Location-Based Mobile Games for Spatial Knowledge Acquisition

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Introduction

Spatial knowledge acquisition has recently been boosted by the universal ubiquity of mobile information and communication technology. This technology allows a range of novel spatial knowledge acquisition approaches, such as *crowd sourcing* (Surowiecki, 2004), *user generated content* aka *volunteered geographic information* (Goodchild, 2007; Krumm *et al.*, 2008), or *geographic information retrieval* (Larson, 1996). Some of these approaches are more direct, as in contributions to maintain existing large data sets, and others are more indirect, as in data mining georeferenced texts to identify the spatial meaning of vernacular place names. They also differ in the depth of contributions: Simple *data* collection or maintenance considers the positioned citizen as a sensor (Haklay and Weber, 2008), while human *knowledge* acquisition considers the positioned citizen as a source of knowledge about their location (Bilandzic *et al.*, 2008; Richter and Winter, 2011).

Common to all these methods is a general lack of control in the data acquisition process. Accordingly, these novel approaches are frequently criticized for heterogeneous quality, uncontrolled contexts, lack of validation, impact on privacy, and more (Flanagin and Metzger, 2008). These concerns are, at least currently, impacting on the trust and acceptance of these acquisition methods, despite their obvious economic and scaling advantages.

Location-based mobile games have been previously suggested to be used to collect data about how humans behave in an environment, and also how they describe their spatial locations and events (e.g., Matyas *et al.*, 2008; Bell *et al.*, 2009). In this paper we outline (a) the potential for location-based mobile games to overcome some of the issues of the spatial knowledge acquisition approaches above, and (b) a line of research not yet fully understood in the community. Most notably, these games allow the designer to specify and design a certain *context*. Context is critical in interpreting human behavior (Dourish, 2004), especially if it

goes beyond simple data conveyance. While an experimenter publishing a game has no control of the gamers, we discuss and illustrate how an experimenter can still control context. We also explain that exactly this possibility—defining a context—gives rise to new research questions: It makes the location-based mobile game itself a subject of investigation, with respect to *how to specify a context*, and *how to control the success of the specification*. This way, location-based mobile games form a platform for testing new knowledge in spatial cognition and spatial linguistics.

Spatial Knowledge Acquisition for Smarter Services

This paper focuses on acquisition of human spatial *knowledge*. Spatial *data* acquisition will not be specifically mentioned because its commercial potential has already led to numerous variants of above mentioned mechanisms. Data acquisition is for immediate consumption in updating spatial databases. Spatial knowledge, however, is of interest not for immediate consumption, but for building smarter services in the future. To be truly useful for their human users, these services need to communicate with the users in a way that matches human understanding of space and of the communicated event. This type of communication service requires deep understanding of human conceptualization of space and of colloquial communication behavior about locations and events.

The established way of achieving this is to collect large amounts of data about how humans describe spatial locations and events. Such data—corpora of verbal descriptions, together with gestures or sketches—reveal not only the communication patterns themselves, but also the cognitive concepts and the cognitive reasoning behind them. This data can then be used to either annotate spatial data sets so that automated services can tap these annotations in communication. This makes direct use of collected data. The data may also be used to train services using machine learning methods, or to adapt their behavior by inferring user behavior and reactions from the data. This is an indirect way of exploiting collected data.

Location-based mobile games

Location-based mobile games are *location aware*: they consider the location of the players in the process of the game, and sometimes also other spatial parameters of the mobile devices such as their heading, orientation, and speed. A game is "*a diversion of the nature of a contest, played according to rules, and displaying in the result the superiority either in skill, strength, or good fortune of the winner or winners*" (Oxford English Dictionary, 2011). A broad range of location-based mobile games exists already, and an industry has formed to service this market. Ma-

jor categories of location-based mobile games are tagging games (reaching a location), scavenger hunts (collecting something), role playing game (in alternate worlds), and strategic games (based on geographic knowledge).

Location-based mobile games offer several advantages for spatial knowledge acquisition compared to other acquisition methods that do not have the playful flavor of contest, for example, location based services or social networking sites. Users (players) of these games get into the game voluntarily and on purpose, i.e., they plan to spend some time immersing themselves in the game environment. Most likely, this will make them succumb to providing requested information because it becomes part of the game. That is, agreeing to play a game gets players in a mindset of accepting effort in interaction in order to advance the game. For example, this effort may include tagging places or events, or performing some spatial tasks they would normally not engage in.

For the same reasons, players may also be more willing to surrender data to be used outside the game context. Typically the collection of user-generated content, be it behavioral or explicitly submitted, touches many privacy issues. In the context of a game, however, players rather may agree to having their data used in anonymous form. For one they may have an interest in improving location based services (in particular their game). But their behavior and communication within a game context also reveals significantly less about their private movement patterns than, say, their car navigation system.

Another advantage of employing games for data collection and subsequent interpretation of the semantics is that the context in which players interact is known or can even be specified by the game design. What players are supposed to do and what they try to achieve can be taken as background in trying to interpret their actions and the occurring events, severely restricting possible semantics.

Finally, location based games may be the ideal environment to test new methods of data collection or new interaction paradigms. While a game obviously needs to be playable, players of such games likely do not give up easily just because something does not work as expected or is somewhat awkward to use. In that respect, games may also be the ideal environment for services that learn: releasing a service to players that does not behave optimally (because it is still in its learning phase) may rather be seen as a game challenge than a showstopper. That way, part of the game may actually be to further the service's learning, for example, getting player and service to agree on some place description or the spatial extent of that place.

Tell Us Where

We have tested the idea of using location-based mobile games for spatial knowledge acquisition in one of our projects. The aim of this project is to collect a large corpus of geo-tagged place descriptions, and to use this corpus for a variety of re-

search questions in computer linguistics, human-computer interfaces and spatial information science (Winter *et al.*, 2010). Developing a location-based mobile game was the methodology of choice. This section reports on our experiences.

Tell-us-where (you are) (Figure 1) was a web-based location-based mobile game collecting human place descriptions from the players of the game. The game idea was deliberately simple. Wherever players are and can spend a minute they can start the game and enter a description of where they are. The place descriptions are stored at the web-server together with the position of the mobile device, which is automatically obtained by GPS and confirmed by the player on a map. As an incentive each submitted place description has a chance to win a gift voucher. *Tell-us-where* was optimized for the web-browsers of different current smartphone operating systems.

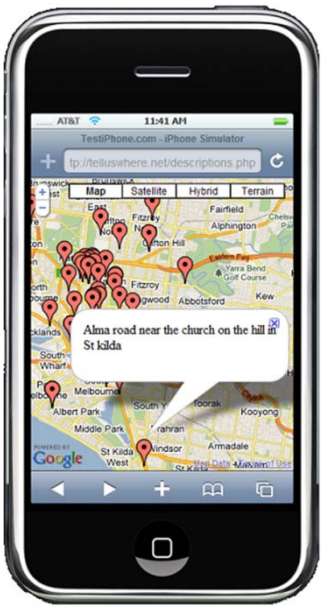

Figure 1: *Tell-us-where*, showing locations of place descriptions collected by the end of Week 1.

The game was covered by the media and quickly gained attraction. We collected about 2000 place descriptions within the six months of running the game. These place descriptions are distributed all over Victoria and beyond, but the majority concentrates on Greater Melbourne (Figure 2).

While the place descriptions are now being investigated, the game allowed us to make a number of generic observations. With respect to the control of context we observed:

- Location-based mobile games can be limited in their spatial extent. *Tell-us-where* was originally constrained to Victoria by a filter on the self-localization

of the players. Within a certain spatial context, location-based mobile games could attract players to specific locations for which knowledge has to be acquired. The filter in *Tell-us-where* applied this strategy to limit place descriptions to Victoria. Within this area we observe an inhomogeneous sampling distribution (influenced by population distribution, mobile internet coverage, and the social networks through which the game was promoted). Geograph (http://www.geograph.org.uk/), for example, implemented an explicit strategy to spread contributions spatially (Dykes *et al.*, 2008). Other recent evidence documents the spatial distribution of mobile application usage that might be of interest in this context (Böhmer *et al.*, 2011; Hecht *et al.*, 2011).

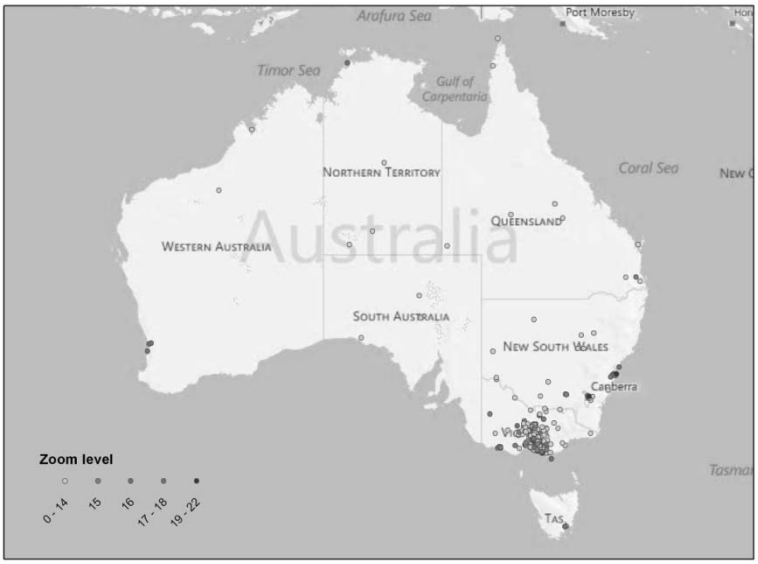

Figure 2: The entries to *Tell Us Where* over the six months, categorized by the Google Maps zoom level of the players' self-localization (© Daniela Richter, 2011).

- To interpret the collected data, knowing (or designing) the context is crucial. Generally, context is created by a role and a purpose. In *Tell-us-where* the context was set by (a) a confirmation of the self-localization by GPS on a map, (b) the question: "Tell us where you are: [*textbox*]", and (c) the purpose of pastime and a chance to win a voucher. This specification actually underdetermined the context, which shows in the variety of place descriptions received. One additional and recorded context factor was the map zoom level the players had chosen for their self-localization.
- Not everybody plays location-based mobile games seriously. Location-based mobile games need filter mechanisms to keep the collected data sets clean. Especially the opportunity to win vouchers made *Tell-us-where* vulnerable for fake participation, and we implemented several mechanisms to test whether the provided descriptions were actually valid place descriptions. Initially, one of

these mechanisms was filtering out place descriptions that did not contain a place name found in a gazetteer of Victoria. These mechanisms constrained the context as well. They actually rejected some place descriptions that would have been acceptable by the rules; therefore, they were removed in a later stage of the game.

Tell-us-where's game aspect is minimal (restricted to the fortune element), and the immersion effect is accordingly limited. Nevertheless, the lessons learned are applicable to other location-based mobile games, despite the relatively small and local set of results.

Summary and Research Questions

Location-based mobile games are appropriate tools for spatial knowledge acquisition, for a number of reasons. The main reason to consider location-based mobile games for spatial knowledge acquisition is the ability to shape, and thus control, the communication context between service (game) and user (player). Games strongly define a context because people immerse themselves. If the context is known, the interpretation of observations of people's behavior and communication can be restricted.

While games allow immersion into role and purpose, some of the sources used in harvesting techniques have at least aspects of specific contexts. For example, in the more mundane context of social networking sites, such as *foursquare* (https://foursquare.com/), people are asked to describe their location for a purpose: to meet other people. Harvesting public place descriptions from foursquare for Melbourne and Sydney in December 2010 has shown that this context leads people to describe their locations (in an overwhelming majority of cases) in the form of an address, or part of an address. For our purpose of knowledge acquisition an addresses is relatively mute, and thus we need more open contexts.

From preliminary experience, new and critical questions for further research in spatial cognition and spatial linguistics arise. First, how can we specify and then create the context in a game for a particular research question on human spatial knowledge? Following from this problem is the reverse question: Do people behave and communicate in the game as intended? A context must specify a role and purpose, but at the same time motivate and encourage the potentially onerous knowledge acquisition steps. It also must be specific enough for the appropriate interpretation of the collected corpus. Ideally it must allow for checking the validity (according to role and purpose).

Early experience with filtering results to check whether players are playing according to rules – i.e., within the specified role and purpose – was mixed. If filters are too restrictive they produce type I errors, rejecting valid place descriptions and frustrating serious players. Thus, future research should address the question of

what are the valid entries in a particular context, in that way defining quality metrics that are context-dependent.

These research questions can lead to an iterative development of location-based mobile games for spatial knowledge acquisition: Improving the context specification and interaction mechanisms in the game will provide the experiment designer with more powerful tools, and will make the game smarter in the sense of richer context provision. Collected knowledge can be used to develop smarter services in the future, including smarter games.

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