The Importance of ‘Neighbourhood’ in Personalising Location-Based Services

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ABSTRACT
Location-Based Services (LBSes) provide information and functionality based on a user’s geographical location and surrounding area, yet there is currently little known about how people actually perceive their surrounding area in relation to its use by online services. With a focus on the home neighbourhood, this paper introduces an experimental platform that supports a variety of LBSes and the results of a study designed to understand how users define ‘neighbourhood’ as a geographical construct for use by online LBSes. To this end, the study analyses the suitability of five different representation methods (freeform, radius, suburb, postcode, and council area) and their frequency of use across four different LBSes (item borrowing, media mention, directory listing, and property).

Results show (1) that user-defined neighbourhoods differ greatly to the existing geographical constructs that are typically employed by LBSes like suburb, postcode, and council area (with only 22% similarity in overlap); (2) that representation methods allowing a user to self-define an area (i.e. freeform and radius) are used significantly more often by users (64% of the time) than pre-defined constructs (i.e. suburb, postcode, and council area); and (3) that many users (61%) have a dominant preference for a particular representation method that they use across multiple services. These findings are statistically significant and indicate that LBSes need to accommodate for individualised representations of neighbourhood, or face missing the next wave of personalisation in this field.

Author Keywords
Location-based services; hyperlocal computing; user studies.

ACM Classification Keywords
H.5.2. Information Interfaces and Presentation: User Interfaces–evaluation/methodology, user-centred design.

INTRODUCTION
Recent statistics from the Australian Bureau of Statistics report that Australians spend most of their time at home (over 70% of their time), followed next by their time spent at work (21%) [3]. It is surprising then that most LBSes still don’t cater to the geographical characteristics of an individual user’s home neighbourhood (or even their work neighbourhood) and that little is known about how people actually perceive ‘neighbourhood’ in relation to its applicability to LBSes.

The contributions of this paper are two-fold. First, we present the Neighbourhood Networks platform that is the foundation for our analyses into neighbourhood representation, and second, we report the results of a study conducted to explore the suitability of a range of representation methods used to define geographical areas for a variety of LBSes.

What is a neighbourhood?
“Neighbourhood” has always been a somewhat elusive concept, and there have been many attempts to define it [2]. It is not an official geographical unit, like a suburb or a city. The term is hard to define because of its ‘spatial’ and ‘social’ dimensions; and the differences in perception of these dimensions by different people [6]. In [2], the concept is defined as being “the area around a residence within which people engage in neighbouring, which is usually viewed as a set of informal, face-to-face interactions based on residential proximity”.

Although urban planners and governing bodies often attempt to ‘lock in’ definitions and boundaries of specific neighbourhoods, neighbourhoods are subjectively defined. Although the term has physical roots, “neighbourhood” - as [1] observes - is a conceptual place. Designers of applications that aim to connect with specific neighbourhoods need to be aware that this is a conceptual place, and their understanding of what that place is will need to be personalised to the individual.

Hyperlocal computing
“Hyperlocal computing” is an emerging field of research that we define to refer to location-based applications and services that target very specific local geographical areas (e.g. neighbourhoods) and the people who live or spend a substantial amount of time within such areas. The concept shares much with ‘place-based’ computing [4], with applications also fixed to a particular location, rather than the user’s current and changing location, though in this paper, we tie hyperlocal to the notion of neighbourhood as it is perceived by each individual person.

In contrast to traditional LBSes that provide information and functionality to users based on their current and changing geographical location [7], users of hyperlocal applications are...
typically: very familiar with their geographical surroundings; very familiar with at least some of the people in the area (and these people have the ability to remain relevant for long periods of time); spend a substantial amount of time within the area (and frequent the area often); and are strongly bound to the area (e.g. due to it being their home).

Due to this specialised feature set of hyperlocal services, they are able to provide very high levels of personalisation and the ability to reach people in a much more targeted manner than most traditional LBSes, by delivering content that is relevant not just to the individual, but to the individual in the specific geographical area in which he/she resides. Such personalisation can benefit existing applications and also enable new applications, e.g. via better utilisation of local resources and reduced transport and time costs.

A comparison of online neighbourhood services
An analysis of some of the more popular online neighbourhood services (everyblock.com, eneighbors.com, harringayonline.com, i-neighbours.org, nextdoor.com, and thesharehood.org) show that neighbourhood representation is often very coarse, with some services based on a combination of postcode and textual group name (and no actual mapping to specific geographical areas) like eneighbors and i-neighbours, while others are based on large pre-defined geographical areas (like harringayonline which caters for all residents of Harringay in the UK), and still others based on smaller system-defined geographical areas (like nextdoor) and radial distances (like thesharehood). These services do not provide flexibility for personalisation of the geographical area, e.g. to allow individual users to define the geographical areas relevant to them (including particular houses belonging to friends and family) and the services for which their area will be used.

THE NEIGHBOURHOOD NETWORKS PLATFORM
Neighbourhood Networks [5] is an experimental platform designed to support hyperlocal services. Features of the platform include the ability for users to register an account, manage their user profile, create and edit multiple geographical neighbourhood representations, activate new services, and link geographical representations to specific hyperlocal services. Prototype hyperlocal services that have already been developed for the platform include: a casual household jobs service, in which users can post and apply for jobs in their neighbourhood, and an interest forum, through which users can join and contribute to local interest groups.

After users register with the system (by providing their name and address details), they can define the geographical area that makes up ‘their’ neighbourhood (see Figure 1). To do this, users view an online map, and are provided with a choice of representation methods to create their neighbourhood. These representation methods are described briefly below:

Self-defined - Freeform and Radius: The freeform method allows users to create multiple irregular polygons to define their neighbourhood. Additionally, users can reposition any existing polygon markers to selectively add or exclude particular buildings or landmarks from the neighbourhood representation. The user’s final representation of their neighbourhood is the composition of each of the individual polygon blocks that they have defined. The radius method, by contrast, allows the user to define a neighbourhood based on a radial measurement in metres.

Pre-defined - Suburb, Postcode, and Council Area: The implemented pre-defined methods are based on spatial data from the Australian Bureau of Statistics (abs.gov.au). It includes all suburbs, postcode areas, and council areas of Australia. These pre-defined methods allow users to select pre-existing areas to compose their neighbourhood representations.

USER EXPERIMENT
This study investigates the representation methods that users chose in order to define their geographical neighbourhood for a range of hyperlocal applications. For this purpose, the Neighbourhood Networks platform was modified to accommodate for the integration of questionnaires, a tutorial, and the experiment tasks.

Experimental Procedure
This laboratory study was conducted with 28 participants, all from the Sydney region (16 male, 12 female), and ranging in age from 19–48 (mean: 26.2 years of age); all but two participants were university students. The experiment took participants between 45 to 60 minutes to complete. After being briefed on the platform and the experiment procedure, participants logged into the survey website using the supplied participation code and password and then filled out a background questionnaire. Next, participants completed a set of tutorial tasks designed to familiarise the participant with each of the representation methods. The next task asked the participant to define their neighbourhood geographically; this task was designed to capture the participant’s area independent of any particular LBS. This was followed by 5 experiment tasks presented in random order, each for a specific hyperlocal service, and with participants defining their neighbourhood geographically for each of these services. These 5 tasks were also each followed by a short questionnaire. The study
concluded with a post-experiment questionnaire that included both 5-point Likert scale questions and short answer questions. These questions enabled us to collect both qualitative and quantitative data from the experiment. Log files on the user interaction with the system (including their geographical neighbourhood representations) were also recorded.

The results of the study focus on the neighbourhood representations defined for the 5 different and hypothetical hyperlocal services: media mention, property notification, neighbourhood directory listing, and item borrowing, whereby item borrowing was represented as two separate tasks focussed on high- and low-value items and encompassing two separate roles for each sub-task, i.e. borrower and lender. For each task, participants were provided a short description of the service and a map, and were required to define their neighbourhood using only one of the available representation methods. The services were presented to participants in a random order to reduce any carryover effects. Short descriptions for each of the hyperlocal services follow:

The ‘media mention’ service allows a user to receive notifications of when their neighbourhood is mentioned in mainstream media outlets like newspapers and TV. The ‘property notification’ service allows a user to receive notifications of properties in their neighbourhood that are on the market to be sold and/or available for rent. The ‘item-borrowing’ service allows users to lend and borrow items from within their neighbourhood (high value items; low value items). The ‘neighbourhood directory listing’ service allows users to lookup detailed information about their nearby neighbours, including name, address, phone number, email address, date of birth, gender, interests, family status, and associated family members in the same household. This last service was purposefully designed to incorporate a large amount of personal information to also try and gauge the privacy that has on neighbourhood definition.

Results

The primary objective of this study was to explore the suitability of different representation methods for a range of hyperlocal services. The data collected for this came from both the methods that the participants chose to define their neighbourhood for each of the experiment tasks (i.e. a practical task component), as well as from each task’s associated questionnaire (i.e. a written questionnaire component), in which participants were asked to answer the following 5-point Likert scale question for the individual representation methods: “Rate the following methods in their ability to help you define your neighbourhood for the given service”: 0=very poor, 1=poor, 2=neutral, 3=good, and 4=very good. For brevity, the representation methods are denoted with the abbreviations: Freeform (F), Radius (R), Suburb (S), Postcode (PC), and Council Area (CA). Similarly, the hyperlocal services are abbreviated to: Item Borrowing High-Value (IB-HV), Item Borrowing Low-Value (IB-LV), Media Mention (MM), Neighbourhood Directory Listing (NDL), and Property Notification (PN).

Similarity between the neighbourhood areas defined by users and pre-defined constructs: Based on captured experiment data, the similarity between each participant’s neighbourhood area and their suburb, postcode, and council area was calculated. The similarity was calculated via the following equation, which takes the form, size, and location of the shapes into account: $\frac{\text{Area}_{\text{user}} + \text{Shape}_1^2 + \text{Area}_{\text{user}} + \text{Shape}_2^2}{\text{Area}_{\text{user}} + \text{Shape}_1^2 + \text{Area}_{\text{user}} + \text{Shape}_2^2}$. As shown in Table 1, the neighbourhood areas defined by participants were found to differ greatly with pre-defined constructs. Suburb had the highest average similarity with user-defined neighbourhoods, though still with 6 out of 28 user-defined areas under 1% similarity. Postcode and council area had even worse average similarities, with 8 out of 28 under 1% and 12 out of 28 under 1% similarity respectively. The highest similarity among all three predefined representations was 66.54%, and the lowest was only 0.03%. This indicates that hyperlocal services cannot assume a user’s neighbourhood to resemble pre-defined constructs like a postcode, suburb, or council area.

### Table 1. The similarity between user-defined neighbourhood areas and their suburb, postcode, and council area, based on geographical overlap.

<table>
<thead>
<tr>
<th></th>
<th>Suburb</th>
<th>Postcode</th>
<th>Council area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>22.03%</td>
<td>18.59%</td>
<td>6.92%</td>
</tr>
<tr>
<td>Maximum</td>
<td>66.54%</td>
<td>66.54%</td>
<td>51.37%</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.16%</td>
<td>0.12%</td>
<td>0.03%</td>
</tr>
</tbody>
</table>

Suitability of representation methods across all hyperlocal services: As shown in Figure 2, the self-defined representation methods (freeform and radius) were found to be more suitable than the pre-defined methods (suburb, postcode, and council area) for the given range of hyperlocal services, and this was supported by participant responses in both the written questionnaires and the practical tasks.

A Chi² test of goodness of fit for the practical component shows that self-defined methods were used significantly more often (64% of the time) than the predefined constructs: Chi²(1,N=196 tasks)>17.163, p<0.05. A Mann-Whitney U-test also shows for the written component that participant preference for self-defined over pre-defined methods is significant in the responses from 11 of the 28 participants (U(15,10)<38,000, p<0.05), with no corresponding significance of pre-defined over self-defined in any of the remaining participants. This may further imply that users prefer the flexibility provided by the self-defined representation methods over the simplicity provided by the pre-defined methods.

Regarding individual preference, it can be noted that 17 from 28 participants in the practical component (i.e. 61%) had a dominant preferred method that was used over 50% of the time (i.e. 4+ times out of the 7 tasks): freeform=4 participants, radius=8 participants, suburb=5 participants. Based on the questionnaire responses, a Mann-Whitney U-test also showed that females rate the freeform method significantly higher than males across all services combined (U(60,80)=1905.000, p=0.027) and that this is a trend also seen with the radius method (p=0.066); i.e. females in particular prefer the representation methods that provide the highest level of control over their geographical neighbourhood. These results indicate that hyperlocal services need to allow not just for individual differences in user preference for representation method, but also for gender-based differences.
Suitability of representation methods to particular hyperlocal services: Table 2 shows the ranking for representation methods based on the individual hyperlocal services. These results were generated from both the written component (i.e. the W rows in the table) and the practical component of the study (i.e. the P rows in the table). In particular, the P rows represent the percentage of participants that chose to use that representation method for a particular practical task, while the W rows represent the average participant rating from 0=very poor to 4=very good that participants chose for that method for the written questionnaires that accompanied each task.

The table shows that each hyperlocal service has multiple commonly-used representation methods across the given user base, which again reiterates the importance for location-based services to allow for the individualisation of geographic areas of relevance for each user. The methods that exhibited above average use (i.e. used by more than 20% of participants) were, for item-borrowing - freeform, radius, and suburb; media mention - suburb, council area, radius; directory listing - radius and freeform; and for property notification - suburb and freeform. This is in stark contrast to many existing online location-based services that provide only very coarse and singular methods (e.g. ‘postcode’) for users to represent their geographical neighbourhood. The table shows that these results are supported in both the questionnaire (i.e. the W rows in the table) and the practical components (the P rows) of the study.

When asked if it would be helpful to also combine multiple representation methods for a given service (i.e. combining suburb with freeform), participants answered positively (yes=82%, no=18%), which a Chi² test showed to be significant: Chi²(1,N=140 tasks)=57.857, p<0.05). This further enforces the need for hyperlocal services to support multiple and diverse ways of defining ‘neighbourhood’.

CONCLUSIONS
This paper has presented a platform called Neighbourhood Networks, which is used as the basis for an explorative study into neighbourhood representation and the use of such representations within hyperlocal and location-based services. Results of the study show that geographical neighbourhood areas defined by users differ greatly with pre-defined geographical constructs (with only 22% similarity in overlap), meaning that hyperlocal services cannot simply assume that a user’s neighbourhood is analogous to their suburb, postcode, or council area. Furthermore, the study shows that methods allowing a user to self-define an area were selected significantly more often than pre-defined methods, and that many users (61%) have a predominant recurring representation method following a user to self-define an area were selected significantly more often than pre-defined methods, and that many users (61%) have a predominant recurring representation method

<table>
<thead>
<tr>
<th>Services</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
</tr>
</thead>
<tbody>
<tr>
<td>IB-HV</td>
<td>P</td>
<td>F24.93%</td>
<td>R23.93%</td>
<td>S26.79%</td>
<td>C25.84%</td>
</tr>
<tr>
<td></td>
<td>W</td>
<td>P25.90%</td>
<td>R23.77%</td>
<td>S24.67%</td>
<td>C24.57%</td>
</tr>
<tr>
<td>IB-LV</td>
<td>P</td>
<td>R22.09%</td>
<td>P23.84%</td>
<td>S22.89%</td>
<td>C23.85%</td>
</tr>
<tr>
<td></td>
<td>W</td>
<td>R25.11%</td>
<td>P24.31%</td>
<td>S23.54%</td>
<td>C24.72%</td>
</tr>
<tr>
<td>MM</td>
<td>P</td>
<td>S29.14%</td>
<td>C24.49%</td>
<td>R21.45%</td>
<td>C22.94%</td>
</tr>
<tr>
<td></td>
<td>W</td>
<td>S29.70%</td>
<td>C26.57%</td>
<td>R22.94%</td>
<td>C24.30%</td>
</tr>
<tr>
<td>NDL</td>
<td>P</td>
<td>R12.86%</td>
<td>P22.12%</td>
<td>S27.71%</td>
<td>C24.14%</td>
</tr>
<tr>
<td></td>
<td>W</td>
<td>R23.10%</td>
<td>P23.86%</td>
<td>S24.65%</td>
<td>C23.12%</td>
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<tr>
<td>PN</td>
<td>P</td>
<td>S22.44%</td>
<td>S25.65%</td>
<td>C19.24%</td>
<td>R22.94%</td>
</tr>
<tr>
<td></td>
<td>W</td>
<td>S23.80%</td>
<td>C23.07%</td>
<td>R23.88%</td>
<td>C23.80%</td>
</tr>
</tbody>
</table>

Table 2. The ranking of representation methods per service, for both the practical task component (P) and the written questionnaire component (W) in the experiment. The colours in the table help to identify between the different representation methods (i.e. freeform, radius, suburb, council area, and postcode).

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