Native Visualization of Mobile Activity Patterns

Bachelor Thesis in Computer Science

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September 1st, 2013

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I hereby declare that I have created this work completely on my own and used no other sources or tools than the ones listed.

Aachen, September 1st, 2013 Christian Janßen

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Part I

Chapter 1 Introduction

Smartphones and their daily usages

Since the introduction of the smartphone and its ongoing boom in sales, those devices getting more and more important for their users. Nearly 30% of the German population own a smartphone and 50% of them use it on a daily basis [6]. Googling a question, making a phone call, sharing your location and status with your friends via facebook or just taking a snapshot of your lunch - smartphones are used in nearly every location and situation. With all these possibilities and potential in usage for everyday situations, it is getting harder and harder to keep track of when one has used its smarthphone, where it was used and most important, for what was it used. Knowing this may have a positive influence in productivity. While on the topic of productivity, another interesting fact is, that 72% of owners state that they use their smartphones at work [6]. The obvious question is, did one use its smartphone for relevant research or emailing, or was it used to chat on whatsapp or checking facebook. It would be desirable with focus on efficiency and productivity if by the end of the day one could check his or her smartphone activity and would see that one may have to improve his or her working or learning behavior, because the smartphone was used in a distracting way or, the more preferable case, that the smartphone was mostly used to get work done.

Need of a structured overview

Another situation in which nine out of ten users utilize their device is while they are on the move [6]. Again, it would be desirable if one had information how he or she got from place A to place B, how much time it took and what has been done in this time.
Not only has the computation power of smartphones significantly improved, their integrated cameras are also quite satisfying and are comparable to low-end digital cameras. Since most people tend to take pictures with their smartphone nowadays, it

would be helpful to get a simple overview in which one can easily see the exact position of the picture's location without taking any further investigation.

The lacking of the possibility to check what has been done with the smartphone may unconsciously lead to a distracting use of it. That is, because, as already mentioned, keeping track of all activities is extremely difficult and thus the total time of the daily usages is normally unknown. There exists a need of a structured overview which provides informations about time, location an d applications to get a self reflecting impression about one's daily mobile activities.

1.1. Objectives

Requirements for the application

Due to the stated need of an application which provides information about one's daily activities the main goal of this Bachelor thesis is to create such an application. Requirements for applications are normally high and the developer has the task to find optimal solutions for them. This application is no exception and thus has its own requirements. On the one hand it should display enough information to grant the ability to draw conclusions about one's daily activities but on the other hand it should also display the data in a visual appealing and intuitive way such that the visual appearance is not too crowded with unnecessary information.
The application should also offer the possibility to take minor adjustments to fit in one's individual needs and thus making the experience with the application feel. In contrast to that those adjustments should not be to detailed and low in number to keep the options structured and understandable.

Applications for partial solutions

As mentioned, the main objective of this thesis is to create an application which provides feedback and a self reflecting view for one's daily activities. There are some existent applications that partially fit in the described situation and offer solutions. For example one can use Google Latitude to see where he or she has been traveled respectively which routes were taken to reach a specific place. But it will not show which applications have been used at a specific place. Also while this thesis was written the support for Google Latitude was discontinued [5]. Another partial solution is facebook. One can share his or her location and photos on facebook but this will not show a route on a map nor does every one want to public his or her whole life on facebook.
To see the most used applications of the day one could take a

look at the operating systems utilization chart which displays the percentage of used battery life and shows the cpu usages in total time. Not only does it not take into account the visited location this is also a very impractical and non intuitive way of gathering information about one's daily activities.

Testing of graphical possibilities

Another objective was to create an application which provides manifold views of the user's daily activities. It should not be limited to a map displaying pins or a list of application names with the total time of usages. Instead the application should show what is possible to develop with the help of already existent graphical views and, what is even more interesting, with creation of new views. All views should differ from each other and show different possibilities in visualizing informations of one's daily activities while each one could be used as a stand alone self reflecting view.

The application of this Bachelor thesis should perform as a central information provider which combines the listed objectives and displays the daily activities of the smartphone. Those information will be presented in various ways and can be filtered by different criteria within a clear, intuitive graphical user interface.

Chapter 2 Background

This chapter provides background information about the main topic of this bachelor thesis. First, the ongoing trend of using a smartphone in nearly every situation and therefore the need of keeping track of one's own mobile activities is discussed. To grant an application the possibility to give self reflecting impressions the application itself needs to be provided with personal data of the user. The second section is about this provided data, its origin and how it is gathered. Once the origin of the information is discussed the next section talks about the representation of this it. In this context the meaning of native visualization is explained and an alternative is presented which involves a short introduction of a currently written master thesis. The last section lists and explains which hardware and software was used during the implementation.

2.1. Self reflection

ADD REFERENCE TO SELF REFLECTION PAPER!

A Smartphone has many usabilities. It can be used as a camera, newspaper, music player or as a portable gaming device and those are just a few examples. There are a lot more ways to use a smartphone and as mentioned in the introduction, they are used in nearly every situation. It is a modern multitool which was used by more than 23 million people in Germany in 2012 [6].

Smartphones as modern multitools

As advantageous as it may be in everyday situations, the downside is that most people do not know how much time they spend on their phone and thus do not know how distracting it may be. For example, checking new mails may lead the user to also check the newest facebook messages and stay within this application a few minutes longer than expected. At least 50% of smartphone owners access the Internet with their device [6], thus most people are always available through instant messaging services like whatsapp. The result is that people write and receive messages

more often. And because smartphones are capable of running diverting games, one may uses its device to beat the last achieved high-score.

Distraction

But a smartphone can be a great helper too. It is an easy to use digital calendar which reminds the user of all upcoming events, it can be used as a travel guide or a navigation system, it allows to quickly respond to an important email and has many more useful advantages. But the previous short examples demonstrate that a smartphone can also have a distracting influence to its owner.

At this point the the idea of self reflection is needed. The concept of self reflection is the critical reflection on one's own actions and positions and coming to a conclusion. This can be used to assess the distracting influence of smartphones to its owner. But for an accurate assessment one needs to keep track of his or hers own daily activities, which is nearly impossible to do for a smartphone without the help of tools that provide background information.

Provide a self reflecting view

As mentioned, the help of a tool is needed which provides information about the owner's mobile day in a self reflecting manner. This tool in form of a smartphone application should display the information such that the user is able to instantly see where, when and for what the device was used. If one is provided with this data, he or she is able to say, that they used their smartphone in a productive manner or if they used it for entertainment. Further more, one could tell if he or she used the smartphone to divert themselves from working or studying. Although the application can display the needed information, the conclusion must been drawn by the user.

Possible improvements in productivity

With this application and the provided information a user may be willing to rethink his or her work respectively study behavior. This then could lead to less frequent use in distracting applications, thus improving efficiency and productivity in daily tasks.

As described, there is a possible application area for such a smartphone application. It would visualize data and information about the owner's daily activities in such a way that the application could be used as a tool for self reflection.

2.2. Provided Data

In the last section the idea of an application which displays information in a way such that one can use it for self reflection was described. What has not been described is from what source this data arises and how it is gathered.

The application itself will not gather the data it uses, instead the data is downloaded from a server and stored internally. The reason that the information will be collected externally, is the limitation of this thesis to the visualization.

Big Brother gathers data

The mentioned data arises from an external application called "Big Brother". This application is based on the master thesis of Torsten Kammer and was reimplemented and developed by diploma computer scientist Hendrik Thüs in 2013 [2]. ...
IMPROVE REFERENCES
The data Big Brother gathers, is send to a server where it can later be downloaded and used by the application developed for this bachelor thesis. The data contains amongst others information about the user's visited locations, the name of the currently used application, start and end time of used applications. This data is uploaded and stored to a web server, which is then accessed by this thesis' application.

Privacy issues

With the revelations published by Edward Snowden in June 2013 about the U.S. American spy program PRISM one might be concerned about privacy violation by third parties. It should just be said, that this project is still an experimental phase. If it should be published for a larger audience than the developers much work would be put into encryption and ensuring the prevention of unauthorized access by third parties.

Reasons for online stored data

One of the reasons why the data of daily activities is stored online is the limited storage of mobile devices. This way the used size of storage can be minimized and only needed information can be downloaded. The possibility to merge data from other devices the user owns like PCs, laptops and tablets is another reason to upload the data. Being able to access the data from multiple devices like tablets is also an important point.

The idea of a data set which also contains information about other used devices has great potential in granting an even better overview of one's daily activities and thus this would make the self reflecting view provided by the application even more meaningful.

2.3. Native Visualization

Now that the origin of the provided data has been explained, the idea of a native visualization will be brought closer.

What does visualization mean?

The term of visualization means representing of abstract data or information, like a text, in a visual ascertainable form. Its meaning is not limited to computer science. It can be found in various situations and places, technically anywhere where someone tries to convey information in a visual way. This may be a picture of an artist or a even a movie. The concept is not even limited to modern time. Since the beginning of mankind, caveman try express their life with pictures in form of cave painting.

Speaking of computer science, visualization means, as mentioned, to represent data in a illustrative way. For example, creating a pie chart for results of a survey or draw a graph representing the daily temperatures for a week. For this thesis the visualization has to fulfills the task of displaying one's daily activities in an appealing and easily to understand way, such that one can directly draw conclusion from the information.

Native visualization

Native visualization describes creating of visual ascertainable objects only by means of resources that a specific system provides without any addition.
In this thesis, the application will be implemented for the mobile operating system Android 4.0.3 and higher. Native visualization under Android means the use of Java and the access to the standard Android application programming interface. The application will not use JavaScript or anything else as this would infringe the terms of native visualization.

A non native visualization of daily activities

An alternative to native visualization of activities can be found in Thomas Honné's Master thesis "Interactive Visualizations of Activity Patterns in Learning Environments" [7]. The thesis describes, among other topics, the visualization of daily activities in a web browser environment. For comparison an interesting fact is, that the data arises from the same application.

An advantage over the non native method is that data can easily be stored locally, thus making the application available for offline usage assuming that the needed data has been downloaded at some point in the past.
With a native application the user has tool for self reflection which is not permanently bound to an Internet connection and does not require any additional non native resources.

2.4. Hardware and Software

As mentioned in the previous section the thesis' application will be developed for Android 4.0.3 and higher. To get an impression of the used tools in the development process this section describes the used software, the development environment and Android, as well as the used hardware, the development device.

The operating system of choice

The application was developed for Android 4.0.3 "Ice Cream Sandwich" with the application programming interface level 15. The application may be able to support lower versions of android but this has not been tested nor was it a goal of development. To minimize overhead due to compatibility adjustments the support is only guaranteed for Android 4.0.3 and newer versions, which account for 63% of all Android devices [4].
Android was the operating system of choice because it has a free developer license, great supportive community and with a share of 76.7% in quart 2 of 2013 [1], Android is the largest market share holder of mobile operating systems.

The test device

The testing device was the Motorola tablet Xoom with Android 4.0.3. The tablet with a screen size of 10.1 inches and resolution of 1280 times 800 pixel gave great advantage in the testing process of the application. Its screen is large enough to display all relevant data without minimizing their visual appearance. In addition the screen size allows precise testing of multi-touch gestures. The alternative to the real development device would have been an Android emulator provided by Google. With the emulator the development of this application would have been nearly impossible due to the fact that it does not support the ability to simulate multi-touch input with a normal mouse and the nonexistent support for GoogleMaps.

The development environment

Google's recommended software development kit Eclipse with Android Development Tools served as development environment. Working and developing with Eclipse was simple and comfortable due to Google's numerous tutorials [3]. Neither installing the software development kit on a Windows 7 computer nor setting up new projects was a problem. The test device connected to the computer was directly recognized by eclipse and executing and testing written code on the it proceeded without problems. Eclipse's debug mode was also very helpful at many points in the development process and helped to track down hidden bugs.

Working with Eclipse and Android was comfortable, a lot easier than expected and straightforward, even for a first time developer. Eclipse's improvement proposals and performance advices and Google's tutorials with helpful examples and background informations made this project a great educational experience.

Part II

Chapter 3 Development and Implementation

"It's done, when it's done"

—An English Phrase

The sections in this chapter will describe the various stages of development and implementation of this Bachelor thesis' application. At first the basic idea of the layout and the individual views will be described and explained. To get an even better impression the early paper prototype will be shown. Afterwards a short description of the aspired time schedule for the development as well as the creation of the written elaboration is given.

The implementation of the basic layout which was displayed and explained with the help of the paper prototype, will be the first part describing the actual implementation process. Second, the handling of the data to be visualized is explained. This covers the server based access as well as local storing and loading.

After the preparations for the visualization have been set forth, the different views will be described. Starting with the explanation of the map view, it will be clarified how the loaded data is visualized. This is followed by the section focusing on the chart view. It explains how a library is used to draw pie charts and how the loaded data has to be prepared. The last section describes how the timeline was implemented. It covers, how one can draw its own views in Android and how to make use of gestures.

3.1. Paper Prototype

The first step of the development process was the creation of a paper prototype. It was needed to demonstrate the idea and visual appearance of the project and application. Another advantage of the paper prototype is to be able to show different people the application and get feedback without even writing one line of code. This provides the ability to eliminate possible false estimations in the forefront of the application's implementation. False estimations may be the assumption of wrong needs of possible future users or the creation of an non intuitive layout. In the following the paper prototype will be shown and explained.

Basic layout

The first idea was to split the screen into two parts, an option part and a view part. The left part should be the option part, occupying one sixth of the visible screen. It should always display the following, in appearing order listed, options.
In the top left a view selection containing three buttons ordered vertically with titles "Map-View", "Chart-View" and "Timeline" are displayed. Taping one of those buttons causes a view switch to display the respective view.
Under the view selection a list of options should be visible. Those options vary from view to view but should always contain a button at the top of the list displaying the currently selected date. Tapping on this button causes a date-selection-window to pop up. Selecting a date leads to an update of the displayed view, now visualizing the respective data. Other options will be explained together with their respective views.

Map-View

When the application has been loaded, the user will be displayed the map view thus making it the application's start view. The view will display a map with a route, representing the user's visited locations. On start up the selected date will be the current day and therefor the draw route represents the user's latest movements. Tapping on the route should bring up a speech bubble which contains information about the tapped location. Those informations will be the time spend on that location, the used applications and possibly shot photos.

Map-View specific options

The view provides two special options. The first option is represented by a check box and has the title "Photos". The option provides the ability to highlight those locations, where a photo was taken. The second option is called "Apps". It lets the user pick applications from a list and colors all parts of the route where those specified applications were used. Those options would provide a great tool to quickly get an overview over the position data of specific applications and actions.

The map view can mainly be used to answer the question "Where was smartphone used?", since the view focuses on visualize the map and traveled routes rather than displaying numbers and percentages.

Figure 3.1.: Map-View

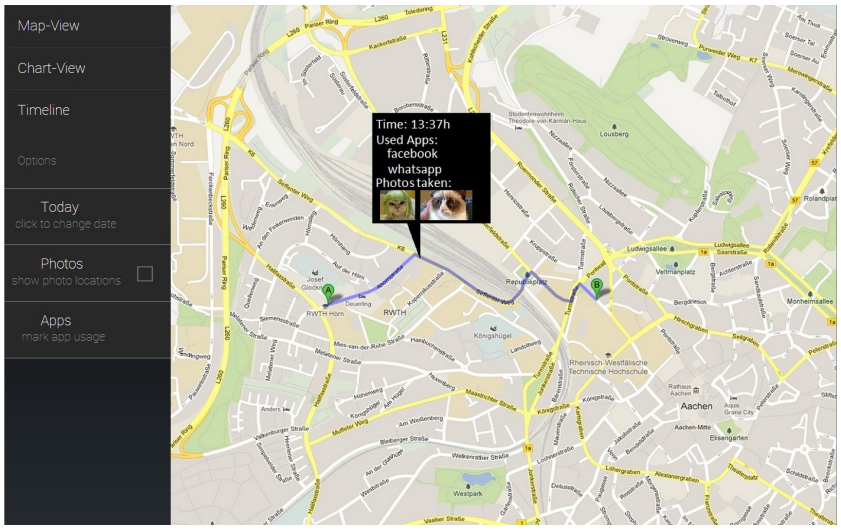


Chart-View

The second view, the chart view, shows the user his or hers daily activities in form of a pie chart. The idea was to create location based charts that shows for each visited place the percentages of used applications. To break down the number of shown charts and thus to give a better overview, locations would be summarized in an intuitive way. That means that one has a chart for work, home and on the move. Those charts are lined up vertically and have an individual chart on the top of the list. This individual chart can be adjusted by the two extra options described in the following.

Chart-View specific options

The first option lets one choose which places are taken into account for the individual chart. The second option determines which specific applications are displayed in the first chart. With these two options, one has the ability to to customize the first chart to visualize only those data which fit one's individual needs.

Grouping of apps and locations

To get an even better overview, applications are classified into different groups. "Social" and "Productive" could be two groups, which split the applications apart. Applications like whatsapp and facebook may be social, while mail programs would be productive. The user would also be able to classify the applications

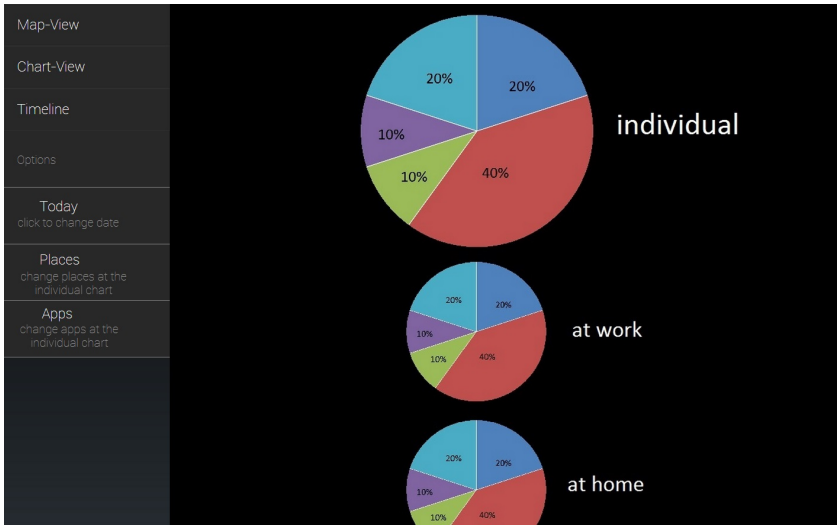
by him- or herself, allowing to personalize the application. Furthermore, home, work and other places are chosen individually and extra places like parent's home can be added by the user, to give the him or her more space for customization.

Interacting with the view

To get an better insight of the application groups, tapping on a slice of the pie chart will bring up a detailed view. In this detail view, one can see which applications are included in the tapped group and how large their percentage of daily activities is. In addition the total usage time of each application is shown, to give the displayed percentages more expressiveness.

The chart view, in contrast to the map view, is able to give a better overview over the percentages of used applications rather than show in which locations they have been utilized. It gives answer to the question "What was the smartphone used for?"

Figure 3.2.: Chart-View



Timeline

The timeline is the third and last view of this thesis' application. This view visualizes the daily activities in a chronological manner with two major parts. The first part is the the timeline itself and is described as follows. At the layout's bottom a horizontal line is draw with markings for every hour, from 0:00 to 24:00. Above this line, colored rectangles are drawn which represent a timespan in which an application was used. At the layout's top one can see markings for the visited location in dependence of the displayed timespan. One has the possibility to scroll horizontally through the view to observe the consecutively occur activities.

The detailed view

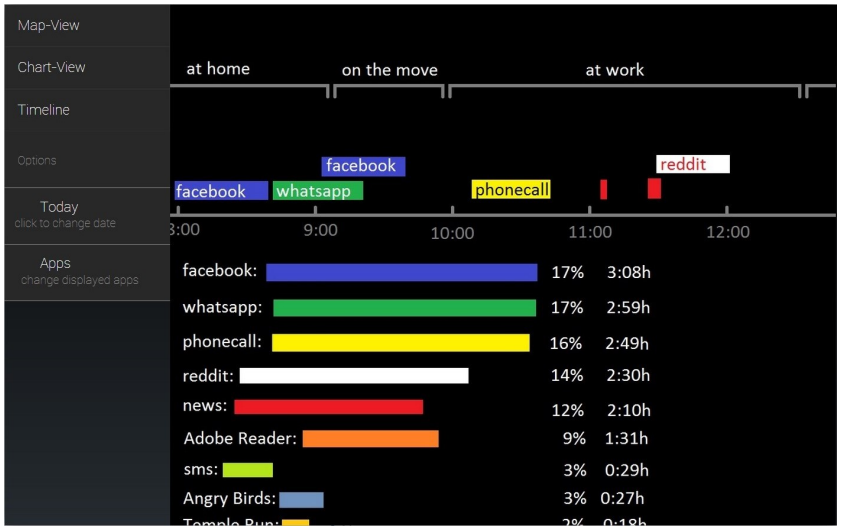
Beneath the actual timeline a detailed view of all applications used on the selected date is found. This second part shows the application in descending order starting with the application mostly used on the chosen date. For each application a rectangle which represents the percentage of daily usage, is drawn. This rectangle will have the same color as the respective rectangles in the timeline and thus the detailed view can be used as a legend to identify the applications displayed in the timeline. Next to the application's bar the respective percentage and total amount of time is displayed.

Timeline specific options

This view offers the extra option "Apps", where one can filter the displayed applications. With that option one is able to hide all other applications and display only those which are relevant for the user and thus giving the application a feel of personality and individuality.

Although it partially acts as a bar chart, the timeline, unlike the other views, focuses on the daily schedule by visualize the activities in a chronological order. With this view the user is able to answers the question "When was the smartphone used?".

Figure 3.3.: Timeline



As mentioned in the first place, this was the basic idea of the application and a few things have been changed during the development process. A summary of changes which differ from the paper prototype, along with the reasons for those changes can be found in the next sections.

3.2. Time Schedule

3.3. Basic Layout

3.4. Data Management

3.5. Mapview

3.6. Chartview

3.7. Timeline

Chapter 4 Evaluation

Part III

Chapter 5 Conclusion

5.1. Review

Appendix A Bibliography

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