Scientific Report

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Period of the fellowship	01/02/2013 to 30/09/2013

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

During the months of the fellowship the fellow has been working on the design of a model that describes the probabilities of the use of the applications that are installed in a smartphone, and in particular the specific functions of the applications that a user needs in his daily life. The final aim of the work is to be able to generate chains of use automatically, that describe a realistic and significant sequence of the use of applications in a mobile device. The work has been carried out using Android based devices, although equivalent solutions could be developed for other mobile operative systems.

For this purpose, the first system proposed has been a Markov chain, whose states are the different activities that compose the applications and in which the next state only depends on the previous visited state of the chain. An activity is a single, focused thing that a user can do. It is usually associated with an interaction with the user and as a consequence it is usually linked with a window of the user interface. The implementation of the system has been done both in Java and Matlab using libraries that are available for these programming languages (in particular the Hidden Markov Model toolbox for Matlab by Kevin Murphy 1998 and the Jahmm library for Java developed by Jean-Marc François). These libraries implement the Baum-Welch method, which is the optimal way to estimate the parameters of a Markov Chain given some training data (Rabiner 1989). These libraries implement also the Forward-backward and the Viterbi algorithms which compute the probability of an observation sequence and try to find the "correct" state sequence respectively.

A Markov Chain must be trained with data that represents the system that is wanted to be modelled. In this way, an application developed by a member of the team has been used to get the necessary information. This application monitors and stores the different activities used (whether the window associated to that activity comes forwards or backwards in the execution) as well as the coordinates of the screen position where the user touches when a change of activity is produced. Thanks to this application it is possible to obtain a complete list of events that can be used for training and testing the Markov Chain. This list of events is split into sequences of events. It is considered that the access to the launcher activity (the one that corresponds to the main window of the user interface) signals the start of a new sequence.

Asynchronous activities must be considered when finding the training sequences for the model. Asynchronous activities are those whose user interface window comes forwards not due to an action of the user but by the action of an external element. Some examples are incoming calls or the firing of an alarm or the notification of an event stored in the calendar. After these activities interrupt the system, it usually goes back to the previous activity that was being used, so that means that the model needs more memory to correctly take into consideration that situation. In this way, the use of conditional random fields has been studied.

Another anomalous sequence of events is a consequence of the use of the notification bar, because it does not run as an activity in the operative system so it is not detected by the application that monitors the activities used. It is thus necessary to implement a unit that detects the access to this bar (using as input the coordinates of the touch events of the user on the screen) to include it as a state into the model.

Future works include the exhaustive acquisition of data from different users to decide

whether the results would be more accurate when training models to characterize the behaviour of different types of users. This can be done by analysing the stability of the models obtained by the training of Markov Chains with the complete set of events, or the data gathered from individuals who have similar behaviour regarding the use of the smartphone.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

Due to the early end of the fellowship no publications have been yet submitted. It was expected to submit at least one publication by the end of the fellowship.

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

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IV – RESEARCH EXCHANGE PROGRAMME (REP)

The fellow visited the FUN team in INRIA (Lille, https://team.inria.fr/fun/) that is led by Nathalie Mitton during the period 18-24 th August. During the visit she had the opportunity to attend a seminar of Arun Sen from the Arizona University about solving coverage and connectivity problems in emerging networks. She had also the opportunity to know the work that is carried out in that team and exchanged ideas and references with a PhD student whose thesis topic is related to the topic of the thesis of the fellow.