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# Privacy and Sharing Outcomes of Using Location Abstractions

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**Abstract**

Many location-based services are now focused on social location sharing. However, these services often employ an all-or-nothing disclosure model that forces users to choose between preserving their privacy and leveraging the service's social utility. We describe how we use location abstractions to alleviate this privacy barrier. We then examine the privacy and social outcomes of sharing abstractions in location sharing applications.

**Author Keywords**

Privacy; location sharing; social sharing; social media.

**ACM Classification Keywords**

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

**General Terms**

Human Factors, Design, Experimentation.

**Introduction**

The ubiquity of location-aware mobile devices has led to a new class of applications that combines location-based services with online social network sites (SNSs). Recent commercial examples of these location sharing applications (LSAs) include FourSquare, Google Latitude, and Facebook's Places. These LSAs have fundamentally shifted how users are consuming and

sharing location information. In particular, location is used for more than just coordination or okayness-checking; it is now used for *social* sharing as well [10].

However, introducing location as a type of social media has several privacy implications. First, one must consider that users' online social networks are often much larger than their offline counterparts [6]; this suggests that social location sharing is done amongst a fairly broad audience. Another consideration is that online social interactions often involve weak social ties [4]; this suggests that there is likely a large variance in how much users trust others with their location data.

Yet, past work has also provided evidence that there is indeed some social utility in location sharing [10]. For example, work by Anthony et al [1] has shown that location sharing can help increase social awareness by making it clearer to others when someone is available. Past work has also shown that location awareness can help facilitate and enrich social interactions. In Connecto, a location-aware micro-blogging system, participants often used location information as a starting point for discussions and ongoing play [2]. Anecdotally, location sharing has also been linked to benefits like conversational grounding and serendipitous interactions [2, 9]. These outcomes suggest that location sharing impacts not only online social interactions, but also offline relationships as well.

### **Privacy vs. Utility Tradeoff**

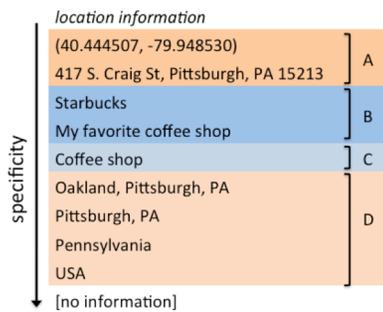
There is an implicit tradeoff between privacy and utility that users are forced to reconcile with when they engage in social location sharing. In current LSAs, this tradeoff is particularly challenging because these services often use an "all-or-nothing" disclosure model

for location sharing. In this model, users can opt to disclose nothing and not have their location shared with others. This choice affords complete privacy to users, but they also miss out on any social benefits that might have resulted if they had shared their location data. On the other hand, users can choose to disclose everything, which for many LSAs means that a fairly precise location description is shared. This choice provides more opportunities for social engagement with others, such as allowing for serendipitous encounters [2] and increasing online social awareness between loosely connected friends [9]. But these social benefits come at the cost of revealing potentially sensitive information. Thus, an all-or-nothing disclosure model forces users to choose whether they value their privacy (and disclose nothing) or the application's social utility (and disclose very detailed locations).

We posit that, in order to provide sufficient privacy mechanisms for social location sharing, LSAs should provide additional disclosure options to better balance users' concerns about preserving location privacy and users' desires to enhance their social interactions. These disclosure options can help scaffold the privacy barrier created by the all-or-nothing disclosure model.

### **Reframing Online Location Sharing**

We refer to these additional disclosure options as *location abstractions*. We use the term "abstractions" to emphasize that these disclosures are less descriptive and less precise than how location is usually presented as geographical coordinates on a map. In our work, we focus on two types of abstractions: geographic and semantic abstractions. Figure 1 provides an overview of our chosen location abstractions.



**Figure 1.** An overview of the types of location abstractions that we have explored. The orange-tinted rows indicate geographic abstractions, with A referring to specific geographic abstraction (e.g., addresses, geographic coordinates) and D referring to general geographic abstractions (e.g., city or neighborhoods). The blue-tinted rows indicate semantic abstractions, with B referring to specific geographic abstractions (e.g., business names or personal places of interests) and C referring to general semantic abstractions (e.g., general categories of places).

While we acknowledge that there are certainly other kinds of abstractions, our selected abstraction types are well grounded in social theory and past works. For instance, abstractions map well to Goffman’s observations of a person’s need for secrecy in certain social interactions. In particular, Goffman observed that people often leverage pretext in order to hide their behaviors from unintended viewers [5]. Abstractions are also well suited to support social steganography [3], where users want to share their information but prefer to do so in a manner that is only accessible to those who are “in the know” (and inaccessible to others). Lastly, these abstraction types also correspond well with how people conversationally describe their location in face-to-face social interactions [8].

### Privacy Outcomes of Sharing Abstractions

One often-cited criticism for location sharing is that it can reveal potentially sensitive locations to others. Our motivation for including abstractions is that, by varying the precision of one’s location information, we can provide more opportunities for plausible deniability [7]. But there is always some risk involved in location sharing, whether using a precise or abstracted description. We are interested in examining how privacy-preserving are users’ abstraction selections.

We conducted a user study where we captured two weeks’ worth of location data from 10 users in the field. Then, in a lab study, we provided a map to remind users where they had been and, for each place, we asked users to retrospectively reflect and determine which location descriptions they would be comfortable sharing with others. Sharing decisions were given for different social groups that are typically found in SNSs, including close friends, acquaintances, and coworkers.

For each selected location label, we examined how easy it would be for a third-party to locate the user using a set of commonly available reverse geo-location tools. A detailed description of our analysis and our findings can be found in [10], but the finding that is most relevant to our discussion here is that, in social location sharing scenarios, users’ locations could be reverse engineered for ~51% of the disclosures. In SNSs, users often unintentionally leak information [6]; we see here that location sharing may lead to more accidental privacy leaks. In addition, findings from our interviews indicate that sometimes participants reveal their location for impression management or to attract attention. These findings have important implications for interactional privacy, as impression management is an activity that requires ongoing framing of oneself in respect to others and can influence the dynamics of interpersonal relationships, especially those involving weak ties.

### Social Outcomes of Sharing Abstractions

We are also interested in understanding what types of social interactions one might expect from social location sharing and to provide initial empirical evidence that location sharing can lead to enhanced social bonding. To this end, we developed a Facebook application that collected a user’s status updates and comment activity. We deployed this application to six undergraduates and collected 3 months of their status messages (Jun-Aug 2010). Participants had, on average, 223.5 friends in their online social networks. In total, we collected 3,545 status updates and 892 comments. 12.3% of these messages contained location information. We then separated these updates based on whether they contained a geographic or a semantic description.

To measure the amount of social utility, we compared comment activity along three dimensions: the type of users who leave comments (i.e., their relationship to the person who left the comment), the number of comments, and the length of comments. We found that status messages with semantic abstractions were more marginally more likely to have more comments ( $p < 0.09$ ) than messages with geographic abstractions. We found no significant differences in terms of the length of comments. However, we did find a significant difference in terms of the types of users who left comments. Status messages that included semantic location descriptions (as opposed to geographic descriptions) were more likely to have comments left by those who have weak social ties to the user.

### **Extending Abstractions to Service Providers**

It is important to note that the abstractions we have discussed thus far are the context of peer-to-peer sharing. In other words, our studies have assumed that the location information stored with the service provider is still the raw data (i.e., the specific geographic details). This data storage scheme allows for users to specify individual abstraction rules for sharing with specific people. However, it is important to acknowledge there are equally important privacy considerations for what users prefer to provide to developers regarding their personal information. In future work, we hope to extend our studies to examine how abstractions can ease these privacy concerns.

### **Conclusion and Future Work**

In this paper, we present one of the problems facing many LSAs, namely that users are faced with a tradeoff between privacy and utility when making decisions about social location sharing. We then introduce a

potential solution to this problem, which is to use location abstractions to alleviate the privacy barrier inherent in many LSA's all-or-nothing disclosure model. We conclude with results from our study that examines the privacy and social outcomes of sharing abstractions in LSAs. We believe that our work provides an initial quantitative look at the types of privacy concerns that affect users, as well as the kinds of social utility that users can benefit from when treating location information as a core type of social media in SNSs.

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