

Mobile Sensing for Mass-Scale Behavioural Intervention

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Background of the Authors

Cecilia Mascolo is a Reader in Mobile Systems in the Computer Laboratory, University of Cambridge. She has published extensively in the areas of mobile computing, mobility and social modelling and sensor networking. In the recent years she has been involved in the EmotionSense project, a platform which is able to infer emotional states of individuals using voice recordings. Another relevant project of hers in this area is FRESNEL, which aims at building a large-scale, city-wide federated infrastructure of heterogeneous mobile and fixed sensing devices belonging to different individuals and organisations. Cecilia is also very interested in the fusion of mobile sensing and online social networking for both analysis and system improvement.

Mirco Musolesi is a Lecturer at the School of Computer Science at the University of St. Andrews, United Kingdom. During his postdoctoral work at Dartmouth he was involved in the CenceMe project, and, more recently, he participated to the development of the EmotionSense platform. His research interests include social computing and analysis of large-scale linked data.

Peter J. Rentfrow is a Lecturer in Social and Developmental Psychology at the University of Cambridge and a Fellow at Fitzwilliam College. He has published extensively in high-ranking psychology journals on personality expression, interpersonal perception, and research methods. More recently, he has been involved in interdisciplinary projects in the area of pervasive and social computing, including EmotionSense.

Vision

The availability of more and more powerful mobile and sensing technologies enables the design of systems able to positively influence the life of individuals in ways that were unimaginable only ten years ago. By means of sensing devices embedded in smartphones, key characteristics of human interactions and individual emotional states can be inferred with an increasing level of accuracy. We are only at the beginning of a new era where mobile technologies, which are already part of the life of millions of people, will contribute to shape society at both local and global level. Mobile social computing is now a reality [4]: CenceMe [5], a system for sharing user presence information, and EmotionSense [6], a platform for inferring emotional states from voice recordings, represent just some of the examples of how smartphones can be used to build intelligent social computing systems for measuring and understanding human behaviour. By means of these technologies, psychological studies can be conducted in a completely unobtrusive way, without the need of explicit user input or time-consuming daily diaries [1], [3].

This is just the first step: researchers are already considering how to *close the loop*, i.e., how to design systems that are able to exploit the sensed data to provide an effective feedback in an automatic way. Projects about the development of mobile technologies for *behavioural interventions* for addressing health problems such sedentary lifestyle are underway [2]. However, until now, these technologies have been designed for sensing information from single users or small groups. We have the opportunity and the need to move to the next level: these technology are already pervasive so with very little help this could be brought to very large scales, targeting entire cities or states. In other words, mobile technologies can be used not only to shape individual behaviour, but also entire societies. This new class of systems should provide an effective feedback on entire user communities and considering social and environmental context, also

exploiting longitudinal and aggregate data. Likewise, the intervention might target not just individuals but the community in its entirety. In order to realise this vision, a set of challenges from both technological and policy point views have to be addressed by the research community as discussed in the following sections.

Challenges and Opportunities

Sensing Human Dynamics at Scale. A first key research area is the development of systems used by hundreds of thousands of individuals. There is an inherent problem of scalability in terms of data collection, processing, storage and visualisation in building such systems. At the same time, many opportunities also arise: for the first time, we will have a complete mapping of human interactions and emotional states at a city, state and, potentially, global level, i.e., we will be able to capture the local and global psychological *zeitgeist* in a quantitative way in the history. Human dynamics and personalities are not the only things that can be observed. We will also be able to intervene, analyse in real-time the effects of the interventions, and, if necessary, re-think and re-tune them.

Deployment and Usability Issues. Since the goal is to reach a very large percentage of the population composed of people from various backgrounds and equipped with different sets of skills, the sensing systems should be easily configurable and be updatable remotely without any user intervention. In particular, sensing systems should be able to automatically adapt and exploit the available resources in the best way. Another key issue is the development of efficient techniques for intelligent energy management in order to avoid the even minimal disruption to the normal functioning of smartphones.

Ethical and Policy Issues. Finally, the use of these technologies at scale also raise potential concerns and questions at a more “philosophical” level. Should governments influence the lives of their citizens? Do they have the rights to do so? Who should be responsible for defining behavioural intervention policies? On which basis? These new questions should be central topics of discussions involving computer scientists, psychologists, philosophers and policy makers.

Privacy Issues. Related to the previous point, these technologies involve the acquisition and processing of information which are by definition personal and private. As for many other classes of systems, developers should design technologies that minimise the storage of individual personal information in central databases. A novel challenge is related to the development of mechanisms that ensure not only the privacy of the single individuals but also of communities. In fact, by aggregating large-scale information, it might be possible to “classify” neighbourhoods, streets and so on in terms of lifestyles, psychological and personality profiles and so on. New questions arise: is there a right of privacy at community level? What is the most appropriate level of granularity for publicly releasing psychological and behavioural data about large groups of individuals?

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