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Faculty of Computer Science and Engineering

**Permission-based Privacy Analysis for Android Applications**

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April 2018

Prishtina



Faculty of Computer Science and Engineering

Master Thesis

Academic Period 2013-2014

Erza GASHI

**Permission-based Privacy Analysis for Android Applications**

Advisor:

**Dr Sc. Zhilbert TAFA**

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Submitted in partial fulfillment of the requirements for the degree of Master of  
Science

## **ABSTRACT**

While Information and Communication Technology (ICT) trends are moving towards the Internet of Things (IoT), mobile applications are becoming more and more popular. Mostly due to their pervasiveness and the level of interaction with the users, along with the great number of advantages, the mobile applications bring up a great number of privacy related issues as well. These platforms can gather our very sensitive private data by only granting them a list of permissions during the installation process. Additionally, most of the users can find it difficult, or even useless, to analyze system permissions. Thus, their guess of app's safety mostly relies on the features like rating and popularity, rather than in understanding context of listed permissions.

In this work, we investigate the relationship between the features collected from Android Market API 23 and app's privacy violation. These features include Popularity, Total Number of Permissions, Number of Dangerous Permissions, Rating and Package Size. To show the influence of each feature we use linear regression and Pearson R statistics.

The conducted research can contribute to the classification of mobile applications concerning the threat on user's privacy.

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## **ABBREVIATION**

ICT – Information and Communication Technology

IoT – Internet of Things

XML – eXtensible Markup Language

PDF - Probability Density Function

CDF - Cumulative Density Function

API - Application programming interface

GPS – Global Positioning System

NFC – Near Field Communication

IOS - iPhone Operating System (Apple)

# 1. INTRODUCTION

With the increased number Mobile Applications, privacy has become a major threat for smartphone users. Two main market stores, that share more than 90% of market, are Android and IOS [1]. In addition, as the number of users increase, the privacy and security threats become more serious and dangerous.

Today, there are lots of free mobile apps in Android official Market that are used for advertisement and similar purposes, but these applications can also be used for personal data identification.

Permission control is one of the major Android privacy/security mechanisms. When an application is to be installed, a user has a choice whether to allow specific permissions or not. One problem is that most of the users are not informed about the permission system and the way permission can be misused. On the other hand, even if a user would be informed about the permission system, the user's denial of permissions would disable the application installation. This implies that the user does not actually have much control over the permission system.

Various applications use much more permissions than needed. Some of these permissions are recognized as more dangerous, which categorizes them as being dangerous in the privacy/security sense. The study presented in this work aims to identify the relation between the user perceptions and this category of applications.

## 1.1 Objective

The objective of this work is twofold. First objective is to have a complete and structured dataset of applications and their information relating to permissions from Google Play Market. This data includes types of permissions and other features that are relevant to user's privacy.

Second, we aim to identify the relationship between user perceptions of app's reliability and the actual level of dangerousness based on number and type of permissions granted. More specifically, we focus to answer our main question:

*Q1. Can a typical user detect dangerous applications based on its popularity?*

## **1.2 Limitations**

In this work, we use data collected from Android Market API 21. This means that insights may not apply to other markets such as that from Apple, Microsoft or third party. Yet, similar methodology may apply and this study can be easily extended to other markets as well.

In addition, data crawled are only for apps available to users in Kosovo that are also subscribers of Telekom of Kosovo (Vala) network. For example, some apps are only marked compatible with some types of phones or tablets, some are limited to certain countries [2] (e.g. PokemonGo was only available in US for a long time) and some apps require a minimum version of Android. This affects results to a specific sample. Still, apps that are available in our dataset are the most downloaded apps in Android Market as well and present a very diverse and so a reliable sample.

Finally, Google has restrictions on the number of purchases with a single credit card [3]. This limited us to crawl and analyze only free apps for this work. Same methodology can be applied in collecting and analyzing paid apps as well.

## **1.3 Thesis Structure**

This thesis work is organized as follows. Chapter 2 gives an overview of literature including related work, some background in android permission-based framework, analysis and definitions of terms and metrics used in this work.

In Chapter 3 we revisit the problems in user awareness of violations of android app's privacy. Chapter 4 describes in details methodology used for this work. In this chapter, dataset is presented together with main features.

Chapter 5 shows experiments, results and insights. Finally, Chapter 6 presents conclusion of discussions and experiments in Chapter 5.

## 2. LITERATURE REVIEW

In the first section of this chapter, we show related work in analysis of smartphone apps and privacy. Then, we define terms, definitions and metrics used to accomplish results of this work.

### 2.1 Related Work

A great amount of work is done in analyzing smartphone apps in the sense of privacy leakage.

Before installing an application from Google Play store, a user is presented with a list of permissions and a short description for each permission. These permissions cannot be changed once they are declared by app developer in manifest file without install updates. In addition, descriptions of each permission inform a user with functionalities and resources an app wants to access in order to perform as intended. Thus, in order for a user to be able to use downloaded application, he or she must grant all requested permissions to the app. The list of permissions has become longer with later versions of Android. In [4] authors show that Dangerous permissions tend to increase over a course of 3 years. They study a dataset of 237 apps with 1,703 versions collected from Google Play Market API 3 to 15 and conclude that apps tend to use of more permissions over time.

In studies about android permission models, authors in [5] and [6], show that permission warnings do not help users make proper decisions. In trying to identify the granularity of expression for permission descriptions, Barrera et.al analyzed 1,100 Android applications and presented a permission-based security model that improves expressiveness without increasing number of requested permissions.

The results from the study [5] that surveys 308 Android users indicate that users pay little attention to permissions during the installation process. Consequently, warnings about

permissions despite the expression level do not help a typical user choose between safe and a potential dangerous app.

With introduction of Permission Manager (App Ops) in Android 4.3, users are offered with some type of control over permission selection by enabling them to choose whether a specific permission is tolerable by a user. As a consequence, such control over permissions comes with a trade-off on apps functionality. Similar extensions to offer users with a finer-grained control over permissions are proposed in [7], [8], [9], [10]. For instance, MockDroid Android simulator application [7] allows users to override access of specific properties at startup time and help them better understand the trade-off between functionality and exposure of personal sensitive data. This extension type application provides support of mocking couple of permissions. However, it is limited to only mocking five types of permissions and their functionalities. TISSA [9] is yet another Android application that allows users to customize privacy setting for untrusted apps by deselecting specific dangerous permissions. TISSA bases app trustworthiness by evaluating permissions found in applications that are known to be leaking private information. The application data set is extracted from TraintDroid [8] application, which aims to inform users about misbehaving applications by monitoring sensitive data flow through different sources.

Finally, different studies were conducted in efforts to define techniques to predict dangerous applications in terms of permissions they use. In [11], the authors study privacy preferences by looking for patterns of permissions requests in Android and Facebook applications. They use matrix factorization technique and were able to identify 30 common patterns of permission requests. Similarly, our work aims to derive a model by setting three conditions based on previous work.

## 2.2 Definitions and Metrics

We continue with a presentation of basics on Android platform, permissions model used in Android applications and definitions of metrics that are used throughout this work. For this part, we follow the same structure as the paper of Wei et al [4].

### 2.1.1 Android Platform

Android is an open-source mobile platform that uses custom Linux Operating System as a software stack, Dalvik Virtual Machine and each application runs on a Virtual Machine (Dalvin VM). It was first launched in 2008 and is widely used by smartphone manufacturer industry such as Samsung, HTC, Motorola and Google itself too. Android is a leading choice of smartphone vendors by 80.7% in global market share, followed by iOS with 17.7% according to Garnters [12], as can be seen in table below.

Operating System	4Q16 Units	4Q16 Market Share (%)	4Q15 Units	4Q15 Market Share (%)
Android	352,669.90	81.7	325,394.40	80.7
iOS	77,038.90	17.9	71,525.90	17.7
Windows	1,092.20	0.3	4,395.00	1.1
BlackBerry	207.9	0	906.9	0.2
Other OS	530.4	0.1	887.3	0.2
<b>Total</b>	<b>431,539.30</b>	<b>100</b>	<b>403,109.50</b>	<b>100</b>

**Table 1. Worldwide Smartphone Sales to End Users by Vendor in 4Q17 (Thousands of Units). Source: Gartner (February 2018)**

Shortly, android uses a permission model that protects sensitive resources such as hardware and data stored in users equipment. These resources are protected by definition of permissions and only apps that are granted with these permissions, at the time of app installation, can access protected resources.



### **2.1.1.1 API Levels**

Android framework offers developers a rich set of packages, classes, different attributes that facilitate granting resources and a list of pre-defined permissions that applications can use to grant such resources. The communication link for development and management between Android framework itself and a specific app is done via Application Programming Interface (API). Since its origin in 2008, Android platform has undergone different changes and upgrades. Today, in 2018, we have Android version 7.1 (code name Nougat++) and API level version 25. At the time of data collection (December 2016) it was API version 23 in use (and Android version 6.0 with code name Marshmallow). Each API upgrade replaces parts of older version or adds new ones, allowing existing applications to work with newer API versions as well.

### **2.1.2 Android Apps**

In addition to Google Play (also known as Android Market), Android ecosystem allows manufacturers to sell smartphone that have already installed apps. This category of applications is defined as pre-installed apps. Pre-installed apps come along with devices and are not subject of our analysis. It is assumed that manufacturers are bound to legal ethics and such are considered a reliable entity to grant sensitive permissions.

On the other hand, so called third-party apps that are available for download from Google Play are developed by individuals that represent a software company or work alone. This set of apps is subject of this thesis work because it forms typical sample that one can find evil-minded developers expose user's personal sensitive data by providing some useful functionality.

### **2.1.3 Android Permissions**

Android platform requires each developer to use specify permissions in *AndroidManifest.xml* source file [13]. By listening permissions in this *xml* file, respective

resources are granted permission with the help of user when app is installed. List of these permissions are presented to the user when she/he installs app and they will be valid until app is uninstalled. On all versions, in order for a developer to declare that app needs permission, she or he puts `<uses-permission>` element in app *AndroidManifest* file. A snippet of manifest file is given below. This file is used when information are crawled to create our structured dataset.

```
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
package="com.example.snazzyapp">

<uses-permission android:name="android.permission.SEND_SMS"/>
<!-- other permissions go here -->

<application ...>
...
</application>
</manifest>
```

API 23 has a list of pre-defined permissions. Some of these permissions are INTERNET that allows an app to user Internet connection for data transmission/receive, ACCESS\_FINE\_LOCATION allowing an app to gather user location updates by GPS and NFC and so on.

### **2.1.3.1 Protection Level**

List of permissions defined by Android platform is divided into three protection levels: normal, signature and dangerous permissions. Protection levels describe if runtime permission requests are required or not [14].

#### *Normal Permissions*

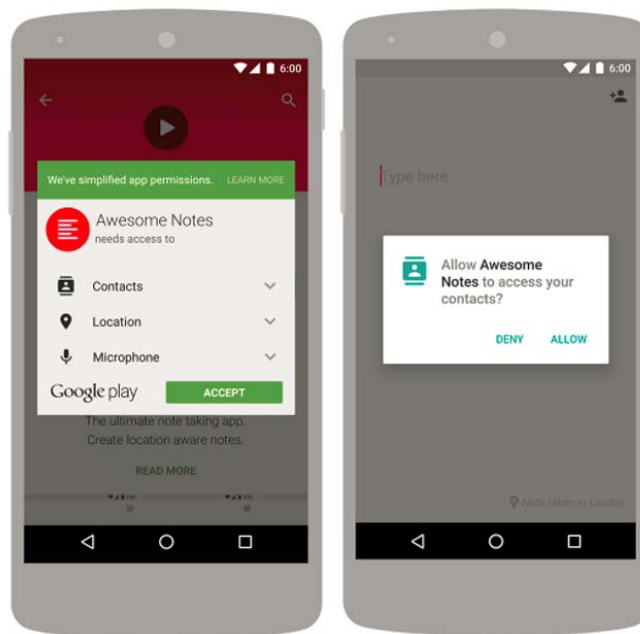
Permissions under this category allow access to resources and data that are very little risk for to the user's privacy or the operation of other apps. Example of such permissions includes

### *Signature Permissions*

Permissions under Signature level category signify the highest privilege and can be granted only when the app requesting such permission is signed by the same certificate as the app defining it.

### *Dangerous Permissions*

These types of permissions ask access to data or resources that involve private and sensitive user's information, or can potentially impact user's data stored and/or operation of other installed apps in respective device. An example of this affect can be the ability to turn microphone on or off, or read/write user's contacts. In addition to install-time, an app must prompt the user to grant permissions as below also during run-time, Figure 1.



**Figure 1. Grant permissions a) at install-time (left) and b) at run-time (right)**

## 2.2 Statistical Methods

In order to gain relationship insights of our variables and evaluate our methodology we use traditional visual statistical methods.

Three methods used for the purpose of this thesis are:

- Pearson correlation coefficient,
- Histogram and
- Scatter plots.

### 2.2.1 Pearson correlation coefficient

Pearson correlation coefficient ( $\rho$ ), also known as *Pearson's r*, measures the linear correlation between two variables. It's values range between  $-1 < \rho < +1$ , where  $-1$  indicates total negative correlation while  $+1$  indicates total positive correlation. For  $\rho = 0$  does not imply any useful information regarding the relationship. In this work, we use Python `DataFrame.corr(method='pearson', min_periods=1)` function to calculate  $\rho$ .

### 2.2.2 Histogram

Histogram helps us present distribution of numerical data in a visual and accurate form. It is an estimate of Probability Distribution Function or PDF. PDF is given as is the derivative of CDF:

$$f(x) = \frac{d}{dx} F(X)$$

When  $X$  is a discrete, we use PDF of probability function  $p(k) = P(X = k)$ . This tells us the probability that a values of  $X$  is equal to  $x$ . Just to mention some of the distributions that one can be able to identify using histogram include exponential, linear and Pareto distribution.

In this work, histogram is used to understand distribution of permissions, number of downloads and applications per category. To plot and calculate histogram, python method is used as below:

```
DataFrame.hist(data, column=None, by=None, grid=True, xlabelsize=None, xrot=None, y  
labelsize=None, yrot=None, ax=None, sharex=False, sharey=False, figsize=None, layout  
=None, bins=10, **kws).
```

### **2.2.3 Scatter plot**

Scatter plots are a graphical representation of relationship between two quantitative variables or can be used to test independence of a one variable when plotted with other variable. If the plot is symmetric, it suggests that no relationship can be observed. In this work, scatter plots are used as another form of visual inspection of relationship using Python in the form as *DataFrame.plot.scatter(x, y, s=None, c=None, \*\*kws)*.

### **3. PROBLEM STATEMENT**

As reported in [15], today a typical smartphone user has 80 installed apps in average. Customizing all permission settings for these apps is frustrating and time consuming.

In addition, a typical user is not aware what their apps do. A normal smartphone user, for example, cannot evaluate privacy issues as a consequence of granting INTERNET permission to a specific app.

Finally, a user intuitively relies on community rating before installing an application. Despite community ratings, primary goal is to reflect opinions about functionality or performance [16], many users take it as an indication whether an app is a safe as well.

Thus, our goal is to study what visible app characteristics during installation process can reveal information about its privacy level. Our work complements prior work in the area of identifying relationship of permissions and app popularity. It might be most similar to the study [16], which uses community ratings in app markets to identify indicators that reveal privacy risk level of an application. They show strong correlation between popularity of an application and the number of ratings an application has gained. Our study is different in a sense that we check relationship between the values of apps rating with number of downloads and package size with number of permission. Indicators that we test are most apparent that a typical user experiences during installation process.

## 4. METHODOLOGY

In the following chapter, we describe the methodology in details. This chapter starts with a description of data collection and analysis phase and moves to the methodology used to estimating privacy risk.

### 4.1 Data Collection

The data set used for this work is crawled from the official Android market (Google Play) in March 2017. We created index of total 1110 apps that were visible to users in Kosovo. More specifically, users of Vala Mobile Network Operator who actually used the Monaco country code +377.

We customized a crawler with the help of libraries in [17] in order to automate the process of data collection. The whole process of data collection, preprocessing, storing and analysis in chronological order can be seen in Figure 2.

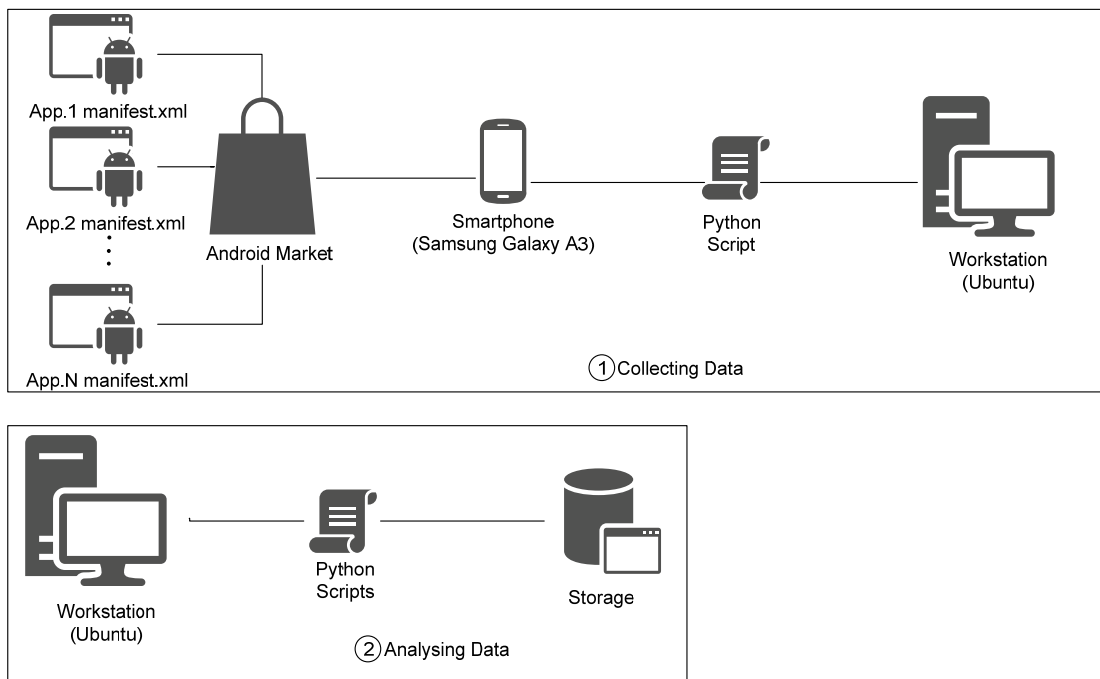


Figure 2. Process of data collection, preprocessing, storing and analysis.

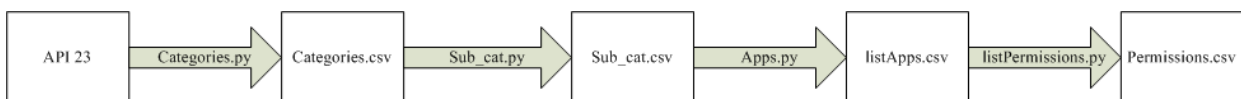
Android version Marshmallow 6.0.1 uses the latest API 23. We accessed and parsed *AndroidManifest.xml* file of each application through customized python scripts. This was done without downloading application files locally. As a result, we obtained the metadata information of the apps and settings from XML files. On table 2, we can find information extracted.

<i>Cat</i>	Defines the category under which application is listed
<i>Subcat</i>	Defines the subcategory (free, paid) in which application is listed
<i>Title</i>	Title given to the app by the developer / creator
<i>Package name</i>	Identifies uniquely the application itself
<i>Version</i>	The current version of application package
<i>Downloads</i>	Number of times application downloaded. This is a rounded number.
<i>Rating</i>	In a scale 1 to 5, users rate an app. It gives the average score
<i>File size</i>	Describes how many MB an application package is
<i>Creator</i>	Name of creator / developer or developing company

**Table 2. Information extracted from *AndroidManifest* file.**

A restriction faced during data collection is Google security mechanism, which does not allow the download of multiple applications at a time from the same IP address and Google account. This made us set a `sleep()` method in our crawler which reduced the performance with regards to the time it takes to get metadata by 30 seconds \* `time_to_get_data_for_each_app`.

The process of collecting the respective information and python files used for each step is given in Figure 3.



**Figure 3. Process of getting the dataset.**



### 4.1.1 Categories

Application on Android market, respectively Google Market, are organized in categories. Therefore, the process of collecting the respective information started initially with getting the main application categories on the market, which in total resulted to be 34 unique categories (Table 3). This information was gathered using python script *categories.py*.

CATEGORIES		
TOOLS	MAPS_AND_NAVIGATION	AUTO_AND_VEHICLES
PRODUCTIVITY	HOUSE_AND_HOME	LIFESTYLE
COMMUNICATION	HEALTH_AND_FITNESS	MEDICAL
ANDROID_WEAR	SPORTS	PHOTOGRAPHY
SOCIAL	PARENTING	ART_AND_DESIGN
TRAVEL_AND_LOCAL	FOOD_AND_DRINK	COMICS
NEWS_AND_MAGAZINES	WEATHER	EVENTS
SHOPPING	ENTERTAINMENT	LIBRARIES_AND_DEMO
FINANCE	PERSONALIZATION	EDUCATION
BUSINESS	BOOKS_AND_REFERENCE	BEAUTY
VIDEO_PLAYERS	MUSIC_AND_AUDIO	DATING
GAME		

**Table 3. The list of Categories on Google Market**

### 4.1.2 Sub-Categories

Next, executing script *sub\_cut.py* we managed to get subcategories of above categories. There is an average of 3 to 4 subcategories for category. A snippet of *category.csv* extracted file is given below.

Category	Subcategory ID	Subcategory
BOOKS_AND_REFERENCE	apps_topselling_free	Top Free
BOOKS_AND_REFERENCE	apps_topgrossing	Top Grossing
BOOKS_AND_REFERENCE	apps_topselling_new_free	Top New Free
BOOKS_AND_REFERENCE	apps_movers_shakers	Trending

**Table 4. Snippet of Subcategories of Category Books and References**

### 4.1.3 Applications

After listing all the subcategories, we went further to collect the applications itself on each of them with the *listApps.py* python script. In addition to name (title) of application, we extracted package name, rating, application size (in MB), number of downloads. Most of this information is used for experiments in this thesis work. One application and its most relative fields are presented below as a sample. For the list of all application and their relevant information, one can refer to our dataset file, *Apps\_Final.csv*.

<i>Cat</i>	ANDROID_WEAR
<i>Subcat</i>	apps_topselling_free
<i>Title</i>	WhatsApp Messenger
<i>Package name</i>	com.whatsapp
<i>Version</i>	451503
<i>Downloads</i>	1000000000+
<i>Rating</i>	4.42
<i>File size</i>	26.1MB
<i>Creator</i>	WhatsApp Inc.

Table 5. Sample of Application Information from *Apps\_Final.csv*

### 4.1.4 Permissions

Finally, script *permissionsList.py* has been used to gather the list of permissions for each application. A snippet of output after executing this script can be seen below. One can see that each line includes the name of application, package name and permission type. This information is stored in a specific file for analysis part.

A snippet from file *Permission.csv* is shown below.

```
Headspace - meditation;com.getsomeheadspace.android; android.permission.ACCESS_COARSE_LOCATION
Headspace - meditation;com.getsomeheadspace.android; android.permission.ACCESS_FINE_LOCATION
Headspace - meditation;com.getsomeheadspace.android; android.permission.ACCESS_NETWORK_STATE
Headspace - meditation;com.getsomeheadspace.android; android.permission.ACCESS_WIFI_STATE
Headspace - meditation;com.getsomeheadspace.android; android.permission.GET_ACCOUNTS
```

### **4.1.5 Basic Statistics**

In order to perform statistical analysis of the data, Python and associated developed packages are used to get the most accurate results. Next we show some basic statistics of our dataset such as total number of applications, total number of categories, number of applications per category and most downloaded apps in the market. This information is very useful to get a better view on our dataset and its' main characteristics.

#### **4.1.5.1 Total number of applications**

We mentioned earlier that out of all available applications in Android Official Market, our sample includes all free Android apps available to Kosovo users considering limitations and restrictions already mentioned and described. After filtering the list, removing missing values and outliers, the number of total applications in our final dataset is comprised of 1110 apps.

The list of all applications in our dataset can be found in Apendix A. One can see that there is a non-negligible of apps that have arabic and chinese characters. These are legitimate apps that are in android market, despite the fact we are not able to find through Google Play search.

#### **4.1.5.2 Total number of categories**

Applications in Google Play android market are divided into different categories. Getting the number of categories means understanding types of applications that we are going to work with. In addition, knowing the application type, based on categories, we also gain a better idea of user behavior. Executing *topNStats.py* script one can get 34 distinct categories ranging from Communications, Games to Lifestyle category applications.

#### 4.1.5.3 Number of applications per category

Similarly, one can find out that one category, in average, has 34 applications assuming a uniform distribution of applications per category.

#### 4.1.5.4 Top N downloaded applications

Human or user behavior is at frontier of our data analysis. Even applications and their use tell us how people act toward them. Top N downloaded apps infers which apps are mostly used and at the same time this information describes which application might be more dangerous and violates user privacy in terms of permissions. On Table 6, it is shown the list of top 20 applications. With initial observations, one can see that top ten applications are downloaded more than 1 billion times while next top 10 applications are half this number, a typical exponential decaying function.

Title	Number of Downloads
WhatsApp Messenger	1000000000
Google+	1000000000
Google Play Newsstand	1000000000
Instagram	1000000000
Facebook	1000000000
Maps - Navigation & Transport	1000000000
Google Play Games	1000000000
Messenger	1000000000
Chrome Browser - Google	1000000000
Hangouts	1000000000
YouTube	1000000000
Google	1000000000
Google Photos	500000000
Twitter	500000000
Skype - free IM & video calls	500000000
Clean Master (Boost&Antivirus)	500000000
Waze - GPS Maps & Traffic	100000000

AliExpress Shopping App	100000000
WPS Office + PDF	100000000
eBay - Buy\ Sell & Save Money	100000000

**Table 6. Top 20 most downloaded Apps in Google Play Store (Android market)**

## 4.2 Estimating Privacy Risk

In this we define privacy estimation in order to address the second objective of this thesis; identification of relationship between apps dangerous level and users' perception. The added value of this work is definition of the condition that estimates dangerousness level. To do so, below are identified and explained three major conditions. These conditions act as a processing filter of our dataset.

***Condition#1: App has more than one dangerous permission.***

***Condition#2: Has set of permissions***

```
list_of_privacy_p = ['android.permission.CAMERA',
                    'android.permission.READ_CONTACTS',
                    'android.permission.ACCESS_FINE_LOCATION',
                    'android.permission.READ_PHONE_STATE']
```

***Condition#3: INTERNET granting permission:***

```
'android.permission.INTERNET'
```

We have fifty apps that satisfy our model based on set conditions, but two of them were ignored because they were antivirus applications and so considered as outliers. As a result we have a sample of forty-eight apps.

#### 4.2.1 Condition#1: App has more than one dangerous permission.

The fact that danger permissions are prompted to the user twice; during installation-time and run-time, it may trigger a user to question the leverage this app has by raising awareness of potential privacy violations.

In contrary to normal permissions, danger ones directly affect the user's privacy. Thus, first condition is *App has more than one dangerous permissions* on our estimation.

As in [4], 66.11% of permission on new versions of app contain of at least one or more Dangerous permission. On the other hand, our dataset has only 14.06% of apps which do not use any dangerous permission. The trend of expansion of dangerous permissions usage is concerning.

#### 4.2.2 Condition#2: Has set of permissions

Second condition includes four-tuple dangerous permissions such as CAMERA; READ\_CONTACTS, ACCESS\_FINE\_LOCATION, READ\_PHONE\_STATE. Despite the fact that the list of dangerous permissions might be longer [2] intuitively the ones above comprise the most delicate information. At the same time these are part of the most frequent permissions asked from malwares as per Zhou and Xiang study [18].

On table below (Table 7) one can see type and amount of personal information these permissions gather from users.

Permission Group	Permissions	Permission Description
CAMERA	CAMERA	Required to be able to access the camera device. This will automatically enforce the manifest element for all camera features. If you do not require all camera features or can properly operate if a camera is not available, then you must modify your manifest as appropriate in order to install on

		<p>devices that do not support all camera features.</p> <p>Protection level: dangerous</p> <p>Constant Value: "android.permission.CAMERA"</p>
CONTACTS	READ_CONTACTS	<p>Allows an application to read the user's contacts data.</p> <p>Protection level: dangerous</p> <p>Constant Value: "android.permission.READ_CONTACTS"</p>
LOCATION	ACCESS_FINE_LOCATION	<p>Allows an app to access precise location. Alternatively, you might want ACCESS_COARSE_LOCATION.</p> <p>Protection level: dangerous</p> <p>Constant Value: "android.permission.ACCESS_FINE_LOCATION"</p>
PHONE	READ_PHONE_STATE	<p>Added in API level 1. It allows read only access to phone state, including the phone number of the device, current cellular network information, the status of any ongoing calls, and a list of any PhoneAccounts registered on the device.</p> <p><i>Note:</i> If both your minSdkVersion and targetSdkVersion values are set to 3 or lower, the system implicitly grants your app this permission. If you don't need this permission, be sure your targetSdkVersion is 4 or higher.</p> <p>Protection level: dangerous</p> <p>Constant Value: "android.permission.READ_PHONE_STATE"</p>

**Table 7 Permissions and their information used by Conditions 2**



### **4.2.3 Condition#3: INTERNET granting permission**

Permissions alone can potentially expose privacy vulnerabilities for users. Yet, they are more dangerous when combined with other, especially communication resource granting permissions. Enck et al. [19] identified a list of vulnerable combinations that can be very risky for the system. Hence, we combined our list from second condition with permission INTERNET. Naturally an app that requests dangerous permissions and has INTERNET access can potentially send information to unauthorized organizations and violate user's privacy.

### 4.3 Final Dataset

After applying three conditions to estimate the privacy risk on our dataset, we obtain the list of apps and their information as below.

ID,PackageName,Title,cat,Creator,SuperDev,VersionCode,SizeMB,Rating,NumDownloads,TotalPermissions,Danger\_P,Privacy\_P,Safety

1,aerobicexercise.danceworkout,Aerobics workout weight loss,HEALTH\_AND\_FITNESS,AppsBundle,0,1.00,5.00,4.17,1000.00,9.00,1.00,1.00,0

2,air.com.KalromSystems.FruitDrawPlay,Fruit Draw: Sculpt Vegetables,ART\_AND\_DESIGN,Kalrom Systems LTD,0,1005006.00,28.90,3.99,100000.00,6.00,3.00,2.00,0

3,air.com.gaetanoconsiglio.EscapePrison,Escape the prison adventure,GAME,Rabbit Bay Games,0,1072000.00,46.50,3.94,1000000.00,6.00,3.00,1.00,0

4,air.com.michbanatDressupgame.alaabmaking,تلبیس و بنات مکیاج عروسات,GAME,LukeMichael,0,1000000.00,13.40,4.07,100000.00,3.00,0.00,1.00,0

5,al.ontv.arlind,Ontv Albania,VIDEO\_PLAYERS,Ontv Albania,0,4.00,16.30,3.87,100000.00,26.00,3.00,1.00,0

6,al.trigonom.alfabeti,Alfabeti Shqip - Abetare,EDUCATION,Trigonom sh.p.k.,0,4.00,42.70,4.34,50000.00,2.00,0.00,1.00,0

## 5. RESULTS

In this section we show the results of experiments conducted based on collected dataset that is described in Chapter 4.1 and Appendix A.

As stated in research question, our experiments focus on finding a correlation between apps and characteristics that are most prevalent to smartphone end user. Specifically, it aims to check for the possible relationship between variables such as apps rating, number of downloads, and the package size on one side, and the number of permissions as another variable defined on the other side.

### 5.1 List of application with most number of permissions

Intuitively, one can expect that applications that use more permission are ones that most violate user's privacy. Thus, we have chosen to focus and analyze these types of applications in more depth. For example, surprising or not, the so called application *Rainbow Camera* has the largest number of permissions while we are all aware that such an app does not necessarily need such a great number of permissions to work properly. In table below, we list applications with the most number of permissions, where Rainbow Camera has twice the number of permissions compared to second and third app.

Title	Number of Permissions
Rainbow Camera	106
Brightest Flashlight-Multi LED	79
Google	77
CM Security AppLock AntiVirus	70
Tap Emoji Keyboard	69
Flash Keyboard - Emojis & More	69
UC Browser - Fast Download	66
Messenger	61

Kindle	54
Facebook	53
GO Security - Antivirus AppLock	51
CM Launcher 3D-Theme Wallpaper	50
WhatsApp Messenger	50
360 Security - Antivirus Free	49
SOMA free video call and chat	48
Virus Cleaner - Antivirus	48
WhatsCall - Free Global Calls	46
Skype - free IM & video calls	45
video chat & free calls icq	45
Mi Live - Live video streaming	45

**Table 8. List of applications with the most number of requested permissions**

## 5.2 Number of permissions per category

In order to understand whether there is a relationship between number of permissions per category and number of applications per category, in this section we manipulated our dataset to extract number of permissions per each category. After that, we counted only the distinct ones. Surprisingly, as can be seen below, the hypothesis is not plausible. Despite some categories having a very large number of applications, they are not ranked among categories that have a very large number of permissions as well. The figure below shows a histogram of number of permissions distributed among categories.

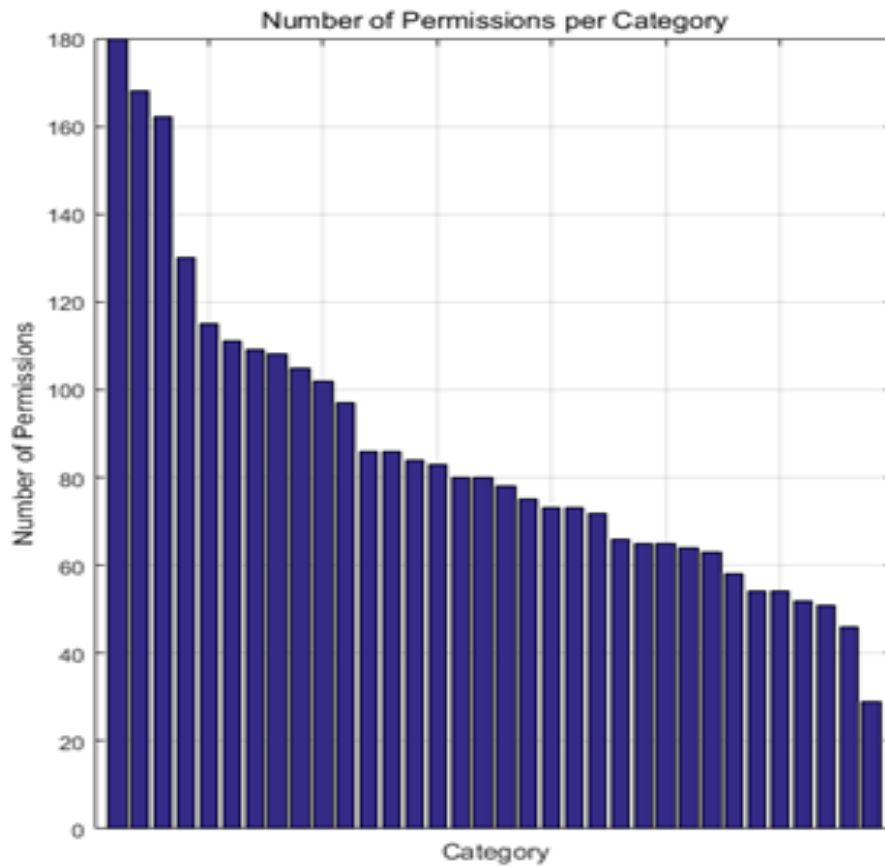


Figure 4. Histogram of permissions distribution among categories.

Category	Number of Applications
ENTERTAINMENT	45
TOOLS	44
VIDEO_PLAYERS	44
PHOTOGRAPHY	41
EDUCATION	39
BEAUTY	38
BOOKS_AND_REFERENCE	37
COMMUNICATION	37
PRODUCTIVITY	37
NEWS_AND_MAGAZINES	35

Category	Number of Permissions
TOOLS	180
PRODUCTIVITY	168
COMMUNICATION	162
ANDROID_WEAR	130
SOCIAL	115
TRAVEL_AND_LOCAL	111
NEWS_AND_MAGAZINES	109
SHOPPING	108
FINANCE	105
BUSINESS	102

PERSONALIZATION	35
COMICS	34
GAME	34
MUSIC_AND_AUDIO	34
SPORTS	33
ART_AND_DESIGN	32
LIBRARIES_AND_DEMO	32
PARENTING	32
SOCIAL	32
TRAVEL_AND_LOCAL	32
WEATHER	32
FOOD_AND_DRINK	31
HOUSE_AND_HOME	30
MEDICAL	30
MAPS_AND_NAVIGATION	29
BUSINESS	28
FINANCE	28
HEALTH_AND_FITNESS	28
LIFESTYLE	28
EVENTS	27
DATING	26
AUTO_AND_VEHICLES	23
SHOPPING	22
ANDROID_WEAR	21

VIDEO_PLAYERS	97
MAPS_AND_NAVIGATION	86
HOUSE_AND_HOME	86
HEALTH_AND_FITNESS	84
SPORTS	83
PARENTING	80
FOOD_AND_DRINK	80
WEATHER	78
ENTERTAINMENT	75
PERSONALIZATION	73
BOOKS_AND_REFERENCE	73
MUSIC_AND_AUDIO	72
AUTO_AND_VEHICLES	66
LIFESTYLE	65
MEDICAL	65
PHOTOGRAPHY	64
ART_AND_DESIGN	63
COMICS	58
EVENTS	54
LIBRARIES_AND_DEMO	54
EDUCATION	52
BEAUTY	51
DATING	46
GAME	29

**Table 9. Side by side the categories sorted by 3a) Number of Applications, and 3b) number of permissions per category**

### 5.3 Cumulative Distribution

In order to view the distribution of permissions from another perspective, CDF is presented below. As can be seen, 95% of permissions in our dataset are observed 200 times or less. While around 5% of permissions are seen more than 200 times. There is a very small number of permissions, 0.1%, that are seen more than 1000 times. This result suggests that there are only a few permissions that almost all apps in android market use in order to provide functionality features to the end-user. CDF reveals some shocking findings as well. Almos 75% of permissions are seen only few times. This suggests that android apps have many distinct permissions, making it even harder for a typical user to recognize an unnecessary permission.

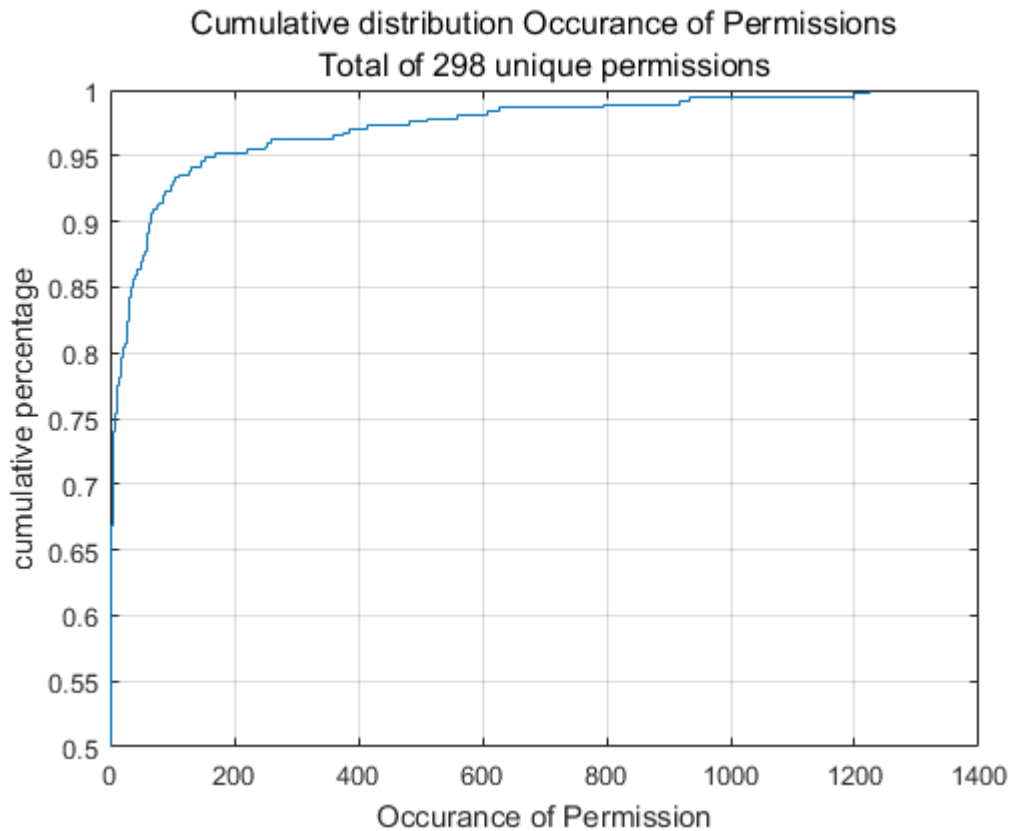


Figure 5. CDF of Android Apps Permissions.

## 5.4 Top 10 Permissions

A breakdown of occurrence of permissions is given below. Top ten most occurred permissions are shown in Figure 6 and their occurrence number together with commulative percentage in Figure 7. Please note that that INTERNET, for example, is appeared 1223 times, which is higher than the number of total applications. This result is because of statistic is applied to initial dataset rather than final dataset. It is considered that ratio is proportional and thus does not affect relevance of this insight information.

```
topTenPermissions =  
  
    'INTERNET'  
    'ACCESS_NETWORK_STATE'  
    'READ_EXTERNAL_STORAGE'  
    'WRITE_EXTERNAL_STORAGE'  
    'WAKE_LOCK'  
    'RECEIVE'  
    'ACCESS_WIFI_STATE'  
    'C2D_MESSAGE'  
    'READ_PHONE_STATE'  
    'VIBRATE'
```

**Figure 6. Top most occurred permissions.**

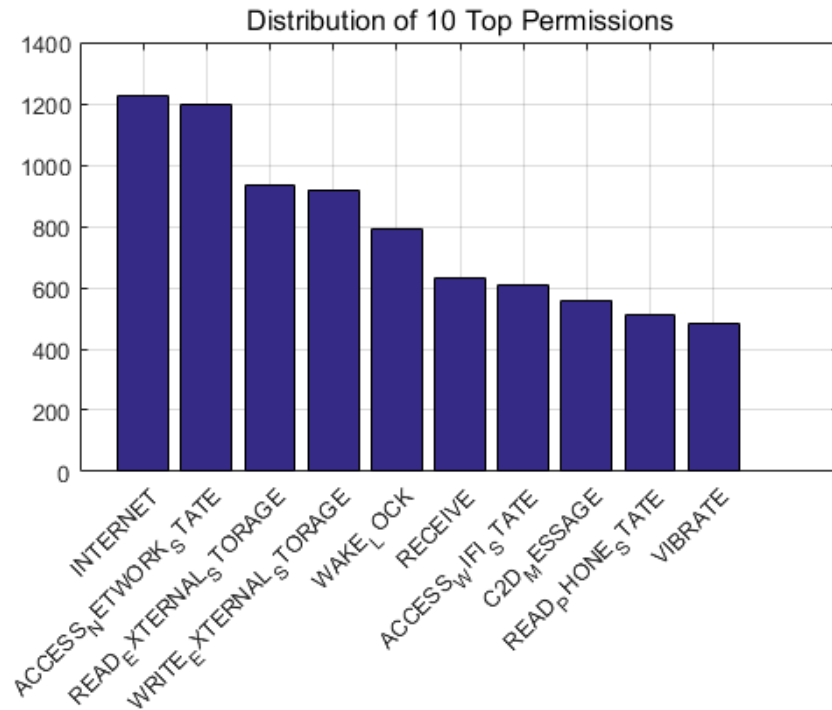


Permissions CumulativePercentOfPermissions	NumOccurrences	PercentOfPermissions	
'INTERNET'	1223	8.2915	8.2915
'ACCESS_NETWORK_STATE'	1197	8.1153	16.407
'READ_EXTERNAL_STORAGE'	934	6.3322	22.739
'WRITE_EXTERNAL_STORAGE'	919	6.2305	28.969
'WAKE_LOCK'	794	5.3831	34.353
'RECEIVE'	629	4.2644	38.617
'ACCESS_WIFI_STATE'	608	4.122	42.739
'SEND_SMS'	560	3.7966	46.536
'READ_PHONE_STATE'	510	3.4576	49.993
'VIBRATE'	482	3.2678	53.261

**Figure 7. Top Permissions, their occurrences and percentage.**

#### 5.4.1 Distribution in visual form

Same experiment is visualized using a *zoomed* histogram of top ten permissions distribution among applications and presented in Figure 8. One can see that READ and WRITE EXTERNAL STORAGE are in top four permissions used by around 90% of apps in collected dataset. These two permissions, are categorized by Android as *Dangerous* permissions and are proposed to be used only when necessary for apps functionality.



**Figure 8. Histogram of Top Ten permissions.**

### 5.5 Correlation between Rating and Number of Downloads

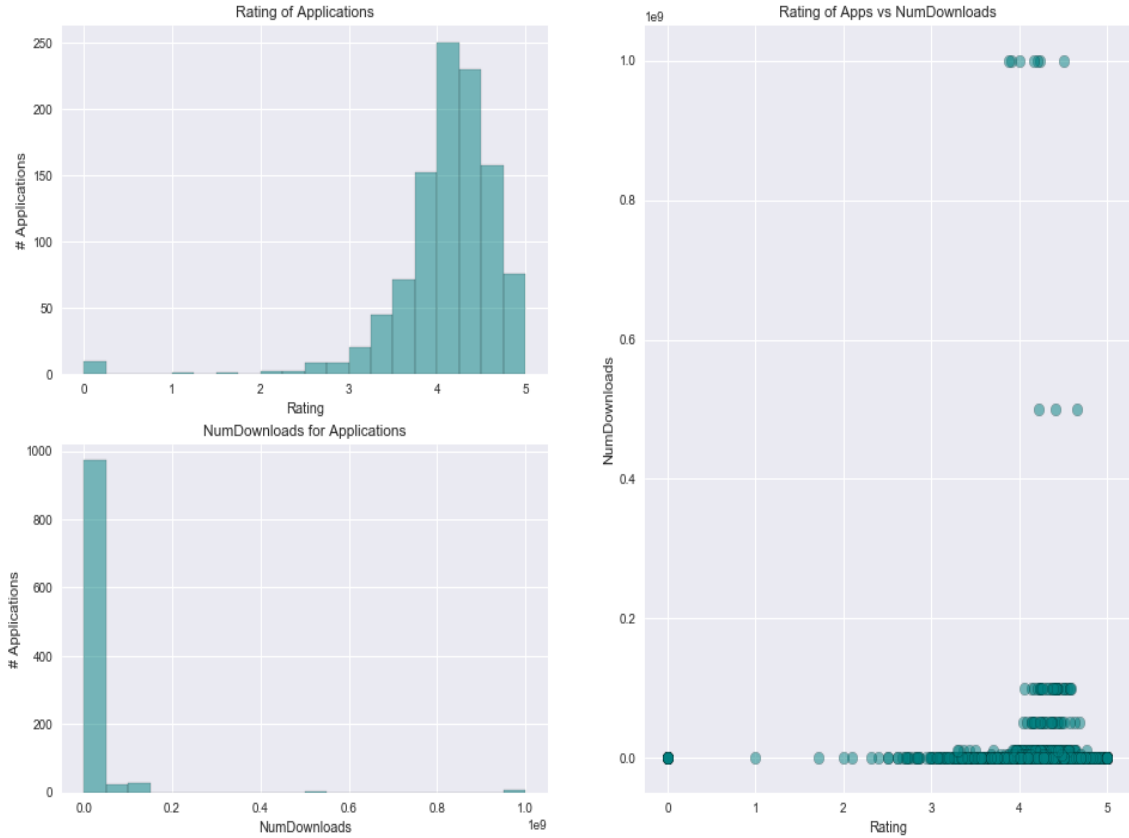
Unlike [16], our experiments aim to show the relationship of apps rating and number of apps installations (downloads). Rating directly expresses the feedback of users regarding apps, sharing their personal experience about apps functionality or user interface. Therefore, they can help the developers to improve their apps and at the same time refer or not the app to new users. Thus, rating is supposed to be important in terms of users, and at the same time is a parameter that impacts the number of downloads. Hence, we suggest that apps with better rating should have larger number of downloads.

In Figure 9, the experiment involves the whole apps of our dataset. From Figure 9.a, one can see that the rating of apps is distributed around score 4 (3.68 – 4.7). Histogram reveals normal distribution of ratings values among applications. As can be noted, most of the applications have a high rating value. On the other hand, Figure 9.b, results show that most

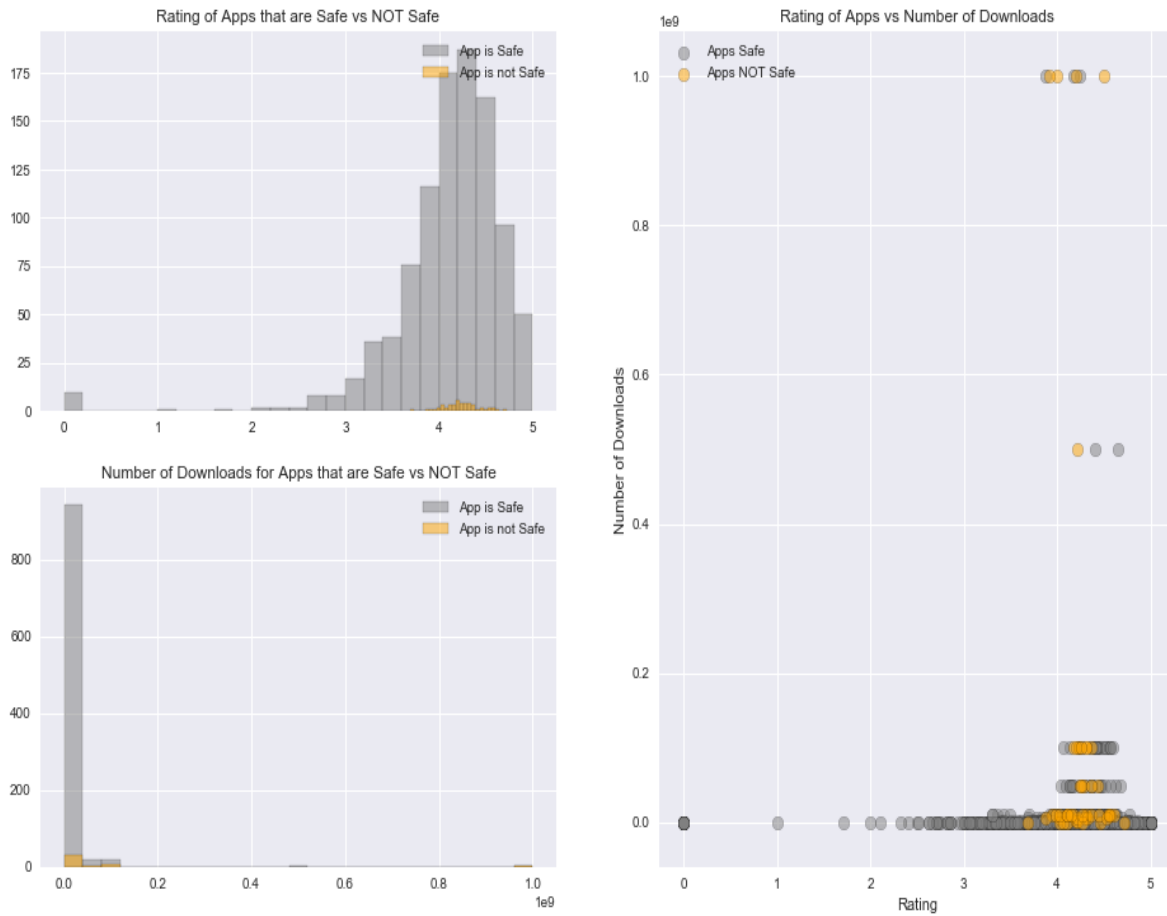
of the apps are downloaded less than 100 thousand times. Histogram in this part shows a typical decaying exponential distribution.

Now, after applying our conditions, in Figure 10 one can see same variables and experiment conducted parallel for both safe and unsafe apps. Same as in Figure 9, even apps that are potential dangerous have high rating values and downloaded around 100 thousand times.

With regards to correlation, a scatter plot in Figure 9.c suggests that rating score and number of downloads have a weak positive correlation value. Yet, our results suggest that high value rated apps are potentially more dangerous than low value rated apps.



**Figure 9. Relationship of Rating and Number of Downloads a) Histogram Rating vs Number of Applications (top left), b) Histogram Number of Downloads vs Number of Applications (down left) and c) Scatter plot Rating vs Number of Downloads (right).**



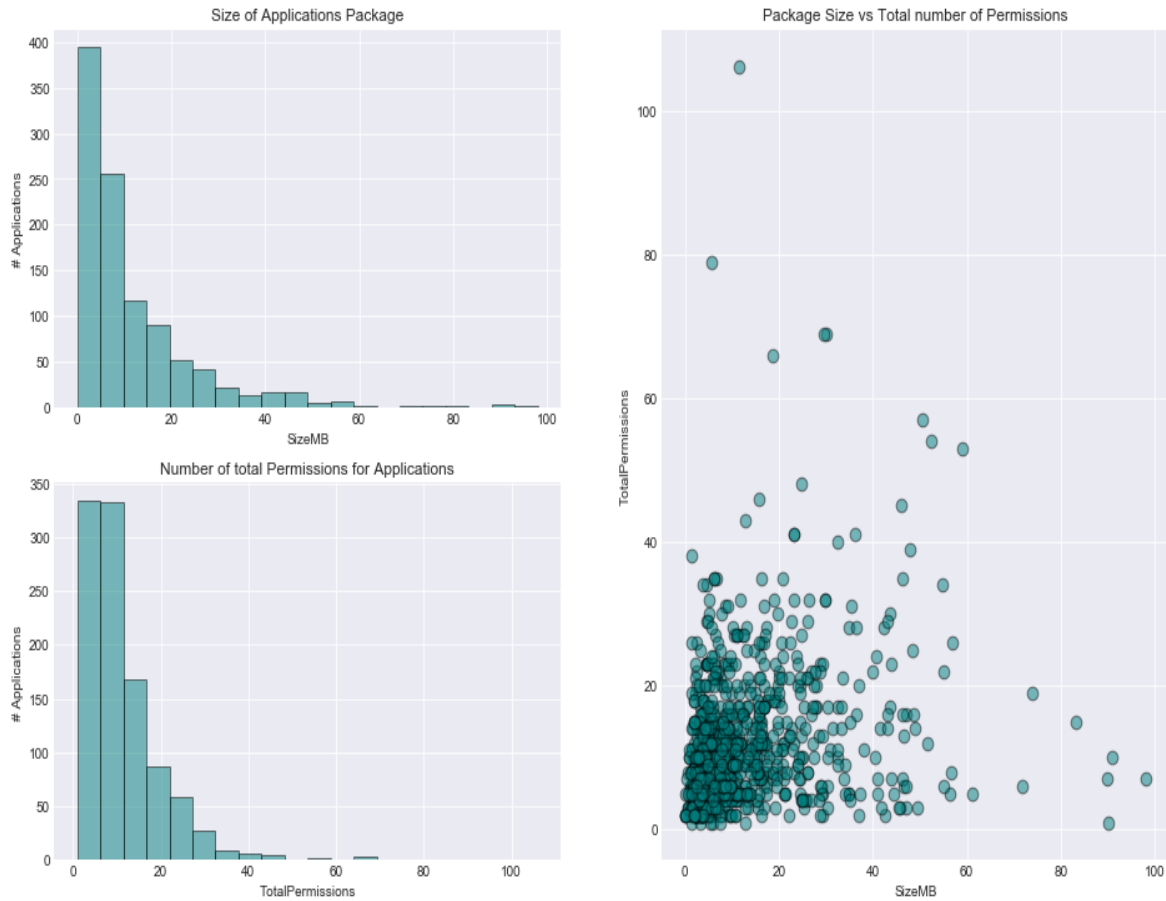
**Figure 10. Relationship between Rating and Number of Downloads on Safe/Unsafe apps a) Histogram Rating vs Number of Applications (top left), b) Histogram Number of Downloads vs Number of Applications (down left) and c) Scatter plot Rating vs Number of Downloads (right).**

Based on this experiment, it is concluded that there is no strong pattern on detecting dangerous apps based on features like rating and number of downloads despite a weak positive correlation.

### 5.6 Correlation between Package Size and Number of Permissions

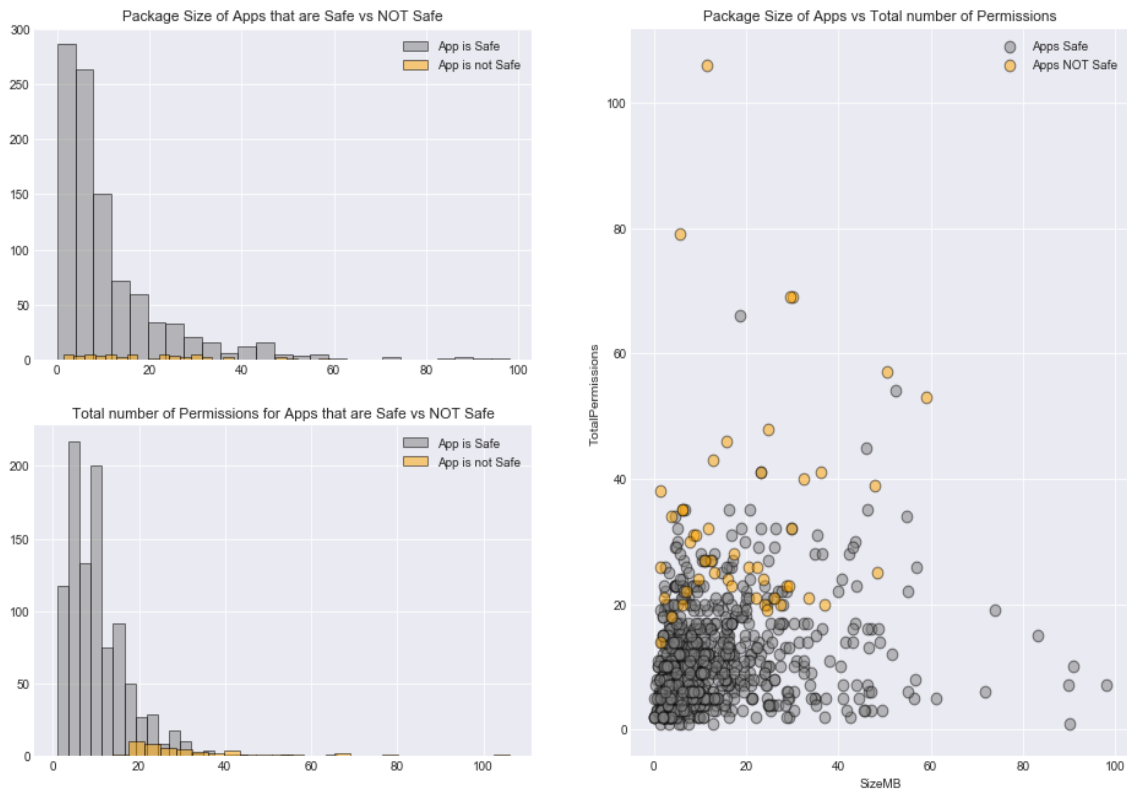
In addition to variables such as rating value and number of downloads, package size is another very obvious parameter to the user during app installation process. Thus, we try to

reveal possible patterns on relationship between size of apps' package in MB and the number of permissions an app requests.



**Figure 11. Relationship between Package Size and Number of permissions a) Histogram Package Size vs Number of Apps (top left), b) Histogram Total Permissions vs Number of Apps (down left) and c) Scatter Plot Package Size vs Number of permissions (right).**

Similar to the first experiment, it can be observed that same techniques of histogram and scatter plot are applied to dataset with variables of Packet Size and Number of Permissions in case of the whole dataset for Figure 11 and only for the dataset after conditions applied in Figure 12.



**Figure 12. Relationship between Package Size and Number of permissions on Safe/Unsafe apps a) Histogram Package Size vs Number of Apps (top left), b) Histogram Total Permissions vs Number of Apps (down left) and c) Scatter Plot Package Size vs Number of permissions (right).**

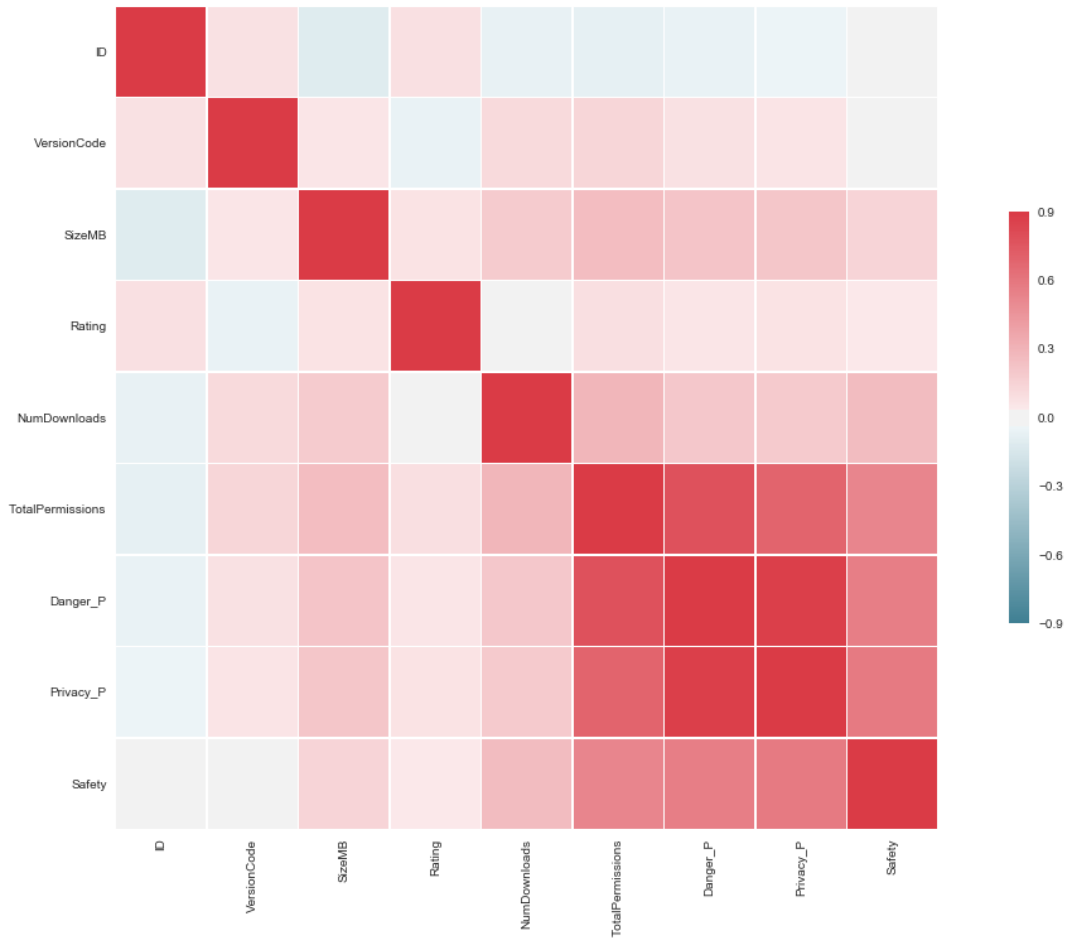
The observations on this experiment show that most of apps have less than 10 MB size, while they contain 10 permissions in average.

In addition we suggest that package size is not a significant predictors on app's number of permissions, and consequently, not significant on safety.

### 5.7 Correlation Heatmap

Using the so called *Heatmap* statistical technique to test initial correlation between all variables in a dataset, it is concluded that there is no need to further investigate relationship between other variables.

As visualized in Figure 13, Pearson correlation coefficient ( $\rho$ ), has values around zero for most of the targeted variables in our dataset. This can be confirmed in Figure 14 that shows the output of Python function `dataset.corr(method='pearson', min_periods=1)` for the dataset before and after *safe/not safe* conditions applied.



**Figure 13. Heatmap for all variables in dataset, including *Safety* categorical variable.**

	ID	VersionCode	SizeMB	Rating	NumDownloads
ID	1.000000	0.079434	-0.108607	0.085469	-0.070210
VersionCode	0.079434	1.000000	0.061930	-0.058302	0.115641
SizeMB	-0.108607	0.061930	1.000000	0.074418	0.189245
Rating	0.085469	-0.058302	0.074418	1.000000	0.032710
NumDownloads	-0.070210	0.115641	0.189245	0.032710	1.000000
TotalPermissions	-0.076901	0.133931	0.259177	0.094516	0.294698
Danger_P	-0.061671	0.078741	0.224777	0.059086	0.210215
Privacy_P	-0.048330	0.067452	0.213531	0.074435	0.191496
Safety	-0.035130	0.007053	0.143419	0.047981	0.262314
	TotalPermissions	Danger_P	Privacy_P	Safety	
ID	-0.076901	-0.061671	-0.048330	-0.035130	
VersionCode	0.133931	0.078741	0.067452	0.007053	
SizeMB	0.259177	0.224777	0.213531	0.143419	
Rating	0.094516	0.059086	0.074435	0.047981	
NumDownloads	0.294698	0.210215	0.191496	0.262314	
TotalPermissions	1.000000	0.780702	0.695687	0.527520	
Danger_P	0.780702	1.000000	0.875838	0.568527	
Privacy_P	0.695687	0.875838	1.000000	0.587891	
Safety	0.527520	0.568527	0.587891	1.000000	

Figure 14. Pearson Coefficient for all variables in dataset, including Safety categorical variable.



## 6. CONCLUSION

In this thesis work, the relationship between the most prevalent apps features to the end-user and their underlying permission structure is investigated. These features include Popularity, Total Number of Permissions, Number of Dangerous Permissions, Rating and Package Size. In order to answer defined research question: *Can a typical user detect dangerous applications based on its popularity?* a complete and structured dataset of applications and their information relating to permissions is extracted from Google Play Android Market.

Firstly, this dataset consists of a 1110 apps, 34 distinct categories, 5 numerical variables and 1 categorical variable after outliers and NA values are removed.

Secondly, results show that there are very few permissions that almost all apps in Android Market use in order to provide functionality features to the end-user. CDF reveals some shocking findings as well, indicating around 75% of permissions to be used only few times. This makes harder for a typical user to recognize an unnecessary permission.

Thirdly, the list of top ten permissions is populated mostly by dangerous permissions such as READ\_EXTERNAL\_STORAGE, WRITE\_EXTERNAL\_STORAGE and INTERNET. Thus, making 95% of apps vulnerable for user privacy exploitation and violation by third-party advertising providers or any type of privacy intruding.

Based on histogram, scatter plot and Pearson R correlation statistical analysis, it is concluded that there is no strong pattern on detecting dangerous apps based on features like rating, number of downloads and package size despite a weak positive correlation between targeted variables and permissions.

Finally, popularity used in Android Market applications is not a reliable indicator of privacy risks. Therefore, user cannot rely on features like number of downloads and rating score to decide if an app violates the least privileged principal.

## 7. APPENDIX A

Below we give the list of applications collected and used for our permission-based privacy analysis of Android applications.

<b>Title</b>
WhatsApp Messenger
Skype - free IM & video calls
Google Translate
Shazam - Discover music
Microsoft Outlook
video chat & free calls icq
Google
Caller ID & Block by CallApp
Hangouts
Maps - Navigation & Transport
Mail.Ru - Email App
Mouse on Screen Scary Joke
Microsoft OneDrive
Newton Mail - Email & Calendar
Snake On Screen Hissing Joke
Snail in Phone best joke
Frog walking on screen joke
Virtual Tea
Lee Sin HD Live Wallpapers
Ekko HD Live Wallpapers
Lux HD Live Wallpapers
Jhin HD Live Wallpapers
Riven HD Live Wallpapers
Wukong HD Live Wallpapers
Jayce HD Live Wallpapers
Floral Watch Face
Annie HD Live Wallpapers
Udyr HD Live Wallpapers
Stylish Name Maker
Cartoon Photo Editor
Urdu On Picture
Name on Pics
FlipaClip - Cartoon animation

PictureWarp
Fingertip Art
Cool Wallpapers HD Kappboom®
Mehndi Design Latest 2017
Logo Maker Free
focus.n.filter
ArtBoard Creative Drawing
How To Draw Super Heroes
Neon 3D Next Launcher Theme
My Name Pics
Pixly - Pixel Art Editor
PoseBook 3D by Silver
Fruit Draw: Sculpt Vegetables
focus.n.filters
focus n filters - Name Art
Insta Focus n Filters
Focus N Filters Official
Herobrine Skins for Minecraft
Pixelmon Skins fr Minecraft PE
Angel Skins for Minecraft PE
Dreamy Diamond Wallpaper
TextO - Write on Photos
Signature Maker
Focus N Filters
Focus N Filter
AutoScout24 - used car finder
mobile.de – vehicle market
Штрафы ГИБДД официальные (ПДД)
Билеты+ПДД 2017 Экзамен 2016
maxim: order a taxi
Cars India - Buy new
CarWale- Search New
첫차
Wi-Fi в метро
iCarros – Comprar Carros
Авто Эксперт - vin проверка
Билеты ПДД 2017 РФ
Штрафы ГИБДД проверка и оплата
Check Engine -На русском языке

Fuelio: Fuel log & costs
MOT History
Where is my OBD2 port? Find it
Антирадар
Радар камер и ДПС
Team Doblo
Fast Car Theme C Launcher
Modifiye Şahin Sesleri
OPL DTC Reader
WCarPs
DashMaker OBD Scanner
RTO Vehicle Info
Beautiful Girls Pictures
Beauty Camera - Selfie Camera
Nails.Makeup.Hairstyle
Pink Rose Love Theme
Eyes makeup 2016 ( New)
गोरा होने के अायुर्वेदिक उपाय
Pink Rose Diamond Theme
Hwahae - analyzing cosmetics
Cute Kittens Keyboard - Kitty
बाल बढ़ाने के 119 घरेलू उपाय
Gold Rose theme business gold
Gold Snow Ball Theme
글로우픽 - 대한민국 1등 화장품 리뷰/랭킹 앱
Cute bear theme love wedding
Simple hairstyles.
गोरा कैसे बने
Cute Girl Selfie Photo Editor
MakeUp Videos
2016 Mehndi Designs
Pink Piano Theme Pink Tiles
Girly m Pictures 2017
Girly m new pictures
Girly wallpapers 2017
Natura - Loja Online
Braid Hairstyle Woman & Child
Makeup Tutorial
Makeup Beauty Camera

Sweet Selfie HD
Gold Christmas 2016 Theme
رقية تيسير الزواج - بدون نت
Face.Makeup.Hairstyle
Makeup Step By Step
गोरा होने के तरीके
Beauty Tips
تسر یحات میكب فساتین
تعلمی مکیاج العیون 2017 بالصور
beauty tips urdu
Lovely Girly pictures
Trucs et Astuces Beauté
Takvimi - Shqip
GUIDE PES 17
Scribd - Reading Subscription
Vodafone Books
GUIDE FIFA 17
Free Books & Stories - Wattpad
Setting Viber for tablets
Tips Dream League Soccer
Guide for Snapchat
Kur'ani Shqip
tips for azar
Transformers AR Guide
Guides Sonic Dash 2
Lutjet e Sherimit
Guide for LEGO Juniors Create
German Albanian dictionary
FHx-Server COC Pro Ultimate
GUIDE Rolling Sky
Kindle
Libra Shqip
이지브라우저
파란브라우저
Lucky Guide
Free VIDMATE Download Guide
Super King Root Media Apps
Modi Note Magic
New Mobizen Screen Record Tips

Modi Note   Modi Key Note
New Xender File Transfer Tips
Modi Ki Note
Tricks Real Steel WRB
Skins for Minecraft PE - FNAF
Guide for LEGO Star Wars
Latest FHX COC TH 11 ALLSERVER
Modi KeyNote Guide
Guide For UC Browser
New 500/2000 Note Guideline
Guide for Mobdro TV free app
New Real STEEL WRB Guide
WPS Office + PDF
Indeed Job Search
알바천국- 알바 구인구직 포털서비스
e-Devlet Kapısı
Facebook Pages Manager
LYFcare
LinkedIn Job Search
알바몬앱 - 알바 채용 구인구직 취업정보검색
Year in Review 2016
Skype for Business for Android
Idea eCaf
Paytm Seller
LinkedIn SlideShare
Basic docx Reader
Call Blocker
TurboScan: PDF scanner
Holy Quran MP3 Audio
Golden Butterfly Flowers
GEOSENZ
Modi keynote live
Luxury Business Watch
캐시넷 2 - 카카오톡하면서 돈 벌기
Black technology sports car
My i9
الدولار لحظه بلحظه
Modi KeyScheme   Modi KeyNote
Zalo Ads

Golden Diamond Business
LINE WEBTOON - Free Comics
네이버 웹툰 - Naver Webtoon
The Avengers-Iron Man Mark VII
Narrator's voice
GIFs for Whatsapp
Drawing Tutorials: Anime
Fashion Graffiti Street Art
White Christmas
Anti theft Alarm Prank Free
Pink Love Bear Theme
pixivコミック - 無料漫画が毎日更新
다음 웹툰 - Daum Webtoon
The Zueira's Voice
Blue Bubbles Bells
How to Draw Manga
マンガZERO-500作品以上の人気漫画が毎日無料で読み放題
Golden Flower Sapphire
Love You Love Me
짱웃긴만화23
Golden Peacock Queen
HipHop Boy Graffiti
Best Castle Theme C Launcher
CKN Toys
Pet Cute Girl Love
Love Stars Dream
FunToyzCollector
Sweet girl emoji keyboard
KidsToysToSee
KidsSurpriseFun
Colorful Skull Graffiti
Anime Alone Guy Wallpapers
Ice Wolf Theme C Launcher
Comic Browser - Cartoon&Anime
Pink Rabbit Bow
Messenger
Viber Messages & Calls Guide
imo free video calls and chat

Telegram
Chrome Browser - Google
Opera Mini - fast web browser
UC Browser - Fast Download
Hello - Talk to Strangers
Get Followers for Insta+ Prank
imo beta free calls and text
Yandex Browser for Android
WhatsCall - Free Global Calls
Guide For Viber Messages Calls
Firefox Browser fast & private
Messenger Super Lite
Psiphon
SOMA free video call and chat
True-Caller show name
Video Call For Whatsapp
Jokes for Whatsapp
Dual BBM Delta Terbaru
بنات شات مطلقات للكبار فقط joke
Light Room Kika Keyboard
Messenger Lite Extreme
Guide for Whatsapp on Tablet
Free imo video calls chat Rec
다이어트올킬 - 오늘의 PT / 강도선택 가능
Whatsapp Gold Messenger
فتيات فيديو شات لكبار فقط Joke
WhatWeb For Whatsapp
Color Flashlight Alert
Inbox for Gmail - Android App
Walkie Talkie Radar
Call Recorder
YoCutie ♥ 100% Free Dating App
Lesbian video chat and dating
Video chat for singles
WoW video chat
Face to face video chat
India girls dating guide
stranger chat - anonymous chat
MeetP: Dating Apps for Singles



Dating Site (Free)
मस्त भाभीजी को पटाये
Пообщаемся Новая Версия
تعارف بنات بمدینتک للحب prank
free girls chat
Chat & Dating Apps - Cupid
Latin Chat Rooms
Pink Roses Theme C Launcher
Teen Chat Rooms
Free Mobdro Reference
Mature Dating
wowchat amigos en un mundo 2.0
rateME - Rate and Match People
Pretty Pink Rose Theme
Illuminate Emoji iKeyboard
Spain Chat Rooms
Пообщаемся Знакомства Общение
Cartoon Couple Theme CLauncher
Best Heart Theme C Launcher
Meso Anglisht Offline
Kids educational puzzle -Tools
Namazi - Shqip
Milioneri Shqip 2
점핑폴리
Alfabeti Shqip - Abetare
Testi i autoshkolles AutoStop
Fjalor Anglisht Shqip
Shkruaj Shkronjat e Alfabetit
AutoShkolla Online
Car & Vehicles Puzzle for Kids
Mëso Gjermanisht - Die Artikel
Learn Animals - Puzzle Game
Fjalor Shqip Gjermanisht
Tayo's Driving Game
Duolingo: Learn Languages Free
Fjalor Shqip Anglisht
Autoshkolla
Namazi PRO - Shqip
MEB E-OKUL VBS

1600
EBA Okul
How to Draw DBZ
How to Draw FNAF
سكس خليجي تعليم
뽀로로 미로찾기 과학놀이 (Lite)
GeoGebra 3D Grapher
المتجر العراقي iq prank store
How to Draw Trolls
Modi Keynote Original App
Power Of Sakash
دورة اللغة التركية من زدني
Awabe Translate Languages
Learn To Draw SLP
Draw for Equestrian Girl
مسلسلات تركية 2016
Islamic Calendar 2017
Testleri Çöz
How to Draw Transformers
Google Play Games
Tom Loves Angela
Superhero & Princess for Kids
Transparent Screen
Key Cheat for GTA Vice City
Qifteli - Instrument Shqipetar
Play Tube
Tom's Love Letters
I Love Filter
Shkabaj
Learn to Draw Paww Patrol
Milk The Cow
Xray Scanner Prank
Power camera
subways surfing guide
Real Saz
Shfleto - Filma me titra shqip
Free iTube Music Player Guide
Replacement Remote Controls
Albanian TV

Netflix
Modi Keynote
Modi Ki Notes
Modi KeyNote (original)
Learn To Draw Pokemonster
New Currency Scanner Prank
Maps of Clash of Clans 2016
Fake Money Scanner Prank
gems clash of clans prank
Fugitif NRJ
Modi KeyNote Official
Cracked Screen Prank
Call From Santa
ColorsTV
Free Follow 3000+
Real Follower plenty Likes
Guns sound
A Call From Santa!
Call From Santa Prank
Обман зрения
Cars Coloring Book For mcqueen
Tip WiFi Map Free Passwords
Cheat Key for GTA 4
Unlimited Subway Coins Prank
Furniture Mod For MCPE
Sing Karaoke
Cheat Mod for GTA Vice City
Color Torch
Anime Skins for Minecraft PE
Muezzin New
Pink Persian white Cat theme
Party Light - Free
Candle Birthday
Days Left (countdown timer)
Petrotech 2016
Peatix
KudaGo: things to do in London
App Advent Calendar 2016
Name days
Events High - Meet Your City!

اغانى دىكە ھجولە
Strobe Light
Ticketpop
Sortir Toot Sweet !
Super Talent Cochín
Decision Defender
Secret santa generator at time
Aksi Bela ISLAM 411 & 212
오천만 촛불-하야/촛불집회/지도
Best Rose Theme C Launcher
Coloring Zoo Topia
Tips Gangstar Vegas 4 Pro
Risteilyohjelma 16
Mingalabar! Festival
PhonePe - India's Payment App
Walnut Money Manager
All Bank Balance Enquiry
State Bank Anywhere
Сбербанк Онлайн
State Bank Freedom
UPI PAY
SBI Quick
Banco do Brasil
Axis Pay UPI App
iMobile by ICICI Bank
Santander Brasil
HDFC Bank MobileBanking
Axis Mobile
CAIXA
Ziraat Mobil
Bradesco
Allahabad Bank UPI
OBC-mPAY
ATM Cash Finder
올원페이 (앱카드)
Cartões CAIXA
KBL Mobile
MMM Nigeria
Menor Preço Nota Paraná

Stanbic IBTC Mobile
ATM Cash No Cash Money Finder
Net Banking for All Bank
بكام في البنك؟
Ultimate Cyclcr
Garanti Emeklilik Mobile
SyndicateBank *99#
UberEATS: Faster Delivery
iFood - Delivery de Comida
Zomato - Restaurant Finder
Swiggy Food Order & Delivery
foodpanda - Food Delivery
Talabat: Food Delivery
Tasty
Foursquare City Guide
FAASOS - Order Food Online
マクドナルド - McDonald's Japan
myTaste Recipes
愛料理
Chefkoch - Rezepte & Kochen
KptnCook - daily new recipes!
Твои Рецепты
Bien Tasty
АкцизКонтроль: Сканер Алкоголя
Adventskalender 2016 - Rezepte
Receitas de Suco Detox
McDelivery Sri Lanka
Kentucky Coupons Germany
Kerala Malayalam Recipes
Guide for UberEATS Food Fast
Mojo Pizza - Delivery
Biryani Recipe Telugu బిర్యానీ
Roy's Rewards
Payasam Recipes in Tamil
Best Fish Guide
Side dishes
Chickers
Bread Recipes in Tamil
Real Drift Racing AMG C63
Don't Grind

Boy - Subway Surf Run Version
Piano Tiles 2s
Piano White Master
Exploration Lite
Escape the prison adventure
Fruit Slice
Drift Horizon Online
Glow Hockey
coloriage de la reine
Coach Bus Simulator Parking
Shoot Hunter-Gun Killer
Crazy aa2
Drive Tractor Simulator
Car Service Station Parking
Crazy Dog Racing
Run Subway Surf
Taxi Game
Russian Trucks Offroad 3D
bhop pro
Racing in Car
Racing Monster Truck
Sofia The First Dress Up Game
American Army Bridge Builder
Игровые автоматы Удача онлайн
Real Shooting Army Training
San Pedro Army Crime Vendetta
City Construction Trucks Sim
Fruity Lipstick Maker Salon
X5 Driving Simulator
مکياج بنات و تلبیس عروسات
Bat Superhero Fly Simulator
Angry Lion City Attack 3D
Period Tracker
Fitbit
Clue - Period Tracker
Pedometer
Google Fit - Fitness Tracking
Flo Period & Ovulation Tracker
30 Day Fit Challenge Workout
Moves

Fitness & Bodybuilding
Twilight
Calorie Counter by FatSecret
Headspace - meditation
Fitbounds Push-Ups
My Ovulation & Period Tracker
F&S Stockholm
Belly Fat Exercise (Videos)
Yoga Videos : Baba Ramdev
Lily - Lịch kinh nguyệt phụ nữ
15 Days Belly Fat Workout App
Fitbounds Sit-Ups
TS20
लंबाई और वजन कैसे बढ़ाये
How To Lose Weight
Wonder Weeks
Aerobics workout weight loss
Fitbounds Squats
Hebbars kitchen
Farmax
Zigbang
Trulia Real Estate & Rentals
Houzz Interior Design Ideas
Realtor.com Real Estate
Trulia Rent Apartments & Homes
DaBang - Rental Homes in Korea
House Maps for Minecraft PE
Domofond.ru Недвижимость
ЦИАН. Снять
Saral Vaastu
idealista
Apartment & Rental Home Search
Zameen: No.1 Property Portal
Telephoto
Flower Assistant
My cook book
Хату.бы - снять квартиру
Школа ремонта
Social Housing
Ремонт. Идеи ремонта

Wooden House
Квартирный Вопрос
Book Your Chotu
House for Rent
다방페이-월세 카드 자동결제
Rashi Phalalu
Small Simple House Exterior
Modern Home Design
Pallets Ideas
Curtains Design Modern
House Ventilation Fans
creative house hold ideas
MX Player Codec (ARMv6 VFP)
MX Player Codec (ARMv7 NEON)
MX Player Codec (ARMv7)
Auto Clean
MX Player Codec (Tegra3)
Refrainplay Black SpiderMan
LIVE MAPS Guide
MX Player Codec (ARMv6)
MX Player Codec (ARMv5)
GPS LIVE MAP Guide
Best VMate Downloader guide
Vide Made 2
Usb OTG Reader
Path 1.0 Pes 2016
TP-Link Tether
Dual Accounts for Whatsapp
Top Voice Changer Ever
Wifi Connector Library
TeslaUnread for Nova Launcher
Plugin Notifications
Quran MP3 Android-Muslim
Adventure Point Blank
Refrainplay for Point Blank
กลยุทธ์ Pokesaga-รับถงรางวัล
Guide Xender FREE
Free Iphone™ 7 Ringtones Remix
New Guide For TV Mobdro



Message Ringtone for Whatsapp™
Actionplay For Deadpool
Winner Formation Ball PS3
القرآن كامل MP3 مجاناً بالتفسير
ذهب وجواهر أون لاين BROMA
Various Free Kick Soccer Goal
استرجاع الملفات المحذوفة Prank
Power Battery and Energy Saver
Actionplay FIFA 17 The Journey
تهكير كلاش اوف كلانس + Prank
Cool Black Theme-Anti Snooper
Trusted Contacts
Recharge
L.POINT - 엘포인트
Pink Theme Eiffel Tower Love
Modi KeyNote Original
Theme Rose Gold Diamond
AADHAAR Card
컬처랜드[문화상품권]
Gesture Lock Screen
Diary with lock
Video Downloader For Instagram
صلاتك (Prayer) Salatuk (time)
Rainy Water Drops
Yellow - Make new friends
X-VIDEO
Polygon Lion Kika Keyboard
كلمات تهز الأحاسيس
قنوات مغربية بدون انترنت MA
Urdu on Picture - Urdu Poetry
Hot Skins for Minecraft PE
MobiKwik Lite-Accept payments
Find ATM With Cash near to you
백점 - 토정비결
Soonsoon Candlelight
Teen Love Story Game For Girls
Baroda Rewardz
Cotton Candy Kika Keyboard
국민촛불

Theme for HTC One A9
Neon Smoke Skull Keyboard
Uber
Waze - GPS
Uber Driver
Grab
Ola cabs - Book taxi in India
Maps
Careem - Car Booking App
Yandex.Taxi
Lyft - Taxi App Alternative
Gett - Fixed fare black cabs
Easy - taxi
Grab Driver
Cabify - Your private driver
Yandex.Transport
Moovit: #1 Transport App
DB Navigator
DigiHUD Speedometer
Kakao Driver
GPS Route and Address Tracker
GPS PHONE TRACKER PRO
DVB mobil
ATM Cash Finder in India
Bluclub
تعليم السياقة بدون نت 2017
GPS Fields Area Measure
Mutti
Guide Uber Driver Incomes Tips
Free Uber Taxi Advice & Promo
Trieste Trasporti
Free Uber Driver Ratings Tips
DVG Route Planner
Free Uber Taxi Ride Tips
Period Calendar
MHRS Mobil
Blood Group Detector Prank
Your.MD
Ovia Pregnancy & Baby Tracker
BPJS Kesehatan Mobile

Pregnancy Week By Week
My Ovulation Calculator
Amil Clientes
Ovia Ovulation & Fertility
Figure 1 - Medical Cases
Netmeds - India Ki Pharmacy
Pregnancy Test Scanner Prank
Img-Save on Medicine/LabTests
طبيب العراق
MySwaasth: Complete Healthcare
صيدلية الأعشاب الشاملة
Termos Técnicos de Enfermagem
Medicover New
الطب العام - نصائح من ذهب
봄빛병원
Ultrasound Scanner (Prank)
UBC Radiology
Finger Blood Pressure Checker
medicinal plants & herbs
موسوعة الطب النبوي - بدون نت
ACNP 2016
Фармакология.Краткий курс lite
Safe Period Calculator
علاج البواسير طبيعيا 2017
Palliative Care Symptom Guide
Homeopathic treatment Hindi
SoundCloud - Music & Audio
Music Player
Muzik Shqip (Shkarko.me)
Piano - Keyboard & Magic Keys
iTube Player
My Piano
Mp3 Player - MH Player
Music Player-GO Music Player
Piano
iTube MP3 Music Player Free
My Music Player
MP3 Video Converter
Default Music Player

iMusic Player: Unlimited Music
Muzik Shqip
Музыка ВКонтакте
Музыка и Видео ВКонтакте
Volume Booster Pro
MUSIC PLAYER CLASSIC
Музыка с ВКонтакте
Ares Red Musica Gratis Player
Volume Booster Black Edition
Electro Drum Pad Extended
Music Equalizer & Bass Booster
Carinha De Anjo Musica + Letra
ВМобилке (Музыка с ВКонтакте)
RadioBox - Free Radio & Music
القران الكريم صوت وصورة دون نت
Музыка из ВКонтакте
Launchpad Dubstep Extended
IDJApps
Music Player Lyrics Equalizer
Energizer Music
UC News - Trending News
Twitter
Dailyhunt (Newshunt) News
Central das Notícias
Narendra Modi
AajTak
India News - Breaking News
ABP LIVE News
Puthiya Thalaimurai TV
Reddit: The Official App
AajTak Lite - Hindi News Apps
GÜNDEM: Son Dakika Haberler
The Times of India News
Google Play Newsstand
Baca - Berita
Polimer News
Way2 ( Way2SMS Free SMS )
BÁO MỚI - Đọc Báo
بث مباشر من يلاشوت
SmartNews

HTTP Injector Config FreeNet
Modi Demonetisation NewsUpdate
نتیجہ الاسکان الاجتماعي
Indian Navy
Quartz
Pakistan Newspaper
Новости Point.md
وكالة نهرين نيوز
News Live me Stream live Tips
Central das Notícias lite
خلية الاعلام الحربي
Fort Wayne's NBC
産経電子版
The Oregonian
كلام له معنى
Yeane.Org یان ی یرہ پلما
Tech Viral
My Pregnancy & Baby Today
Family Locator & GPS Tracker
Baby Sleep Instant
家族アルバムみてね - 子供の写真や動画を共有、整理アプリ
Toy AndMe
I'm Pregnant / Pregnancy App
Pregnancy Tracker Glow Nurture
Contraction Timer
ماما علمنتی - بدون انترنت
Pepe Videolari
Feed Baby - Breastfeeding
Find My Kids - Kid Tracker
Parentune: Parenting Community
Glow Baby for Breastfeeding
Choose HATCHIMAL Test & guide
Elige tu HATCHIMAL test y guía
AwesomeToys
Chansons de bébé
Новогодние стихи
BubblePOP Kids
Детские товары
Rose Heart Theme

Video Kisah Para Nabi & Rasul
Belajar Bersama Upin Ipin
Прикорм для детей по месяцам
Молодая Мама
Календарь беременности
homemade pregnancy tests
Современная мама
PlayToys
Gravidez Digital
Educenet Mobile
ZEDGE™ Ringtones & Wallpapers
CM Launcher 3D-Theme
(FREE) Z CAMERA ABS STICKER
Wallpapers for Me
Backgrounds HD (Wallpapers)
(FREE) Z CAMERA TATTOO STICKER
Earth HD Free Edition
Lock Screen & AppLock Security
WhatsApp Wallpaper
Ringtones & Wallpapers for Me
Hola Launcher - Simple
Christmas Live Wallpaper Free
Wallpaper
Speed radar prank
FREE-ZCAMERA 3D TATTOO STICKER
Backgrounds (HD Wallpapers)
Nova Launcher
Shqiponja 3D - Live Wallpaper
New Years Countdown to 2017
Transparent Live Wallpaper
Heart Droplet Kika Keyboard
(FREE) COOL 3D STICKER FOR SPE
CM AppLock Theme Sparkle
GoldButterflyGO Launcher Theme
مسلسلات بدون نت simulator 2017
Launcher Theme for iPhone 7
Merry Christmas 3D Theme
Twinkle GO Launcher Theme
Travel-APUS Launcher theme
Mistyforest Theme-Anti Snooper

Theme for Huawei Honor
Pink Hello Diamond Theme
Blue Water Drop Keyboard Theme
Gold for Samsung S6 Edge
Branco White Christmas Theme
Football Theme - Fingerprint
Luxury Metal Gold
Romantic Sakura Live Wallpaper
New Theme I OS 10
Retrica
YouCam Perfect - Selfie Camera
Collage Maker Pic Grid
Photo Editor Collage Maker Pro
Google Photos
YouCam Makeup: Selfie Makeover
FotoRus - Photo Collage Editor
Candy Camera for Selfie
Layout from Instagram: Collage
Boomerang from Instagram
Photo Collage Editor
Photo Editor Pro
Insta Square Size - No Crop
Photo Lab Picture Editor FX
PIP Selfie Photo in Pic
Square InstaPic - Photo Editor
Mirror Image - Photo Editor
Colour Effect Photo Editor
Snappy photo filters&Stickers
PIP Camera - Photo Editor Pro
Photo Collage - InstaMag
Passport ID Photo Maker Studio
Video Editor Music
Photo Editor Montage Collages♥
HD Camera
Square Quick Pro-No Crop Photo
Cat Face Filter Effect
Logo Maker Plus
HD Selfie Camera
Zen Photo Editor
HD Professional Camera

Auto Background Changer
3D Photo Collage Maker
Professional HD Camera
The Mannequin Challenge Maker
Text Photo Collages
360 HD Camera
HD Apple Camera
Spyglass with zoom
Super-Bright LED Flashlight
Flash Keyboard - Emojis & More
Tap Emoji Keyboard
Mobo Market
ES File Explorer File Manager
Kika Keyboard - Emoji
Free VPN -Hotspot Shield Basic
Torch - Flashlight
Google PDF Viewer
Google Docs
Brightest Flashlight-Multi LED
Emoji keyboard - Cute Emoji
Google Sheets
Smart Emoji Keyboard
TeamViewer for Remote Control
Clean My Android
Google Slides
Emoji Keyboard Plus
Fake Call
9Apps
SB Game Tool
How to call JIO4GVoice
Appvn
ATM Cash Status-India
GoldenCrown Kika KeyboardTheme
Great MP3 Converter
Asaan Urdu Keyboard
Mobo Market for apps
Christmas Emoji Keyboard Theme
Modi Keynote checker
Root Android One Click
Urdu Keyboard




The Squad Wallpaper HD
Mobo Market for Games
Mobomarket Plus
Beta Apps
Antivirus 2017 Free Premium
Payments
AliExpress Shopping App
Amazon Shopping
Snapdeal: Online Shopping App
Wish - Shopping Made Fun
Flipkart Online Shopping
Lazada - Shopping & Deals
eBay - Buy
Avito
letgo: Buy & Sell Used Stuff
Mercado Libre
LimeRoad Men & Women Shopping
Myntra Online Shopping App
Jabong-Online Fashion Shopping
ShopClues: Online Shopping App
Appstoide
신세계 면세점
鞋全家福
Online Shopping India New
家樂福 Carrefour TW
Guide OLX Costumer
Max Fashion
Centrepoint
Splash
Instagram
Facebook
Facebook Lite
Guide for viber calls messages
Вконтакте с друзьями
Likes for Instagram
Pinterest
Free Snapchat Social Chat Tips
OK.RU
Real Followers and Likes

Who viewed my Instagram profil
Unlimited Subway Keys Prank
SFriends - Chat Friends Finder
Real Followers Unlimited Likes
Emoji Keyboard
BIGO LIVE - Live Broadcasting
Google+
InstaFake (Direct Message)
Kate Mobile Lite для ВКонтакте
Мой Севастополь
Clash Amino em Português
Takipçi Begeni Kazanma
Twize
Лайки и Подписчики ВК
Старая Версия для Вконтакте
EVA
İnsta Takipçi Kazan
Bolsa Família Consulta
Невидимка Вконтакте
오토봇-24시간 자동으로 돈버는어플
أكبر شات تعارف عربي 2016
Одноклассники в сети
Followers for Instagram Plus
вайбер скачать бесплатно tips
Dudeapp - Top Fun Pics & GIFs!
Diffusion Kika Keyboard
All Football
LiveScore
BeSoccer - Football Live Score
SofaScore Live Score
UEFA Champions League
CrowdScores - Live Scores
بث مباشر للمباريات
Onefootball - Football scores
Premier League - Official App
CBS Sports
Goal Live Scores
يلا شوت بث مباشر □ yalla shoot
T20 Cricket Games New HD 3D

Football Live Scores
FlashScore
La Liga TV – Official Football
Embratoria G6
الأهلي
Yalla Shoot - بث مباشر
Football TV Live Streaming HD
MotoGP™
Cricket Games 2017
StrictlyBet - Betting Tips
Xem Tivi Anviens Bóng Đá
Betting Tips : 2
Точные прогнозы на спорт
PBA - The App
livesporte - بث مباشر
Everton
بين سبورت مباشر tv مجانا 2016
All Sports TV Channel Live HD
Tips: Dream League Soccer 2017
Women's EHF EURO 2016
بث مباشر   يلا كورة yallakora
HSBC World Rugby Sevens Series
All Live Cricket TV Channel HD
Security
Clean Master (Boost&Antivirus)
CM Security AppLock AntiVirus
SHAREit - Transfer & Share
SuperVPN Free VPN Client
360 Security - Antivirus Free
Kika Emoji Keyboard Pro + GIFs
Albania Flag Zipper UnLock
Air Share - File Transfer
Quick Screen Lock
Clean Master Lite (Boost)
Torch - Tiny Flashlight ®
Emoji Keyboard Cute Emoticons
VPN - Hola Free VPN
Flashlight - Brightest&Free
Ace Cleaner (Boost & Optimize)
CM Security Lite - Antivirus

Smart Mirror
Avast Cleanup & Junk Cleaner
GO Security
video call whatsapp prank
AppLock
Let's Clean (Boost & App Lock)
Virus Cleaner - Antivirus
9Apps
Guide Xender big file transfer
Gallery
Flashlight
Speed Cleaner (Security)
Virus Removal & Anti Malware
Xcleaner - Speed Cache Booster
Clever Camera
Tip.Club - TIP Plus
AwePSX- PSX Emulator
AppLock Theme Pond
Rainbow Camera
My Battery Saver
Game Killer
Marathi Calendar 2017
Turkcell Hesabım
SuperB Cleaner (Boost & Clean)
Your Video Downloader Manager
Mobile number tracker
Facemoji Keyboard + GIFs
Real Zipper Madrid lock
Deck Advisor for CR
MAPS.ME Offline Map+Navigation
Booking.com Hotel Reservations
trivago - Hotel Search
Skyscanner
Yandex.Navigator
Airbnb
2GIS: directory & navigator
TripAdvisor Hotels Restaurants
Traveloka Book Flight & Hotel
Goibibo-Hotel Flight Bus Car
Train Status & Indian Rail PNR

Cleartrip - Travel + Local
Indian Rail Train PNR Status
GO-JEK
Friend Locator : Phone Tracker
OYO - Online Hotel Booking App
Expedia Hotels
Agoda – Hotel Booking Deals
Yandex.Maps
Driving Rout Map Maker
AirAsia BIG
tripsta
Kangaroo Cabs
Pamukkale Turizm
VirtualTraveller
TAP FlyMoji
Авиабилеты: AviaLab
Easy Bus booking
Wifi Bank - Free WiFi
Histoire des rues de Paris
L'Orne dans ma poche
NearBy ATM (Find cash on ATM)
Klik Opole
iTube Music
YouTube
MX Player
Shiko Tv Shqip
Video Editor-Feature by Google
IPTV Shqip
VLC for Android
IPTV
Om Nom Toons
Digitalb Kudo
Dubsmash
Ontv Albania
YouTube Creator Studio
HD Video Tube
Yarik Paw - Ярик Лапа
TvMAK.Com - SHQIP TV
video player for android
ALBtv

Photo Video Slideshow Music
파일캐스트 - 최신영화 드라마 애니 TV다시보기 무료앱
Home Security Surveillance
Videostream Chromecast: Mobile
Mi Live - Live video streaming
Pahale kee taareekh veediyo
Video Maker Photos with Song
Modi Kinote Scan
Modi KeyNote Video
Slow Motion Video Editor Maker
Video Star Editor!
Video Downloader
NEV Privacy - Hide Pictures
Cool Tv Mobile
Video Downloader for Facebook
HD Video downloader free
Cool Tv App
Play Tube Plus
Photo to Video Collage Maker
Mannequin Challenge Videos
How To Play Dragon Ball Z
Screen Recorder
All TV Channels
All Video Converter
 year youcan Editor app PRO
Transparent clock & weather
Weather & Clock Widget Android
Weather
iWeather - Best Weather Widget
Yahoo Weather
Weather Report & Climate Today
Free Weather Widget for Sydney
Cool Android Weather Widget
Best Galaxy Live Weather Widge
Live Weather
Weather & Widgets
Yandex.Weather
Transparent Clock&Weather Free
All Weather

Gismeteo lite
Sydney Weather Forecast Report
Climate Weather Forecast Poke
News & Weather App Widgets
Yurekuru Call
Surflin Surf Reports/Forecast
Met Office Weather
Analog Clock Widget Android
3D Digital Clock Widget Free
Weather forecast
Blue Sky - Best Weather Widget
Merry Christmas Weather Widget
World Weather Forecast Report
Sydney Weather Forecast Widget
Transparent Glass Wallpaper
Clock & Weather Widget Android
360 Weather
Analog Clock Widget & Weather

## 8. APPENDIX B

On Appendix B you can find the 50 applications which have fulfilled our three conditions to estimate privacy risk. Note that there is the package name instead of application name, and the private\_P represents the 5 dangerous permissions that are include in our

conditions: INTERNET; CAMERA; READ\_CONTACTS, ACCESS\_FINE\_LOCATION, READ\_PHONE\_STATE. Two of the apps were excluded because they were antiviruses and are considered as outliers.

<b>Packet</b>	<b>Private_P</b>
br.com.bb.android	5
com.airbnb.android	5
com.amazon.mShop.android.shopping	5
com.axis.mobile	5
com.cgp.saral	5
com.cmcm.whatscall	5
com.cmsecurity-lite	5
com.color.rainbow.camera	5
com.csam.icici.bank.imobile	5
com.dotc.ime.latin.flash	5
com.emoji.coolkeyboard	5
com.facebook.katana	5
com.facebook-lite	5
com.facebook.orca	5
com.fitbit.FitbitMobile	5
com.flashlight.brightestflashlightpro	5
com.flipkart.android	5
com.freeimofreevideocallschatrec	5
com.gojek.app	5
com.google.android.apps.plus	5
com.houzz.app	5
com.iexceed.KTKB_ONLINE	5
com.imo.android.imoim	5
com.imo.android.imoimbeta	5
com.instagram.android	5
com.instanza.baba	5
com.jabong.android	5
com.lcode.allahabadupi	5
com.mobilemotion.dubsmash	5
com.myntra.android	5
com.opera.mini.native	5
com.phonepe.app	5
com.qihoo.security	5
com.raii220.securityalarmbot	5



com.santander.app	5
com.shopping.limeroad	5
com.snapdeal.main	5
com.trackview	5
com.ttech.android.onlineislem	5
com.twitter.android	5
com.ubercab	5
com.ubercab.driver	5
com.venticake.retrica	5
com.xime.latin.lite	5
klabs.beleza	5
kr.co.station3.dabang	5
me.lyft.android	5
org.telegram.messenger	5
ru.ok.android	5
ru.sberbankmobile	5

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