

4.3 Location as information attribute

Location can also be an attribute of any kind of information on the web, e.g. geo-referenced web pages or images. The ongoing diffusion of positioning technologies leads to increasing numbers of spatially referenced information on the web that in turn can be accessed and/or filtered by LBS or location-aware web applications.

4.4 Location as place

Location in LBS and location-aware web applications is generally treated as a geometrical reference to space, commonly expressed as coordinates. However, users often think of location in space rather as places that have a meaning attached to them (see Figure 2 ❷). Places may also offer specific functions or afford certain actions. Location in a LBS or location-aware web applications can serve as a pointer to places or regions (e.g. by gazetteer lookup). Places and regions often build a hierarchy that can be used to acquire further spatial relations and knowledge from and allows to access information associated to a higher level for instance and link it to the place,

4.5 Location and mobile activities

As mentioned in subsection 4.4 certain places or regions afford or enable certain activities. Reciprocally and even more important for the relevance of information is the fact that mobile activities constrain places or regions (activity space). As illustrated in Figure 2 (❸) for the activity *dining*, one needs a place that offers the possibility to eat there and hence for instance locations of restaurants are more relevant than garment shops.

The distribution or pattern of geospatial objects in space can provide information about densities of objects or opportunities of places and regions to users, i.e. an area where the density of bars is significantly higher than in the rest would be more relevant for someone looking for one or two drinks.

Related to activities and space is the notion of accessible space, i.e. the parts of space that can be reached within a certain time. Certainly, the part of space that is not accessible within a reasonable time bound to a activity is less relevant for the user undertaking that activity.

4.6 Location and its neighborhood

Although a location in LBS or location-aware web applications already adds valuable information to be employed, considering the neighborhood of that location. Such an analysis of the neighborhood might identify associate places or regions as well as co-located objects (see Figure 2 ❹). As mentioned in the beginning of this section, distance and direction in space are important for assessing the relevance.

4.7 Location as predictor

The analysis of user locations over time can serve to predict likely future locations of the user. Mountain [12] proposes such a method by analyzing the user's trajectory in space over time and by interpolating the movements to the most likely future locations (speed ahead prediction surfaces) (Figure 2 ❺). This predicted region where the user most likely will be in the next future could be used to pre-select information objects, since only those are considered as relevant.

A similar approach analyzing past locations of users to estimate location importance is described by [10]. Aggregating such user behavior would allow to identify important locations on a more general level and to infer relevant places for certain communities of users.

4.8 Different conceptions of space

The conception of space needs to be addressed on different levels:

1. *(Geo)metrical* (locations, distance, direction) (Figure 2 ❻); this conception of space is useful in determining proximities.
2. *Topological* (spatial relations and associations) (Figure 2 ❼); for assessing the relevance based on accessibility connectivity in a network, i.e. a topological conception of space is more adequate.
3. *Structural* (spatial configurations/layout, patterns) (Figure 2 ❽); certain arrangements of objects or object densities can have an influence on their relevance (c.f. subsection 4.5)
4. *Semantic* (e.g. places, regions; functions and qualities of places) (Figure 2 ❾); some places are more relevant than others due to a specific meaning attached to them.
5. *Perceptual* (Figure 2 ❿); often the part of space that can be directly perceived and experienced is more relevant than more distant locations.

There are of course more conceptions of space than the ones mentioned above. Raper [7], for instance, separates two geographic models of space: "geo-representation" (space modeled with geometric entities) and "geo-context" (mental constructs, such as places or landmarks). The representations of space in external artifacts (e.g. LBS) as well as the internal mental representation of space need to match by mapping the objects based on their relevance.

5. ADAPTATION AND FILTERING OF GEOGRAPHIC INFORMATION

The main application of location within LBS or location-aware web applications is its use as a filter criterion to reduce the amount of information. In a first step, the initial set of objects which we need to assess the relevance for (used for later filtering) might be determined based on an activity taxonomy that includes the information needed for their execution. For the remaining set of objects the relevance might be determined based on spatial, temporal or semantic proximity.

Although methods, such as the Geolocation API and Open Geospatial Consortium Web Feature Service query filters are useful tools they do not help resolve the problem of which relevant objects we have to represent and how can we filter geographic information based on its relevance in a specific context for mobile users (see Figure 1).

6. CONCLUSIONS

This paper aimed at rising issues involved in enhancing existing concepts of LBS and location-aware web applications. As conclusions that might be explored at the workshop the following points can be stated:

1. A deeper understanding of geographic relevance may substantially improve LBS.
2. A better and richer model of space and place serving as contextual information is a prerequisite for geographic relevance.
3. The information content of depicted objects in LBS should add new information to the user's knowledge, i.e. be relevant.
4. For more complex or nested spatial questions a holistic, synoptic, and cognitively adequate visuo-spatial display of geographic information (e.g. a map) incorporating a representation of the relevance of the portrayed information is more effective and efficient and will substantially improve geographically informed decision-making in everyday life situations.
5. Geographic relevance is not only fundamental and applicable to LBS and other mobile geoservices, but could also provide a valuable concept for several additional aspects within GIScience and web applications.

7. ACKNOWLEDGMENTS

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