Process Mining and Activity Recognition on Mobile Devices Using Crowdsourcing and User Information from the Cloud

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Abstract

Emerging trends in ubiquitous computing and mobile cloud computing have accelerated the interest for mobile sensing and activity recognition. Nowadays, almost every person possesses a mobile device (e.g. smartphone or tablet) that is technically able to trace the users' activities and give us insights about their behaviour. Most of them are also connected to several cloud services.

In the context of my PhD, activity recognition is not only applied, but intended to be enhanced regarding several factors. First, there will be investigations regarding the impact of crowdsourcing, i.e. the comparison of sensor (activity) data from different users. Second, we want to test if activity recognition can be improved by including user information taken from the cloud. Third, it is to be examined whether and what kind of processes can be mined from activity data.

Research Topic and Work in Progress

The focus of my research are mobile devices and the humans who are using them. I want to use process mining and activity recognition methods to retrieve behaviour (activities and behavioural processes) from the users' mobile devices.

Nowadays, each mobile device is equipped with several sensors. These sensors offer a lot of possibilities, e.g.

defining geopgraphical position of a user (via GPS) or checking the direction he is looking in (via integrated compass). Additionally, sensors like accelerometer, ambient light sensor or proximity sensor release information about how the user interacts with his phone, e.g. whether the user has moved the phone to the ear, whether the device is outside or inside a pocket or whether the phone is rotated sideways.

I intend to use information gathered by these sensors to perform activity recognition. Of course, this is nothing new. There is already a lot of research going on in this area. What I want to do is to extend these approaches and enhance them in several ways.

First of all, I do not only want to retrieve activities, but behavioural processes. If some activities are performed in a certain order this means that a certain process is performed. I want to retrieve this behaviour. It is interesting to know which processes can be determined and with which accuracy. I am also wondering if it is possible to retrieve anomalies. If we know which processes are usually performed and then such processes are not performed we can try to retrieve the reason for it.

Second, I want to include user informationen, taken from cloud services, into the activity recognition. Imagine the user inputs his sports courses into his calender and allows our app to use this information. This helps improving the activity recognition. Information from other cloud services can deliver more information, e.g. the profession or the age of the user. This can give useful hints, too. Of course, I will only use the cloud information the user allows us to use. It would be interesting to know if the cloud information are of any use. Which ones are most important and which are not? How is the impact of using them?

Third, I intend to perform something called crowdsourcing. By this, I want to compare the determined activities of different users to each other. Are all users doing the same when we detected a certain activity or are there differences? Some important research questions are the following. Is the crowdsourcing approach useful or not? What is the least number of people to participate in the crowdsourcing to make it work? Is the effort justified?

I would like to answer these questions or at least provide a basis for answering them. My plan for the next steps is as follows.

There are several scenarios extending each other. The basis is the activity recognition (AR). An app is developed to gather sensor information from the mobile device. This data is used to retrieve activities. In the framework of a user study, the activity mining will be tested and afterwards evaluated. This AR appraoch is extended firstly by a crowdsourcing (CS) approach. The retrieved activity profiles are put into the cloud and compared to other users' profiles. The second extension is the inclusion of cloud information (CI) about the user. Information is taken from cloud services to support the activity recognition. The activity recognition is extended thirdly by a process mining (PM) approach. Instead of only mining activities, behavioural processes are retrieved. All remaning scenarios are combinations of the former ones, i.e. AR+CS, AR+CI, AR+CS+CI, PM+CS, PM+CI and PM+CS+CI.

All these experimental scenarios will be performed, evaluated and also compared to each other. Which approach is more useful? What is the impact of crowd sourcing or the usage of cloud information? Additionally it is interesting to see whether and how accurate behavioural processes can be retrieved.

I am planning to spend the next years preparing and performing these experiments, inducing scientific findings and publishing these in my thesis and research papers.

Motivation for Attending the Doctoral School

Currently, I am still in the initial phase of my PhD. The topic is more or less defined. I am also a novice in ubiquitious computing. The "UbiComp" is a well-known and important conference in this area. I would like to participate the doctoral symposium to share and discuss my ideas with other (young) researchers. I expect to meet interesting persons and some experts in the field of ubiquitous computing, maybe also cloud computing or activity recognition. Moreover, I expect to get a better insight into this area. I am looking forward to have interesting discussions and a lively exchange of experiences.

Brief Biographical Sketch

From October 2007 until September 2012 I studied Computer Science at the Otto von Guericke university of Magdeburg. My research focus was on computational intelligence and data intensive systems. Since October 2012, I am working at KIT in Karlsruhe. In parallel to my work I am conducting my PhD. I decided that I want to participate in the area of data mining and ubiquitous computing. Up to now, I spent my time researching related work and looking for a suitable topic. This led to my rising interest and activities in the area of process mining, activity recognition and mobile cloud. I intend to finish my PhD in September 2015.

My supervisor is Prof. Michael Beigl. He owns the chair of "pervasive computer systems" at KIT and is researcher in the area of ubiquitous, pervasive and wireless computing. Yet, I don't have a second and a third supervisor for my thesis as it is still in its initial phase. Prof. Beigl is a an expert in the area of ubiquitous computing. I think about asking some experts in the area of process mining or mobile cloud to do me the favour of supervising my thesis. Maybe the doctoral symposium can help me to get to know some interesting researchers.