An Efficient Approach for Classification and Recommendation of Mobile Apps with Security

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***Abstract*- An application software, 'mobile app' is a computer program made to run on smartphones, laptops etc. Apps became popular due to its benefits such as building relationships, gaming, security etc. Mobile app recommendation is an upcoming approach in which the recommender system identifies the user's needs or task the user is trying to perform and recommend the user with an app which helps in performing that task. The previous work focused on mobile app classification based on a predefined category. This paper proposes a mobile app recommendation approach for app users by making use of three features such as apps installed by a user, interuser communications and location of the user. Before recommending an app the security of the app will be checked by making use of a rank calculation algorithm. Finally based on the rank calculation algorithm and the three features, the user will be recommended with a secure app which matches his/her preferences.**

Keywords: Recommendation, Recommender System, Security, Mobile App Classification.

I. INTRODUCTION

Smartphones have become an unavoidable part in the daily life of mobile phone users. In recent years smart phones have become a new trend among all the age groups. The desirability for smartphones is mainly due to the applications it supports. An extremely large number of apps have been developed for smartphone users. Day by day the app developers are launching different categories of apps for app users because the users are now depending on apps for performing some business task and they are mostly used in free time for gaming, social networking etc. Apps are downloaded from different app stores such as Google's app store, Android app store, Apple's app store etc.

The previous work deals with mobile app classification based on a predefined category set and apps are classified due to the reason that in recent years an extremely large number of apps have been developed and so it is expected to have an efficient classification method and the name of the app is too sparse and so from the name the user won't be able to identify its purpose. The smartphones helps in capturing the usage history of users which in turn can be used for identifying the user's interest for a particular app category. Based on the user's interest for a particular category the recommender system recommends new app for the user. Nowadays recommendations are very common in all kind of websites and especially in social networking sites. For example, the recommendation engines takes note of every action a visitor to a website makes and also notes down the time the visitor spends on that particular website. And then these systems analyse and interpret the obtained data and then make recommendations based on the user's behavior.

Therefore, this paper deals with mobile app classification and recommendation of new apps for app users based on the three main features such as apps installed by the user and the time the user spend on each app, inter user communications and the user's location. After extracting these features the recommender system will be able to identify the user's interested category. The recommender system finally performs a security check for the apps before recommending it to a user and this is done based on a rank calculation algorithm. The main advantage of this recommender system is that the recommended app will be a secure app and will never be a malicious software.

The remainder of this paper is organized as follows. The related work is presented in section II. section III described about the system model. Algorithms and its working details provided in section IV. Performance evaluation done in section V. Finally, conclusion is given in section VI.

II. RELATED WORK

Mobile app recommendation system automatically recognizes the task the user is trying to perform (using information derived from the user's context log) and to recommend apps that helps the users to accomplish the task). To identify users preferences, Hengshu Zhu [1] proposed how to extract the context aware preferences of users by making use of their context log, but a major problem with this paper is that the context log of users are insufficient to predict the preferences. Matthias Bohmer [2] proposed a paper which gave rise to the context aware recommendation of mobile application by considering the changing context of users, many existing systems neglect the changing context of mobile users. Smart mobile devices have the sensing capability to capture rich contextual information of smart phone users and store in context log and by making use of this context log,

Kuifei Yu [3] proposed to provide personalized context aware recommendation for users by making use of the context log of many mobile user's context logs.

Nana Yaw Asabere [4] proposed a framework for recommending learning resourses to learners in a mobile social learning community by making use of the contextual information. Due to the rapid increase in the use of internet and smart phones the users have access to large number of videos, audios, text and images. Mobile users normally save multimedia contents based on their interest to solve the problem of multimedia overload to users, Feng Xia [5] proposed to recommend relevant multimedia content based on their preferences,so that the users does not have to waste their time by searching for their interested contents. Vito Claudio Ostuni [6] presented 'Cinemappy' which is a location based application used to recommend movies to the users to be watched in theatres that are located in user's neighbourhood by tracing the location of the user.

Nowadays the mobile users are reluctant to download or install new apps due to privacy and security issues, therefore to solve this issue Enhong Chen [7] proposed to develop a mobile app recommender system with privacy and security awareness and for that the recommender system is equipped with a functionality which allows to automatically detect and evaluate the security risk of mobile apps. Deguang Kong [8] proposed a paper by incorporating both interest-functionality interactions and users' privacy preferences to perform personalized App recommendations.

In recent years a large number of android apps have been developed. Android has a defence mechanism against malicious software ie before a user installs an app, the system warns the user about the permissions the app requires, trusting that the user will make the right decision. Hao Peng [9] proposed how to conduct effective risk communication for mobile devices on Android platform. The focus is on the Android platform. The Android platform has emerged as one of the fastest growing operating systems. . This paper helps in understanding the importance of effectively communicating the risk of an application to users, and propose several methods to rate this risk..

With increasing numbers of people switching to smartphones, the mobile application space is an emerging domain for recommendation systems.Kent Shi [10] proposed an approach for mobile app recommendation with incomplete or small amount of dataset. For that this paper compare a latent factor (PureSVD) and a memory-based model with our novel PCA-based model,which is called as call Eigenapp.

Due to the advancement in tourism economics it is possible to collect massive amounts of travel tour data which can be used by the recommender system for tour recommendation. Yong Ge [11] proposed a cost aware travel tour recommendation system which helps in real time decision making. And the recommendation is based on considering the travel cost and the tourist's interest and it will be decided or predicted based on their previous journey.

III. SYSTEM MODEL

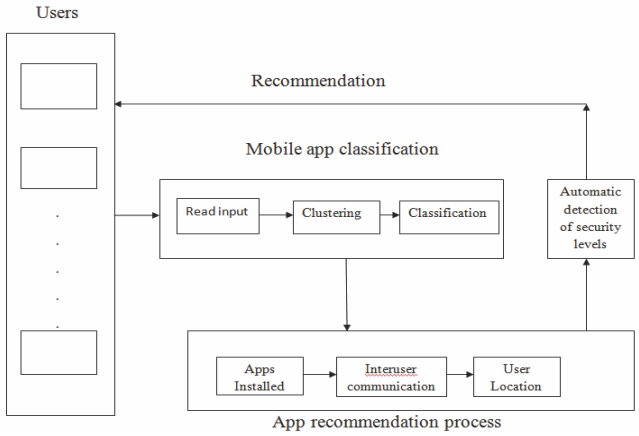

Fig.1. Framework of the proposed approach

Overview of Proposed Approach

The proposed approach mainly consist of three main stages. First, mobile app classification is done based on web features and the users contextual features. App classification is done in order to classify or separate apps into predefined app category, so that without trying an app its purpose can be identified. Second stage deals with mobile app recommendation and for this three main features are considered, they are app installed by the user, interuser communication and location of the user. This stage helps in recommending the user with new applications based on his/her interested category. Third stage deals with automatic detection of app security.Fig.1 shows the system framework and the Individual components are described in the following sections:

Read Input

Web based features and contextual features are the input required for app classification. Web features are collected by submitting the app name to a web search engine(Google search engine)and snippets will be taken from the search results along with its frequency(word frequency). Contextual features are the app usage records of a person taken from his/her smart phone. Smart phone have the ability to capture and store all the usage records of users.

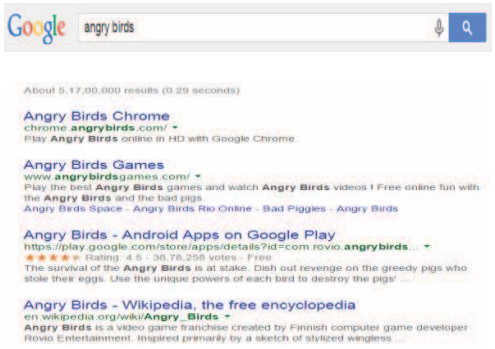

Fig.2. Example for web search

Clustering

After extracting web features and contextual features of many users the next process is to cluster the users according to their similarity of app usage. This process helps in classification as well as recommendation.

Mobile App Classification

Finally integrate both the web features and contextual features into a MaxEnd model for training an app classifier.

Apps Installed

This field identifies all the apps installed by the user and the time spend by the user on each app. Different users have interest on different categories of applications. The user's interested category is identified with the assumption that the user will always install more apps from his/her interested category and will spend more time on it.

Interuser Communication

The user's call list is checked in order to find his/her communication details. This field identifies a person's most contacted number, and so they may be close friends. So we can assume that they both will have similar interest and same app can be recommended for both.

User Location

There are different locations like bus stand, railway station, hospital, shopping mall etc. This field identifies the user's location and finds to which location he/she visits more. And based on this new app will be recommended. For example, if a person visits hospital very often then he/she will be recommended with apps related to hospital.

Rank Calculation Algorithm

Nowadays security or privacy is a big concern for everyone. Therefore due to privacy issues mobile phone/smart phone users stopped downloading or installing apps. So to solve this issue a rank calculation algorithm is proposed in this paper which helps in recommending the user with secure apps ie apps will be ranked in ascending order with respect to their risk scores assuming that smaller the risk score safer will be the app.

Finally, the user will be recommended with secure app based on his/her interested category.

IV. IMPLEMENTATION

From the system model the overall working of the system is understood. There are mainly 3 stages and they are mobile app classification, app recommendation and app security using rank calculation algorithm.

Stage 1:-Mobile app classification

There are different steps for app classification,

Step 1:- Create an app taxonomy

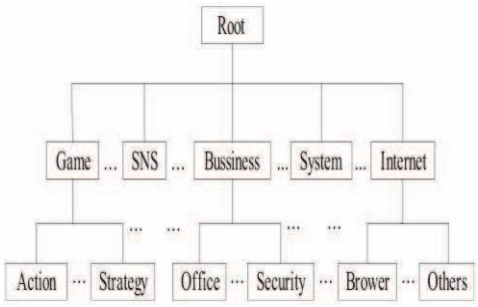

Fig.3. Example for app taxonomy

Step 2:- Web feature extraction

Given an app 'a' and its category label 'c' submit a's name to web search engine and based on the words/snippets retrieved from the web search engine build a normalized vector for each app category,

$$\text{dim}[n]=\text{freq}_{i,c} \quad (1)$$

$$\text{dim}[i]=\frac{\text{freq}_{i,c}}{\sigma_{\text{freq}_{i,c}}} \quad (2)$$

where $\text{freq}_{i,c}$ represents the frequency of i^{th} word in category 'c'.

Step 3:- Context feature extraction

For each preselected and labelled app 'a' collect all the context records from the context logs of mobile users. Build a context profile for app 'a', and find the context vector for each category'c'.

$$R_a=\{(P_i,\text{freq}_{i,a})\} \quad (3)$$

$$\text{dim}[m]=\text{freq}_{i,a} \quad (4)$$

$$\text{dim}[i]=\frac{\text{freq}_{i,a}}{\sigma_{\text{freq}_{i,a}}} \quad (5)$$

Step 4:- Clustering

Clustering is used to group the users according to their similarity of app usage. The users with same app usage records or with same context pairs are grouped together.

Step 5:- Mobile app detector

Based on the snippets retrieved from web and the context log similar users are grouped together and vector values are found for all the categories. And finally based on the word rank and context rank we can conclude that to which category a particular app belongs to.

Stage 2:-Mobile app recommendation

For recommending apps to the users the recommender system will have to identify users interested category and for that three main features are considered:-

Step 1:- Apps installed by the user

This feature identifies all the apps installed by a user and from that the most installed apps will be sorted out and that will be considered as his/her most interested category. User's interested category can be found by constructing an MxN matrix,where M is the number of users(rows) and N is the number of categories(colunms).

Example:-

	C_1	C_2	C_3	C_4
U_1	a_{11}	a_{12}	a_{13}	a_{14}
U_2	-	-	-	-
U_3	-	-	-	-
U_4	-	-	-	-

Where a_{11} is the total number of apps installed by user U_1 from category C_1.

$$A_{i,j}=\text{[illegible]} \quad (6)$$

where n is the number of users and m is the number of categories.

Step 2:- Interuser communication

To find a user's most contacted person. This can be identified by considering an MxN matrix with M and N are the number of users.

Example:-

	U_1	U_2	U_3	U_4
U_1	a_{11}	a_{12}	a_{13}	a_{14}
U_2	-	-	-	-
U_3	-	-	-	-
U_4	-	-	-	-

Where a_{12} will be the maximum number of times U_1 communicated with U_2.

$$IU_{i,j}=\text{[illegible]} \quad (7)$$

Where m and n are the user limits.

Step 3:- User Location

To find the user's most visited location. This is also identified by constructing an MxN matrix where M rows indicates different users and N column indicates different locations.

$$UL_{i,j}=\text{[illegible]} \quad (8)$$

Where m is the different users and n is the different locations.

Step 4:- Location-Category relation

To find the relation between user's location and category again an MxN matrix is constructed with M indicates different locations and N indicates different categories.

$$L_{i,j}=\text{[illegible]} \quad (9)$$

Finally based on all these findings a person's affinity towards a particular category can be found,

User X's affinity towards category J,

$$U_{x,j}=\text{[illegible]}+(\sigma\ \text{[illegible]} * \text{[illegible]})+(\sigma\ \text{[illegible]} *A(i,j)) \quad (10)$$

where m is the total number of categories and n is the user count.

Stage 3:- Rank calculation algorithm

This algorithm helps in finding the security level of the mobile apps.

Step 1:- Compute the risk scores of each app based on access permissions.

Step 2:- After computing the risk scores arrange the apps in ascending order.

Smaller the risk score safer will be the app.

And the app with the smallest risk score will be recommended first.

If any apps have same risk scores then it will be arranged or sorted based on app's popularity.

V. PERFORMANCE EVALUATION

The proposed approach consist of 3 parts and they are classification, recommendation and security check. The previous work or the old recommender system could not achieve expected efficiency. The efficiency of the new system is much better because the proposed recommender system made use of the three main features such as apps installed,interuser communication and user location. And also the proposed work provides security for the users which in turn increases the efficiency of the new system.

Corpus size indicates the amount of data or data count. To achieve better efficiency or better result there should be large amount of data.

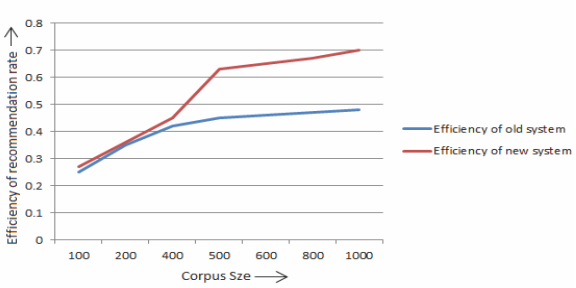

Fig.4.Efficiency versus Corpus size

VI. CONCLUSION

This paper deals with the problem of mobile app classification, recommendation and app security. The critical problem identified is that most of the recommender system will recommend apps based on app's popularity and user's behavior but it will not consider the security level of the app recommended. To this end, this paper proposed a recommender system which recommends the user with new apps based on his/her interested category and which are secure for the user. To be specific, three main features are extracted for identifying the user's interested category and they are apps installed by the user and the time user spends on each app,inter user communication and users location. Based on this the user's affinity towards a particular category is found. Finally the app's security will be checked based on a rank calculation algorithm and the user will be recommended with an app with minimum risk.

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