Sensing Multi-dimensional Human Behavior in Opportunistic Networks

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ABSTRACT

The massive spread of small personal devices equipped with different radio technologies is enabling the formation of a heterogeneous wireless networking platform on top of which new mobile computing services are deployed to flexibly and ubiquitously reach a target user. With the emerging of ubiquitous wireless communications, mobile applications are becoming highly personalized and influenced by user location, mobility, social attitudes and interests, or, shortly, by his/her behavior. In this work, we propose a framework having the aim of capturing and allowing the modeling the multiple dimensions of the human behavior. In order to measure and perform a cross analysis of those dimensions, we briefly describe an Android-based application able to collect face-to-face encounters and online social relations of a certain set of users.

Categories and Subject Descriptors

I.6 [**Simulation and Modeling**]: Model Validation and Analysis

Keywords

Opportunistic networks, mobility models, Android platform

1. INTRODUCTION

The massive spread of small personal devices equipped with different radio technologies is enabling the formation of a heterogeneous wireless networking platform on top of which new mobile computing services are deployed to flexibly and ubiquitously reach a target user. With the emerging of ubiquitous wireless communications, mobile applications are becoming highly personalized and influenced by user location, mobility, social attitudes and interests, or, shortly, by his/her behavior. It has been argued that mobility and sociality are tied one another and that both are essential to the design and the delivery of behavior-sensitive mobile services [3, 4, 5, 6]. Mobility is defined in the space-time plane, while sociality is defined in the social attitude-time plane. We name 3-dimensionality of human behavior (for short H3D) the integration of space, sociality and time (Fig.1).

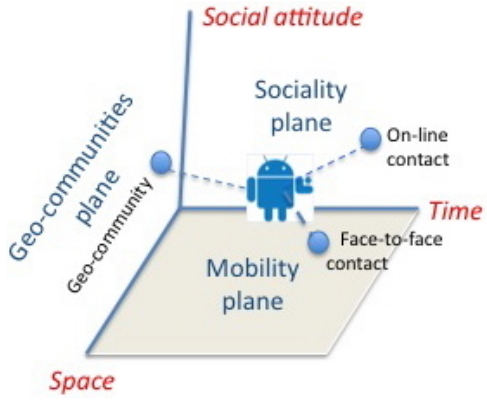

Figure 1: Three dimensions of human behavior.[1]

Our final goal is to build a unifying modelling framework in which the relationships among the three behavioral components naturally emerge and are well described to drive the design and the deployment of behaviour-sensitive services in an opportunistic networking scenario. To date, mobility and sociality planes have been considered by several studies but only separately. By contrast, the third plane, the social attitude-space plane, has been studied only in a few works, e.g. in [1] where geo-communities are defined as the combination of the spatial concept of location with the social concept of community. As far as we know, only the Stumbl project [3] has started combining mobility and sociality.

The main constraint to a wider combined analysis is related to the lack of rich datasets where H3D is represented. This poster has a twofold objective: the first is to describe the Android-based application we developed to generate such a dataset; the second is to utilize and extend the existing analysis methodology, based on the concept of geo-community, to obtain a unified modelling.

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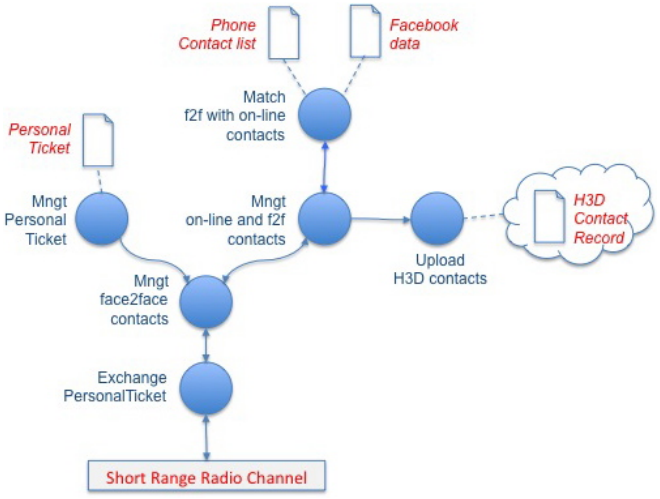

Figure 2: Functional architecture of the Android-based application.

2. SENSING THE THREE HUMAN DIMENSIONS

We designed an Android-based application, we name it *face2face*, that enables to detect and record the contacts in the real world, their location and enrich them with the contacts the involved people have in their on-line social experience. We focus on face-to-face (intentional) contacts because they tell more then extemporaneous contacts about people' sociality and because their expressiveness can be augmented by adding social contacts the encounters have on-line. To the purpose, when a face-to-face encounter is detected the application enriches data about the contact in the mobility plane with data about the sociality plane and concerning, for instance, friendship in a social network and phone numbers in the personal contact list. As far as we know, this approach represents a novelty in the area of similar experiences and enables to collect a very rich dataset.

In Fig.2, we show the functional architecture of the *face2face* application. The installed application is configured with the user's personal ticket that contains: an optional photo, the name, the phone number and the facebookID. Bluetooth is used to detect the contact, to exchange tickets, and to record the contact start and duration. To detect face-to-face contacts the ticket exchange is enabled by explicit authorization of the users via simple popup menu. The use of a popup menu also simplifies the BT criticalities of synchronizing devices and electing the piconet master station. When receiving the personal ticket of the encounter, a device seeks for possible matching in the phone contact list and facebook data, and records the matching results. The obtained contact descriptor is uploaded to the server.

3. ANALYZING THE THREE HUMAN DIMENSIONS

The analysis of H3D needs specific methodology and models able to operate in the three planes described in Fig.1. To operate in the geo-community plane, we developed a methodology to extract social relationships from GPS traces; the system (node, geo-community) is represented as a bipartite graph whose projections on nodes indicate the strength of the relationships [2]. As regards the mobility plane, a new mobility model, named Geo-CoMM [7, 8], has been defined. People move within a set of geo-communities, following speed, pause time and choice rules whose distribution is obtained by the statistical analysis of large GPS datasets; similarly, inside a geo-community, people move according to a Levy walk. Geo-CoMM is able to properly reproduce not only the spatial and temporal features, but also the local and global social properties observed in real mobility datasets.

The analysis of H3D imposes to expand our tools to include in this general framework more tied social relationships as obtained by face-to-face and on-line contacts, and study their interactions with space-time patterns. To the purpose, we are using measures of similarity on graph to analyze the time-varying graphs deriving from different social interactions: nodes are the same, but communities derive from geo-community, on-line social network and face-to face contacts. This allows, for instance, to detect nodes with higher multi-dimensional centrality, on top of which to build algorithms for opportunistic routing.

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