Workshop Proceedings of the 9th International Conference on Intelligent Environments
J.A. Botía and D. Charitos (Eds.)

doi:10.3233/978-1-61499-286-8-663

Helping Tourists to Plan Activities with Shared Urban Social Context

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Abstract. Ubiquitously available map-based services for tourism are becoming a norm, with the spread of smartphones and the integration of pervasive displays in the urban infrastructure. At the same time, interactions with the urban environment through social networks is rife, with actions such as tagging locations and checking-in to these now a part of mainstream mobile social network use. In this paper, we discuss how exploiting mined interactions with the urban environment can help tourists better plan activities, through sharing the collectively generated social context of a smart, connected city, as a background layer to mapped POIs.

Keywords. Social context, ubiquitous maps, tourism

Introduction

Visitors and tourists rely heavily on third party information relating to sights of interest, locations worth visiting and areas suitable for wandering around during different times. Traditional information sources for tourists include guidebooks and recently, community websites for travel. Websites such as Wikitravel and Trip Advisor reflect the subjective opinions of contributors. Even though on-line media are regarded as more collaborative and hence somewhat more likely to present a more accurate picture, Gretzel and Yoo [1] found that reviews therein play a much less significant role during planning, on determining “What to do, where to go and when to go” (just 32.5%, 27.7% and 26% of participants respectively, the most popular use of online reviews was for “Where to stay” with 77.9%). Just under half of online site users look for information from local destination (44.6%) and state tourism websites (29.7%), though these could be expected to more accurately reflect a local’s knowledge about what to see and do. White and Buscher [2] showed that relying on information from other tourists is probably not optimal. In their study, they discovered that non-locals tended to select worse quality experiences (restaurants) than locals. Hence the reviews likely to be shared on online websites for tourism do little to help tourists uncover hidden gems or get an idea of what is truly worth visiting.

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What seems to be lacking from both guidebooks and community websites is the locals' experience of a place. As is evident, the sharing of local knowledge has large potential in helping enhance visitor experiences. Bearing in mind the difficulty in capturing this knowledge from locals and also sharing it, we discuss in the following sections a system able to automatically infer such knowledge by mining check-in data. Furthermore, we present an early investigation into the utility of this information for the in-situ planning of activities by tourists.

1. Representing context in maps

Past research in mobile location based services for tourism has led to the commercial offering of many map-based guides for visitors. Most such ubiquitous systems incorporate a mapping component, in which information filtering through context awareness plays an important role considering the limited screen real estate and the limited interaction time that users typically exhibit when using ubiquitous computing equipment [3]. Reichenbacher [4] discusses the need for relevance in mobile cartography by aligning it to objective and subjective dimensions. Objective dimensions include physical relevance (spatial and temporal) as well as system relevance (query and algorithmic relevance). On the other hand, subjective relevance rotates around a particular user's context, such as thematic interests, cognitive abilities, planned or current activity, task and goals.

The introduction of social media and the ability to mine users' interactions with these, through open APIs, yields the potential of the introduction of a previously unused type of context in ubiquitous cartography, that of social context. This type of context is composite and consists of user presence at a location (spatial), user interaction with this location through a social media network (something that signifies positive disposition) and time. The aggregation of this type of context from a multitude of users for a particular geographic area can be used to build a higher-level abstraction of social context that reflects collective behaviour, and thus can be considered to be part of the environmental context. Environmental context can play a significant role in adapting information for users, for example Nivala et al. [5] show how it can be used to filter displayed information for activities on a map, based on the current season of the year.

Reichenbacher [4] discusses how visual complexity in a map is influenced through structural and syntactic properties symbols, such as the density, number and opacity of map elements, their visual complexity or number of colour values or hues. He shows how context can be communicated through manipulation of these properties. Cognitive complexity emerges during the processing of the map, i.e. the understanding of the map within a specific context, as users attempt to understand the underlying relationships between displayed elements [6]. Finally, Crease [7] separates the complexity that emerges during the representation of many elements of differing categories (high semantic) and many elements of the same category (high visual).

Based on this background, we decided to investigate the potential of conveying environmental (social) context semantics on a map, without cognitively burdening the user. In POI-driven applications, a 2-D graphical background (map) is used to visualize spatial context spatial context (i.e. the location of POIs), which shows the contextual relationship between items of information (i.e. the POIs). Based on this successful principle, we considered adding a further background layer upon which spatialised context can be overlaid. Hence we used a heatmap technique to display the "busy" areas of a city. This heatmap is temporally sensitive (i.e. it is calculated using temporally relevant data such as the weekday and current hour) and displays the intensity of user interactions with venues through social media under that temporal context. The use of a heatmap to display density of POIs has been explored in the past in such studies as Kisilevich [8] and Girardin [9] but we are not aware of any studies that have used such a technique in conjunction with POI layers.

2. Using social context in maps

2.1. Collecting and disseminating social context over the cloud

In [10] we describe our system for collecting social context in more detail and also demonstrate that the collected data is a reliable indicator of human activity in a urban area, as it correlates well with other independent data such as air pollution from traffic. Hence we will describe the system briefly. The system is based on a set of virtual "listening posts", i.e. a set of coordinates in a urban area, which can be arbitrarily placed or positioned based on local knowledge of a city. For each coordinate we perform a request for data on various APIs (Facebook, Google Places, Foursquare) every half hour. The returned data is stored in a database and thus allows us to perform temporally and spatially contextual queries in order to build aggregate pictures of activity in an area. From this data, we can offer cloud-based services to power a number of ubiquitous applications, such as desktop or large display websites, mobile websites, mobile apps and augmented reality apps (Figure 1).

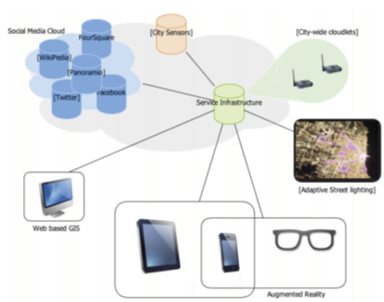


Figure 1. Area coverage for social data by listening posts and abstract system architecture for sharing social context as a cloud service

2.2. Using social context for ubiquitous maps

We focused on a scenario of travel that includes the use of ubiquitous maps and involves planning tasks. This scenario includes a difficult planning task – firstly, the user is in a completely new location for which she is unprepared. Because this is a transit destination, the user has not made previous plans and has to rely on whatever information can be gathered quickly. The user not only has to think about the landmarks which they will visit and how far apart they might be, but also has to consider the task of getting lunch somewhere before heading off. The scenario is as follows:

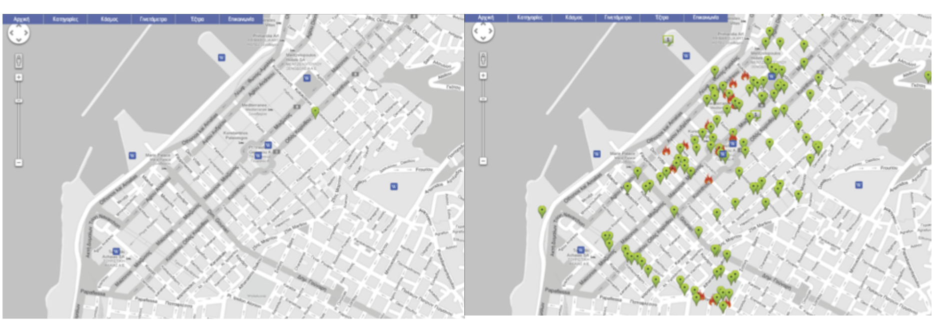
"You are transiting through a city which you are unfamiliar with. Having just missed your train connection, you are waiting in this city for a few hours in order to catch the next train towards your final destination. It's 11am on a Saturday morning, and your train leaves at 4pm, so you have enough time to visit a couple of landmarks and then get lunch, before heading off."

Of course, in a real system the scenarios could be more complicated or a system could attune its performance to respond to different situations (e.g. filtering out data from one-off events such as concerts etc). However our target here was to investigate how a background visualization of context might help planning tasks, so we focus on the impact of visualizations in decision making, not on how these are derived.

2.3. Experiment design

We planned to show users four different maps (Figure 2) and ask them to circle up to two areas on these maps which they think they would like to visit. For each map type, we would take the time taken to complete the task, as well as a short subjective opinion questionnaire to determine complexity, ease of use, learnability, confidence and perceived utility. We further wanted to see if users' perceptions might be affected by their use of social networks thus a separate questionnaire was given pre-task.

On the first map, only information about landmarks is presented. The landmarks are drawn from geo-tagged Wikipedia entries. The second map shows landmarks and a further layer of POIs, which are restaurants. The POIs are presented in two ways – simple green markers and "fire" markers, which indicate really popular restaurants. The popularity of restaurants is calculated through the total number of check-ins at these venues. The third map shows landmarks and a heatmap background layer. This heatmap is calculated from restaurant check-in data between the hours of 1-4 pm, hence it shows which areas of the city are bound to be "busy" or otherwise "active" at these times. The fourth and final map is a combination of all the above elements.



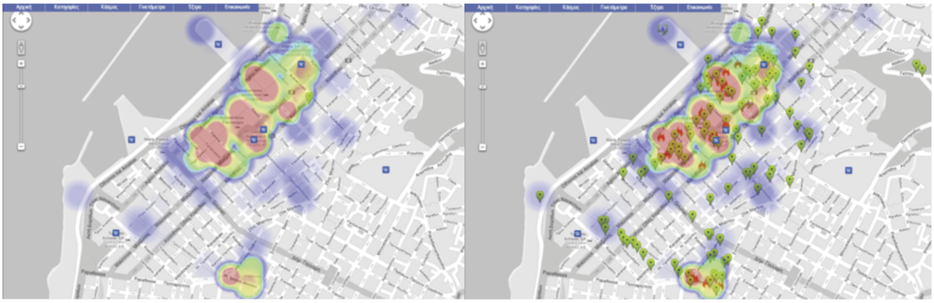


Figure 2. Map types shown to participants (clockwise from top-left: Landmarks, Landmarks + POIs, Landmarks + Heatmap, All)

2.4. Participants

We recruited fifteen participants (6 female) in a university café. One was over 34, four were between 30-34, four between 19-23 and six between 24-29 years old. We asked participants about social media use (which network and how often) and also the type of actions taken through these networks (tagging friends or locations and checking-in). We found that all users were familiar with the concept of checking into a location using social media, though this action is the least popular (six participants stated they never do it). This was important, as we wanted to ensure that participants understood how the map visualizations were derived.

We examined the frequency of use of the various social networks as well as the interactions with these, which related to spatial context (Figure 3). Using a simple metric of multiplying the frequency of use score with the sum of location tagging and checking-in frequency scores, we split our users into two categories based on "location consciousness" exhibited through the use of social networks (min=8, max=130, mean=61, stdev=43.4). Figure 4 below shows how these participants use information sources, both traditional and electronic, when planning activities before or during a visit to a new location. We observe that location conscious (LC) participants favour guidebooks (1st) and community websites (2nd) most, while other participants seem to value friends and relatives (1st), followed by community websites (2nd). For them, guidebooks rank 4th, while their third preference is locals and residents. These findings confirm that community websites, i.e. information that is compiled by independent individual internet users is seen as a trusted resource of information.

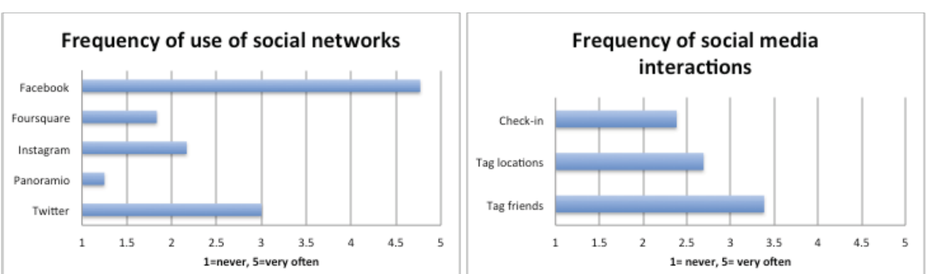


Figure 3. Use of social media by participants

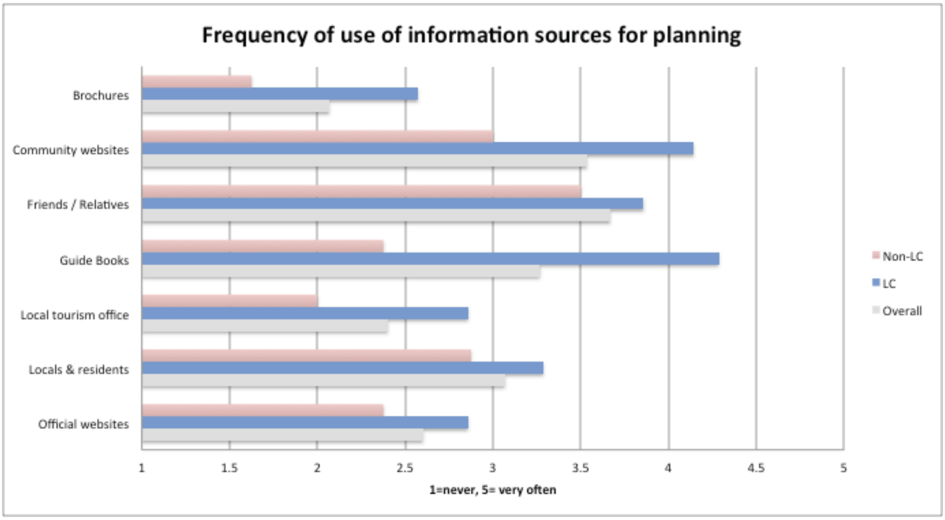


Figure 4. Participants' use of information sources for tourism

2.5. Attitude towards map use

We showed the participant each map type (as shown in Fig. 2) one at a time. The map types contained landmarks only (L), landmarks and POIs (L+P), landmarks and heatmap (L+H) and a combination of all data (A). Before showing a map, we reminded the participants of the scenario to affirm that their planning needs have not changed and then provided them with a pen to mark down the areas they would like to visit. We measured the time taken to complete the task and issued a short questionnaire after each task was completed. The results of the questionnaire responses are shown in Figure 5.

In terms of time taken to complete the requested tasks, we found that users were quickest with the map type A (m=7.25s, stdev=3.22s) followed by types L+P (m=8.32s, stdev=4.03s), L+H (m=9.12s, stdev=3.04s) and L (m=13.43s, stdev=2.77s).

To determine the validity of average differences in the time and questionnaire responses for each map, we performed an ANOVA analysis (Table 1), which indicated that there are no statistically significant variations in the times taken to complete the tasks. However we found statistically significant variations in the means measured in the questions of whether it was easy to make a decision using each map type ($p<0.05$), the level of confidence on making choices ($p<0.05$) and finally intention to use each map type during a visit ($p<0.01$). We note that in all cases apart from complexity, the landmark-only map is the worst-performing of all. In all cases the different display modes (POIS, heatmap or combination) are quite close in terms of their mean scores. This result is encouraging as it suggests that the use of heatmaps as an additional visual mode to represent context does not overburden the user.

We did not make any analyses on the individual groups as the sample size was too low for meaningful interpretation. However, some interesting observations emerge. Firstly, location-conscious social network users found it easier to decide with the A-type map, which contained a combination of all data, than in any other case. In contrast, other participants were not majorly affected by the map types, though their confidence in their choices also increased when shown the map that contained the most information. Both groups indicated the same intent levels for using the A-type map in future visits, though intent levels for map type L+P were somewhat stronger for the location-conscious users.

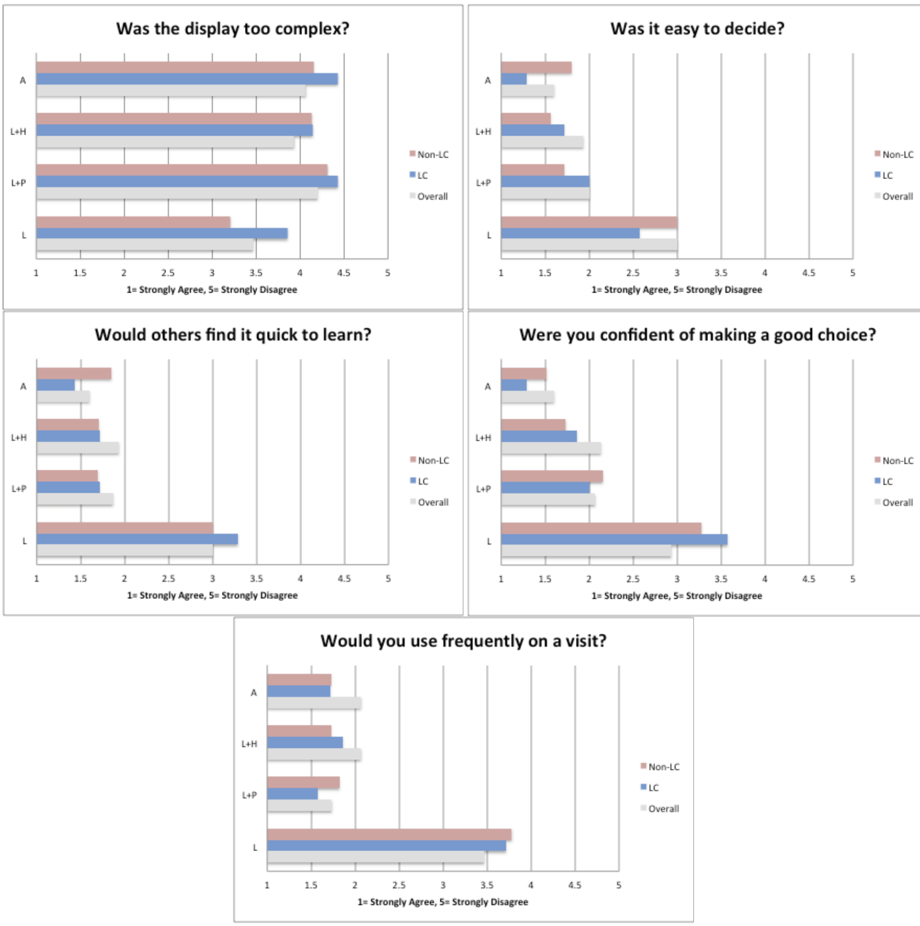
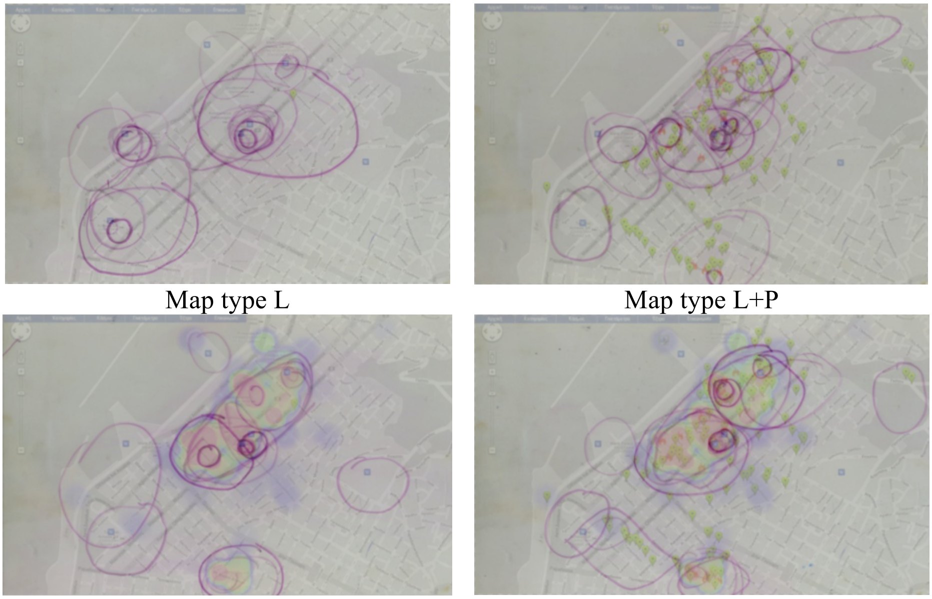


Figure 5. Participants' attitudes towards the map styles

2.6. Area selection behaviour

As stated previously, part of the experiment was getting users to demonstrate the areas of their choice. Users were able to select up to two areas, which could be as big or as small as they desired, based on how much they thought they had time to explore. Users marked these areas on transparencies, which were laid over each map type, without being able to see what previous participants had chosen. We scanned and assembled these choices to form a collective impression for each map type. Figure 6 below shows how participants indicated their preferred areas.



Map type L

Map type L+P

Map type L+H

Map type A

Figure 6. Participants' choices of areas to visit

From these pictures it is easy to see that for the first style of map (landmarks only), behaviour is centred on the landmarks and uncertaintly is apparent as the participants seem to make larger area selections that in other style maps. When presented with POI information (map two), participants seemed to narrow down the areas of visit and also appeared lured by the presence of POIs that were not near any the landmarks. Similar behaviour is exhibited in map style three, though this time users made fewer choices of areas to visit (i.e. more users selected just one area). Finally, map four again shows very similar behaviourthough in this case, all exploratory selections (i.e. those that are far from the landmarks) are made either on areas where POIS are clustered or where activity is indicated (contrast with map two where the mere presence of POIs does not seem to tempt the explorers).

2.7. Informal feedback

We engaged the users in a short, unstructured interview after the tasks had been completed in order to elaborate on some of their behaviour. We noted from their choices that some participants (six in total) were keen to avoid busy areas as indicated by the presence of POIs or heatmaps and identified themselves as independent and exploratory travelers. They mentioned that heatmaps were particularly useful in order to be able to determine where "off-the-beaten-track" locations were likely to be found and enjoyed this feature. Another female participant stated that she quite liked the heatmap visualization, as she felt safer knowing that she would be in a busy area, particularly in a city that she didn't know as well. Overall thirteen out of the fifteen participants stated they preferred the combinatory system out of all the map types, because it provided the most amount of information without making the display overly complex or cluttered.

Table 1. Detailed results of attitude towards map types (L=Landmarks, P=POIs, H=Heatmap, A=All)

Question		Mean	St.Dev.	F	p
Was the display too complex? 1=Strongly Agree 5=Strongly Disagree	L	3.4667	1.1457	0.778	0.511
	L+P	4.2000	1.1464		
	L+H	3.9333	1.3345		
	A	4.0667	1.6242		
Was it easy to decide based on this information? 1=Strongly Agree 5=Strongly Disagree	L	3.0000	1.4639	3.308	0.027
	L+P	2.0000	1.1953		
	L+H	1.9333	1.3870		
	A	1.6000	1.0556		
Would other people find this system quick to learn? 1=Strongly Agree 5=Strongly Disagree	L	3.0000	1.1559	2.366	0.081
	L+P	1.8667	1.0601		
	L+H	1.9333	1.3354		
	A	1.9333	1.1338		
Did you feel confident that you made a good choice with help from this system? 1=Strongly Agree 5=Strongly Disagree	L	2.9333	1.5338	3.020	0.037
	L+P	2.0667	1.0998		
	L+H	2.1333	1.3020		
	A	1.6000	0.9103		
Would you use this system frequently during visits to unfamiliar cities? 1=Strongly Agree 5=Strongly Disagree	L	3.4667	1.3558	4.879	0.004
	L+P	1.7333	1.0998		
	L+H	2.0667	1.3345		
	A	2.0667	1.5796		
Time	L	13.425	3.2003	1.153	0.361
	L+P	8.3250	4.0333		
	L+H	9.1250	8.0454		
	A	7.2500	3.2265		

3. Conclusions and Future work

Our study into visualizing urban social context and sharing it with visitors of a city is in its preliminary stages. As the work presented here is a first step towards investigating the use of background layers to convey environmental context, there are limitations to our methods and findings which leave considerable scope for additional work to be carried out.

Asking our participants to “circle” areas of interest is, in a way, an artificial task. One could envisage how a user might actually do this if a map was presented on a tablet-size device, but such a task would be hard to do using a mobile phone (small scree, large fingers). Also, as noted from our experiments, different users use different size of “circles” to indicate areas of interest. Some like to use wide circles, others prefer a smaller area (indicating more or less a spot around which they would like to wander). Offering guidance to users so they can visit an area has to depend on a definition of an area, negotiated between the user and a device. We believe here that given the users’ behaviour, it might be best to allow users to “tap” on a point and have the area defined (drawn) around it by the system, either in terms of a circle, or by automatically discovering road edges and creating enclosing polygons to define the area. Also, we believe that it would be good to allow users to define the radius of this area, but using “time to walk” as a parameter instead of actual distance (meters), since this is measure is more meaningful to most users.

Further to this, we are not confident that a heatmap is the optimal way to present background context information. Based on our participants’ comments, a more abstract representation might be preferable. One possible alternative approach is to divide a city into “areas” corresponding to sections defined by road segments, and then colorize the segments according to social context data. We have began looking into this approach using OpenStreetMap data (Figure 7), however there are technical complexities in defining the “areas”, particularly in cities where the road structure is not a neat grid and also where the map data is not “clean” and contains erroneous or mal-described nodes.

Figure 7. Grid-based visualization of context as an alternative to heatmaps

Our first findings however, suggest that visualizing social context as a background layer in maps, does not hinder users cognitively and can lead to a useful service. We uncovered some early indications that our visualization has an effect on user choice of areas, which is made with more confidence than just by presenting POIs alone. In the near future we will expand our work to investigate the emergent issues more systematically, with more users and further map complexity levels on varying devices.

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