Poster Abstract: LifeMaps – An Automated Diary System Based on the Structure of Lives

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ABSTRACT

Diaries are used to record aspects of lives — activities, events, experiences, feelings, thoughts, and physiological measures. Smart diaries can reduce the user's burden by automatically registering some of these aspects. Existing systems have two weaknesses: (a) they are not extensible, and (b) their design is not theory-driven. We introduce LifeMaps, a cloud-based automated, extensible, theory-driven smart diary. Because it is inspired by theory, "The Deep Structures of Lives," it organizes data to conform to the way we experience our lives and may lead a deeper understanding of lives.

CCS Concepts

•Human-centered computing → Ubiquitous and mobile computing systems and tools; •Computer systems organization → Sensors and actuators;

Keywords

Online diaries; mobile sensing; in-situ sensing; structure of lives

1. INTRODUCTION

To understand individuals, we need to know what they do, with whom, and how they experience and evaluate their activities. Current diary systems have a narrow focus (e.g., fitness or emotional states) and are not based on theory. We are developing LifeMaps, a theory-driven on-line diary system that collects structured data from a person using both automatic sensing and manual inputs. LifeMaps accommodates special-purpose extensions designed for clinical applications and behavioral studies.

Its design is guided by a theory based on cognitive principles of perceptual and conceptual organization — 'The Deep Structure of Lives' — that "describes the structure of lives as a composite of nearly independent strands that run concurrently, and are asynchronous" [2]. Each strand is characterized by three features: (a) The user's role, (b) the cast of characters, and (c) a typical location. Commonly observed strands are parenting, job, hobby, religion. This structure differs from other approaches, such as the Day Reconstruction Method (DRM) [1], that represent lives as a "flat" succession of episodes. For example, the DRM asks people to consider their activities as a series of scenes in a film. This can only get at the surface structure of lives.

LifeMaps is designed to automatically collect data of a person's life (such as activities, mobility, and location) using sensors, thus minimizing the burden on users. This information is complemented by entry of first-person data about events deemed noteworthy by users, which gives a rich, nuanced, and accurate picture of their lives.

2. SYSTEM DESCRIPTION

LifeMaps is a cloud-based system that provides interfaces for data acquisition from multiple sources such as the user, wearable and in-situ sensors, and mobile devices. Sensing and its automatic interpretation minimizes the user's need to remember and log information. But where inference based on sensors is unreliable or when it is important to understand the user's emotions and motivations, user input is essential and adds a first-person perspective to the objective data. Special-purpose modules can be embedded in LifeMaps to accommodate new clinical and research uses.

We have implemented prototype user interfaces for LifeMaps that embody concepts from the theory of the Deep Structure of Lives. Figure 1 shows an interface that records the start time, end time, place, participants, and nature of activities and events. The user assigns some events or activities to user-defined strands, here coded with different colors. Much of this information can be determined automatically. After an initial phase, during which the user trains the system and corrects its inferences, LifeMaps will accurately classify activities and assign them to strands. The first-person data from the user helps LifeMaps improve its performance on automatic inference. Clicking on the "Noteworthy" icon (a star) triggers another interface that allows the user to input more information including experience, feelings, and thoughts. This interface is not shown due to space limitation.

3. APPLICATIONS

To illustrate potential applications, we describe three clinical uses of LifeMaps: (i) Post Traumatic Stress Disorder (PTSD), (ii) asthma, and (iii) pollution and stroke. Each involves the design of a specialized add-on to combine purpose-

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	Strand	Noteworthy	Start	End	What	Where	Who	Type
1		☆	6:30 AM		Wake up			Repeating
2	Hygiene	★	6:30 AM	7:00 AM	Toilet, Brush Teeth	Home		Repeating
3	Hygiene	★	7:00 AM	7:30 AM	Shower	Home		Repeating
4	Eating	★	7:30 AM	8:10 AM	Breakfast	Home	Spouse	Repeating
5		☆	8:10 AM	8:30 AM	Preparing for office	Home		Repeating
6	Commuting	★	8:30 AM	9:00 AM	Commute	To Office		Travel
7	Work	★	9:00 AM	11:00 AM	Work on Project A	Office		Continuing
8	Work	★	11:00 AM	12:00 PM	Meeting	Office	John	Unique
9	Eating	★	12:00 PM	1:00 PM	Lunch	Office		Repeating
10	Work	★	1:00 PM	2:00 PM	Meeting	Office	Kevin, Matthew	Repeating
11	Work	★	2:00 PM	5:00 PM	Work on Project B	Office	David	
12	Commuting	★	5:00 PM	5:30 AM	Commute	To Home		Travel
13		☆						

Figure 1: Some activities of daily living with strands marked with different colors

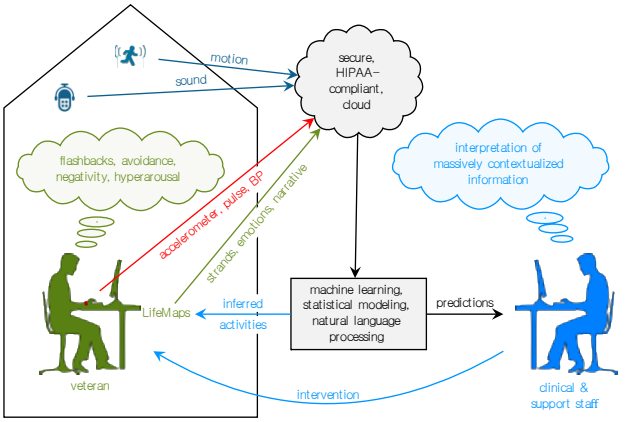

Figure 2: PTSD scenario.

specific data with the rich quantifiable information obtained by LifeMaps.

3.1 Post Traumatic Stress Disorder (PTSD)

Figure 2 shows how in-situ and on-body sensors collect PTSD-related information and automatically combine it with the wealth of information in LifeMaps through a mental-health add-on. As data accumulate over time, the combined information may allow a machine-learning algorithm to infer levels of stress, to predict an impending crisis (e.g., violent behavior or suicide) and alert a clinician to intervene before a severe crisis occurs.

3.2 AsthmaGuide

Many asthmatics monitor and manage their illness with a mobile app such as AsthmaGuide [3]. AsthmaGuide collects physiological and environmental information, automatically detects wheezing, and can provides advice and/or alert a clinician. This information is collected continuously and is pushed to a specialized add-on that collates the data from AsthmaGuide with the rich data in LifeMaps. Machine learning algorithms applied to these combined data may effectively predict a user's asthma triggers, as well as assess the effectiveness of treatments. Figure 3 shows the sensor suite used in AsthmaGuide.

Figure 3: Sensor suite: (a) Littmann 3200 electronic stethoscope, (b) Sensordrone, (c) Contec SP10W spirometer, and (d) Nonin Medical pulse oximeter.

3.3 Stroke and Pollution

Exposure to pollution — especially to particulates such as PM2.5 — increases the risk of stroke in the elderly or those with certain medical conditions. Furthermore, according to the US Environmental Protection Agency, indoor air quality can be more polluted than outdoor air. To protect vulnerable individuals, a portable system using G3 dust sensors has been designed to monitor the quality of the air in the users' environment. Together with outdoor pollution information retrieved from national databases, this information is sent to a LifeMaps add-on that collates the users' exposure to pollutants with other objective and subjective information. These measurements and machine-learning algorithms may predict stroke triggers and/or alert the user's clinician.

4. CONCLUSION

LifeMaps is an automated, theory-driven diary system to capture, process and visualize lives. The system promises to be an effective tool for understanding the structure and complexity of lives, and has the potential to become an important platform and supporting tool for many domains such as healthcare, psychology, economic behavior, and behavioral clinical interventions.

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