Getting Personal with Personal Informatics

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PERSONAL INFORMATICS AND MOBILE COMPUTING

We have entered the age of personal informatics, defined by applications helping people collect and reflect on their personal information [26]. Connected devices and mobile applications are now available in a variety of health domains (e.g., devices for tracking blood pressure, heart rate, physical activity, sleep, and weight available from *Basis*, *Fitbit*, *JawBone*, and *Withings*). Over 69% of United States adults currently track a health factor, with 14% using technology to so do [15]. These numbers will continue to rise, as new sensing removes barriers to long-term personal monitoring. Research challenges and opportunities in personal informatics are inherently intertwined with mobile computing, as mobile and connected devices are key to *capture* as well as in-the-moment *reflection* and *feedback*.

We propose to lead an HCIC 2014 discussion on the state of personal informatics, organized around research we are conducting in a variety of personal informatics domains. Current approaches are not working, as they often provide little value or impose unbearable burdens. Using examples from our research in physical activity, food, and sleep, we will argue the way forward lies in moving away from “more is better” to designing for the variety of personal goals that people bring to personal informatics applications.

CURRENT PITFALLS IN SELF-TRACKING

Our perspectives on the future of personal informatics are shaped by the challenges people currently face in obtaining meaningful value from self-tracking. The Quantified Self community provides early adopters of these technologies, so we studied 52 videos of Quantified Self presentations, each focused on a person discussing what they tracked, how they tracked, and what they learned [6]. A set of common pitfalls emerge, with people attempting to track too many things, failing to track appropriate triggers and contexts, or reaching causal conclusions that are not supported in their data.

At the highest level, the challenge is a mismatch between value and effort. On one hand, current approaches to automatic sensing require minimal effort for capture, but often provide limited value in reflection or feedback. On the other, a combination of multiple sensors and thorough journaling can provide multi-dimensional data for reflection and feedback, but often requires too much effort to be sustainable. The combinations fosters a “more is better” faith among tool developers and early adopters, a trap wherein self-trackers expend significant effort but gain little value.

We argue for understanding and designing support for the goals people bring to personal informatics. We will first discuss physical activity, considering how to improve the value people obtain for the effort they invest. We will then discuss food journaling, considering how to reduce the burden of capture to levels more appropriate for the value it might provide. We will finally discuss sleep, which requires understanding many inter-related dimensions of daily life. These current personal informatics domains highlight design challenges and opportunities that will continue to grow as personal sensing becomes increasingly ubiquitous.

PHYSICAL ACTIVITY

Step tracking goes as far back as Leonardo Da Vinci [9], with widespread use as early as the 1965 manpo-kei (万歩計, literally the “10,000 steps meter”) [32]. Steps were among the earliest self-tracking topics explored by the HCI and UbiComp communities (e.g., [1, 8, 27]). Modern mobile devices and applications can record steps at fine-grained time intervals, infer related physical activities (e.g., running), and link step activity to personal location traces.

Despite rapid advances in physical activity capture, the value of self-tracking remains limited by a lack of corresponding advances in reflection and feedback. Activity trackers generally display a simple step count or other activity representation for the day, leaving the self-tracker to attempt to monitor goals or identify actionable findings in their data. Some activity tracking applications completely lack support for goals, while others default to a fixed goal of 10,000 steps. Without understanding goals, designers cannot even know how to valence feedback (e.g., 10,000 steps per day may be too high for many people to achieve, but too low for somebody training for a long hike) [7, 33]. Even applications that are aware of personal goals do not currently use tracked data to effectively support those goals (e.g., the Fitbit mobile application includes reminders of how many steps people need to reach a goal, often delivered in the evening when it is too late for people to take meaningful action).

People may have varying and overlapping goals for being active (e.g., losing or maintaining weight, training for an event, managing a chronic disease). Alternatively, some may be trying to limit physical activity (e.g., if recovering from injury). Goals may also be more social (e.g., being more able to play with children, being more connected to a friend through shared activity, competing with a friend / partner / sibling, or creating an impression of athleticism) [29]. Physical activity may also be a means toward other goals, such as a more environmentally sustainable lifestyle [16].

Understanding self-tracker goals can enable new designs that do more to support reflection and feedback. In recent work, we surveyed 113 physical activity trackers regarding their goals and factors that influence their physical activity [14]. We designed cuts and visualizations of activity histories, intended to support people in making actionable findings in their self-tracking data. We then conducted a deployment and interviews with 14 people, each tracking their activity and location data for one month. Compared to existing approaches, participants found our cuts and visualizations supported their desire to find actionable information via self-tracking. Their observations include: "*Yep, [my husband and I] should be walking on short trips more and biking on medium trips more.*" and "*I guess it's because I feel guilty for leaving work early [on Tuesdays], so I come in a little bit earlier on Wednesdays. Huh, I didn't even know that.*"

We are also currently developing approaches to continuous real-time prediction of goal achievement. In a survey of 101 self-trackers, we identified a checkpointing practice wherein people learn how many steps they must have by different points in a day if they are to reach their overall goal [11]. Importantly, we also found their response to likely shortfalls changes based on when they realize they need extra steps. If still early in the day, they integrate the extra activity into their day (e.g., adding a walk, taking the long way home). But if the shortfall is not discovered until late, they often abandon the goal or attempt to reach it using less desirable methods (e.g., pacing within the house). We therefore have obtained detailed activity histories for 158 self-trackers (80 Fitbit trackers, 78 Moves trackers), and are examining automated approaches to predicting step goal success throughout the day. We are also interested in whether such models can enable personalized suggestions on how to integrate additional activity into the day. We see within-day goal support as a powerful complement to existing approaches to higher-level goal support (e.g., activity coaches that can generate personalized training schedules).

Finally, the design of social mechanisms in self-tracking presents equally compelling and challenging questions. This problem is hard in part because research suggests that making goals public can actually reduce the likelihood a person performs the activity, as they can get all of the social benefits up front and do not need to follow through on actually achieving their goal [18]. We have conducted interviews with people about their existing sharing practices [29] and also deployed our own applications with goal sharing features [28]. We found sharing activity on Facebook or Twitter can support impression management, but also runs the risk a person will be perceived as boring or an oversharer. People turn to their networks for emotional support, motivation, and advice around health goals, but also want to portray themselves as positive and in control. In GoalPost, we gave people the ability to share goals and progress on social networks with either their entire audience or a support group they crafted. Some participants felt this made their goals "more real", and others tried to use this feature to solicit emotional support. Sharing was limited by fears of violating social norms, and those who did share were sometimes disappointed by the lack of response. In a value-sensitive design study including interviews with 12 participants, we found a tension around highly-detailed sharing of personal informatics data [13]. Detailed data can enable better or more specific advice and social support, but can also reveal more than people intend to share. Going forward, we are interested in exploring social sharing based on routines and deviations from routine, as distilled from activity data. We believe these may enable more rewarding and effective sharing (e.g., generating greater discussion and feedback, generating responses that better correspond to a sharer's needs in terms of support, challenge, or advice).

FOOD

Food is one of our most frequent and consequential health decisions, but capturing and understanding food choices is notoriously difficult. The problem is difficult to automate through sensing, and doing so might actually undermine the mindfulness that comes with manual journaling [34]. Food journals have been shown to be effective for monitoring eating habits [4, 20], and researchers have proposed mobile systems that help balance calorie intake versus exercise [31]. But the burden of journaling is high, so people are generally able to keep journals only for short periods of time and resulting data is also questionable and incomplete [12, 21].

POND is a system we developed to reduce the burden of food journaling by allowing people to mix traditional food database lookups with lightweight tracking of components from the USDA's Health Eating Index [2]. Although this reduces the burden of searching through a food database, we found it introduces a new food literacy burden, in that people need to carefully think about the nutritional components of their food. Participants also noted that the component-based tracking meant there was no record of what actual food was eaten, limiting their ability to reflect on food choices.

Informed by this, we have begun to re-explore opportunities for lightweight photo-based food journaling [10]. We conducted a survey of 140 current and past food journalers to understand their journaling techniques, benefits they received, and experiences and challenges with food journals. Importantly, only 25 of these participants identified calories as among their goals for food journaling. We also developed a lightweight photo-based food journal that we deployed with 27 participants for an average of 5 weeks. In contrast to prior work that has treated photos as an intermediate representation (e.g., to support later encoding as calories), our work reveals an opportunity to treat photos as the primary form of the food journal. Participants reported the act of taking the picture promoted mindfulness, said that they preferred journaling without the judgment they found in designs that emphasized calorie budgets, and were able to identify trends and contexts based on the food photos. Although calorie tracking will remain important for some people, we believe new designs that better support the broad range of food-related goals can help reduce the burden of journaling and support efforts to improve food decisions.

SLEEP

Sleep has generally received less attention from the HCI and UbiComp communities, but is critical to health and can be just as important as physical activity and food. We conducted a formative study involving contextual inquiry, surveys, and interviews to help define the design space for sleep-related technologies [5]. This informed our design of Lullaby, a capture and access system that people can use to examine environmental factors that may be disrupting their sleep (e.g., temperate, light, noise, other disruptions) [22]. But sleep is also about mobility, as understanding sleep requires considering the rest of the day, including such factors as drinking caffeine or alcohol, exercising, eating large meals, and technology use.

We designed ShutEye as an extremely low-burden mobile technology to help improve sleep [3]. ShutEye uses the active wallpaper of Android-based phones to display a timeline showing various time-based factors that can impact sleep. For example, sleep can be impacted by caffeine, meals, alcohol, or exercise too late in the day. The ShutEye wallpaper provides a quick information display that shows whether it is too late in the day for these activities. Deployment with 12 participants for 4 weeks showed that the display was very low burden but also still effective at prompting participants to think about the behaviors they do throughout the day. For about half of the participants, we saw improved scores on a validated measure of sleep.

Our study of ShutEye also revealed that people prioritize other things over sleep. Informed by this, we are currently working on tools to help people understand how sleep impacts their lives, such as by comparing sleep quality to factors such as reaction time, mood, and work productivity. One example is PVT-Touch, a mobile application we developed to implement the Psychomotor Vigilance Task [23]. PVT-Touch allows people to use their mobile device to measure their reaction time, as a reaction time greater than 300ms can be a sign of sleep deprivation. This can allow people to track their sleepiness over time, and is a step towards tools that can support people in understanding the relationships among their many different aspects of health.

CONCLUSION

In addition to the "big three" dimensions of health above, we have developed and are continuing to explore new elements of sensing, mobility, personal informatics, and health. Systems like CoughSense and Spirosmart repurpose existing mobile devices as low-cost medical monitoring [24, 25]. Our prior work in infrastructure-mediated sensing can potentially support low burden activity recognition throughout the home [17, 19, 30], supplementing the information available from mobile devices. We are examining questions of how to support people in assembling and making sense of data from across multiple sensing systems, and also questions of how to support interactions around personal informatics data with clinicians and caregivers.

Overall we look forward to HCIC 2014 as an environment for vibrant discussion of current and future opportunities in personal informatics. As we have noted, the topic seems intertwined with mobile computing, helping people both capture and act upon data from throughout their lives. This submission tries to convey the wide range of work we bring as background to such a conversation, and has attempted to organize that work in a manner we think appropriate for such a discussion. But of course it is a discussion, and so we would welcome feedback on this proposed approach.

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