Examining Obstacles to Sharing Fine-Grained Personal Activity Data

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Abstract
Many personal informatics applications integrate social sharing of sensed activity data. Sharing can promote personal goals through social mechanisms such as encouragement and competition. However, fine-grained sharing can often allow people to infer the context of sensed activity. This can surface significant privacy concerns, as people may unintentionally disclose aspects of their everyday life unrelated to their motivations for sharing. We first discuss scenarios that motivate fine-grained sharing but are restricted by current all-or-nothing approaches. We then discuss our interests in exploring potential alternative approaches to sharing fine-grained personal activity data.

Author Keywords
Personal informatics, social sharing, privacy.

ACM Classification Keywords
H.5. Information Interfaces and Presentation

Introduction and Motivation
Personal devices with activity sensing capabilities have become increasingly ubiquitous (e.g., on-body sensors, pedometers, mobile phones). These devices enable a wide variety of personal informatics applications that promote behavior change by supporting self-reflection.

Such applications can also significantly benefit from social mechanisms as a motivator for behavior change. For example, Consolvo et al. developed the UbiFit prototype to examine sharing of sensed step counts with "fitness buddies" [1]. They found participants were often motivated by words of encouragement or by not wanting to disappoint friends. In another example, Mankoff et al. developed Stepgreen.org to promote positive environmental behaviors by sharing energy-saving commitments with friends [8]. Participants listed comparing their commitments with friends who use the website as one of their most desired features, so it was incorporated into a redesign.

Social mechanisms appear to be most effective among people who already know one another. For example, Lin et al. developed Fish'N'Steps, which presents a visual representation of step count as fish in a tank [7]. Participants were grouped into teams with a shared tank, and team members were able to message encouraging words to each other. This feature was rarely utilized because participants felt uncomfortable contacting teammates they did not personally know.

Privacy Concerns

The benefits of social sharing in personal informatics applications need to be balanced against concerns that people have for their privacy. For example, Mankoff et al. report a Stepgreen.org participant wanting to exclude personal hygiene activities from sharing [8]. People also react to the nature of sensors and how applications capture and store sensed data. For example, Klasnja et al. found that participants were generally comfortable with sensor data being used to provide a service, such as determining a runner's pace using location data in a fitness application [4]. Participants were comfortable with low-level sensors that do not inherently provide context for sensed activity, but had concerns regarding always-on sensors that could reveal unintended details of the context of activity (e.g., location logging, raw audio capture).

Extensive research has examined privacy concerns in location sharing. In a literature survey, Krumm finds that sharing preferences vary according to subtle differences in granularity and time of sharing [5]. He suggests degrading data prior to sharing, such as by adding noise. We are interested in extending prior work on location privacy to the diverse types of activity data found in personal informatics applications.

Inferring the Context of Activity Data

Sensed activity can take on additional meaning when considered in the context of its collection. For example, Li et al. developed IMPACT, which uses journaling and location data to inform people of the contexts in which they accumulate steps [6]. Li et al. report people use this additional context to draw conclusions about their activity habits. For example, participants identified activities that offered more intense physical activity, and some changed their behavior to incorporate more of these activities into their daily routine.

We believe an important class of privacy concerns is raised when fine-grained sharing unintentionally allows other people to infer such context. A person who shares fine-grained activity data from a FitBit pedometer [2] or a HydroSense home water sensor [3] expects to give some visibility into the associated activities, but may object if people are able to infer unrelated context. The next section introduces several problematic scenarios.

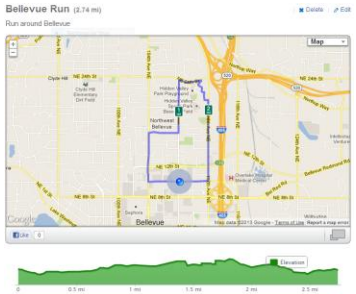

Figure 1. Although Gloria would like feedback on a running route through her neighborhood, she is concerned that sharing her run will reveal where she lives.

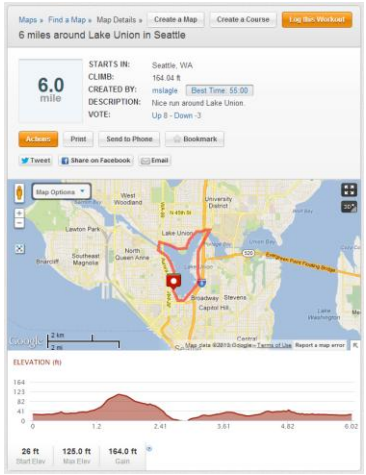

Figure 3. Hunter shares his record time for biking around the lake, but now his co-worker wonders why Hunter left work in the middle of the afternoon.

Revealing Unintended Context

The problem of fine-grained activity data revealing unintended context is not limited to any particular sensor, application, or approach to sharing. We present a set of scenarios to illustrate some of the possibilities.

A Concern for Safety

Gloria is training for a marathon, and she is using RunKeeper [10] to track her progress. She wants advice on nearby trails, so she considers sharing her running route through her neighborhood to collect alternatives from other people using RunKeeper in the same area (see Figure 1). But she realizes this would also share where she lives (i.e., the start and end of her route), so she decides not to share her route at all.

Embarrassing Illness

Peter and his housemates are using HydroSense to track and reduce their water usage [3]. When Peter has a case of food poisoning, HydroSense captures his additional late-night bathroom activity. Embarrassed, he attempts to blame a leaky flapper valve in the toilet. There is no explicit social network in this scenario, but privacy concerns emerge from the shared household.

Caught Partying

Whitney is using a FitBit to track her step data [2], and is proud of an active day (see Figure 2). She decides that she wants to share her detailed step log on a social networking site to highlight her accomplishment. In doing so, she realizes she would also reveal that she walked home at 2:00am on a weeknight. Her parents would be very upset by this, as they believe she was home studying. She decides not share her activity, missing out on encouragement from her friends.

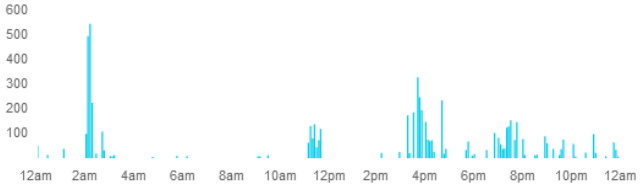

Figure 2. Whitney is proud of her step activity, but does not want her parents to see that she was out late on a weeknight.

Slacking Off

Hunter is training for a triathlon while also managing important deadlines at work. On the day of a training ride, he comes to work several hours early to ensure he has met all of his responsibilities. He leaves in the early afternoon, bikes a nearby trail, and finishes in record time. Excited by his time, he uses MapMyRide [9] to post his ride to Facebook (see Figure 3). Darlene, a co-worker and Facebook friend, later sees Hunter's post. She wonders why Hunter went for a ride in the afternoon with such important deadlines, and questions whether Hunter has been pulling his weight at work.

Exploring Other Approaches

Fine-grained sharing of personal activity data could enhance a variety of personal informatics applications. But these and other scenarios highlight privacy perils that are non-trivial to resolve. Existing applications generally take one of two approaches: (1) sharing only high-level summary data (e.g., step count for a day, length of a run), or (2) forcing all-or-nothing decisions about whether to share detailed activity data.

We are interested in exploring other approaches to sharing fine-grained activity data. One possibility is to support detailed filtering of activity data prior to sharing. For example, Whitney might limit data sharing

to between 9:00am and 9:00pm, thus receiving encouragement from her friends without exposing late-night activity to her parents. Similarly, Peter might delete his late-night bathroom activity, removing his potential embarrassment while preserving data collected about the household's typical water usage.

We are also interested in exploring how people might actively manipulate sensed data prior to sharing. For example, Hunter might shift the time of his bike ride to later in the day. This would preserves Hunter's original reason for sharing (i.e., his record time), while also protecting him from critical co-workers. Similarly, Gloria might edit the location trace of a run before sharing it to solicit feedback on her route. By leaving most of the route unmodified, she could get feedback on the route without revealing where she lives.

Workshop Participation

We are enthusiastic to participate in this workshop for several reasons. We look forward to discussing ideas in this position paper: the potential for fine-grained activity sharing in personal informatics applications, potential privacy risks, and how applications might support fine-grained sharing while giving people the control needed to manage their privacy. We hope to gather perspectives on the positive and negative implications of fine-grained activity sharing and the possibility that people are manipulating data prior to sharing. Finally, we are excited by the collaborative nature of the workshop and the opportunity for exposure to a broader variety of personal informatics sensors, applications, and motivations. Although health and sustainability applications are important, we are interested to see how our ideas might apply in a wider range of personal informatics applications.

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