

Chapter 15

Research Challenges for Personal and Collective Awareness

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ABSTRACT

The “big data” explicitly produced by people through social applications, or implicitly gathered through sensors and transaction records, enables a new generation of mining and analysis tools to understand the trends and dynamics of today’s interconnected society. While important steps have been made towards personal, urban, and social awareness, several research challenges still need to be addressed to fully realize the pervasive computing vision. On the one hand, the lack of standard languages and common semantic frameworks strongly limit the possibility to opportunistically acquire available context data, reason with it, and provide proactive services. On the other hand, existing techniques for identifying complex contextual situations are mainly restricted to the recognition of simple actions and activities. Most importantly, due to the unprecedented quantity of digital traces that people leave as they go about their everyday lives, formal privacy methods and trust models must be enforced to avoid the “big data” vision turning into a “big brother” nightmare. In this chapter, the authors discuss the above-mentioned research issues and highlight promising research directions.

DOI: 10.4018/978-1-4666-4695-7.ch015

THE BIG DATA CHALLENGE

Currently, people leave an unprecedented quantity of digital traces, which describe their life and mind under several dimensions:

- **Activities, Location and Movements:** Can be inferred based on data produced by sensors integrated in mobile phones, GPS navigation system, transaction records, surveillance systems, pictures and videos posted on social media sites.
- **Moods and Opinions:** Can be derived based on blog posts, Twitter messages, search engine queries, sensor data from personal devices.
- **Social Relationships:** Can be revealed by social network connections, digital contacts, frequent co-occurrence in specific places.

The combined analysis of the above dimensions can reveal further details, such as lifestyle, purchase habits, health issues, political affiliations, religious beliefs, and many others. One of the greatest challenges of today's world is how to understand the dynamics of our interconnected society from the "big data" originated by the single persons, in order to improve both the existence of individuals, and the fairness of societies. This is the intriguing vision of a *planetary nervous system* (Giannotti, et al., 2012), which necessarily starts from achieving personal, urban, and social awareness. However, several research challenges still need to be faced to realize this vision.

At the level of personal awareness, a plethora of sensors are available today, to recognize individual activities, sentiments, and other context data at both fine- and coarse-grained levels. Unfortunately, the recognition of high-level context data like complex activities is still not sufficiently realized, due to different technical issues and

limitations of existing approaches. On the one hand, the lack of interoperability and integration limits the quantity of data available for context inference, claiming for the definition of novel methods for opportunistic data acquisition and reasoning. On the other hand, existing statistical learning methods for activity recognition are mainly restricted to simple actions.

At the level of collective awareness, we are overwhelmed by massive amounts of data fed to social networks, mobile carriers, communication and transaction systems: one of the most challenging issues is how to extract useful information from these data, without violating the privacy of individuals.

OPEN CHALLENGES AND RESEARCH DIRECTIONS

In this section, we discuss some of the most challenging open issues to realize personal and collective awareness, and highlight promising research directions.

Opportunistic Context Data Acquisition and Reasoning

Given the multifaceted nature of people's activities and interactions, a wide spectrum of context data should be acquired from different context data sources (including sensors, mobile apps, and social network sites) to fully characterize the personal context. The availability of these sources is highly dynamic: for instance, during a day, a person can move from indoor environments in which a plethora of sensors is available, to outdoor environments in which the sensor infrastructure is limited. Ideally, a pervasive computing system should be able to proactively discover the available context sources, get the needed data based on user's activities and goals, and activate reasoning

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