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Thesis Report

Behavior Analysis of Smartphone Users Based on Custom Application Usage

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Abstract

Now a day's smartphone has become a demanding need to the next generation activities. With different facilities these smartphones have given us a lot of application to experience new inventions of science. People of different territory have different taste to judge these applications. In our research we try to know about their behavioral states depending on their usage of some particular custom applications and information from sensors . We are going to present a system that takes the log data from smartphone of different applications and sensors (like Accelerometer) and analyze the behavior of that user. These applications are already available in most of the smartphones. While people use the phone they simultaneously use different kind of applications for a period of time. In our system we will try to collect the log data of the popular applications used by smartphone users in different timeframe and make a specific relation between them so that in future we can analysis the behavior of the specific user with our system. The reason behind this analysis is to find the similar users and the users of different interest and provide them some relevant recommendations.

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Introduction

Human Behavior refers to the potential and expressed capacity of human for their physical, mental, and social activity during different phases of life. Human behavior modeling refers to computer-based models that imitate either the behavior of a single human or the collective actions of a team of humans (Pew and Mavor1998). [1] Because of the openness and extensibility Smartphones are becoming prevailing. Among the popular mobile operating systems, Android OS is one with great extensibility. Its great flexibility in modifying and supplementing extra functions for the system allows one to implement a 'monitoring' application to keep track of user operation .[2] According to their usage of different features such as button press activity, the users behavior can be categorized .

The behaviors of using a smart phone are very complex in the setting of Everyday life. An application on the smart phone may consist of several functions to work together simultaneously. For example, a photo-taking activity may consist of taking the location information from the GPS system, taking the picture, and transferring the picture to a social network site. A user can make phone calls by entering the phone number manually, through the phone book, or selecting from the call history. Although the result of these actions is all making a phone call, each action pattern may mean a different usage context. The studies of these behaviors are crucial for the design of a smart phone and its applications and cannot be easily conducted in a controlled laboratory [2]. We are interested in this field because here we can find out the actual behavioral state of a user and we can also find out about the popularity of a particular application so that the developers may take some help from our work to make improvement of their software through their latest versions of the software.

1.3 Overview:

We have also studied about the collection of log data. We have found some related work in this area. Using ‘log-cat’ tool is an option or method to collect data from the android device. Another method is the built-in app ‘apps use’ to monitor only internet usage data for mobile. And we can also collect data from background process and send it to server when internet connection is available.

We built an app which is mainly collecting all user activity and send to local server. Our application is collecting user activity and stores it into local server. Then for further processing we can use weka tool for result.

We found an interesting server regarding this area, named Google analytics. This is a server where we can found all the activity inside an app. But we have not found any application or tool that provides suggestions to the users. So we are trying to implement an application which will provide the suggestion for the users. And we are also trying to develop an algorithm that will extract similar type of user based on application usage and sensors.

1.4 Thesis Goals:

We have tried to reach some goals in this thesis. The main reason that we are trying to implement is given below:

1. To collect log data from the device of a user on the basis of ay custom application usage.

2. To ensure the collection of logs we have to make sure that correct tools or application is selected.

3. After collection of the activity created by user, we need to establish a connection between our apps and Google analytics server.

4. We have to make sure the connection is correct or not.

5. After that we need to send it to the server via wireless network or Gmail or internet.

6. In the Google analytics server we will find a lot of built-in tools such as app profiling, current users, location etc.

7. There we can find the number of active user at a time and their work such as their activities in our application.

8. In the end we will develop an algorithm that will extract the similar type of user based on application usage and sensors.

9. And then we will find out a table which will contain different type of user in different column.

10. After differentiating the users we will provide the suggestion to the users. For example, if a particular user is fond of social site activities then analyzing other users of same category we can suggests him to look for a new social site just like Facebook or g+.

Chapter-2

Motivation and Thinking

Depending on the features of an application usage a user can be categorized in different aspects. First of all the users can be classified in to 2 simple categories Active and Inactive. Among the active users we can classify their behavior by their nature. Some behavior are habitual behavior, some can be categorized in to regular behavior. Some user may use the applications or host by others, they are known as Passive users only for these applications.

2.1 Categorization of Users:

According to habitual behavior there was a categorization of users. 1. Users of low entropy behavior and 2. Users of high entropy behavior. Low entropy means they use somewhat regular routine applications and exhibit less change in their behaviors. And high entropy means the users who have some changes in applications of daily life. We got the idea from a relevant paper "Human Behavior Analysis Using Data Collected from Mobile Devices" [3].

Active Smartphone users are those users who randomly use all features and application in a proper way corresponding to other activities of his life. Inactive users have very low activity in smartphone usage as well as in daily life. On which applications features we will categorize which user that will be discussed in the next session of this Paper.

So the categorization can be viewed by the following diagram -

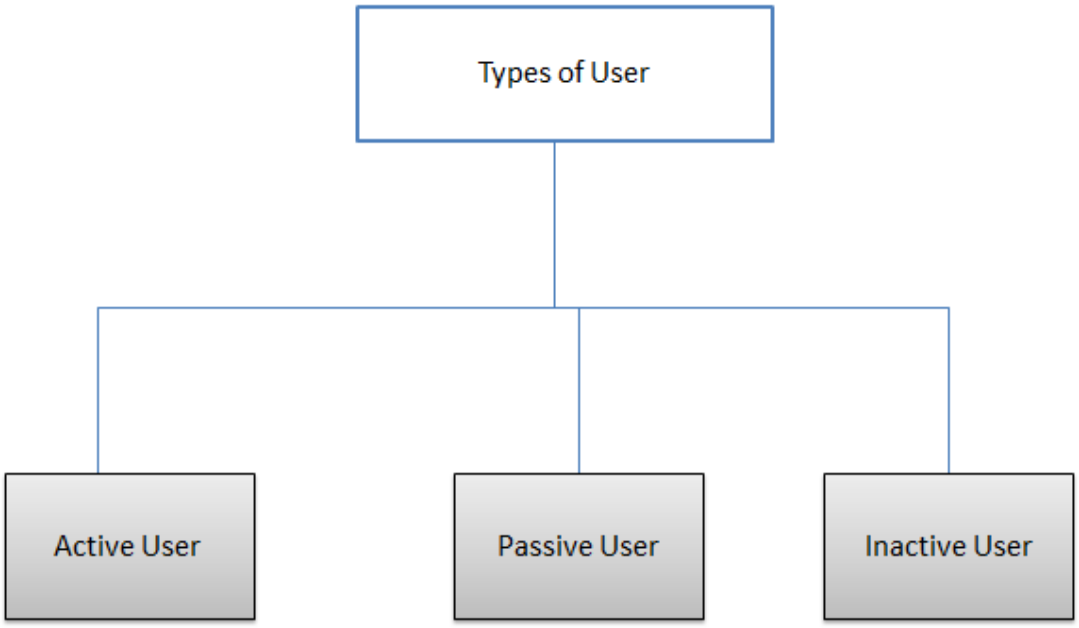

Fig.1: Categorizations of Smartphone Users

2.2 Features:

For the category research of smartphone user behavior we have to first gather the log data. The log data will be collected from different applications and sensors commonly used in the smartphone. The applications with the features are discussed here

- Voice Call Log :
  - ✓ The person is using the phonebook for calling
  - ✓ The person is checking the call log for calling
  - ✓ The person manually inputs the number for calling

- Messaging Log :
  - Message send via Bluetooth
  - Message send via Email
  - Message send via Service Provider
  - ✓ How many messages sent
  - ✓ How many messages received

- Camera Log :
  - ✓ Only taking Pictures with Camera
  - ✓ Taking pictures with different configurations
  - ✓ Taking pictures and sharing pictures with friends (Flicker)
    - How many pictures taken per day

- Music Log :
  - ✓ Music played from memory storage
  - ✓ Music played from radio
    - Time spend in listening music per day
- Facebook Log :
  - ✓ User has given how many comments
  - ✓ User has given how many posts
  - ✓ User has uploaded how many photos
  - ✓ User has liked how posts
  - ✓ User has messaged how many people
- GPS Tracker :
  - ✓ Movement info
  - ✓ Location based service

2.3 Problem Statement:

In the above related works we have seen many research about the smartphone user behavior there was no suggestions for using applications for people of same behavior sates. Another is that there were no categorizations of the users as we have mentioned in the paper. In the motivation part we have discussed about the categorization of the users interest according to some relevant papers.

Another problem is the feature selection problem. Efficient features of the applications were not selected in the previous research works. The data gathering techniques and organizing was also not efficient. So far these problems we have seen in the related works.

Chapter-3

Background Study & Related Works

The behaviors of using a smart phone are very complex in the setting of Everyday life. An application on the smart phone may consist of several functions to work together simultaneously. For example, a photo-taking activity may consist of taking the location information from the GPS system, taking the picture, and transferring the picture to a social network site. A user can make phone calls by entering the phone number manually, through the phone book, or selecting from the call history. Although the result of these actions is all making a phone call, each action pattern may mean a different usage context. The studies of these behaviors are crucial for the design of a smart phone and its applications and cannot be easily conducted in a controlled laboratory [2].

3.1 Human Behavior (Definition):

In a related paper [3], we have seen mainly two types of user behavior. One is low entropy and other one is high entropy. If the user in his daily life, repeat the activities and routines with less change, it will be known as 'low entropy' behavior. On the other hand a more change in daily routine patterns is considered as 'high entropy' behavior. This idea is also come from another paper [4]. For example a working person who follows the routine of going to the office and coming back home every day using the same means of the transport, or an elderly person with regular routines can be the examples of the people with more regular routines and hence less change in the behavior. The motivation of this research work is to idle or busy or inactive people to live their lives more independently by using smartphone apps more frequently.

As we have already found low and high entropy user from related paper [3], we use this idea to categorize user behavior in our system. We have divided our user based on their behavior into three parts. Active user passive and inactive user.

We denoted active user as the main user or high entropy user. That means the user who frequently change his application or switch his application is the active user. For example a student may use Facebook application when he is not busy but he

may go to another link while using Facebook and he can also play games. So the point is he is always changing his apps randomly as he has better amount of time in his hand.

Active user is the user who mainly hosts an application for other user to use it. For example, an active user may play marvel avengers alliance in Facebook. It is a social site game. So he can send request to his friends, and if anyone accepts it and playing it then he will be the passive user.

Inactive user is the user who has low entropy [3]. That means the user who does not change his usage of phone frequently and does not operate too much apps provided by Smartphone is the inactive user. For example, a business man may not have enough time to logon Facebook and playing games. He is a busy man and he uses his phone mainly for voice call and sms (short message service). So, he is not using any apps of Smartphone and only communicating his client with voice call and message. He can do it with any phone and he will not need any Smartphone for that.

Google Analytics:

Google Analytics not only lets you measure sales and conversions, but also gives us fresh insights into how visitors use our site, how they arrived on your site, and how you can keep them coming back.

Analysis Tools

Google Analytics is built on a powerful, easy to use, reporting platform, so you can decide what data you want to view and customize your reports, with just a few clicks.

Content Analytics

Content reports help you understand which parts of your website are performing well, which pages are most popular so you can create a better experience for your customers.

Social Analytics

The web is a social place and Google Analytics measures success of your social media programs. You can analyze how visitors interact with sharing features on

your site (like the Google +1 button) and engage with your content across social platforms.

Mobile Analytics

Google Analytics helps you measure the impact of mobile on your business. Additionally, if you build mobile apps Google Analytics offers Software Development Kits for iOS and Android so you can measure how people use your app.

Conversion Analytics

Find out how many customers you're attracting, how much you're selling and how users are engaging with your site with Google Analytics' range of analysis features.

Advertising Analytics

Make the most of your advertising by learning how well your social, mobile, search and display ads are working. Link your website activity to your marketing campaigns to get the complete picture and improve your advertising performance.

3.2 Different Types of Application:

There are mainly two types of smart phone application. One is independent and other is dependent applications. We have studied about the classification of the apps that available now in smartphone [3]. One is independent app and other one is dependent app.

Independent app is the app which does not require any internet connection (such as temple run, voice call, sms, camera etc.).

Dependent app is the app which need internet connection (such as Facebook, Gmail, play-store, time square etc.).

But some other application may be both or combination of independent and dependent apps. For example, one may take picture with mobile camera and upload it via mobile internet using 3g or Wi-Fi. So he/she is using both at a time.

3.3 Behavior Based On Smartphone:

Smartphone users are increasingly shifting to using apps as “gate-ways” to Internet services rather than traditional web browsers. App marketplaces for iOS, Android, and Windows Phone platforms have made it attractive for developers to deploy apps and easy for users to discover and start using many network-enabled apps quickly. For example, it was recently reported that the iOS App Store has more than 350K apps and more than 10 billion downloads. For further detail, the appearance of tablets and mobile devices with others form factors, which also use these marketplaces, have increased the diversity in apps and their user population. Despite the increasing importance of apps as gateways to network services, we have a much sparser understanding of how, where, and when they are used compared to traditional web services, particularly at scale [7].

The data set that we use to study mobile apps is significantly more diverse geographically and in user base than previous studies. It covers hundreds of thousands of smart-phones throughout the U.S. in a tier-1 cellular network. This allows us to make more generalizable conclusions about smartphone usage patterns we find that a considerable number of popular apps (20%) are local, in particular, radio and news apps. In terms of traffic volume, these apps are accountable for 2% of the traffic in the smartphone apps category (i.e., all the marketplace apps that can be identified by User-Agent) that is, their user base is limited to a few U.S. states. This suggests significant potential for content optimization in such access networks as LTE and Wi-Fi where content can be placed on servers closer to clients. Furthermore, it suggests that network operators need to understand the impact of different app mixes in different geographical areas to best optimize their network for user experience [7].

3.3.1. Why Smartphone:

The type of data we need is only available in smartphone. We cannot get our desired log by using Symbian phone or normal phone. So we need smart phones to get the desired log data and also to achieve the goals.

Smartphones are getting smarter all the time, but the people using them aren't necessarily doing so. Today, we have devices at our disposal that snap photos faster than one can blink, surf the Web at speeds that make his/her home

broadband jealous and download apps that can do everything and anything. Why we should we use it- the reason is here

1. Alternate Keyboards

From text predictors like Swift key to the innovative like Swipe and the downright adventurous like 8pen, you have a lot of different keyboard choices on Android. Typing on a tiny phone keyboard isn't anyone's idea of fun, so it's great that Android provides so many options to make it as painless for people as possible, and super easy to install. The iPhone has other keyboards, but they're usually separate apps that require you to import text to another program—it's just the kind of system-level functionality that's hard to get around

2. Automation

One of the most powerful, useful Android apps around is Tasker, the automation program that lets you turn your phone into a super phone. You can turn settings on and off for certain applications, by location, time of day, and pretty much any other condition you can think of. With the right commands in place, Tasker can access the deepest and darkest settings on your phone, which is something you just can't do on other platforms. Be sure to also check out our second list of Tasker setups, three handy Taker profiles from our readers, and how to roll your own "Find my iPhone" for Android. Similar apps like the battery Juice Defender would also fall into this category

3. Custom Home Launchers

While iPhone users can customize their home screen quite a bit if they've jail broken, they don't allow the kind of customization that you can get on Android with custom home launchers. Third party launchers can add all sorts of extra features to the home screens of your device, like gestures, different kinds of shortcuts, and even low-level settings that can help speed up an older phone. Whether you're using the super-fast Launcher Pro or the insanely customizable ADW Launcher, third-party launchers add a ton of configuration to your device

4. Widgets

Sure, they take up a bit of space, but there's no substitute for the convenience of having a big weather widget right on your home screen, or a music widget to show you the currently playing track. Even more useful are the to-do list widgets, that take an "in your face" approach to productivity, which is not only effective but

necessary from people, as they don't require you to actually *look* for your to-do list—they're always reminding you of what you need to do. If you've jailbroken, you can get widget-like apps for the iPhone, but you can only put them on your lock screen—not the actual home screens that you're always swiping through

5. Removable Storage and Battery

It isn't part of the Android software, necessarily, but Android's open nature allows for quite a few hardware advantages too—namely the ability to take out, swap, and upgrade your battery and SD card. If you find that you've maxed out the storage on your iPhone, you're pretty much out of luck, whereas with an Android phone you can pop in a new SD card and have gigabytes more storage to play with. Similarly, you can swap out a spare battery for longer trips or even get an extended battery that'll help your phone go longer without charging.

6. Wireless App Installations

With the next Android release, Google could get around to fixing its app Market's weaknesses—and maybe you'll get that update this year. In …Read…
Browsing for and discovering new apps should be fun, not challenge to make it through a tiny app store with your sanity intact. The App Store and Cydia App Store aren't exactly fun to browse on your phone, but you either have to download apps on your phone or plug it into iTunes to sync them all over. With the new Android Market, or with third-party sites like AppBrain, you can find a cool app, hit the install button, and it'll be on your phone the next time you pick it up. It doesn't get much more convenient than that

7. Custom ROMs

While there are a lot of third-party apps that give you advanced features on Android, one of the coolest parts about the entire OS being open source is that people can take it, tweak it all over, and install their version instead of the one that comes with your phone. Whether it's the feature Cyanogen Mod or the interface-overhauling MIUI ROM, there's little limit to how much you can tweak your Android experience. As with launchers, these give you a lot of system-level tweaks that you just wouldn't be able to get this easily on other platforms—and it puts them easily within users' reach. Whether it's tweaks that speed up your phone or

features like FM radio, custom ROMs are without a doubt one of the biggest advantages to Android's openness around

8. Controlling Your Phone from Your Computer

This one's a little more out there, but we've featured quite a few apps that let you actually control your Android phone from your PC—whether you just want to send texts from Chrome or access any of its other functions right from a web browser. Yes, you can VNC into your iPhone, but it's not the same as using a separate app that accesses its baser functions’

9. Flash

Say what you want about Flash, but it's everywhere you go, and when you're forced to view the web without it, you realize how much you actually rely on it day-to-day. Whether its accessing fully Flash web sites, watching Flash videos, or playing games like the ones on Kongregate, having Flash installed on your phone and tablet let you access a lot of things you otherwise couldn't have. We may grimace when we hear its name, but it's too prevalent to go without. It just feels like you don't have the whole web at your fingertips.

10. True App Integration

The experience will never be the same as it is on Android. Other iPhone apps always direct you to the default dialer and visual voicemail apps, so even if you want to use Google Voice full time, you have to manually navigate it to yourself. On Android, apps like Google Voice integrate directly with the operating system—if you want to make calls with Google Voice, every call you make from the phone's dialer goes through Google Voice. When you click on a phone number in your browser or in Google Maps, it goes through Google Voice instead of sending you to the wrong dialer. True app integration like this makes using custom phone, SMS, voicemail, and even browser apps absolutely seamless on Android, which is something you won't find on the more locked-down iPhone platform.

3.3.2. Workflow of a smartphone:

A simple work flow of an android phone is given below

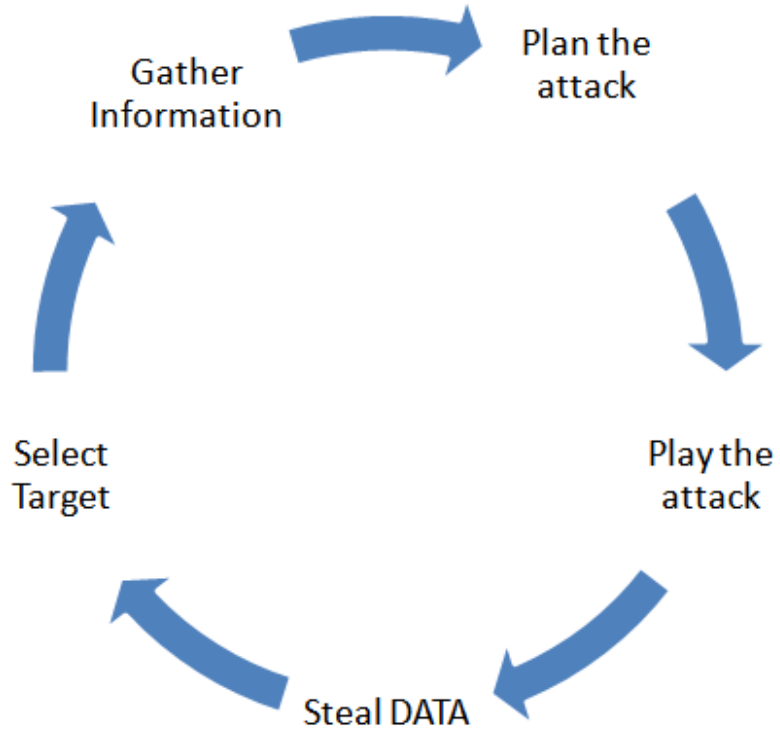

Fig.2: simple workflow of a smartphone

Here, any users first plan the goal or plan what he/she wants to achieve. Then according to the plan the system will collect the information that is required to meet the desired criteria.

Then the system will plan the attack and do what necessary and also play the attack which means the sequence of work to reach goal.

And finally the user will reach to the goal by having the desired result.

3.3.3. Benefits of smartphone:

Because greater functionality is built-in, smartphones can do things much more quickly than their standard mobile phone and PDA precursors.

Keeping you organized - smartphone handsets can function as personal organizers, with electronic diaries, contact lists, and automatic reminders.

Flexible working - as with a PDA, you can use your smartphone to take notes, review and edit your appointments, contacts and documents, all while you're on the move.

Information at your fingertips - more and more services are being made available on smartphones, from access to maps, satnav and directions to television transmissions with news coverage or weather reports to traffic information and scheduling alerts - which means your business, can always stay one step ahead of what's going on.

Examples of products and companies included in this guide do not in any way imply endorsement or recommendation. Bear in mind that prices quoted are indicative at the time it was published. Smartphones combine the functionality of PDAs, wireless PCs, phones, and even digital cameras in one handset, making them a powerful business tool.

Never out of touch - you can connect to the internet for e-mail and web access 'on the move', or connect to your computer network to access relevant data, wherever you are, making it easier for remote workers, or a mobile workforce to stay in touch with the business.

Better information sharing - considerably more data can be received and transmitted via a smartphone, such as large e-mail attachments or data files from websites. Previous mobiles could only manage small e-mails without attachments.

Greater functionality - many models offer built-in digital cameras with immediate snap and send functionality, so remote workers or offsite staff can instantly photograph and send images or videos of anything from supplier's goods to site inspections or damaged warehouse machinery. Smartphones could offer you a new way of marketing to customers, Multimedia Messaging Services (MMS) lets you include animation, graphics and music in a message.

Faster communication - web access is quicker than in previously available mobiles, making it easier to access e-mail and information from the Net.

3.4 Data Gathering Techniques:

To find out the different types of user behavior and also to find out similar users we need log data from mobile device. We may have huge collection of logs but we have to find out the desired logs. To ensure that we need to filter the html or xml file with our requirements. And finally develop an algorithm to find out similar users.

Here using Google Analytics server we have found the button activity & session duration.

		Total
	Event Label	Total Events ↓
1.	play_button	93

Fig.3: Button Activity

Session Instances	Sessions	Avg. Session Duration
1	4	00:00:12
2	4	00:00:16
3	3	00:00:08
4	2	00:00:12
5	2	00:00:07
6	2	00:00:34
7	2	00:00:31
8	1	00:00:21

Fig.4: Session Activity

3.4.1. Critical Analysis:

- ✓ We need a .xml or .html file which will contain a huge amount of log
- ✓ We also need an algorithm which will show us the similar types of users
- ✓ We also need a table that will contain various types user in column and also similar types of user in those columns.
- ✓ The apps will be shown in the rows
- ✓ Finally analyzing the table we will provide suggestions.

3.4.2 Activity Log Overview:

We have used a custom app which is called ‘userbehavioranalysis’ to find out the log of an android device for a particular user.

The application looks like the following

Fig.5: User Interface

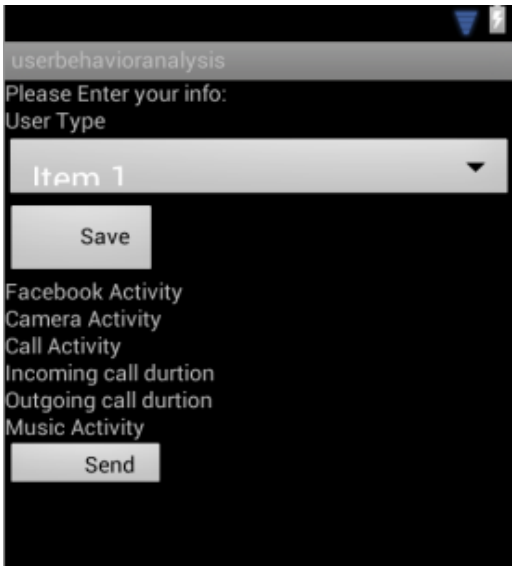

Fig.6: Activity Log collector

3.5 Existing App (Log Collector):

We have found an existing application which is known as 'log collector'. It is An android based (.apk) application which is used to collect all logs from a device and send it via Bluetooth or email.

3.5.1. Log Collection:

- First, we have to install the .apk file from our sdcard or phone memory.
- After installing we run the program
- Then it will show a screen (fig.2) which contains the information based on log
- Clicking yes it will appear another screen (fig.3) which will ask our permission to send the log via any of the medium

Fig.7: Log collector

Fig.8: Send the log via any medium

3.5.2. Drawbacks of existing system:

- Give a large amount of data simultaneously from all process
- Read unnecessary logs
- Log data are not well organized
- Features not specified
- Vulnerable for a new user

3.6 Related works

There are only few research works that have been done in the context of smartphones user behavior. A novel data mining method, namely temporal mobile access patterns that can efficiently discover mobile user's temporal behavior patterns associated with location and requested services [5]. This method could efficiently discover mobile user's temporal behavior patterns associated with location and requested services.

A Two-stage approach for addressing the sparseness of behavior pattern space and thus made possible to leverage behavior patterns for discover similar mobile users with respect to their habit [6].
Another one is LMA-based Human Behavior Analysis Using HMM by Kamran Khoshhal.

We found some related research paper similar to this topic. Logging and analyzing Mobile user behavior [2] is one of them which give us the idea about the logging data that comes from the user behavior. They also suggests a method to analyze these log data using 'log-cat' tool and visualize this using log charting service.

Human behavior analysis using data collected from mobile devices [3]**,** this paper provides us the definition and explanation of human behavior and also gives us the knowledge of different types of smartphone apps. They collect data from mobile devices such as GSM location patterns (cell tower ID data) and Bluetooth proximity data and use these data to find out low entropy users.

A service platform for logging and analyzing mobile user behavior [4], in this paper, researcher presents a service platform for logging and analyzing mobile user behaviors. We have implemented a log collection service which records all user operations on the mobile unit.

We find another paper which takes a first step in addressing this knowledge gap by presenting results on app usage at a national level using anonym zed network measurements from a tier-1 cellular carrier in the U.S. We identify traffic from distinct marketplace apps based on HTTP signatures and present aggregate results on their spatial and temporal prevalence, locality, and correlation. Many social networking and games apps are more frequent lysed when users are moving around. Mobility affects connectivity and performance, so bandwidth sensitive

content that are mobile may need to consider techniques to compensate for bandwidth variability. Their findings on the diverse usage patterns of smartphone apps in spatial, temporal, user, device dimensions will motivate future work in the mobile community [7].

We studied another paper based on CTMSP-Mine (Cluster-based Temporal Mobile Sequential Pattern - Mine) algorithm is used to mine CTMSPs. In CTMSP-Mine requires user clusters, which are constructed by Cluster-Object-based Smart Cluster Affinity Search Technique (CO-Smart-CAST) and similarities between users are evaluated by Location-Based Service Alignment (LBS-Alignment) to construct the user groups. The temporal property is used by time segmenting the logs using time intervals. The specific time intervals to segment the huge data logs are found using Genetic Algorithm based method called GetNTSP (Get Number of time Segmenting Points). The user cluster information resulting from CO-Smart-CAST and the time segmentation table are provided as input to CTMSP-Mine technique, which creates CTMSPs. The prediction strategy uses the patterns to predict the mobile user behavior in the near future [8].

A group of studies attempted to improve the performance of mobile apps via OS infrastructure support [11, 10, 9], offloading resource intensive computation to cloud [11], providing clean intermediate interface for apps by the OS [10], and signaling mobile devices by network providers via notification channel to severe source [9]. Our study is complementary to these, as it focuses on profiling the usage patterns of mobile apps; we note that the design of supportive infrastructure would also benefit from the knowledge of mobile app usage patterns.

Another paper is aimed at modeling how to build mobile user's behavior pattern with a temporal association rule In mobile agent systems. The mobile agent system consists of semi-structure data like XML data. Temporal association rules can be used to decide the next likely user's request services based on significant dynamic correlations. In the past, sequential association rule have been used to capture the co-occurrence of user's sequential movement pattern in mobile web systems domains. Episodes were designed to capture significant patterns form sequence of events. However, these models were not designed for the user's temporal movement patterns in mobile agent systems. And the deficiency of existed studies is that they considered only one of the characteristics, i.e. location associated with requested services. Obviously, both movement and location or

service requested with the temporal association rule should be considered simultaneously in order to discover complete information of user behavior patterns when the user request services. As a result, it remains an open question how to discover the mobile user's interesting movement behavior patterns by temporal mobile access patterns based on temporal association rule for user and services provider.

The Weka (pronounced Way-Kuh) workbench contains a collection of visualization tools and algorithms for data analysis and predictive, together with graphical user interfaces for easy access to this functionality. The original non-Java version of Weka was a TCL/TK front-end to (mostly third-party) modeling algorithms implemented in other programming languages, plus data preprocessing utilities in C, and a Make file-based system for running machine learning experiments. This original version was primarily designed as a tool for analyzing data from agricultural domains,[2][3] but the more recent fully Java-based version (Weka 3), for which development started in 1997, is now used in many different application areas, in particular for educational purposes and research. Advantages of Weka include:

- free availability under the GNU General Public License
- portability, since it is fully implemented in the Java programming language and thus runs on almost any modern computing platform
- a comprehensive collection of data preprocessing and modeling techniques
- ease of use due to its graphical user interfaces

Weka supports several standard data mining tasks, more specifically, data preprocessing, clustering, classification, regression, visualization, and feature selection. All of Weka's techniques are predicated on the assumption that the data is available as a single flat file or relation, where each data point is described by a fixed number of attributes (normally, numeric or nominal attributes, but some other attribute types are also supported). Weka provides access to SQL databases using Java Database Connectivity and can process the result returned by a database query. It is not capable of multi-relational data mining, but there is separate software for converting a collection of linked database tables into a single table that is suitable for processing using Weka.[4] Another important area that is currently not covered by the algorithms included in the Weka distribution is sequence modeling [12]

Chapter-4

Our Proposed Mechanism & System Design

Our first priority is to develop an information gathering Technique, as we have mentioned earlier that the existing ones are not so effective. New software has been proposed here for the betterment of log collection. So we are focusing on the improvement of existing log collector software. A new categorization of user by more efficient feature selection is also proposed in our work. Generating an algorithm for the process is another proposal which will be helpful for providing user recommendations.

4.1 Our Prepared System:

Among the highly configured smartphones we have chosen Sony Xperia SL and Samsung Galaxy S3 as our experimental device for the time being. The configurations of the Xperia SL are 1.7 GHz Dual core processor, 1 GB RAM and a high performance GPU with other sensors. And the configuration for the Samsung Galaxy S3 is 1.5 GHz Quad core processor, 1 GB RAM and a high performance GPU with other sensors. The system we are proposing will run in the phone as a background application.

One question may come that all the logs that we are considering may be personal. For example what a user does in Facebook is completely his personal issue. So why should he or she share with us. That's why we also modify the current existing log collector tool to ensure no personal data are hampered or leaked. If any user does not want to share he or she can uncheck the Facebook log. So we are considering this effect and made a better collector to get logs from mobile.

Collecting the logs of different applications used by the users is the most important task here. We have proposed a new software which will work more efficiently than the existing one. The interface of the software is given here

Fig.9: Our prepared interface

4.2 A new tool (Google Analytics):

What is Google Analytics?

Currently we are working on Google analytics. It's a framework for tracking an instance of an app. The Google Analytics SDK for Android makes it easy for developers to collect user engagement data from their apps.

Where it's being used:

Developers can then use Google Analytics reports to measure

1. The number of active users is using their applications.
2. From where in the world the application is being used,
3. Adoption and usage of specific features,
4. In-app purchases and transactions,
5. The number and type of application crashes. And many other useful metrics.

Google Analytics lets us measure our advertising ROI as well as track our Flash, video, and social networking sites and applications.

Why we use it:

Google Analytics is a service offered by Google that generates detailed statistics about a website's traffic and traffic sources and measures conversions and sales. The product is aimed at marketers as opposed to webmasters and technologists from which the industry of web analytics originally grew. It is the most widely used website statistics service.

Google Analytics can track visitors from all referrers, including search engines and social networks, direct visits and referring sites. It also displays advertising, pay-per-click networks, email marketing and digital collateral such as links within PDF documents.

Benefits:

The Google Analytics SDK for Android is an easy way to help determine how your users are using your Android applications. There are several different event tracking methods which can be used to determine what parts of the application are being used, as well as what features of the application your users use routinely or rarely. The data being sent to the Google servers should be generic enough to protect users' privacy but specific enough to generate useful reports for the developer. This is a balancing act that usually requires some tweaking on an app-by-app basis.

Google Analytics is a service provided by Google that makes it easy to track what users do. In this tutorial, learn how to track Android application events like screen loads and button clicks in order to determine what your application's users are doing and what they are not.

The Google Analytics SDK for Android provides helpful classes and methods to track user activity and generate useful statistics about your Android app activities. Here is a typical custom dashboard for some application behavior.

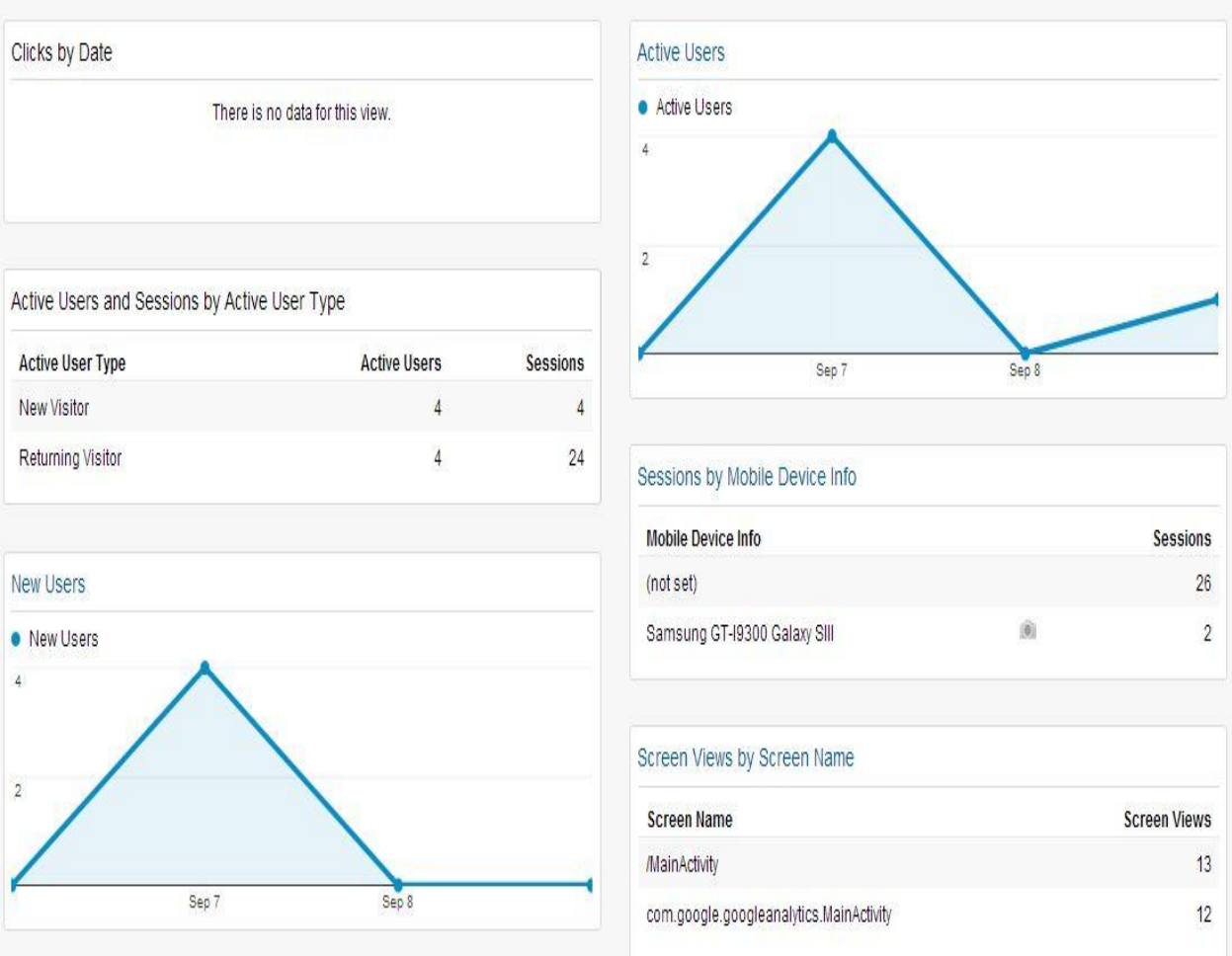

Fig.10: Google Analytics Server

The proposed software can do the following operations

- ✓ *can read specific apps activity run time*
- ✓ *Saves categorized user activity in local database*

4.3 System Architecture & Design:

Our designed system architecture is given based on mainly two ends. User end and server end. In the user end, all the users' activity is being collected via log collector. Then it's being written into .xml file and sends via email to server.

In the server end, Xml file of logs have been collected and store in the primary storage. From there we are going to be filtered the file in order to get the desired categorization of user. Now we want to develop an algorithm to specify user categorization and find out the similar types of users. Finally we give some recommendation to the similar users for better performance.

Our whole system architecture is given below

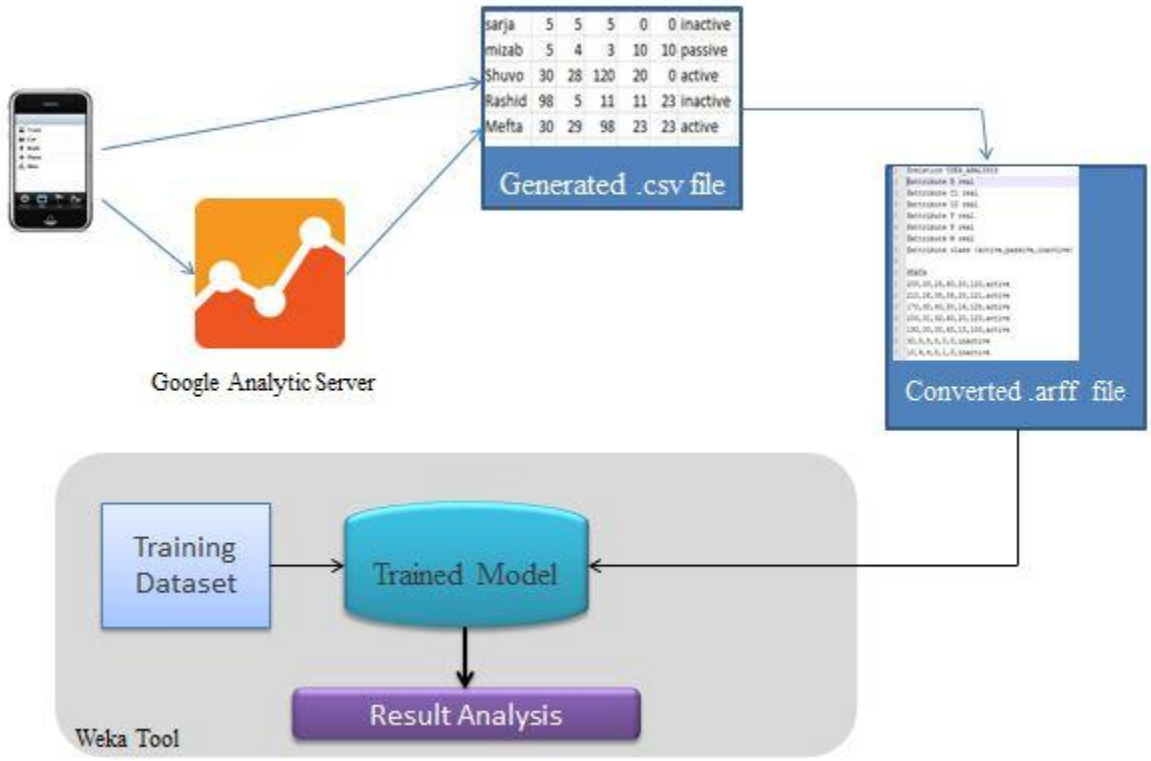

Fig.11: System Architecture

4.4 Work Flow of Current System:

- ✓ We designed both server and user end architecture and our logs are also collected
- ✓ Now relationship between logs and user is given below

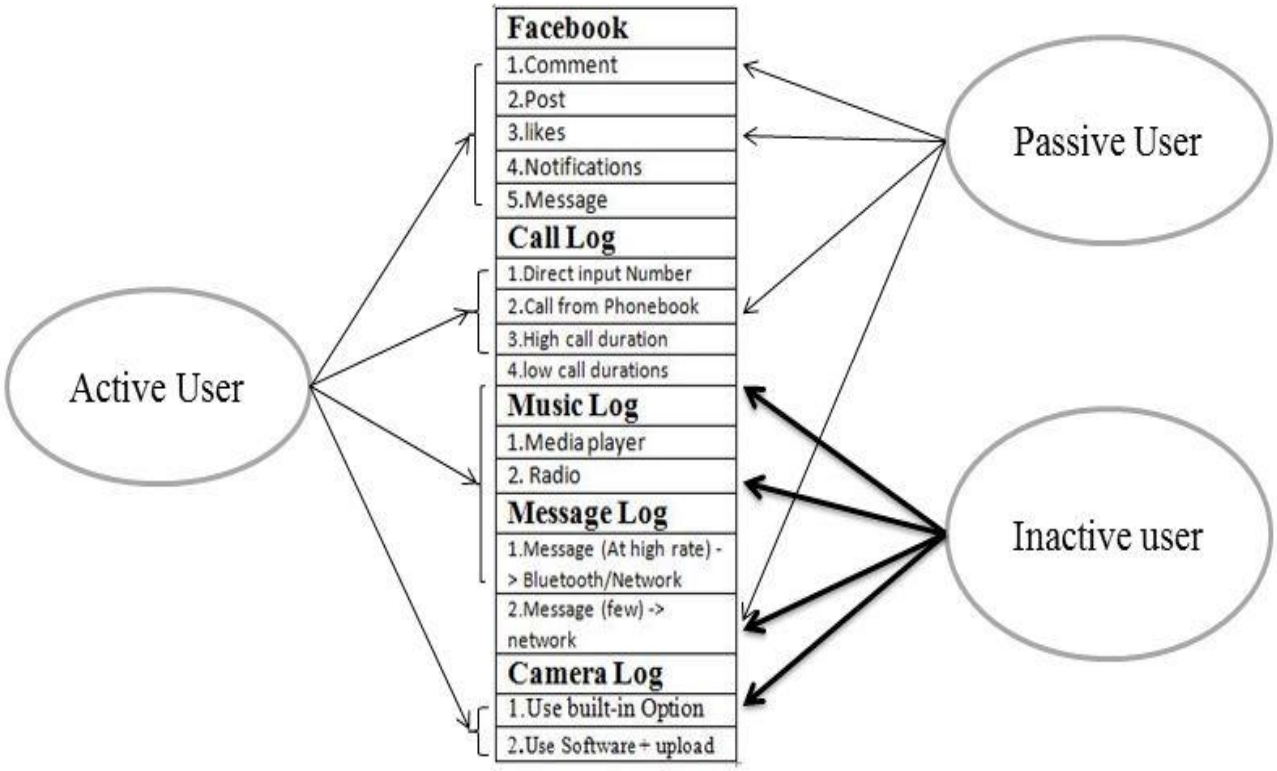

Fig.12: Relationship between user and logs

Here, as we can see in the figure active users have the maximize of activities in all the features that we have described earlier. Passive users are the user who has the activities that are created by the active user. And inactive user has the lowest activities among all the others.

Chapter-5

Result Analysis

After the phase of data gathering techniques we have a test dataset for further analysis. As we already stated before we have categorized our user behavior into three different parts.

Now we need to convert our test dataset into train dataset by converting .csv file into .arff file.

5.1 Testing:

We used Weka's several machine learning algorithm to analyze our data. Weka provides various machine learning algorithm for implementing train data set. We have used mainly Random tree, BF tree and j48 algorithms here. These algorithms showed results with different level of accuracies. The test datasets are being evaluated against these models.

The following diagram is the result that we have found by evaluating our datasets.

User Classification	Algorithm	Success Rate
Active	Random Tree	78.58%
Passive	BF tree	73.34%
Inactive	J48	92.02%

Fig.13: success rate of different algorithms in different user

Some output results of weka for various behavior classes are shown here for example. These results are output given by weka.

The following example is for active user

```
=== Run information ===

Scheme:weka.classifiers.trees.RandomTree -K 0 -M 1.0 -S 1
Relation:     USER_ANALYSIS
Instances:    15
Attributes:   7
              B
              C1
              C2
              F
              P
              M
              class
Test mode:user supplied test set: size unknown (reading incrementally)

=== Evaluation on test set ===
=== Summary ===

Correctly Classified Instances          11               73.3333 %
Incorrectly Classified Instances         4               26.6667 %
Kappa statistic                          0
Mean absolute error                      0.1778
Root mean squared error                  0.4216
Relative absolute error                 40      %
Root relative squared error             89.4427 %
Total Number of Instances               15
=== Confusion Matrix ===

  a  b  c   <-- classified as
 11  3  1 |  a = active
  0  0  0 |  b = passive
  0  0  0 |  c = inactive
```

This is for passive user

```
=== Run information ===

Scheme:weka.classifiers.trees.BFTree -S 1 -M 2 -N 5 -C 1.0 -P POSTPRUNED
Relation:     USER_ANALYSIS
Instances:    15
Attributes:   7
              B
              C1
              C2
              F
              P
              M
              class
Test mode:user supplied test set: size unknown (reading incrementally)

=== Evaluation on test set ===
=== Summary ===

Correctly Classified Instances          11               78.5714 %
Incorrectly Classified Instances         3               21.4286 %
Kappa statistic                          0
Mean absolute error                      0.1429
Root mean squared error                  0.378
Relative absolute error                 32.1429 %
Root relative squared error             80.1784 %
Total Number of Instances               14

=== Confusion Matrix ===

  a  b  c   <-- classified as
  0  0  0 |  a = active
  1 11  2 |  b = passive
  0  0  0 |  c = inactive
```

And finally for the inactive user

```
=== Run information ===

Scheme:weka.classifiers.trees.J48 -C 0.25 -M 2
Relation:     USER_ANALYSIS
Instances:    15
Attributes:   7
              B
              C1
              C2
              F
              P
              M
              class
Test mode:user supplied test set: size unknown (reading incrementally)

=== Evaluation on test set ===
=== Summary ===

Correctly Classified Instances          12               92.3077 %
Incorrectly Classified Instances         1                7.6923 %
Kappa statistic                          0
Mean absolute error                      0.0513
Root mean squared error                  0.2265
Relative absolute error                 11.5385 %
Root relative squared error             48.0384 %
Total Number of Instances               13

=== Confusion Matrix ===

  a  b  c   <-- classified as
  0  0  0 |  a = active
  0  0  0 |  b = passive
  1  0 12 |  c = inactive
```

Chapter-6

Future prospects And Conclusion

Future Plan:

- Add new features in the system. It means to improve our proposed system more by adding different types of new features.
- Develop an algorithm to find out the similar apps just like the similar type of users.
- New categorization of users. In this proposed system we have taken three major types of user active, passive and inactive user. We also take high and low entropy of users an a part of active user. So we will try to find more categorization of users if possible and more input in the user database.
- Build an android application (.apk) that will provide us the user behavior along with the apps behavior (independent or dependent or combined type of user.)

Conclusion:

Our main objective was to analyze the human behavior based on some custom applications and sensor logs developed Google analytics .Through various implementations we were trying to develop a custom application which will be run as a background process for the users and will collect their respective logs for the desired analysis. In future we will try to develop the software with some more useful features which will eventually save the data locally and then we will extract the data so that that data can be mapped with different behavioural states of human.

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