Designing Personal Informatics Applications and Tools that Facilitate Monitoring of Behaviors

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ABSTRACT

A new class of applications and web sites called *personal informatics* is appearing that collects personal behavioral information about users and provides access to this information to help users become more aware of their own behaviors. Interaction with personal informatics systems has two inter-dependent phases: monitoring and feedback. Users must interact with the system in at least one of the phases for users to become aware of their behavior. In my proposed work, I focus on user's interaction with the system during the monitoring phase. The main question of my research is *what are the problems with the monitoring phase of personal informatics and how can they be resolved?* I explore three aspects of this question: (1) How do you reduce the burden of manual monitoring? (2) How can systems motivate manual monitoring? (3) What are the advantages and disadvantages of automated monitoring?

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INTRODUCTION

Knowing oneself through self-awareness and self-reflection has many benefits, such as fostering self-insight [4], improving learning and exam performance [11], increasing self-control [7], and promoting positive behaviors such as exercise [8] and energy conservation [10]. Unfortunately, knowing oneself can be difficult because we often have incomplete knowledge of ourselves [11]; we cannot monitor our behaviors all the time and we may be too busy to introspect.

Computers can help. Computers can store large amounts of data, analyze the data for patterns, visualize the data, and provide feedback to users at opportune times. A new class of applications and web sites called *personal informatics* is appearing that collects behavioral information about people and provides access to these information (*e.g.*, Mint.com and Google Web History).

Interaction with personal informatics systems has two

phases: monitoring and feedback. The monitoring phase is when information is collected about the user's behavior and the feedback phase is when information is provided back to the user. The time between these phases can be long (e.g., your monthly electricity bill showing your electricity usage) or short (e.g., a pedometer that counts each of your steps). These two phases are inter-dependent in helping users become aware of their behaviors. The user must be engaged with the system in at least one of the phases for the personal informatics tool to be useful.

In my proposed work, I focus on user's engagement with data during the monitoring phase. The main question of my research is: *what are the problems with the monitoring phase of personal informatics and how can they be resolved?* I will discuss techniques to motivate and reduce the burden of manual monitoring. I will also discuss implications of automated monitoring on user engagement with data and how the feedback phase becomes more important for personal informatics as monitoring is automated.

In my proposed work, I explore three aspects of this question:

1. *How can systems motivate manual monitoring?* There are several reasons why users may not want to record behavioral information about themselves: the value of the information may not be immediately obvious or they may not know what to do with the information. I conducted a study that shows that participants in an experience sampling study would record more information if they saw visualizations of the data. *What are other techniques that can be used to motivate manual monitoring and make the data more relevant to users?*

2. *How do you reduce the burden of manual monitoring?* Recording one's behavior can be time-consuming and tedious. The user may need to record several times a day over several days depending on the type of behavior being recorded. I developed Grafitter to allow users to record various data about their behavior during social activities such as communication using Twitter, IM, and blogs, and sharing using Delicious. I also developed MoodJam as an example of making manual recording of moods more fun by letting users create visualizations about their mood. *What other techniques can be used to reduce the demands of manual monitoring?*

3. *Automated monitoring can significantly reduce the monitoring demand on the user, but at what cost and how can it be resolved?* While automatic monitoring can resolve some of the above problems, automatic monitoring can lead to less engagement with the data during the monitoring phase and thus making the feedback phase critical in making the data useful to users. *How can feedback help with the loss of engagement during the monitoring phase?*

RELATED WORK

Collecting personal behavioral information

Recently, web sites (e.g., Mint.com, Google Web History) have appeared that provide visualizations of trails of user behaviors, such as purchases and search behavior. Many research projects are exploring the possibility that many aspects of our lives can be recorded automatically (e.g., MyLifeBits [3]). However, there are still many behaviors that cannot easily be recorded automatically because either the data is subjective (e.g., moods and thoughts) or monitoring requires infrastructure that does not exist yet (e.g., tracking a person's daily activities or disease symptoms). For these, services have depended on manual entry. Web sites have appeared that allow users to use an online form to report their moods (http://happyfactor.com and http://moodstats.com), their daily activities (http://daytum.com and http://mycro.media.mit.edu), and disease symptoms (http://curetogether.com).

Experience sampling techniques

Problems with manual and automatic monitoring have been tackled to encourage participation in experience sampling studies. Traditional experience sampling method studies requiring manual input have used compensation to encourage participation [9]. However, compensation may not work for personal informatics systems because there is no third party who would provide the funds. Several ubiquitous computing systems have been developed to facilitate ESM studies through automation. The context-aware experience sampling method [6] reduces demand for input from participants by only collecting self-reports when a particular context is detected. The MyExperience system extends context-triggered ESM with passive logging of contextual information discerned from device usage and sensor readings [2]. The system collects more information without increasing participation from participants. Momento [1] leverages text messaging (SMS) and media messaging (MMS) supported by most mobile phones to collect ESM samples and to share data between participants and experimenters. I have some evidence from my studies that automation reduces the amount of engagement users experience with the data. This needs to be explored further to determine what value users would get from the data.

METHODOLOGY AND NEXT STEPS

In this section, I discuss the three areas I am exploring and discuss work that I have completed and further work that needs to be done.

Motivating manual monitoring

I worked on a system called ES+feedback [5] or Experience Sampling with Feedback (Figure 1) that shows that visualizations can encourage users to participate in manual monitoring of their behaviors in the context of experience sampling. The system increases the compliance or response rate in experience sampling studies by visualizing participants' collected data. My field study showed that those who saw visualizations of their behavior answered more experiment questions than those who did not see visualizations.

I need to explore further why participants increased response rates when they saw visualizations of their data. I suspect participants found personal value in the visualizations of the data they manually collected. The visualizations may have sparked curiosity among the participants about their behavior. One participant said they looked at the visualizations "to know how many times I have answered the questions and to know about my mood for a week." Also, the visualizations may have revealed self-reflective trends and patterns. For example, one participant said, "When I was doing something productive, my mood was high." I am currently preparing studies to explore these questions.

Reducing the burden of manual monitoring

I explored ways to make manual data collection easier with MoodJam (Figure 2) and Grafitter (Figure 3). Some personally relevant information cannot be reliably collected automatically (e.g., mood and productivity), so users must log this information manually. MoodJam (http://moodjam.org) with 4000 registered users makes

Figure 1. One of the ES+feedback visualizations.
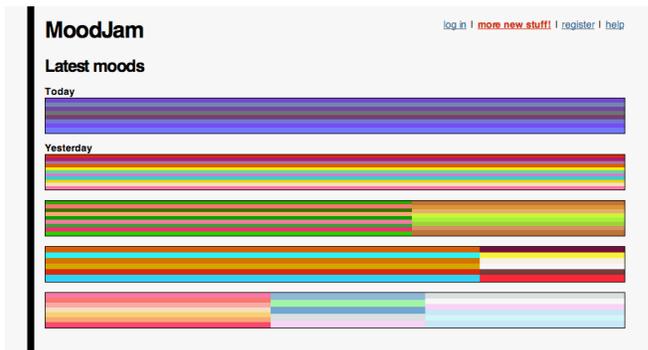

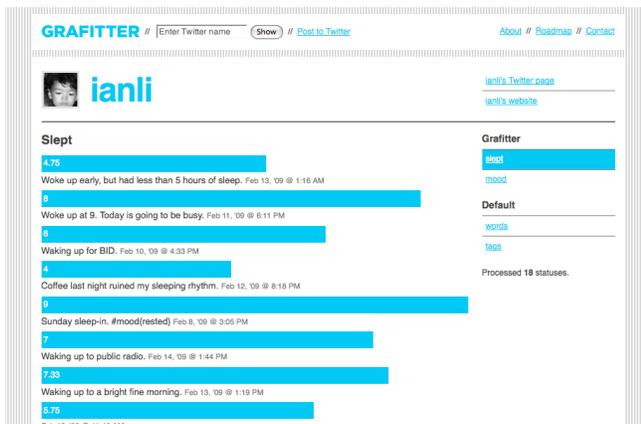Figure 2. Screenshot of MoodJam.

Figure 3. Screenshot of Grafitter.

Figure 4. Screenshot of IMPACT.

logging moods an enjoyable experience by providing a simple interface to associate colors and words with moods. Users can share their moods visualized in colorful strips. Grafitter (http://grafitter.com) facilitates collection of personal information by leveraging people's everyday use of communication and sharing media, such as Twitter, instant messenger, blogs, and Delicious. Users can explore their Twitter updates for patterns and trends using Grafitter visualizations. I plan to run studies that explore how much MoodJam and Grafitter reduce the burden of manual monitoring.

Currently, I have a survey exploring what problems people have collecting information about their behaviors and their selves. The survey asks users what tools they use, what they learn from the data, and how their experience collecting information can be improved. Results of this survey will help me identify problems people are experiencing in collecting different kinds of behavioral information. Knowing the existing problems with personal informatics tools would help with developing techniques that reduce the burden of manual monitoring.

Effects of automated monitoring
I created a system called IMPACT (Improving Monitoring of Physical Activity using ContexT) to explore personal informatics tools for physical activity. The first prototype of the IMPACT system required manual monitoring. In a 7-week study, the prototype helped users to become more aware of opportunities for physical activity, but people found the system very hard to use.

I added automated monitoring to the second prototype of IMPACT (http://mobileimpact.cmubi.org) to reduce the burden of monitoring on users (Figure 4). The prototype had two parts: (1) a mobile phone that monitors both physical activity and location and allows users to provide other contextual information and (2) a web site with visualizations for a historical view of how different activities, people, and places affects one's physical activity. I deployed the system for 8 weeks comparing it to other versions of IMPACT without contextual information. I found that having contextual information was not better at increasing awareness of opportunities for physical activity. In fact,
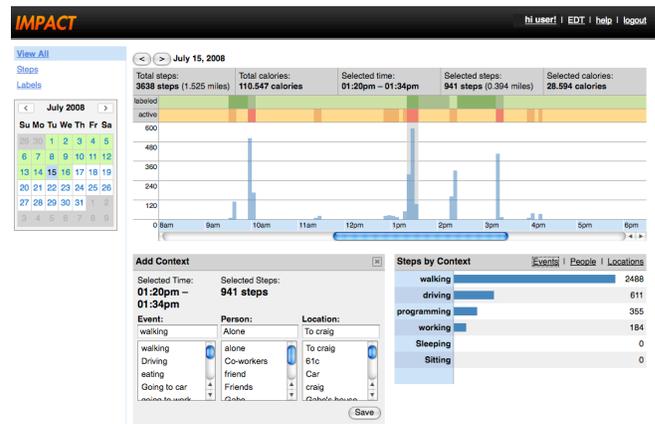
awareness of opportunities increased for all users, regardless of the system that they used.

A follow-up study that I did six months later revealed the value of the extra contextual information collected by the IMPACT system. All users were curious about the peaks that they saw in their graphs, they wanted to know what they were doing during those times of peak activity. However, only users who had collected contextual information were able to deduce what they were doing. Interestingly, some users pulled out their electronic calendars to see what they were doing on particular dates. These observations suggest that automatic labeling of contextual information is useful for reflection, especially, at a later time when users have likely forgotten their history. Another observation is that existing records, such as electronic calendars, may be leveraged to provide contextual information.

The observations from the previous studies suggest several areas of exploration. First, the balance between burden of monitoring and richness of data for feedback needs to be further elaborated. I observed from my prototypes that automating monitoring relieved users of the burden of monitoring, but users were also less engaged. However, since more data has been collected about the users, the quality of feedback provided should be improved. What are some effective feedback techniques so users may gain the full benefit from their data? One idea is to make the system proactive in showing data to the user, *e.g.*, the system can provide feedback when the user needs the information most. Another idea is to set regular moments for users to reflect on their data. This technique would require determining what the right amount of reflection is necessary to offset the loss of engagement from the automation of monitoring.

CONTRIBUTIONS TO UIST
I hope to make the following contributions at the completion of my thesis work. First, I will identify the barriers to recording personal behavioral information. Second, I will design several interaction techniques that circumvent these barriers. Third, I will develop systems and tools that demonstrate the interaction techniques. Lastly, I want to determine a general framework for encouraging input in per-

sonal informatics systems. I also hope that the results of this work will lead to systems that help people learn more about their behaviors and their selves.

MOTIVATION FOR ATTENDING THE CONSORTIUM

Since I have been working on interaction techniques to support personal informatics, the Doctoral Consortium will be relevant to the development of my Ph.D. thesis. I look forward to receiving valuable feedback from more experienced UIST researchers and to discuss my research with other colleagues. I also hope that the fresh perspective of others may help me identify missing aspects of my research. Lastly, I hope that I can also contribute in the development of other fellow students' research.

I am currently a fifth-year graduate student in the Human Computer Interaction Institute at Carnegie Mellon University. I work with Anind Dey and Jodi Forlizzi.

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