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MÁSTER UNIVERSITARIO EN INGENIERÍA DEL SOFTWARE – EUROPEAN MASTER IN SOFTWARE ENGINEERING

Investigating User Profiles for Mobile Application Categories and Providing Recommendations to Software Engineering

Master Thesis

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This thesis is submitted to the ETSI Informáticos at Universidad Politécnica de Madrid in partial fulfillment of the requirements for the degree of Master of Science in Software Engineering.

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1 Introduction

Mobile apps are a type of software applications developed for use on mobile devices such as smartphones and tablets. Once developed, an app is made available for users via an application distribution platform, commonly known as an app store. (Lim, Bentley, Kanakam, Ishikawa & Honiden, 2015). Mobile apps in an app store are presented via mobile application categories. List of app categories may change from app store to app store. A mobile app can be in more than one category. For instance: A photo editing and sharing mobile app can be in both social networking and photo & video app category. Generally a mobile application's success is measured by its number of downloads. App stores and mobile app developers want more users to download their apps. In order to do this, they prepare a marketing strategy and promote their apps through different platforms. (E.g: Social Media, Search Ads, TV Advertising, etc). To make this app promotion strategy more effective they need to identify best user profiles for their app category. In other words, they need to identify user profiles which have a high percentage of downloading apps from that app category.

My thesis work is about using data mining to identify these user profiles for each mobile app category. In order to apply data mining techniques I needed to find an open source dataset about user profiles and their preferences about mobile apps. Luckily, I found a research about this topic including a survey and an open source dataset. Dataset is filled with users' answers to survey questions. This academic work is performed from researchers of University of College London and National Institute of Informatics, Japan. These researchers published an academic paper which is about mobile app user behaviour based on country differences. (Lim, Bentley, Kanakam, Ishikawa & Honiden, 2015).

Throughout data mining and master thesis process I followed CRISP-DM Methodology. CRISP-DM methodology is a structured way of planning a data mining project It consists six different stages: Business understanding, Data understanding, Data preparation, Modeling, Evaluation and Deployment. (Vorhies, 2016) I followed methodology in its exact order. However, I wrote only one deployment section which covers all app categories.

2 Business Understanding

Master thesis dataset consists twenty two different mobile app categories (E.g: social networking, music, games etc.). Through my thesis I have two main investigations: First investigation is identifying user profiles which are mostly likely to download apps for each app category. While I try to reach this information, I should also discover how user characteristics affect downloading percentage of an app category. An example related to this could be: Is being male increases probability of downloading sports apps? Another example could be: Is being alone as a relationship status increases probability of downloading music apps? When I try to identify these user profiles I will try to reach them from three different perspectives: Location of users, general user characteristics and used application store. Second investigation is discovering common user characteristics among all mobile app users in the survey and their effect on mobile app downloading percentage. Briefly, first investigation is about going into deeper to identify user profiles who have more possibility to download an app category. On the other hand, second investigation is about focusing common user characteristics in the market and their effect on downloading app category. This section could be summarized with four titles that are explained below:

Business objective: Identifying user profiles which are mostly likely to download apps for each mobile app category and discovering common user characteristics and their effect on mobile app downloading percentage. Afterwards, I should explain how a marketing campaign or an app promotion strategy could be performed with using these insights.

Business success criteria: Identifying at least one user profile which are mostly likely to download apps for each mobile app category. At least this information needs to be provided for a applying a marketing or app promotion strategy.

Data mining objective: Using decision tree and apriori algorithms to identify user profiles. I will try to identify user profiles from three different perspectives: Location of users, general user characteristics and used application store. For general user characteristics perspective, I am not planning to consider data about

country of residence or used application store. Moreover, regarding used application store perspective I am not planning to consider data about country of residence.

Data mining success criteria: Identifying at least one user profile that has a downloading app percentage 50% or more for each app category.

3 Data Understanding

Master thesis dataset is derived from answers to a mobile app user behaviour questionnaire. This survey questions can be seen in annex section which is located at the end. This questionnaire is performed in more than 15 countries. Participants were asked to 30 questions in total. First half part (Question 1 to Question 15) is about their mobile app behaviour and second part (Question 16 to Question 30) is about user demographic profile and their personality. There are a lot of things that can be investigated through this questionnaire and provided dataset. However, for my thesis I investigated question 15 which is "Which types of app do you download? (Please select all that apply)" To investigate this question I used data which is coming from answers to some of the questions that I selected from the survey. Selected questions can be listed as:

- Do you own a mobile device? (Question 2)
- Which app store do you use? (Question 4)
- What is your gender? (Question 16)
- What is your age? (Question 17)
- What is your marital status? (Question 18)
- What is your country of residence? (Question 20)
- What is your first language (Question 21)
- What is the highest level of education you have completed? (Question 23)
- What is your current employment status? (Question 26)
- What is your current or recent occupation? (Question 27)
- What is your personality? Please rate the extent to which the pair of traits applies to you if one characteristic applies more strongly than the other (Question 30)

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I didn't use data coming from other questions because I decided data coming from these questions don't provide me business insights that I would like to get at the end of my work.

Dataset actually is an excel file which consists 10208 data records with 161 columns. Most of the columns are categorical variables with numerical representation. These numerical values don't have any mathematical meaning. Although survey seems like an open questionnaire apart of text questions the answers are recorded as only numbers in the dataset. For instance: Regarding question 4, answer 9 means "other application stores". But in the dataset it is just recorded as number 9. There is no any content explanation. When I analyzed data from the selected questions, I noticed some data quality problems:

- If a participant gives answer "2" to question 2 that means he doesn't have a mobile device (phone or tablet). Rest of the survey questions are not asked to these participants. This issue causes a lot of empty rows in the dataset.

- The survey wasn't conducted carefully. There are a lot of missing values in dataset. The number of missing values for each column is different. For instance: Regarding question 4, there are 2310 missing data records and regarding question question 16, there are 4942 missing data records.

- Dataset contains a lot of dummy variables. Dummy variables mean replacing a categorical variable with one or more new features that can have the values 0 and 1. Question 15 is represented with twenty three dummy variables (Q15_1, Q15_2, Q15_3, Q15_4, … , Q15_23) in the dataset. However, these dummy variables contain only values 1. If a data record doesn't have value 1 it is left as empty (NULL). These NULL values about question 15 cause data quality problems.

4 Data Preparation

After I had observed quality problems in the dataset I needed to prepare it for data mining algorithms. For data preparation I carried out the following steps.

- I discarded all data columns which are not in the list of selected survey questions. (selected survey questions are listed in "Data Understanding" part) I also discarded data columns named: ID, StartDate, EndDate and Response Status. I discarded these data columns because I didn't want to use data coming from these columns in data mining algorithms.

- I discarded the data rows which have answer "2" to question 2. If a participant gives answer "2" to question 2, that means he doesn't have a mobile device (phone or tablet). Rest of the survey questions are not asked to these participants. This issue causes empty rows in dataset and they are also not mobile app users which is my goal to investigate. Although, I discarded these participants as a part of data preprocessing, it is good to know percentage of this type of users. There are 1216 participants who don't have any mobile device (phone or tablet). It corresponds to 11.9% of the all participants.

- I discarded the data rows which have answer "7" to question 4. If a participant gives answers "7" to question 4 that means his mobile device can't run apps. This answer causes missing values in the dataset and they are also not mobile app users which is my goal to investigate. Although, I discarded these participants, it is good to know percentage of this type of users. There are 2748 participants that their mobile device can't run apps. It corresponds to 26.9% of the all participants.

- I discarded the data rows which have answer "10" to question 4. If a participant gives answers "10" to question 4 that means he doesn't prefer to use any mobile apps. This answer causes missing values in the dataset and they are also not mobile app users which is my goal to investigate. Although, I discarded these participants, it is good to know percentage of this type of users. There are 76 participants that don't prefer to download/use any mobile apps. It corresponds to 0.7% of the all participants.

The percentage of discarded three different participant profiles can be seen below:

Participant Profile	Percentage Among All Participants
Don't have a mobile device	11.9%
Mobile device can't run apps	26.9%
Don't prefer to download/use any mobile apps	0.7%

These three non mobile application user profiles corresponds to approximately 39.5% of all the participants. After discarding these 3 participant profiles, I received 6168 data records. However, I still had to do more about data processing.

- Dataset contains a lot of dummy variables. Dummy variables mean replacing a categorical variable with one or more new features that can have the values 0 and 1. For example: Question 15 is represented with twenty three dummy variables (Q15_1, Q15_2, Q15_3, Q15_4, … , Q15_23) in the dataset. However, these dummy variables contain only values 1. If a data record doesn't have value 1 it is left as empty (NULL). I filled these empty values in question 15 data columns with 0 in order to prepare them for data mining algorithms.
- The survey wasn't conducted carefully.There are still a lot of missing values in dataset. Due to these values are categorical values and they can not be interpolated or filled. For this reason, I discarded the rows which consists empty values. At the end I received 5168 valid data records. (Initially it was 10208)
- I decided to use decision tree algorithm in dataset. Due to decision tree algorithm is a supervised algorithm. It needs to have a training and test dataset parts. For this reason, I partitioned dataset into "training" and "test". Training dataset consist 70% of the cleaned data and test dataset consists the remaining 30%. Due to my cleaned dataset isn't massive (it has 5168 data

records), I decide to train more data to built my model. For this reason, I partitioned training part more than 50%.

I created many new fields from user answers to survey questions. Created new fields can be explained below:

- For question 4 "Which app store do you use?" I created new fields for each app store such as: Apple_Store, Blackberry_App_World, Google_Play_Store, Nokia_Ovi_Store, Samsung_Application_Store and Other
- For question 16 "What is your gender?" I created new fields such as: Male and Female
- For question 17 "What is your age?" I created six new fields such as: Young, Young_Adult, Adult, Middle_Aged, Old and Very_Old. Generally people older than 25 years old finish their education life (except phd students) after age 25, I created new age groups per each decade (10 years). Table diagram of the created new fields about age and their range can be seen below:

Age_Group	Age Range
Young	< 26
Young_Adult	>=26 and < 36
Adult	>=36 and < 46
Middle_Aged	>=46 and < 56
Old	>=56 and < 66
Very_Old	>=66

- For question 18 "What is your marital status?" I created new fields such as: With_Someone_In_A_Relationship and Alone_Person.
  With_Someone_In_A_Relationship field have value true when user selects In a relationship or married otherwise, its value is false. Alone_Person field have value true when user selects single, divorced, separated or widowed otherwise, its value is false.

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- For question 20 "What is your country of residence?" I created new fields for each country of residence in the survey: Australia, Brazil, Canada, China, France, Germany, India, Italy, Japan, Mexico, Republic of Korea, Russian Federation, Spain, United Kingdom, United States and Other.

- For question 20 "What is your country of residence?" I created new fields based on geographical closeness such as: North America, South America, East Asia and Europe. North America field have value true when user's country of residence is Canada or United States. South America field have value true when user's country of residence is Brazil or Mexico. East Asia field have value true when user's country of residence is Japan, Republic of Korea or China. Europe field have value true when user's country of residence is France, Germany, Italy, Spain or United Kingdom.

- For question 21 "What is your first language?" I created new fields such as: English_Speaker and Spanish_Speaker.

- For question 23 "What is your highest level of education you have completed?" I created new fields such as: With_University_Degree and Without_University_Degree. With_University_Degree field have value true when user selects undergraduate_degree, master's degree or doctoral degree. Without_University_Degree field have value true when user selects primary school or secondary/high school or diploma or vocational training

- For question 26 "What is your highest level of education you have completed? I created new fields such as: Working and Not_Working. Working field have value true when participant selects Full-time, Part-time or Self-employed Not_Working field have value true when participant selects unemployed, unable to work, student or retired.

- For question 27 "What is your current or most recent occupation?" I created new fields such as: Administrators, Professionals, Healthcare Service, Protective Service Workers Service Maintenance, Skilled Craft Workers - Technicians and Student. I derived these fields based on answers to survey. A table diagram about this can be seen below:

Created New Field	Based On Survey Answers
Administrators	Management Occupations
	Office and Administrative Support Occupations
Professionals	Business and Financial Operations Occupations
	Computer and Mathematical Occupations
	Architecture and Engineering Occupations
	Life, Physical, and Social Science Occupations
	Community and Social Services Occupations
	Legal Occupations
	Education, Training, and Library Occupations
	Arts, Design, Entertainment, Sports, and Media Occupations
	Sales and Related Occupations
Healthcare Service	Healthcare Practitioners and Technical Occupations
	Healthcare Support Occupations
Protective Service Workers	Protective Service Occupations
	Military Specific Occupations
Skilled Craft Workers - Technicians	Installation, Maintenance, and Repair Occupations
	Production Occupations
Student	Student

Service Maintenance	Food Preparation and Serving Related Occupations
	Building and Grounds Cleaning and Maintenance Occupations
	Personal Care and Service Occupations
	Farming, Fishing, and Forestry Occupations
	Construction and Extraction Occupations
	Transportation and Material Moving Occupations

- For question 30 "What is your personality? Please rate the extent to which the pair of traits applies to you if one characteristic applies more strongly than the other" I created new fields based on being "agree" and "disagree" to have that personality which is asked in the survey. Created new fields can be listed as:

Agree_Extraverted_Enthusiastic, Disagree_Extraverted_Enthusiastic,

Agree_Critical_Quarrelsome, Disagree_Critical_Quarrelsome,

Agree_Dependable_Self-Disciplined, Disagree_Dependable_Self-Disciplined,

Agree_Anxious_Easily-Upset, Disagree_Anxious_Easily-Upset,

Agree_Open-To-New-Experiences_Complex

Disagree_Open-To-New-Experiences_Complex,

Agree_Reserved_Quiet, Disagree_Reserved_Quiet,

Agree_Sympathic_Warm, Disagree_Sympathic_Warm,

Agree_Disorganized_Careless, Disagree_Disorganized_Careless,

Agree_Calm_Emotionally-Stable, Disagree_Calm_Emotionally-Stable,

Agree_Conventional_Uncreative, Disagree_Conventional_Uncreative

5 Modeling & Evaluation

For master thesis, I applied data mining techniques for question 15 "Which type of apps do you download?" I investigated all the mobile app categories that is a part of this question. Through this process, I applied two data mining techniques: Decision tree algorithm and apriori algorithm.

Decision tree algorithm is a widely used model for classification tasks. Essentially, they learn a hierarchy of if/else questions, leading to a decision.
This series of questions can be expressed as a decision tree. (Guido & Müller, 2016, p. 70) I build a decision tree for each mobile app category. I determined maximum tree depth parameter as 5 in order not to make my model overfitting. I generated rules from decision tree with minimum 20 instances. I ignored decision tree rules in which have less than 20 instances.

Decision tree input list

Decision tree inputs can be listed as : App Store, Gender, Age Groups, Language, Continents, Relationship Status, Education Degree, Working Status, Gender, Marital Status, Country of residence, Education, Employment Status and Occupation Group, Extraverted_Enthusiastic, Critical_Quarrelsome, Dependable_Self_Disciplined, Anxious_Easily_Upset, Open_To_New_Experiences_Complex, Reserved_Quiet, Sympathic_Warm, Disorganized_Careless, Calm_Emotionally_Stable and Conventional_Uncreative.

Apriori algorithm is widely used for association rules, which enumerate all of the frequent item sets. (Yabing, 2013) I applied apriori association rule algorithm for each mobile app category. I determined maximum number of antecedents parameter as 5. I also determined support percentage parameter as minimum 10% and confidence rule percentage parameter as minimum 20% for apriori algorithm. I ignored apriori results which have less than 10% support or less than 20% confidence rule

<u>Apriori input list</u>

Apriori inputs can be listed as :

Apple_Store, Blackberry_App_World, Google_Play_Store, Nokia_Ovi_Store,

Samsung_Application_Store, Windows_Phone_Marketplace,

Other_App_Store, Young, Young_Adult, Adult, Middle_Aged, Old, Very_Old,

English_Speaker, Spanish_Speaker, South America, North America, Europa,

East Asia, With_Someone_In_A_Relationship, Alone,

With_University_Degree, Without_University_Degree, Working, Not_Working,

Australia, Brazil, Canada, China, France, Germany, India, Italy, Japan,

Mexico, Korea, Russia, Spain, United_Kingdom, United_States,

Other_Countries, Administrator, Professionals, Healthcare_Service,

Protective_Service_Worker, Service_Maintenance_Worker and

Skilled_Craft_Worker_Technician, Student, Agree_Extraveted_Enthusiastic,

Disagree_Extraveted_Enhusiastic, Agree_Critical_Quarrelsome,

Disagree_Critical_Quarrelsome, Agree_Dependable_Self_Disciplined,

Disagree_Dependable_Self_Disciplined, Agree_Anxious_Easily_Upset,

Disagree_Anxious_Easily_Upset,

Agree_Open_To_New_Experiences_Complex,

Disagree_Open_To_New_Experiences_Complex

Agree_Reserved_Quiet, Disagree_Reserved_Quiet,

Agree_Sympathic_Warm, Disagree_Sympathic_Warm

Agree_Disorganized_Careless, Disagree_Disorganized_Careless,

Agree_Calm_Emotionally_Stable, Disagree_Calm_Emotionally_Stable,

Agree_Conventional_Uncreative, Disagree_Conventional_Uncreative

Note: For each app category, I have selected some of the data mining results from the outputs of decision tree and apriori. I didn't list all of the outputs because that means huge number of results. I selected results which provide more meaningful insights or informations. After this selection I grouped data mining results based on a common feature (E.g: residence of country, used application store, being male etc.) and represented them in a table format. Observing these tables could be an easier way of analysis process.

5.1 Navigation App Category

Mobile applications in this category generally offer turn-by turn directions, bicycle routes, traffic updates and access to offline maps (Strokes, 2017). Their content could be about driving assistance, walking assistance and topographical maps. Example apps: Google Maps, GPS Navigation and Gyro Compass. In the survey there are 1688 mobile app users that download navigation apps. It corresponds to 32.6% of all mobile app users.

Navigation App Category Decision Tree Results

- Users who live in Brazil, are not in a relationship with someone in their personal life, use Apple Store, Google Play Store or Windows Phone Marketplace as their application store and male download navigation app category with percentage 71.2% (number of instances are 66)

- Users who live in China, have a university degree in their education life and have a personality of being open to new experiences and complex download navigation app category with percentage 68.4% (number of instances are 234)

- Users who live in Italy, Australia or India, use Google Play Store as their application store, male and have a personality of dependable, self-disciplined download navigation app category with percentage 64.4% (number of instances are 59)

Navigation App Category Apriori Results

- Users who live in China download navigation app category with percentage 55.8% (support percentage is 10%)

- Users who live in South America (Brazil or Mexico) and have a personality of agree to open new experiences, complex download navigation app category with percentage 45.3% (support percentage is 10.7%)

- Users who are male download navigation app category with percentage 39.5% (support percentage is 49.1%)

- Users who are male and are aged from 26 to 36 (Young_Adult) download navigation app category with percentage 51.6% (support percentage is 12.2%)

- Users who are male, aged from 26 to 36 (Young_Adult) and working download navigation app category with percentage 53.3% (support percentage is 10.5%)

- Users who are male, working, have a personality of being extraverted, enthusiastic and sympathetic, warm and don't have a personality of disorganized, careless download navigation app category with percentage 57.4% (support percentage is 10.1%)

- Users who use Google Play Store as their application store download navigation app category with percentage 37.4% (support percentage is 36.2%)

- Users who use Apple Store as their application store download navigation app category with percentage 39.8% (support percentage is 20.2%)

- Users who use Apple Store as their application store, in a relationship with someone and have a personality of dependable, self-disciplined download navigation app category with percentage 45.3% (support percentage is 10.7%)

- Users who use Google Play Store as their application store, male and don't have a personality of self conventional, uncreative download navigation app category with percentage 49.9% (support percentage is 10.3%)

- Users who use Google Play Store as their application store, working and male download navigation app category with probability 53% (support percentage is 10.3%)

User Profile	Download App Percentage
Living in South America (Brazil or Mexico) + Open to new experiences, complex	45.3%
Living in China	55.8%
Living in Italy, Australia or India + Google Play Store + Male Self disciplined, dependable	64.4%
Living in Brazil + Not in a relationship + Male + Apple Store, Google Play Store or Windows Phone Marketplace	71.2%

User Profile	Download App Percentage
Male	39.5%
Male + Young_Adult	51.6%
Male + Young_Adult + Working	53.3%
Male + Working + Extraverted, enthusiastic + Sympathetic, warm + Not Disorganized, careless	57.4%

User Profile	Download App Percentage
Google Play Store	37.4%
Apple Store	39.8%
Apple Store + In a relationship + Dependable, Self-disciplined	45.3%
Google Play Store + Male + Not Conventional, uncreative	49.9%

Evaluation of Navigation App Category

For navigation app category these are the best user profiles for highest downloading app percentage:

- Based on location: Users who live in Brazil, are not in a relationship with someone in their personal life, use Apple Store, Google Play Store or Windows Phone Marketplace as their application store and male download navigation app category with percentage 71.2%

- Based on general user characteristics: Users who are male, working have a personality of being extraverted, enthusiastic and sympathetic, warm and don't have a personality of disorganized, careless download navigation app category with percentage 57.4%

- Based on application store: Users who use Google Play Store as their application store, male and don't have a personality of self conventional, uncreative download navigation app category with percentage 49.9%

Based on support percentage (coverage ratio) these user characteristics should also be taken into consideration:

- Approximately 49.1% percent of all mobile app users are male. 39.5% of them download navigation app category.

- Approximately 55.5% percent of all mobile app users are working. 38.8% of them download navigation app category.

Accuracy of built model can be seen below:

App Category	Training Accuracy	Test Accuracy
Navigation App Category	72.73%	68.46%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for navigation app category.

5.2 Business App Category

Apps in this category can perform many business tasks such as: billing, buying, booking, sending emails or in general tracking working progress (Sokhanych, 2016). Their content could be about document management (PDFs, scanning, file viewing/editing), job search, customer resource management, collaboration, enterprise resource planning and sales. Example apps: Quickoffice and Square Point of Sale - POS. In the survey there are 687 mobile app users that download business apps. It corresponds to 13.2% of all mobile app users.

Business App Category Decision Tree Results

- Users who live in either Brazil, Mexico or India, working, use Apple Store or Google Play Store as their application store, don't have a personality of sympathetic and warm and have a personality of calm and emotionally stable download business app category with percentage 63% (number of instances are 46)

Business App Category Apriori Results

- Users who live in China download business app category with percentage 31.5% (support percentage is 10%)
- Users who are male and working download business app category with percentage 23.4% (support percentage is 28.7%)
- Users who are male and aged from 26 to 36 (Young_Adult) download business app category with percentage 27.4% (support percentage is 12.2%)
- Users who are male, aged from 26 to 36 (Young_Adult) and working download business app category with percentage 29.6% (support percentage is 10.5%)
- Users who are male, aged from 26 to 36 (Young_Adult), working and have a personality of being open to new experiences, complex and dependable, self-disciplined download business app category with percentage 32.8% (support percentage is 10.4%)

User Profile	Download App Percentage
Living in China	31.5%
Living in Brazil, Mexico or India + Working + Apple Store or Google Play Store + Not sympathetic or warm	63%

User Profile	Download App Percentage
Male + Working	23.4%
Male + Young_Adult	27.4%
Male + Young_Adult + Working	29.6%
Male + Young_Adult + Working + Open to new experiences, complex + Dependable, self-disciplined	32.8%

Evaluation of Business App Category

For business app category these are the best user profiles for highest downloading app percentage:

- Based on location: Users who live in either Brazil, Mexico or India, are working, use Apple Store or Google Play Store as their application store, don't have a personality of sympathetic and warm and have a personality of calm, emotionally stable downloads business app category with percentage 63%
- Based on general user characteristics: Users who are male, aged from 26 to 36 (Young_Adult), working and have a personality of being open to new experiences, complex and dependable, self-disciplined download business app category with percentage 32.8% (support percentage is 10.4%)

Based on support percentage (coverage ratio) these user characteristics should also be taken into consideration:

- Approximately 32.4% percent of mobile app users are have a university degree in their education life and have a personality of dependable, self-disciplined. 20.7% percent of them downloads business app category.

Accuracy of built model can be seen below:

App Category	Training Accuracy	Test Accuracy
Business App Category	86.1%	88.36%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for business app category.

5.3 Catalogues App Category

Mobile apps in this category curate a visual collection of goods or services for promotion or sale (Choosing a Category [APA], n.d.) Example mobile app: 1001 Home Interior Catalog. In the survey there are 401 mobile app users that download catalogues apps. It corresponds to 7.7% of all mobile app users.

Catalogues App Category Decision Tree Results

In decision tree algorithm there is no any results with minimum 20 number of instances.

Catalogues App Category Apriori Results

In the Apriori association algorithm there is no any results with at least 20% confidence rule - 10% support rule.

Evaluation of Catalogues App Category

For Catalogues app category, there is no any significant pattern in dataset that satisfies minimum requirements for decision tree and apriori algorithms. Built model didn't achieve data mining success criteria which is determined in business understanding section.

5.4 Travel App Category

These apps make traveling activity easier, more comfortable, fun and informative. Some of them could turn traveller's smartphone into universal travel diary, or could literally guide a traveller through the unknown sites abroad using maps. (Sokhanych, 2016). Example mobile apps: TripAdvisor and Lonely Planet Traveller. In the survey there are 1035 mobile app users that download travel apps. It corresponds to 20% of all mobile app users.

Travel App Category Decision Tree Results

- Users who live in China, use Apple Store as their application store, have an education level as either doctoral degree, master degree or undergraduate degree or vocational training and have a personality of being open to new experiences and complex download travel app category with percentage 82.5% (number of instances are 40)

Travel App Category Apriori Results

- Users who live in China download travel app category with percentage 39.6% (support percentage is 10%)
- Users who use Apple Store as their application store download travel app category with percentage 33.7% (support percentage is 20.2%)
- Users who use Apple Store as their application store and working download travel app category with probability 38.9% (support percentage is 13.6%)
- Users who use Apple Store as their application store and have university degree in their education life download travel app category with percentage 43% (support percentage is 10.9%)
- Users who use Apple Store as their application store, working and have a personality of being open to new experiences, complex download travel app category with percentage 43.1% (support percentage is 10.7%)
- Users who are aged from 26 to 36 (Young_Adult) download travel app category with percentage 27.7% (support percentage is 26%)

- Users who are aged from 26 to 36 (Young_Adult) and have a university degree in their education life download travel app category with percentage 34.6% (support percentage is 15.4%)
- Users who are aged from 26 to 36 (Young_Adult), have a university degree in their education life and working download travel app category with percentage 36.3% (support percentage is 13.4%)
- Users who are aged from 26 to 36 (Young_Adult), have a university degree in their education life, working and have a personality of being open to new experiences, complex download travel app category with percentage 40.1% (support percentage is 10.4%)

User Profile	Download App Percentage
Living in China	39.6%
Living in China + Apple Store + Open to new experiences, Complex + Doctoral degree, Master degree, Undergraduate degree or Vocational training	82.5%

User Profile	Download App Percentage
Young_Adult	27.7%
Young_Adult + University degree	34.6%
Young_Adult + University degree + Working	36.3%
Young_Adult + University degree + Working + Open to new experiences, complex	40.1%

User Profile	Download App Percentage
Apple Store	33.7%
Apple Store + Working	38.9%
Apple Store + University degree	43%
Apple Store + Working + Open to new experiences, complex	43.1%

Evaluation of Travel App Category

For travel app category these are the best user profiles for highest downloading app percentage:

- Based on location: Users who live in China, use Apple Store as their application store, have an education level as either doctoral degree, master degree or undergraduate degree or vocational training and have a personality of being open to new experiences and complex download travel app category with percentage 82.5%

- Based on general user characteristics: Users who are aged from 26 to 36 (Young_Adult), have a university degree in their education life, working and have a personality of being open to new experiences, complex download travel app category with percentage 40.1%

- Based on used application store: Users who use Apple Store as their application store, working and have a personality of being open to new experiences, complex download travel app category with percentage 43.1%

Based on support percentage (coverage ratio) these user characteristics should also be taken into consideration:

- Approximately 43% percent of all mobile app users are in a relationship with someone in their personal life and have a personality of being open to new experiences, complex. 25.6% of them download travel apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Travel App Category	81%	80.1%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for travel app category.

5.5 Books App Category

Mobile applications in this category could provide free ebooks, shopping ebooks or customized preferences about digital reading (font size, background color, screen brightness). Example apps: Kindle and Audiobook & Podcast Player. In the survey there are 1450 mobile app users that download books apps. It corresponds to 28% of all mobile app users.

Books App Category Decision Tree Results

- Users who live in China and use Apple Store or Google Play Store as their application store download books app category with percentage 60% (number of instances are 240)
- Users who live in South America (based on survey it should be Brazil or Mexico), do not work as professional job group, have a university degree in their education life and use Samsung Application Store, Google Play Store or Nokia Ovi Store download books app category with percentage 54.4% (number of instances are 68)

Books App Category Apriori Results

- Users who live in China download books app category with percentage 51.8% (support percentage is 10%)
- Users who live in South America (based on survey it should be Brazil or Mexico) download books app category with percentage 32.1% (support percentage is 13.4%)

- Users who use Apple Store as their application store download books app category with percentage 39.1% (support percentage is 20.2%)
- Users who use Apple Store as their application store and working download books app category with probability 42.3% (support percentage is 13.6%)
- Users who use Apple Store as their application store and have a university degree in their education life download books app category with percentage 44.9% (support percentage is 10.9%)
- Users who use Apple Store as their application store, in a relationship with someone in their personal life and have a personality of being open to new experiences, complex download books app category with percentage 45.5% (support percentage is 10.3%)

User Profile	Download App Percentage
Living in China	51.8%
Living in China + Apple Store or Google Play Store	60%
Living in South America	32.1%
Living in South America + Not Professional + University degree + Samsung Application Store, Google Play Store or Nokia Ovi Store	54.4%

User Profile	Download App Percentage
Apple Store	39.1%
Apple Store + Working	42.3%
Apple Store + University degree	44.9%
Apple Store + In a relationship + Open to new experiences, complex	45.5%

Evaluation of Books App Category

For books app category these are the best user profiles for highest downloading app percentage:

- Based on location: Users who live in China and use Apple Store or Google Play Store as their application store download books app category with percentage 60%
- Based on used application store: Users who use Apple Store as their application store, in a relationship with someone in their personal life and have a personality of being open to new experiences, complex download books app category with percentage 45.5%

Based on support percentage (coverage ratio) these user characteristics should also be taken into consideration

- Approximately 59.8% percent of all mobile app users are don't have a personality of being conventional, uncreative. 30.3% of them download books apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Books App Category	73.2%	72.23%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for books app category.

5.6 Photo & Video App Category

Mobile applications in this category assist in capturing, editing, managing, storing, or sharing photos and videos (Choosing a Category [APA], n.d.) Example apps: Snapseed, iMovie, VSCO and Adobe Photoshop. In the survey there are 1808 mobile app users that download photo & video apps. It corresponds to 34.9% of all mobile app users.

Photo & Video App Category Decision Tree Results

- Users who live in Brazil, Mexico, Republic of Korea, India or Spain, use Apple Store or Google Play Store as their application store, not aged from 36 to 46 (not adult), have a personality of being open to new experiences, complex and download photo & video app category with percentage 65.3% (number of instances are 251)

- Users who live in Canada, United States, Italy, United Kingdom or other countries, use Apple Store or Google Play Store as their application store, and don't have a personality of being conventional, uncreative download photo & video app category with percentage 50.1% (number of instances are 353)

Photo & Video App Category Apriori Results

- Users who are aged less than 26 years old (Young) download photo & video app category with percentage 44.8% (support percentage is 31.6%)

- Users who are aged less than 26 years old (Young) and have a personality of being extraverted, enthusiastic download photo & video app category with percentage 49.8% (support percentage is 16.4%)

- Uses who are aged less than 26 years old (Young), students and female download photo & video app category with percentage 51.7% (support percentage is 10.3%)

- Users who are aged less than 26 years old (Young) and have a personality of being extraverted, enthusiastic and not disorganized, careless download photo & video app category with percentage 52.1% (support percentage is 10.3%)

- Users who use Google Play Store as their application store download photo & video app category with percentage 40% (support percentage is 36.2%)

- Users who use Apple Store as their application store download photo & video app category with percentage 42% (support percentage is 20.2%)

- Users who use Google Play Store as their application store, aged less than 26 years old (Young) and have a personality of being sympathetic, warm download photo & video app category with percentage 50% (support percentage is 10.5%)

- Users who are student download download photo & video app category with percentage 45.7% (support percentage is 19.5%)

- Users who are student and female download download photo & video app category with percentage 49.5% (support percentage is 11.1%)

User Profile	Download App Percentage
Living in United States, Canada, United Kingdom, Italy or Other countries + Apple Store or Google Play Store + Not conventional and uncreative	50.1%
Living in Brazil, Mexico, Republic of Korea, India or Spain + Apple Store or Google Play Store + Not adult	65.3%

User Profile	Download App Percentage
Young	44.8%
Young + Student	46.8%
Young + Student + Female	51.7%
Young + Extraverted, enthusiastic + Not Disorganized, careless	52.1%

User Profile	Download App Percentage
Student	45.7%
Student + Female	49.5%

User Profile	Download App Percentage
Google Play Store	40%
Apple Store	42%
Google Play Store + Young + Sympathetic, warm	50%

Evaluation of Photo & Video App Category

For photo & video app category these are the best user profiles for highest downloading app percentage:

- Based on location: Users who live in Brazil, Mexico, Republic of Korea, India or Spain, use Apple Store or Google Play Store as their application store, not aged from 36 to 46 (not adult), have a personality of being open to new experiences, complex and download photo & video app category with percentage 65.3%

- Based on general user characteristics: Users who are aged less than 26 years old (Young) and have a personality of being extraverted, enthusiastic and not disorganized, careless download photo & video app category with percentage 52.1%

- Based on used application store: Users who use Google Play Store as their application store, aged less than 26 years old (Young) and have a personality of being sympathetic, warm download photo & video app category with percentage 50%

Based on support percentage (coverage ratio) these user characteristics should also be taken into consideration:

- Approximately 41.1% percent of all mobile app users are alone as their relationship status. 38.9% of them download photo & video apps.
- Approximately 71.3% percent of all mobile app users are have a personality of open to new experiences, complex. 37.9% of them download photo & video apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Photo & Video App Category	66.41%	63.92%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for photo & video app category.

5.7 Lifestyle App Category

This app category could be the widest category compared to others. As it covers plenty of common human activities and interests. Such as: Shopping, flirting, fashion and virtual fitting room (Strokes, 2017) Example apps: Tinder and AroundMe. In the survey there are 1106 mobile app users that download lifestyle apps. It corresponds to 21.4% of all mobile app users.

Lifestyle App Category Decision Tree Results

- Users who live in China, working and use Apple Store as their application store download lifestyle app category with percentage 66.7% (number of instances are 96)

Lifestyle App Category Apriori Results

- Users who live in China download lifestyle app category with percentage 49.3% (support percentage is 10%)

- Users who use Apple Store as their application store download lifestyle app category with percentage 34.8% (support percentage is 20.2%)

- Users who use Apple Store as their application store and in a relationship with someone in their personal life download lifestyle app category with percentage 37.2% (support percentage is 12.8%)

- Users who use Apple Store as their application store and have a university degree in their education life download lifestyle app category with percentage 40% (support percentage is 10.9%)

- Users who use Apple Store as their application store, working and don't have a personality of being disorganized, careless download lifestyle app category with percentage 41.4% (support percentage is 10.1%)

- Users who are aged from 26 to 36 (Young_Adult) download lifestyle app category with percentage 30.2% (support percentage is 26%)

- Users who are aged from 26 to 36 (Young_Adult) and have a university degree in their education life download lifestyle app category with percentage 36.5% (support percentage is 15.4%)

- Users who are aged from 26 to 36 (Young_Adult), have a university degree in their education life and in a relationship with someone in their personal life download lifestyle app category with percentage 38.9% (support percentage is 11.4%)

- Users who are aged from 26 to 36 (Young_Adult), have a university degree in their education life, in a relationship with someone in their personal life and working download lifestyle app category with percentage 40.6% (support percentage is 10%)

User Profile	Download App Percentage
Living in China	49.3%
Living in China + Working + Apple Store	66.7%

User Profile	Download App Percentage
Young_Adult	30.2%
Young_Adult + University degree	36.5%
Young_Adult + University degree + In a relationship	38.9%
Young_Adult + University degree + In a relationship + Working	40.6%

User Profile	Download App Percentage
Apple Store	34.8%
Apple Store + In a relationship	37.2%
Apple Store + University degree	40%
Apple Store + Working + Not disorganized, careless	41.4%

Evaluation of Lifestyle App Category

For lifestyle app category these are the best user profiles for highest downloading app percentage:

- Based on location: Users who live in China, working and use Apple Store as their application store download lifestyle app category with percentage 66.7%
- Based on general user characteristics: Users who are aged from 26 to 36 (Young_Adult), have a university degree in their education life, in a

relationship with someone in their personal life and working download lifestyle app category with percentage 40.6%

- Based on used application store: Users who use Apple Store as their application store, working and don't have a personality of being disorganized, careless download lifestyle app category with percentage 41.4%

Based on support percentage (coverage ratio) these user characteristics should also be taken into consideration:

- Approximately 26 % percent of all mobile app users are aged from 26 to 36 (Young_Adult). 30.2% of them download lifestyle apps.
- Approximately 28.4 % percent of all mobile app users have a university degree in their education life and working. 31.8% of them download lifestyle apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Lifestyle App Category	79.86%	77.93%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for lifestyle app category.

5.8 Entertainment App Category

These applications are generally interactive and designed to entertain and inform user. Their content could be about streaming, chatting or searching events, television,movies, theatre and fan clubs (Choosing a Category [APA], n.d.) Example mobile apps: Netflix, Dubsmash and X Factor. In the survey there are 1493 mobile app users that download entertainment apps. It corresponds to 28.8% of all mobile app users.

Entertainment App Category Decision Tree Results

- Users who live in China, use Apple Store or Google Play Store as their application store, aged less than 36 years old (Young or Young_Adult) have a personality of open to new experiences, complex download entertainment app category with percentage 70.9% (number of instances are 165)

- Users who live in South America (Brazil or Mexico), use Apple Store as their application store and aged less than 36 years old (Young or Young_Adult) download entertainment app category with percentage 60.4% (number of instances are 53)

- Users who live in India and aged less than 26 years old (Young) download entertainment app category with percentage 52.1% (number of instances are 165)

Entertainment App Category Apriori Results

- Users who live in China download entertainment app category with percentage 56.4% (support percentage is 10%)

- Users who live in East_Asia (China, Japan or Republic of Korea) and don't have a personality of being anxious, easily upset download entertainment app category with percentage 44.4% (support percentage is 10.3%)

- Users who are aged less than 26 years old (Young) download entertainment app category with percentage 40.2% (support percentage is 31.6%)

- Users who are aged less than 26 years old (Young) and male download entertainment app category with percentage 44.3% (support percentage is 14.1%)

- Users who are aged less than 26 years old (Young), male and alone as their relationship status download entertainment app category with percentage 45.9% (support percentage is 11.2%)

- Users who use Samsung Application Store as their application store download entertainment app category with percentage 30.1% (support percentage is 12.4%)

- Users who use Google Play Store as their application store download entertainment app category with percentage 31.5% (support percentage is 36.2%)
- Users who use Apple Store as their application store download entertainment app category with percentage 35.4% (support percentage is 20.2%)
- Users who use Apple Store as their application store and have a university degree in their education life download entertainment app category with percentage 36.6% (support percentage is 10.9%)
- Users who use Apple Store as their application store and don't have a personality of being conventional, uncreative download entertainment app category with percentage 38.5% (support percentage is 12.1%)

User Profile	Download App Percentage
Living in East Asia (China, Japan or Republic of Korea) + University degree	40.9%
Living in India + Young	52.1%
Living in China	56.4%
Living in South America (Brazil or Mexico) + Apple Store + Young or Young_Adult	60.4%
Living in China + Apple Store or Google Play Store + Young or Young_Adult + Open to new experiences, complex	70.9%

User Profile	Download App Percentage
Young	40.2%
Young + Male	44.3%
Young + Male + Alone	45.9%

User Profile	Download App Percentage
Samsung Application Store	30.1%
Google Play Store	31.5%
Apple Store	35.4%
Apple Store + University degree	36.6%
Apple Store + Not conventional, uncreative	38.5%

Evaluation of Entertainment App Category

For entertainment app category these are the best user profiles for highest downloading app percentage:

- Based on location: Users who live in China, use Apple Store or Google Play Store as their application store, aged less than 36 years old (Young or Young_Adult) have a personality of open to new experiences, complex download entertainment app category with percentage 70.9%

- Based on general user characteristics: Users who are aged less than 26 years old (Young), male and alone as their relationship status download entertainment app category with percentage 45.9%

- Based on used application store: Users who use Apple Store as their application store and don't have a personality of being conventional, uncreative download entertainment app category with percentage 38.5%

Based on support percentage (coverage ratio) these user characteristics should also be taken into consideration:

- Approximately 71.3% percent of all mobile app users have a personality of open to new experiences, complex. 30.5% of them download entertainment apps.

- Approximately 41.1% percent of all mobile app users are alone as their relationship status. 32.5% of them download entertainment apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Entertainment App Category	72.82%	72.62%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for entertainment app category.

5.9 Finance App Category

These apps perform financial transactions or assist the user with business or personal financial matters. Their content could be about personal financial management, mobile banking, investment, bill reminders, budgets, debt management, tax and insurance (Choosing a Category [APA], n.d.). Example mobile apps: BBVA mobile app, Debt Manager, Account Tracker. In the survey there are 710 mobile app users that download finance apps. It corresponds to 13.7% of all mobile app users.

Finance App Category Decision Tree Results

- Users who live in East Asia (Japan, Republic of Korea or China) or South America (Brazil or Mexico), use Google Play Store as their application store, are aged from 26 to 36 (Young_Adult), do not work as professional, work full time in their employment status download finance app category with percentage 57.7% (number of instances are 52)

Finance App Category Apriori Results

- Users who live in China download finance app category with percentage 29.4% (support percentage is 10%)
- Users who are working and male download finance app category with percentage 21.6% (support percentage is 28.7%)
- Users who use Apple Store as their application store download finance app category with percentage 22.1% (support percentage is 20.2%)
- Users who use Apple store as their application store and working download finance app category with percentage 24.8% (support percentage is 13.6%)
- Users who use Apple store as their application store and have a university degree in their education life download finance app category with percentage 28.1% (support percentage is 10.9%)

User Profile	Download App Percentage
Living in China	29.4%
Living in South America (Brazil or Mexico) or East Asia (Japan, China, Republic of Korea) + Google Play Store + Young_Adult + Not professional + Full Time	57.7%

User Profile	Download App Percentage
Apple Store	22.1%
Apple Store + Working	24.8%
Apple Store + University Degree	28.1%

Evaluation of Finance App Category

For finance app category these are the best user profiles for highest downloading app percentage:

- Based on location: Users who live in East Asia (Japan, Republic of Korea or China) or South America (Brazil or Mexico), use Google Play Store as their application store, are aged from 26 to 36 (Young_Adult), do not work as professional, work full time in their employment status download finance app category with percentage 57.7%
- Based on general user characteristics: Users who are working and male download finance app category with percentage 21.6%
- Based on used application store: Users who use Apple store as their application store and have a university degree in their education life download finance app category with percentage 28.1%

Based on support percentage (coverage ratio) these user characteristics should also be taken into consideration:

- Approximately 31.9% percent of all mobile app users have a university degree in their education life and have a personality of open to new experiences, complex. 21.3% of them download finance apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Finance App Category	86.6%	85.28%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for travel app category.

5.10 News App Category

Apps in this category provide information about current events or developments in areas of interest such as politics, entertainment, business, science, technology, and so on. Their content could be about television or online news outlets or programs (Choosing a Category [APA], n.d.) Example apps: Sunday Times, Bloomberg and Businessweek. In the survey there are 1361 mobile app users that download news apps. It corresponds to 26.3% of all mobile app users.

News App Category Decision Tree Results

- Users who live in China, use Samsung Application Store, Google Play Store or Windows Phone Marketplace as their application store and have an education status as doctoral degree or undergraduate degree download news app category with a percentage 55.7% (number of instances are 122)
- Users who use Apple Store as their application store, have a university degree in their education life, with an employment status self-employed, homemaker, retired, student or unable to work download news app category with a percentage 51.3% (number of instances are 117)

News App Category Apriori Results

- Users have a university degree in their education life, working, in a relationship with someone in their personal life and have a personality of being extraverted, enthusiastic and dependable, self-disciplined download news app category with percentage 48.5% (support percentage is 11%)
- Users who live in China download news app category with percentage 47.1% (support percentage is 10%)
- Users who use Apple Store as their application store download news app category with percentage 40.2% (support percentage is 20.2%)
- Users who use Apple Store as their application store and have a university degree in their education life download news app category with a percentage 46.9% (support percentage is 10.9%)

User Profile	Download App Percentage
Living in China	47.1%
Living in China + Samsung Application Store + Google Play Store + Windows Phone Marketplace + Doctoral degree or Undergraduate degree	55.7%

User Profile	Download App Percentage
Apple Store	40.2%
Apple Store + University degree	46.9%
Apple Store + University degree + Self-employed, homemaker, retired, student or unable to work	51.3%

Evaluation of News App Category

For news app category these are the best user profiles for highest downloading app percentage:

- Based on location: Users who live in China, use Samsung Application Store, Google Play Store or Windows Phone Marketplace as their application store and have an education status as doctoral degree or undergraduate degree download news app category with a percentage 55.7%
- Based on general user characteristics: Users have a university degree in their education life, working, in a relationship with someone in their personal life and have a personality of being extraverted, enthusiastic and dependable, self-disciplined download news app category with percentage 48.5%
- Based on used application store: Users who use Apple Store as their application store, have a university degree in their education life, with an

employment status self-employed, homemaker, retired, student or unable to work download news app category with a percentage 51.3%

Based on support percentage (coverage ratio) these user characteristics should also be taken into consideration.

- Approximately 55.5% percent of all mobile app users are working. 30.9% of them download news apps.
- Approximately 49.1% percent of all mobile app users are male. 30.1% of them download news apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
News App Category	74.12%	74.08%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for news app category.

5.11 Health & Fitness App Category

Mobile apps under this category are related to healthy living, including stress management, fitness and recreational activities. Their content could be about yoga, muscle diagrams, workout tracking, running, cycling, stress management, pregnancy, meditation, weight loss and pilates, (Choosing a Category [APA], n.d.) Example mobile apps: Calorie Counter, Simply Yoga. In the survey there are 1020 mobile app users that download health & fitness apps. It corresponds to 19.7% of all mobile app users.

Health & Fitness App Category Decision Tree Results

In decision tree algorithm there is no any results with minimum 20 number of instances.

Health & Fitness App Category Apriori Results

- Users who use Apple Store as their application store download health & fitness app category with percentage 31.6% (support percentage is 20.2%)
- Users who use Apple Store as their application store and in a relationship with someone in their personal life download health & fitness app category with percentage 34.2% (support percentage is 12.8%)
- Users who use Apple Store as their application store and female download health & fitness app category with percentage 35.5% (support percentage is 11.2%)
- Users who use Apple Store as their application store, working and don't have a personality of being disorganized, careless download health & fitness app category with percentage 38% (support percentage is 10.1%)
- Users who are female, have a university degree in their education life and in a relationship with someone in their personal life download health & fitness app category with percentage 33.3% (support percentage is 12.2%)

User Profile	Download App Percentage
Apple Store	31.6%
Apple Store + In a relationship	34.2%
Apple Store + Female	35.5%
Apple Store + Working + Not disorganized, careless	38%

Evaluation of Health & Fitness App Category

For health & fitness app category these are the best user profiles for highest downloading app percentage:

- Based on general user characteristics: Users who are female, have a university degree in their education life and in a relationship with someone in their personal life download health & fitness app category with percentage 33.3%

- **Based on used application store:** Users who use Apple Store as their application store, working and don't have a personality of being disorganized, careless download health & fitness app category with percentage 38%

Based on support percentage (coverage ratio) these user characteristics should also be taken into consideration:

- Approximately 32.4% percent of all mobile app users have a university degree in their education life and have a personality of dependable, self-disciplined. 25.9% of them download health & fitness apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Health & Fitness App Category	80.67%	80.36%

Built model couldn't find a satisfactory result for identifying at least one user profile that has a download app percentage 50% for health & fitness app category.

5.12 Games App Category

Mobile apps under this category provide single or multiplayer interactive activities for entertainment purposes. Their content could be about action, adventure, board, card, family, puzzle, racing, role playing, simulation and strategy. (Choosing a Category [APA], n.d.) Gaming apps offer sense of achievement and high engagement in the process (Sokhanych, 2016) Example apps: Angry Birds, Candy Crush Saga and Flight Control. In the survey there are 2926 mobile app users that download games apps. It corresponds to 56.6% of all mobile app users.

Games App Category Decision Tree Results

- Users who live in South America (Brazil or Mexico), use Apple Store or Google Play Store as their application store, less than 26 years old (Young) and don't have a personality of disorganized and careless download games app category with percentage 73.3% (number of instances are 60)

- Users who use Apple Store or Google Play Store as their application store, aged less than 26 (Young), and have a personality of disorganized and careless download games app category with percentage 74.7% (number of instances are 419)

- Users who use Apple Store or Google Play Store as their application store, aged from 26 to 36(Young_Adult), and have a personality of sympathetic and warm download games app category with percentage 75.5% (number of instances are 534)

- Users who live in North America (Canada or United States) or East Asia (Japan, China or Republic of Korea), aged from 36 to 46 (Adult), in a relationship with someone in their personal life and use Apple Store, Google Play Store or Blackberry App World as their application store download games app category with percentage 80.9% (number of instances are 110)

Games App Category Apriori Results

- Users who are aged less than 26 years old (Young) download games app category with percentage 73.6% (support percentage is 31.6%)

- Users who are aged less than 26 years old (Young) and alone as their relationship status download games app category with percentage 74.1% (support percentage is 23.5%)

- Users who are aged less than 26 years old (Young) and have a personality of being sympathetic, warm download games app category with percentage 75.6% (support percentage is 23.1%)

- Users who are aged less than 26 years old (Young) and do not have a university degree in their education life download games app category with percentage 76.5% (support percentage is 21.8%)

- Users who use Google Play Store as their application store download games app category with percentage 65.2% (support percentage is 36.2%)

- Users who use Google Play Store as their application store and do not have a university degree in their education life download games app category with percentage 67.6% (support percentage is 22.7%)

- Users who use Apple Store as their application store download games app category with percentage 69.3% (support percentage is 20.2%)

- Users who are male download games app category with percentage 53% (support percentage is 49.1%)

- Users who are female download games app category with percentage 60% (support percentage is 50.8%)

- Users who are alone as their relationship status download games app category with percentage 63.1% (support percentage is 41.1%)

- Users who are aged from 26 to 36 (Young_Adult) download games app category with percentage 65.7% (support percentage is 26%)

User Profile	Download App Percentage
Living in South America + Apple Store or Google Play Store + Young + Not disorganized, careless	73.3%
Living in North America or East Asia + Adult + In a relationship + Apple Store, Google Play Store or Blackberry App World	80.9%

User Profile	Download App Percentage
Young	73.6%
Young + Alone	74.1%
Young + Sympathetic, warm	75.6%
Young + Without university degree	76.5%

User Profile	Download App Percentage
Male	53%
Female	60%

User Profile	Download App Percentage
Google Play Store	65.2%
Google Play Store + Without university degree	67.6%
Apple Store	69.3%
Apple Store or Google Play Store + Young + Disorganized, careless	74.7%
Apple Store or Google Play Store + Young _Adult + Sympathetic, warm	75.5%

Evaluation of Games App Category

For games app category these are the best user profiles for highest downloading app percentage:

- Based on location: Users who live in North America (Canada or United States) or East Asia (Japan, China or Republic of Korea), aged from 36 to 46 (Adult), in a relationship with someone in their personal life and use Apple Store, Google Play Store or Blackberry App World as their application store download games app category with percentage 80.9%

- Based on general user characteristics: Users who are aged less than 26 years old (Young) and do not have a university degree in their education life download games app category with percentage 76.5%

- Based on used application store: Users who use Apple Store or Google Play Store as their application store, aged from 26 to 36(Young_Adult), and have a personality of sympathetic and warm download games app category with percentage 75.5%

Based on support percentage (coverage ratio) these user characteristics should also be taken into consideration:

- Approximately 76.7% percent of all mobile app users have a personality of sympathetic, warm. 58.3% of them download games apps.
- Approximately 55.5% percent of all mobile app users are working. 57.6% of them download games apps.
- Approximately 49.1% percent of all mobile app users are male. 53% of them download games apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Games App Category	70.93%	67.18%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for games app category.

5.13 Food & Drink App Category

These apps provide recommendations, instruction, or critique related to the preparation, consumption or review of food or beverages. Their content could be about recipe collections, cooking guides, restaurant reviews, celebrity chefs/recipes, dietary & food allergy, and international cuisine. (Choosing a Category [APA], n.d.) Example apps: Foursquare, Good Food Magazine, Dominos Pizza. In the survey there are 898 mobile app users that download food & drink apps. It corresponds to 17.3% of all mobile app users.

Food & Drink App Category Decision Tree Results

- Users who live in China and use Apple Store as their application store download food & drink app category with percentage 53.3% (number of instances 107)

Food & Drink App Category Apriori Results

- Users who live in China download food & drink app category with percentage 42.1% (support percentage is 10%)
- Users who live in East_Asia (Japan, Republic of Korea, China) download food & drink app category with percentage 35.1% (support percentage is 10.9%)
- Users who use Apple Store as their application store download food & drink app category with percentage 30% (support percentage is 20.2%)
- Users who use Apple Store as their application store and female download food & drink app category with percentage 31.4% (support percentage is 11.2%)
- Users who use Apple Store as their application store and working download food & drink app category with percentage 33.2% (support percentage is 13.6%)
- Users who use Apple Store as their application store, working and don't have a personality of being disorganized, careless download food & drink app category with percentage 36.9% (support percentage is 10.1%)
- Users who are aged from 26 to 36 years old (Young_Adult) and have a university degree in their education life download food & drink app category with percentage 30.3% (support percentage is 15.4%)
- Users who are aged from 26 to 36 years old (Young_Adult), have a university degree in their education life and working download food & drink app category with percentage 32.6% (support percentage is 13.4%)
- Users who are aged from 26 to 36 years old (Young_Adult), have a university degree in their education life, working and have a personality of being dependable, self-disciplined download food & drink app category with percentage 36% (support percentage is 10.7%)

User Profile	Download App Percentage
Living in East Asia (Japan, Republic of or Korean, China)	35.1%
Living in China	42.1%
Living in China + Apple Store	53.3%

User Profile	Download App Percentage
Young_Adult + University Degree	30.3%
Young_Adult + University degree + Working	32.6%
Young_Adult + University degree + Working + Dependable, self-disciplined	36%

User Profile	Download App Percentage
Apple Store	30%
Apple Store + Working	32.4%
Apple Store + Working + Not disorganized, careless	36.9%

Evaluation of Food & Drink App Category

For food & drink app category these are the best user profiles for highest downloading app percentage:

- Based on location: Users who live in China and use Apple Store as their application store download food & drink app category with percentage 53.3%
- Based on general user characteristics: Users who are aged from 26 to 36 years old (Young_Adult), have a university degree in their education life,

working and have a personality of being dependable, self-disciplined download food & drink app category with percentage 36%

● Based on used application store: Users who use Apple Store as their application store, working and don't have a personality of being disorganized, careless download food & drink app category with percentage 36.9%

Based on support percentage (coverage ratio) these user characteristics should also be taken into consideration:

● Approximately 16.8% percent of all mobile app users are aged from 26 to 36 (Young), working and have a personality of dependable, self-disciplined. 30.6% of them download food & drink apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Food & Drink App Category	82.75%	82.85%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for food & drink app category.

5.14 Education App Category

Mobile apps under this category provide an interactive learning experience on a specific skill or subject. Their content could be about arithmetic, alphabet, early learning and special education, language learning, pet training, astronomy and crafts. (Choosing a Category [APA], n.d.). Example apps: Duolingo, MathStudio and TED. In the survey there are 941 mobile app users that download education apps. It corresponds to 18.2% of all mobile app users.

Education App Category Decision Tree Results

There is no any decision tree finding with a minimum 20 number of instances.

Education App Category Apriori Results

- Users who use Apple Store as their application store download education app category with percentage 26.3% (support percentage is 20.2%)
- Users who use Apple Store as their application store and have a university degree in their education life download education app category with percentage 32% (support percentage is 10.9%)
- Users who use Apple Store as their application store, working and don't have a personality of being disorganized, careless download education app category with percentage 36.9% (support percentage is 10.1%)
- Users who are aged from 26 to 36 (Young_Adult) and have a university degree in their education life download education app category with percentage 29.2% (support percentage is 15.4%)
- Users who are aged from 26 to 36 (Young_Adult), have a university degree in their education life, working and have a personality of being dependable, self-disciplined download education app category with percentage 36% (support percentage is 10.7%)

User Profile	Download App Percentage
Using Apple Store	26.3%
Using Apple Store + University Degree	32%
Using Apple Store + Working + Not disorganized, careless	36.9%

User Profile	Download App Percentage
Young Adult + University degree	29.2%
Young Adult + University degree + Working + Dependable, self-disciplined	36%

Evaluation of Education App Category

For education app category these are the best user profiles for highest downloading app percentage:

- Based on general user characteristics: Users who are aged from 26 to 36 (Young_Adult), have a university degree in their education life, working and have a personality of being dependable, self-disciplined download education app category with percentage 36%

- Based on used application store: Users who use Apple Store as their application store, working and don't have a personality of being disorganized, careless download education app category with percentage 36.9%

Based on support percentage (coverage ratio) these user characteristics should also be taken into consideration:

- Approximately 28.4% percent of all mobile app users are working and have a university degree in their education life. 25.6% of them download education apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Education App Category	81.47%	82.53%

Built model couldn't find a satisfactory result for identifying at least one user profile that has a download app percentage 50% for education app category.

5.15 Medical App Category

Mobile apps under this category are focused on medical education, information management, or health reference for patients or healthcare professionals. Their content could be about skeletal, muscular, anatomy, medical record-keeping, diseases, symptom reference and health tracking. (Choosing a Category [APA], n.d.) Example apps: iStethoscope, Vision Test. In the survey there are 481 mobile app users that download medical apps. It corresponds to 9.3% of all mobile app users.

Medical App Category Decision Tree Results

Regarding decision tree algorithm there is no any result with a minimum 20 number of instances.

Medical App Category Apriori Results

Regarding Apriori association algorithm there is no any results with at least 20% confidence rule - 10% support rule.

Evaluation of Medical App Category

For medical app category, there is no any significant pattern in dataset that satisfies minimum requirements for decision tree and apriori algorithms. Built model didn't achieve data mining success criteria which is determined in business understanding section.

5.16 Social Networking App Category

Social media apps could be the most popular types of mobile app category. Simply, social networking apps connect people. Users can share a post to their social network and can receive a post from other users. Users generally check these apps every day. (The 6 Main Types of Mobile Apps [APA], n.d.) In the survey there are 2670 mobile app users that download social networking apps. It corresponds to 51.6% of all mobile app users.

Social Networking App Category Decision Tree Results

- Users who use Google Play Store or Blackberry App World, aged less than 36 years old (Young or Young_Adult), male and living in South America (Brazil or Mexico) download social networking app category with percentage 80.9% (number of instances 68)
- Users who live in South America (Brazil or Mexico), use Apple Store and aged less than 36 years old (Young or Young_Adult) download social networking app category with percentage 90.6% (number of instances 53)

Social Networking App Category Apriori Results

- Users who live in North America (Canada or United States) download social networking app category with percentage 58% (support percentage is 16.4%)
- Users who live in South America (Brazil or Mexico) download social networking app category with percentage 68.8% (support percentage is 13.4%)
- Users who live in South America (Brazil or Mexico) and have a personality of sympathetic, warm download social networking app category with percentage 71.4% (support percentage is 10.4%)
- Users who are female download social networking app category with percentage 55.5% (support percentage is 50.8%)
- Users who are female and working download social networking app category with percentage 57.8% (support percentage is 26.7%)
- Users who are female and have a university degree in their education life download social networking app category with percentage 59.3% (support percentage is 18.2%)
- Users who are female and aged less than 26 years old (Young) download social networking app category with percentage 62.8% (support percentage is 17.5%)
- Users who are female, aged less than 26 years old (Young) and have a personality of being open to new experiences, complex download social networking app category with percentage 67.7% (support percentage is 11.5%)

- Users who use Google Play Store as their application store download social networking app category with percentage 58.6% (support percentage is 36.2%)

- Users who use Apple Store as their application store download social networking app category with percentage 62.8% (support percentage is 20.2%)

- Users who use Apple Store as their application store and female download social networking app category with percentage 66.3% (support percentage is 11.2%)

- Users who use Apple Store as their application store and don't have a personality of being conventional, uncreative download social networking app category with percentage 70.3% (support percentage is 12.1%)

- Users who are aged from 36 to 46 (Adult) download social networking app category with percentage 50.1% (support percentage is 17.5%)

- Users who are aged less than 26 (Young) download social networking app category with percentage 61.6% (support percentage is 31.6%)

- Users who are aged from 26 to 36 (Young_Adult) download social networking app category with percentage 61.9% (support percentage is 26%)

- Users who are aged less than 26 (Young) and have a personality of being open to new experiences, complex and dependable, self-disciplined and not conventional, uncreative download social networking app category with percentage 71.2% (support percentage is 11.2%)

- Users who work download social networking app category with percentage 54.8% (support percentage is 55.5%)

- Users who are student download social networking app category with percentage 58.6% (support percentage is 19.5%)

User Profile	Download App Percentage
Living in North America (Canada or United States)	58%
Living in South America (Brazil or Mexico)	68.8%
Living in South America (Brazil or Mexico) + Sympathetic, warm	71.4%
Living in South America (Brazil or Mexico) + Male + Young or Young_Adult + Google Play Store or Blackberry App World	80.9%
Living in South America (Brazil or Mexico) + Young or Young_Adult + Apple Store	90.6%

User Profile	Download App Percentage
Female	55.5%
Female + Working	57.8%
Female + University Degree	59.3%
Female + Young	62.8%
Female + Young + Open to new experiences, complex	67.7%

User Profile	Download App Percentage
Adult	50.1%
Young	61.6%
Young_Adult	61.9%
Young + Open to new experiences, complex + Dependable, self-disciplined +Not conventional, uncreative	71.2%

User Profile	Download App Percentage
Google Play Store	58.6%
Apple Store	62.8%
Apple Store + Female	66.3%
Apple Store + Not conventional, uncreative	70.3%

Evaluation of Social Networking App Category

For social networking app category these are the best user profiles for highest downloading app percentage:

- Based on location: Users who live in South America (Brazil or Mexico), use Apple Store and aged less than 36 years old (Young or Young_Adult) download social networking app category with percentage 90.6%

- Based on general user characteristics: Users who are aged less than 26 (Young) and have a personality of being open to new experiences, complex and dependable, self-disciplined and not conventional, uncreative download social networking app category with percentage 71.2%

- Based on used application store: Users who use Apple Store as their application store and don't have a personality of being conventional, uncreative download social networking app category with percentage 70.3%

Based on support percentage (coverage ratio) these user characteristics should also be taken into consideration:

- Approximately 50.8% percent of all mobile app users are female. 55.5% of them download social networking apps.

- Approximately 63% percent of all mobile app users have a personality of calm and emotionally stable. 53.4% of them download social networking apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Social Networking App Category	68.1%	62.44%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for social networking app category.

5.17 Reference App Category

Reference apps assist users in accessing or retrieving information. They are a kind of digital encyclopedia. Their content could be about everything such as: atlas, dictionary, law, religion, history, geography, politics, animals and plants. (Choosing a Category [APA], n.d.) Example mobile apps: Birds of Brazil, World's Longest Rivers. In the survey there are 499 mobile app users that download reference apps. It corresponds to 9.6% of all mobile app users.

Reference App Category Decision Tree Results

There is no any decision tree finding with a minimum number of 20 instances.

Reference App Category Apriori Results

- Users who use Apple Store as their application store and have a university degree in their education life download reference app category with a percentage 20.1% (support percentage is 10.9%)
- Users who use Apple Store as their application store, working and have a personality of dependable, self-disciplined download reference app category with a percentage 20.3% (support percentage is 11.3%)

User Profile	Download App Percentage
Apple Store	20.1%
Apple Store + Working + Dependable, self-disciplined	20.3%

Evaluation of Reference App Category

For social reference app category there are not many data mining results. However, based on used application store this result could be an insight

- Based on used application store: Users who use Apple Store as their application store, working and have a personality of dependable, self-disciplined download reference app category with a percentage 20.3%

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Reference App Category	90.21%	90.66%

Built model couldn't find a satisfactory result for identifying at least one user profile that has a download app percentage 50% for reference app category.

5.18 Sports App Category

Sports app are related to professional or amateur sport activities. Their content could be about live score, sport organizations, professional teams/leagues, athletes and sport news. (Choosing a Category [APA], n.d.) Example apps: NFL Game Pass, Bein Sport and LiveScore. In the survey there are 860 mobile app users that download sports apps. It corresponds to 16.6% of all mobile app users.

Sports App Category Decision Tree Results

There is no any decision tree finding with minimum 20 number of instances.

Sports App Category Apriori Results

- Users who are male download sports app category with a percentage 24.5% (support percentage is 49.1%)

- Users who are male and working download sports app category with a percentage 27.5% (support percentage is 28.7%)

- Users who are male, have a university degree in their education life and don't have a personality of being anxious, easily upset download sports app category with a percentage 32.6% (support percentage is 13.2%)

- Users who are male, have a university degree in their education life, working and have a personality of being sympathetic, warm and dependable, self-disciplined download sports app category with percentage 37.8% (support percentage is 10%)

- Users who are aged from 26 to 36 (Young_Adult) download sports app category with percentage 20.3% (support percentage is 26%)

- Users who are aged from 26 to 36 (Young_Adult) and working download sports app category with a percentage 22.1% (support percentage is 20.7%)

- Users who are aged from 26 to 36 (Young_Adult), working and male download sports app category with percentage 31.9% (support percentage is 10.5%)

- Users who use Apple Store as their application store download sports app category with percentage 23.2% (support percentage is 20.2%)

- Users who use Apple Store as their application store and have a personality of being extraverted, enthusiastic and sympathetic, warm download sports app category with percentage 28.5% (support percentage is 10.2%)

User Profile	Download App Percentage
Male	24.5%
Male + Working	27.5%
Male + University degree + Not anxious, easily upset	32.6%
Male + University degree + Working + Sympathetic, warm + Dependable, self-disciplined	37.8%

User Profile	Download App Percentage
Young_Adult	20.3%
Young_Adult + Working	22.1%
Young_Adult + Working + Male	31.9%

User Profile	Download App Percentage
Apple Store	23.2%
Apple Store + Extraverted, enthusiastic + Sympathetic, warm	28.5%

Evaluation of Sports App Category

For sports app category these are the best user profiles for highest downloading app percentage:

- Based on general user characteristics: Users who are male, have a university degree in their education life, working and have a personality of being sympathetic, warm and dependable, self-disciplined download sports app category with percentage 37.8%

- Based on used application store: Users who use Apple Store as their application store and have a personality of being extraverted, enthusiastic and sympathetic, warm download sports app category with percentage 28.5%

Based on support percentage (coverage ratio) these user characteristics should also be taken into consideration:

- Approximately 49.1% percent of all mobile app users are male. 24.5% of them download sports apps.

- Approximately 40.1% percent of all mobile app users are working and don't have a personality of disorganized, careless. 21% of them download sports apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Sports App Category	83.16%	83.31%

Built model couldn't find a satisfactory result for identifying at least one user profile that has a download app percentage 50% for sports app category.

5.19 Utilities App Category

Mobile applications under this category generally help users to perform a specific task. They are mostly used by mobile users in a frequent way but most of them even not aware of it. (Strokes, 2017) Their content could be about alarms, calculators and measurements. Example mobile apps: Calculator and Alarm Clock. In the survey there are 1979 mobile app users that download utilities apps. It corresponds to 38.2% of all mobile app users.

Utilities App Category Decision Tree Results

- Users who use Apple Store as their application store, working in professional occupation group and do not speak english as a native language download utilities app category with percentage 69% (number of instances 155)
- Users who use Google Play Store as their app store, don't have a university degree in their education life, male and have a personality of being reserved, quiet download utilities app category with percentage 82.5% (number of instances 40)

Utilities App Category Apriori Results

- Users who are aged from 36 to 46 (Adult) download utilities app category with percentage 41.8% (support percentage is 17.5%)
- Users who are aged from 26 to 36 (Young_Adult) download utilities app category with a percentage 46.5% (support percentage is 26%)
- Users who are aged from 26 to 36 (Young_Adult) and working download utilities app category with percentage 47.8% (support percentage is 20.7%)
- Users who are aged from 26 to 36 (Young_Adult) and work as professional occupation group download utilities app category with percentage 51% (support percentage is 11.9%)
- Users who are aged from 26 to 36 (Young_Adult), have a university degree in their education life and have a personality of being open to new experiences,

complex and dependable, self-disciplined download utilities app category with percentage 53.6% (support percentage is 10.1%)

- Users who are male download utilities app category with percentage 40.1% (support percentage is 55.5%)

- Users who use Apple Store as their application store download utilities app category with percentage 52% (support percentage is 20.2%)

- Users who use Apple Store as their application store and have a university degree in their education life download utilities app category with percentage 54.8% (support percentage is 10.9%)

- Users who use Apple Store as their application store and have a personality of being sympathetic, warm and not conventional, uncreative download utilities app category with percentage 56.9% (support percentage is 10.1%)

- Users who use Google Play Store as their application store download utilities app category with percentage 44.4% (support percentage is 36.2%)

- Users who use Google Play Store as their application store and working download utilities app category with percentage 47.9% (support percentage is 18.7%)

- Users who use Google Play Store as their application store, working and male download utilities app category with percentage 51.2% (support percentage is 10.3%)

- Users who use Google Play Store as their application store, and have a university degree in their education life download utilities app category with percentage 52.2% (support percentage is 13.3%)

- Users who use Google Play Store as their application store, have a university degree in their education life and have a personality of being open to new experiences, complex download utilities app category with percentage 53.8% (support percentage is 10.1%)

User Profile	Download App Percentage
Adult	41.8%
Young_Adult	46.5%
Young_Adult + Working	47.8%
Young_Adult + Working +Professional occupation group	51%
Young_Adult + University degree + Open to new experiences, complex + Dependable, self-disciplined	53.6%

User Profile	Download App Percentage
Apple Store	52%
Apple Store + University degree	54.8%
Apple Store + Sympathetic, warm + Not conventional, uncreative	56.9%
Apple Store + Professional occupation group + Not native english native speaker	69%

User Profile	Download App Percentage
Google Play Store	44.4%
Google Play Store + Working	47.9%
Google Play Store + Working + Male	51.2%
Google Play Store + University degree	52.2%
Google Play Store + University degree + Open to new	53.8%

experiences, complex	
Google Play Store + Without university degree + Male + Reserved, quiet	82.5%

Evaluation of Utilities App Category

For utilities app category these are the best user profiles for highest downloading app percentage:

- Based on general user characteristics: Users who are aged from 26 to 36 (Young_Adult), have a university degree in their education life and have a personality of being open to new experiences, complex and dependable, self-disciplined download utilities app category with percentage 53.6%
- Based on used application store: Users who use Google Play Store as their app store, don't have a university degree in their education life, male and have a personality of being reserved, quiet download utilities app category with percentage 82.5%

Based on support percentage (coverage ratio) these user characteristics can also be taken into consideration:

- Approximately 55.5% percent of all mobile app users are working. 42.7% of them download utilities apps.
- Approximately 76.5% percent of all mobile app users have a personality of dependable, self-disciplined. 40.3% of them download utilities apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Utilities App Category	65.91%	61.16%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for utilities app category.

5.20 Weather App Category

These apps provide forecasts, alerts and information about weather conditions. Their content could be about forecast, storms, radar and severe weather. (Choosing a Category [APA], n.d.) Example mobile apps: Yahoo Weather, Forecaster and Radarscope. In the survey there are 1894 mobile app users that download weather apps. It corresponds to 36.6% of all mobile app users.

Weather App Category Decision Tree Results

- Users who live in North America (Canada or United States) are in a relationship with someone in their personal life, use either Google Play Store or Windows Phone Marketplace as their application store download weather app category with percentage 53.7% (number of instances are 164)
- Users who live in China, in a relationship with someone in their personal life, use Google Play Store or Windows Phone Marketplace as their application store download weather app category with percentage 66.3% (number of instances are 89)

Weather App Category Apriori Results

- Users who use Google Play Store as their application store download weather app category with percentage 40.4% (support percentage is 36.2%)
- Users who use Google Play Store as their application store, in a relationship with someone in their personal life and have a personality of being open to new experiences, complex and not conventional, uncreative download weather app category with percentage 52.1% (support percentage is 10.7%)
- Users who use Apple Store as their application store download weather app category with percentage 51.8% (support percentage is 20.2%)
- Users who use Apple Store as their application store and working download weather app category with percentage 55.1% (support percentage is 13.6%)
- Users who use Apple Store as their application store, in a relationship with someone in their personal life and have a personality of being dependable,

self-disciplined download weather app category with percentage 59.1% (support percentage is 10.7%)

- Users who live in North America (Canada or United States) download weather app category with percentage 48.7% (support percentage is 16.4%)

- Users who live in North America (Canada or United States) and have a personality of being calm, emotionally stable download weather app category with percentage 52.1% (support percentage is 10.9%)

- Users who are aged from 26 to 36 (Young_Adult) download weather app category with percentage 44.4% (support percentage is 26%)

- Users who are aged from 26 to 36 (Young_Adult), working and have a university degree in their education life download weather app category with percentage 47.9% (support percentage is 13.4%)

- Users who are aged from 26 to 36 (Young_Adult), working, have a university degree in their education life and in a relationship with someone download weather app category with percentage 49.1% (support percentage is 10%)

- Users who are aged from 26 to 36 (Young_Adult), working and have a personality of being calm, emotionally stable and dependable, self-disciplined and not conventional, uncreative download weather app category with percentage 52.4% (support percentage is 10.1%)

User Profile	Download App Percentage
Living in North_America (Canada or America)	48.7%
Living in North_America (Canada or America) + Calm, emotionally stable	52.1%
Living in North_America (Canada or America) + Google Play Store or Windows Phone Marketplace + In a relationship	53.7%
Living in China + Google Play Store or Windows Phone Marketplace + In a relationship	66.3%

User Profile	Download App Percentage
Young_Adult	44.4%
Young_Adult + Working + University degree	47.9%
Young_Adult + Working + University degree + In a relationship	49.1%
Young_Adult + Working + Calm, emotionally stable + Dependable, self-disciplined + Not conventional, uncreative	52.4%

User Profile	Download App Percentage
Google Play Store	40.4%
Google Play Store + In a relationship + Open to new experiences, complex + Not conventional, uncreative	52.1%
Apple Store	51.8%
Apple Store + Working	55.1%
Apple Store + In a relationship + Dependable, self-disciplined	59.1%

Evaluation of Weather App Category

For weather app category these are the best user profiles for highest downloading app percentage:

- Based on location:Users who live in China, in a relationship with someone in their personal life, use Google Play Store or Windows Phone Marketplace as their application store download weather app category with percentage 66.3%

- Based on general user characteristics: Users who are aged from 26 to 36 (Young_Adult), working and have a personality of being calm, emotionally

stable and dependable, self-disciplined and not conventional, uncreative download weather app category with percentage 52.4%

- <u>Based on used application store:</u> Users who use Apple Store as their application store, in a relationship with someone in their personal life and have a personality of being dependable, self-disciplined download weather app category with percentage 59.1%

Based on support percentage (coverage ratio) these user characteristics can also be taken into consideration:

- Approximately 58.5% percent of all mobile app users are in a relationship with someone in their personal life . 40.7% of them download weather apps.
- Approximately 55.8% percent of all mobile app users have a personality of sympathetic, warm and not disorganized, careless. 41% of them download weather apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Weather App Category	66.96%	66.09%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for weather app category.

5.21 Productivity App Category

Productivity mobile apps make a specific process or task more organized or efficient. Their content are generally about task management, calendar management, note taking, password management and flow chart generators. (Choosing a Category [APA], n.d.) Example mobile apps: Google Calendar and Evernote. In the survey there are 939 mobile app users that download productivity apps. It corresponds to 18.1% of all mobile app users.

Productivity App Category Decision Tree Results

- Users who use Apple Store as their application store have an education level either master or doctoral and male download productivity app category with percentage 57.8% (number of instances are 64)

Productivity App Category Apriori Results

- Users who use Apple Store as their application store download productivity app category with percentage 28% (support percentage is 20.2%)
- Users who use Apple Store as their application store and working download productivity app category with percentage 31.1% (support percentage is 13.6%)
- Users who use Apple Store as their application store, working and male download productivity app category with percentage 32.5% (support percentage is 10.3%)
- Users who use Apple Store as their application store and have a university degree in their education life download productivity app category with percentage 35.5% (support percentage is 10.9%)
- Users who are aged from 26 to 36 (Young_Adult) download productivity app category with percentage 25.1% (support percentage is 26%)
- Users who are aged from 26 to 36 (Young_Adult) and have a university degree in their education life download productivity app category with percentage 31.3% (support percentage is 15.4%)
- Users who are aged from 26 to 36 (Young_Adult), have a university degree in their education life and in a relationship with someone download productivity app category with percentage 32.2% (support percentage is 11.4%)
- Users who are aged from 26 to 36 (Young_Adult), have a university degree in their education life and have a personality of being open to new experiences, complex and dependable, self-disciplined download productivity app category with percentage 35.4% (support percentage is 10.1%)

User Profile	Download App Percentage
Young_Adult	25.1%
Young_Adult + University degree	31.3%
Young_Adult + University degree + In a relationship	32.2%
Young_Adult + University degree + Open to new experiences, complex + Dependable, self-disciplined	35.4%

User Profile	Download App Percentage
Apple Store	28%
Apple Store + Working	31.1%
Apple Store + Working + Male	32.5%
Apple Store + University degree	35.5%
Apple Store + Master or doctoral education level + Male	57.8%

Evaluation of Productivity App Category

For productivity app category these are the best user profiles for highest downloading app percentage:

- Based on general user characteristics: Users who are aged from 26 to 36 (Young_Adult), have a university degree in their education life and have a personality of being open to new experiences, complex and dependable, self-disciplined download productivity app category with percentage 35.4%

- Based on used application store: Users who use Apple Store as their application store have an education level either master or doctoral and male download productivity app category with percentage 57.8%

Based on support percentage (coverage ratio) these user characteristics can also be taken into consideration:

- Approximately 35.7% percent of all mobile app users are male and have a personality of open to new experiences, complex. 25.1% of them download productivity apps.
- Approximately 28.7% percent of all mobile app users are male and working. 26.7% of them download productivity apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Productivity App Category	81.69%	81.89%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for productivity app category.

5.22 Music App Category

Apps under this category are for discovering, listening to, recording, performing or composing music, and in general they are interactive. Their content could be about music creation, radio, sound editing, music discovery composition, lyric writing, band and recording artists and concerts. (Choosing a Category [APA], n.d.) Example apps: Spotify, TuneIn Radio and Shazam. In the survey there are 2006 mobile app users that download music apps. It corresponds to 38.8% of all mobile app users.

Music App Category Decision Tree Results

- Users who live in Russian Federation or India and don't have a personality of being open to new experiences, complex download music app category with percentage 64.1% (number of instances are 142)

- Users who live in China, Brazil, Mexico or Republic of Korea, use Apple Store as their application store download music app category with percentage 68.9% (number of instances are 193)

Music App Category Apriori Results

- Users who live in South America (Brazil or Mexico) and have a personality of being sympathetic, warm download music app category with percentage 53.3% (support percentage is 10.4%)
- Users who live in East Asia (Japan, Korean Federation or China) and have a personality of being sympathetic, warm and open to new experiences, complex download music app category with percentage 54% (support percentage is 11.1%)
- Users who live in China download music app category with percentage 61.1% (support percentage is 10%)
- Users who are student download music app category with percentage 50.6% (support percentage is 19.5%)
- Users who are student and female download music app category with percentage 52.5% (support percentage is 11.1%)
- Users who are student and have a personality of being dependable, self-disciplined and sympathetic, warm download music app category with percentage 53.1% (support percentage is 10%)
- Users who are student, female and aged less than 26 years (Young) download music app category with percentage 53.8% (support percentage is 10.3%)
- Users who are aged less than 26 years old (Young) download music app category with percentage 51.1% (support percentage is 31.6%)
- Users who are aged less than 26 years old (Young), alone as their relationship status and have a personality of being sympathetic, warm and not conventional, uncreative download music app category with percentage 55.7% (support percentage is 10.5%)
- Users who use Nokia Ovi Store as their application store download music app category with percentage 41.1% (support percentage is 13.9%)

- Users who use Samsung Application Store as their application store download music app category with percentage 41.4% (support percentage is 12.4%)

- Users who use Apple Store as their application store download music app category with percentage 43% (support percentage is 20.2%)

- Users who use Google Play Store as their application store download music app category with percentage 43.5% (support percentage is 36.2%)

- Users who use Google Play Store as their application store, alone as their relationship status download music app category with percentage 48.8% (support percentage is 16.7%)

- Users who use Google Play Store as their application store, alone as their relationship status and aged less than 26 years old (Young) download music app category with percentage 53.5% (support percentage is 10.7%)

User Profile	Download App Percentage
Living in South America (Brazil or Mexico) + Sympathetic, warm	53.3%
Living in East Asia (Japan, China or Republic of Korea) + Sympathetic, warm + Open to new experiences, complex	54%
Living in China	61.1%
Living in Russia or India + Not open to new experiences, complex	64.1%
Living in China, Brazil, Mexico or Republic of Korea + Apple Store	68.9%

User Profile	Download App Percentage
Student	50.6%
Student + Female	52.5%
Student + Dependable, self-disciplined + Sympathetic, warm	53.1%
Student + Female + Young	53.8%

User Profile	Download App Percentage
Young	51.6%
Young + Alone + Sympathetic, warm + Not conventional, uncreative	55.7%

User Profile	Download App Percentage
Nokia Ovi Store	41.1%
Samsung Application Store	41.4%
Apple Store	43%
Google Play Store	43.5%
Google Play Store + Alone	48.8%
Google Play Store + Alone + Young	53.5%

Evaluation of Music App Category

For music app category these are the best user profiles for highest downloading app percentage:

- Based on location: Users who live in China, Brazil, Mexico or Republic of Korea, use Apple Store as their application store download music app category with percentage 68.9%

- Based on general user characteristics: Users who are aged less than 26 years old (Young), alone as their relationship status and have a personality of being sympathetic, warm and not conventional, uncreative download music app category with percentage 55.7%

- Based on used application store: Users who use Google Play Store as their application store, alone as their relationship status and aged less than 26 years old (Young) download music app category with percentage 53.5%

Based on support percentage (coverage ratio) these user characteristics can also be taken into consideration:

- Approximately 59.3% percent of all mobile app users don't have a personality of conventional, uncreative 42.1% of them download music apps.

- Approximately 41.1% percent of all mobile app users are alone as their relationship status. 43.3% of them download music apps.

Accuracy of built model can be seen below:

App Category Name	Training Accuracy	Test Accuracy
Music App Category	68.82%	63.85%

Built model gave a satisfactory result for identifying at least one user profile that has a download app percentage 50% for music app category.

6 Deployment

Decision on the use of data mining results have been stated in the evaluation of each app category. Briefly, selected data mining results identifies target app users for related app category. Now the question is how to use these data mining results as a business action. There are multiple ways that an app store or a mobile app developer can benefit from the results as an app promotion strategy. Main point is matching characters used in marketing channel with the user profiles selected in an app's evaluation category. In other words, potential app downloaders/users should be represented in that marketing channel. Prepared content of marketing channel (product video, tv advertising etc.) should emphasize characteristics of the selected user profile. (E.g: Gender, age group, working status, personality etc.)

One of the best way is preparing a "product video". A simple product video which displays features is an effective tool for showing off an app or app category in general. This video could be promoted in Facebook Ads, YouTube clips or various social media platforms. (10 "Must-have" App Promotion and Marketing Strategies [APA], n.d.). The scenario or characters in a video could match selected data mining results in evaluation section. An example related to this could be for navigation app category. For this app category users with following profile have a high percentage of downloading: Users who are male, working, have a personality of being extraverted, enthusiastic and sympathetic, warm and don't have a personality of disorganized, careless. In a product video for navigation app category, main character could be a man who goes to his job in the morning. And ad scenario can can be written in a way to emphasize male character's extraverted, enthusiastic and sympathetic, warm and not disorganized, careless personality.

An alternative way could be TV ads. TV ads or ads during streaming online is also commonly used in traditional advertising strategies (10 "Must-have" App Promotion and Marketing Strategies [APA], n.d.) But it is still effective and could be performed by mobile app developer company or by an app store.

An alternative marketing channel could be tech blog posts especially for mobile app developers. Regarding writing a blog post solely about an app, they should write a complete story about app. (Blair [APA], n.d.). While creating this story

they can benefit from app market research which has identified potential app downloaders/users.

From mobile app developer's perspective, they can observe data mining results and decide which app store to give priority for distribution of developed apps. For instance: Apple Store users are more likely to download entertainment apps compared to Google Play Store, Samsung Application Store and other app stores. With using this knowledge app store priority could be given to first Apple Store, second Google Play Store, third Samsung Application Store and then other app stores. Or using best user location data mining result they can check what is the native language in that country and write an app description section in that language. For instance: Regarding lifestyle app category China provides a better market compared to other countries that survey is performed. With this knowledge a chinese app description can also be provided to aim more users to download/use their apps.

This deployment section could be planned in details by marketing professionals. Above I just gave some possible ideas how an application store or a mobile app developer can use identified user profiles in order to promote a whole app category or a single mobile app in this competitive market.

7 Recommendations to Software Engineering

In the deployment section I mentioned how data mining results can be used as a part of marketing strategy of a whole app category by an app store or a single app by a mobile app company. In this section, I am going to explain how data mining results can be used by software engineering area.

After an app store is determined where mobile app will be distributed, developers need to examine that app store's guideline. Guidelines change frequently and are different across platforms and countries. Examining guidelines carefully will save time for software engineers through development stage and will reduce possibility of being rejected from the store. (Lim, Bentley, Kanakam, Ishikawa & Honiden, 2015)

Mobile app developers generally want to make their apps available on multiple app stores in order to reach more users. However, they face difficulties due to differences in hardware specifications (screen size, resolution, memory), software architecture, API, programming languages and app store guidelines. To solve this problem techniques from software product line development can be used. This methodology develop apps with few features and then enable them to be released and updated quickly across multiple platforms (Lim, Bentley, Kanakam, Ishikawa & Honiden, 2015). Software product line development, refers to software engineering methods, tools and techniques for creating a collection of similar software systems from a shared set of software assets using a common means of production. (Effective software design, 2013)

Mobile app usage is highly related to user's physical and social context. For instance: Utility apps (alarms, clocks) are mostly used at home. Travel apps are mostly used during a vacation. Another example is news and weather apps are used as daily and at a certain time during the day. With using this activity logs knowledge, developers could implement prefetching mechanisms in their apps to reduce latency perceived by users. (Lim, Bentley, Kanakam, Ishikawa & Honiden, 2015)

Mobile app companies could use "creative requirements engineering" techniques to invent new functionalities and catch users' interests. Requirement engineering is commonly seen as passively listening and recording what stakeholder

says. However, creative requirement engineering is far beyond it. It is about creative thinking directly and brainstorming with stakeholder. (IEEE computer society, 2006) This creative requirement engineering may result with more differentiated and unique apps in the market. It is especially valuable for app categories which are most popular such as: Games and social networking. (Lim, Bentley, Kanakam, Ishikawa & Honiden, 2015)

Lastly, more customized mobile app recommender systems can be used through app stores. These recommender systems should recommend apps based on user profiles' characteristics. (E.g: gender, age group, country of residence etc.) These systems should recommend same mobile apps to different users who consists a certain degree similarity.

8 Conclusion

Throughout my master thesis, I followed CRISP-DM methodology. In data preparation part I discovered insight about non mobile app users and their percentage. Approximately, 39.5% of survey participants are non mobile app users. In modeling & evaluation part I also discovered downloading percentage of each app category among all mobile app users in the survey. Most downloaded three mobile app categories are respectively: Games, social networking and music. In addition least downloaded three mobile app categories are respectively: Catalogues, medical and reference.

Decision tree and apriori algorithms achieved to identify mobile app users for twenty categories out of twenty two. Only for catalogues and medical app categories, algorithms couldn't find any user profile that satisfies minimum standards about getting a data mining result. Regarding data mining success criteria, built model made success for sixteen categories out of twenty two. In other words, for sixteen categories algorithms found a user profile which has at least 50% of downloading app percentage. The failed six categories are: catalogues, health & fitness, education, medical, reference and sports.

Regarding analysis results and model accuracy, most of the categories resulted with test dataset accuracy more than 70%. (some of them are between 60% 70%) if dataset had more data records, this accuracy percentage could be more. Because presence of more data results in better and accurate models. (Ray, 2015) Moreover, this issue may help to achieve data mining success criteria for the failed six categories. These six categories are not popular app categories compared to other categories. An alternative solution could be algorithm tuning. Machine learning algorithms are driven by parameters and setting an optimum value for these parameters (e.g: depth of tree, minimum support percentage etc.) is essentially important. Tuning parameters may lead more accurate models. (Ray, 2015)

In the deployment section I also explained how a an app store or a mobile app company can use data mining results to provide a business value. I gave some example ideas about how they can use these identified user profiles in a marketing strategy of a whole app category or a single app in this competitive market.

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At the end I provided some recommendations to software engineering area. Briefly, recommendations can be expressed as: Examining app store guideline before starting app development, software product line development methodology to enable apps in multiple stores, considering activity logs of apps to reduce latency experienced by users, creative requirement engineering to differentiate apps in the market and more customized recommender systems in app stores.

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ANNEX

Q1 Browser Meta Info
- Browser (1)
- Version (2)
- Operating System (3)
- Screen Resolution (4)
- Flash Version (5)
- Java Support (6)
- User Agent (7)

Q2 Do you own a mobile device? (e.g., phone or tablet)
- Yes (1)
- No (2)

Q3 What mobile device do you use?
- Manufacturer name (e.g., Nokia) (1)
- Model name and number (e.g., E71) (2)

Q4 Which app store do you use?
- Apple iOS App Store (1)
- Blackberry App World (2)
- Google Play / Android Market (3)
- Nokia Ovi Store (4)
- Samsung Application Store (5)
- Windows Phone Marketplace (6)
- None - my mobile device cannot run apps (7)
- I don't know (8)
- Other (please specify) (9) _____
- None - I don't use apps (10)

Q5 How frequently do you visit the app store to look for apps?
- Never (1)
- Less than once a month (2)
- Once a month (3)
- More than once a month (4)
- Once a week (5)
- More than once a week (6)
- Once a day (7)
- Several times a day (8)
- Other (please specify) (9) _____

Q6 On average, how many apps do you download a month?

- 0 - 1 (1)
- 2 - 5 (2)
- 6 - 10 (3)
- 11 - 20 (4)
- 21 - 30 (5)
- More than 30 (6)

Q7 When do you look for apps? (please select all that apply)

- When feeling depressed. (1)
- When I need to carry out a task. (2)
- When I am feeling bored. (3)
- When I want to be entertained. (4)
- When I need to know something. (5)
- Other (please specify) (6) _____

Q8 How do you find apps? (please select all that apply)

- I compare several apps in order to choose the best ones. (1)
- I download the first app that I see on the list of apps presented to me. (2)
- I look for apps that are featured on the front page of the app store. (3)
- I look at the top downloads chart. (4)
- I browse randomly for apps that might interest me. (5)
- I search the app store using keywords. (7) (keyword/name)
- I visit websites that review apps. (8)
- I use search engines (e.g., Google). (9)
- Other (please specify) (10) _____

Q9 What do you consider when choosing apps to download? (please select all that apply)

- Reviews by other users (1)
- Name of app (e.g., catchy name) (2)
- Number of users who have downloaded the app (3)
- Icon (e.g., if the icon is attractive) (4)
- Description of the app (5)
- Features (6)
- Number of users who have rated the app (7)
- Price (8)
- Star rating (9)
- Size of app (10)
- Screen shots (e.g., to see how the app looks like when running) (11)
- Who developed the app (12)

- Other (please specify) (13) _____

Q10 Why do you download an app? (please select all that apply)
- To interact with friends and/or family. (1)
- To interact with people I don't know. (2)
- To help me carry out a task. (3)
- It is featured in the app store. (4)
- It is on the top downloads chart. (5)
- It is advertised in the apps that I am using. (6)
- For entertainment. (7)
- Out of curiosity. (8)
- An impulsive purchase. (9)
- It features brands or celebrities that I like (e.g., Coca-Cola, Michael Jackson). (10)
- It was mentioned in the media (e.g., TV, newspaper, radio, blogs). (11)
- It is an extension of the website that I use (e.g., Facebook app). (12)
- It is recommended by friends and/or family. (13)
- For someone else (e.g., children, partner). (14)
- Other (please specify) (15) _____

Q11 Why do you spend money on an app? (please select all that apply)
- I do not pay for apps. (1)
- To remove advertisements from the app. (2)
- The paid app is on sale for a reduced price. (3)
- To subscribe to free content (e.g., magazine, newspaper). (4)
- The app is initially free but I have to pay for features that I want. (5)
- I can't find a free app with similar features. (6)
- I think paid apps have better quality than free apps in general. (11)
- I think paid apps have more features than free apps in general. (12)
- To get additional features or content for a paid app. (7)
- To subscribe to paid content (e.g., magazine, newspaper). (8)
- Compared to free apps with similar features, the paid app appears to be of better quality. (9)
- Other (please specify) (10) _____

Answer If Why do you spend money on an app? (please select all that... To remove advertisements from the app. Is Selected Or Why do you spend money on an app? (please select all that... The paid app is on sale for a reduced price. Is Selected Or Why do you spend money on an app? (please select all that... To subscribe to free content (e.g., magazine, newspaper). Is Selected Or Why do you spend money on an app? (please select all that... The app is initially free but I have to pay for features that I want. Is Selected Or Why do you spend money on an app? (please select all that... I can't find a free app with similar features. Is Selected Or Why do you spend money on an app? (please select all that... I think paid apps

have better quality than free apps in general. Is Selected Or Why do you spend money on an app? (please select all that... I think paid apps have more features than free apps in general. Is Selected Or Why do you spend money on an app? (please select all that... To get additional features or content for a paid app. Is Selected Or Why do you spend money on an app? (please select all that... To subscribe to paid content (e.g., magazine, newspaper). Is Selected Or Why do you spend money on an app? (please select all that... Compared to free apps with similar features, the paid app appears to be of better quality. Is Selected Or Why do you spend money on an app? (please select all that... Other (please specify) Is Selected

Q12.1 What is the most you have spent on an app? (including in-app purchases such as additional features and subscription)

      What is the amount you spent? (please specify currency) (1)
      What is the name of the app? (2)
      Why did you download the app? (e.g., I wanted to find my way, my friend told me the app was good) (3)
      Describe the best and/or worst feature of the app. (4)

Answer If Why do you spend money on an app? (please select all that... To remove advertisements from the app. Is Selected Or Why do you spend money on an app? (please select all that... The paid app is on sale for a reduced price. Is Selected Or Why do you spend money on an app? (please select all that... To subscribe to free content (e.g., magazine, newspaper). Is Selected Or Why do you spend money on an app? (please select all that... I can't find a free app with similar features. Is Selected Or Why do you spend money on an app? (please select all that... I think paid apps have better quality than free apps in general. Is Selected Or Why do you spend money on an app? (please select all that... I think paid apps have more features than free apps in general. Is Selected Or Why do you spend money on an app? (please select all that... To get additional features or content for a paid app. Is Selected Or Why do you spend money on an app? (please select all that... To subscribe to paid content (e.g., magazine, newspaper). Is Selected Or Why do you spend money on an app? (please select all that... Compared to free apps with similar features, the paid app appears to be of better quality. Is Selected Or Why do you spend money on an app? (please select all that... Other (please specify) Is Selected Or Why do you spend money on an app? (please select all that... The app is initially free but I have to pay for features that I want. Is Selected

Q12.2 On average, how much do you spend on apps each month? (including in-app purchases such as additional features and subscription)

Q13 Why do you rate apps? (please select all that apply)
- I don't rate apps. (1)
- To let other users to know that the app is good. (2)
- Someone asked me to do so. (3)
- The app asked me to rate it. (4)
- To let other users to know that the app is bad. (5)
- The app rewards me for rating it. (6)
- Other (please specify) (7) _____

Q14 What makes you stop using an app? (please select all that apply)
- It crashes. (1)
- I found better alternatives. (2)
- The advertisements are annoying. (3)
- It is difficult to use. (4)
- It is no longer used by my friends and/or family. (5)
- I need to pay extra for the features I need. (6)
- I forgot about the app. (7)
- I do not need the features it provides. (8)
- It invades my privacy. (9)
- It is too slow. (10)
- I got bored of it. (11)
- It does not work. (12)
- It does not have the features I hoped for. (13)
- I don't need it anymore. (15)
- Other (please specify) (14) _____

Q15 Which type of apps do you download? (please select all that apply)
- Navigation (e.g., GPS Navigation, Gyro Compass) (1)
- Business (e.g., PrintCentral, Quickoffice) (2)
- Catalogues (e.g., 1001 Home Interior Catalog, Art) (3)
- Travel (e.g., TripAdvisor, Lonely Planet Traveller) (4)
- Books (e.g., Kindle, Audiobook & Podcast Player) (5)
- Photo & video (e.g., Adobe, iMovie) (6)
- Lifestyle (e.g., eBay, Gumtree) (7)
- Entertainment (e.g., X Factor, Toca Hair Salon) (8)
- Finance (e.g., Debt Manager, Account Tracker) (9)
- News (e.g., Sunday Times, Bloomberg Businessweek) (10)
- Health & fitness (e.g., Calorie Counter, Simply Yoga) (11)
- Games (e.g., Angry Birds, Flight Control) (12)
- Food & drink (e.g., Domino's Pizza, Good Food Magazine) (13)
- Education (e.g., MathStudio, TED) (14)

- Medical (e.g., iStethoscope, Vision Test) (15)
- Social networking (e.g., Skype, Facebook) (16)
- Reference (e.g., Birds of Brazil, World's Longest Rivers) (17)
- Sports (e.g., NFL Game Pass, LiveScore) (18)
- Utilities (e.g., Calculator, Alarm Clock) (19)
- Weather (e.g., Weather+, Weather Live) (20)
- Productivity (e.g., Dropbox, Pages) (21)
- Music (e.g., djay, Piano*) (22)
- Other (please specify) (23) _____

Q16 This section asks about your demographic information (e.g., age, nationality, occupation). This is to ensure that we have surveyed a varied mix of people in society.What is your gender?
- Male (1)
- Female (2)

Q17 What is your age?

Q18 What is your marital status?
- In a relationship (1)
- Single (2)
- Married (3)
- Divorced (4)
- Widowed (5)
- Separated (6)
- Other (please specify) (7) _____

Q19 What is your nationality?
- American (1)
- Australian (2)
- Brazillian (3)
- British (4)
- Canadian (5)
- Chinese (6)
- French (7)
- German (8)
- Indian (9)
- Italian (10)
- Japanese (11)
- Mexican (12)
- Russian (13)

- South Korean (14)
- Spanish (15)
- Other (please specify) (16) _____

Q20 What is your country of residence?
- Australia (1)
- Brazil (2)
- Canada (3)
- China (4)
- France (5)
- Germany (6)
- India (7)
- Italy (8)
- Japan (9)
- Mexico (10)
- Republic of Korea (11)
- Russian Federation (12)
- Spain (13)
- United Kingdom (14)
- United States (15)
- Other (please specify) (16) _____

Q21 What is your first language?
- English (1)
- French (2)
- German (3)
- Italian (4)
- Japanese (5)
- Korean (6)
- Mandarin (7)
- Portuguese (8)
- Russian (9)
- Spanish (10)
- Other (please specify) (11) _____

Q22 What is your ethnicity?
- Asian (please specify, e.g., Chinese) (1) _____
- Black (please specify, e.g., African American) (2) _____
- Hispanic (please specify, e.g., Puerto Rican) (3) _____
- White (please specify, e.g., Scottish) (4) _____
- Mixed (please specify, e.g., English and German) (5) _____
- Other (please specify) (6) _____

- Prefer not to say (7)

Q23 What is the highest level of education you have completed?
- Primary school (1)
- Secondary / High school (2)
- Diploma (3)
- Vocational training (4)
- Undergraduate degree (5)
- Master's degree (6)
- Doctoral degree (7)
- Other (please specify) (8) _____

Q24 How many years of education have you received?(from age 5 until now, including kindergarten / pre-school, excluding gaps in between)

Q25 Do you have a disability?
- Yes (please specify) (1) _____
- No (2)
- Prefer not to say (3)

Q26 What is your current employment status?
- Full-time (1)
- Part-time (2)
- Self-employed (3)
- Student (4)
- Homemaker (5)
- Unemployed (6)
- Unable to work (7)
- Retired (8)
- Other (please specify) (9) _____

Q27 What is your current or most recent occupation?
- Management Occupations (1)
- Business and Financial Operations Occupations (2)
- Computer and Mathematical Occupations (3)
- Architecture and Engineering Occupations (4)
- Life, Physical, and Social Science Occupations (5)
- Community and Social Services Occupations (6)
- Legal Occupations (7)
- Education, Training, and Library Occupations (8)

- Arts, Design, Entertainment, Sports, and Media Occupations (9)
- Healthcare Practitioners and Technical Occupations (10)
- Healthcare Support Occupations (11)
- Protective Service Occupations (12)
- Food Preparation and Serving Related Occupations (13)
- Building and Grounds Cleaning and Maintenance Occupations (14)
- Personal Care and Service Occupations (15)
- Sales and Related Occupations (16)
- Office and Administrative Support Occupations (17)
- Farming, Fishing, and Forestry Occupations (18)
- Construction and Extraction Occupations (19)
- Installation, Maintenance, and Repair Occupations (20)
- Production Occupations (21)
- Transportation and Material Moving Occupations (22)
- Military Specific Occupations (23)
- Student (24)
- Other (please specify) (25) _____

Q28 What currency is your household income in?
- Australian Dollar (AUD) (1)
- Brazilian Real (BRL) (2)
- British Pound (GBP) (3)
- Canadian Dollar (CAD) (4)
- Chinese Yuan Renminbi (CNY) (5)
- Euro (EUR) (6)
- Indian Rupee (INR) (7)
- Japanese Yen (JPY) (8)
- Mexican Peso (MXN) (9)
- Russian Ruble (RUB) (10)
- South Korean Won (KRW) (11)
- US Dollar (USD) (12)
- Other (please specify) (13) _____

Answer If What currency is your household income in? Australian Dollar (AUD) Is Selected
Q29.1 What is your annual household income in
${q://QID36/ChoiceGroup/SelectedChoices}? (before tax)
- 0 - 10,000 (1)
- 10,001 - 20,000 (2)
- 20,001 - 40,000 (3)
- 40,001 - 60,000 (4)
- 60,001 - 80,000 (5)
- 80,001 - 100,000 (6)

- 100,001 - 150,000 (7)
- 150,001 - 200,000 (8)
- 200,001 - 300,000 (9)
- 300,001 - 450,000 (10)
- More than 450,000 (11)
- Prefer not to say (12)

Answer If What currency is your household income in? Brazilian Real (BRL) Is Selected
Q29.2 What is your annual household income in
${q://QID36/ChoiceGroup/SelectedChoices}? (before tax)
- 0 - 5,000 (1)
- 5,001 - 10,000 (2)
- 10,001 - 20,000 (3)
- 20,001 - 30,000 (4)
- 30,001 - 40,000 (5)
- 40,001 - 50,000 (6)
- 50,001 - 75,000 (7)
- 75,001 - 100,000 (8)
- 100,001 - 150,000 (9)
- 150,001 - 250,000 (10)
- More than 250,000 (11)
- Prefer not to say (12)

Answer If What currency is your household income in? British Pound (GBP) Is Selected
Q29.3 What is your annual household income in
${q://QID36/ChoiceGroup/SelectedChoices}? (before tax)
- 0 - 5,000 (1)
- 5,001 - 10,000 (2)
- 10,001 - 15,000 (3)
- 15,001 - 20,000 (4)
- 20,001 - 30,000 (5)
- 30,001 - 40,000 (6)
- 40,001 - 50,000 (7)
- 50,001 - 75,000 (8)
- 75,001 - 100,000 (9)
- 100,001 - 150,000 (10)
- More than 150,000 (11)
- Prefer not to say (12)

Answer If What currency is your household income in? Canadian Dollar (CAD) Is Selected

Q29.4 What is your annual household income in
${q://QID36/ChoiceGroup/SelectedChoices}? (before tax)

- 0 - 10,000 (1)
- 10,001 - 20,000 (2)
- 20,001 - 30,000 (3)
- 30,001 - 50,000 (4)
- 50,001 - 70,000 (5)
- 70,001 - 100,000 (6)
- 100,001 - 150,000 (7)
- 150,001 - 200,000 (8)
- 200,001 - 250,000 (9)
- 250,001 - 350,000 (10)
- More than 350,000 (11)
- Prefer not to say (12)

Answer If What currency is your household income in? Chinese Yuan Renminbi (CNY) Is Selected

Q29.5 What is your annual household income in
${q://QID36/ChoiceGroup/SelectedChoices}? (before tax)

- 0 - 5,000 (1)
- 5,001 - 10,000 (2)
- 10,001 - 20,000 (3)
- 20,001 - 30,000 (4)
- 30,001 - 40,000 (5)
- 40,001 - 50,000 (6)
- 50,001 - 75,000 (7)
- 75,001 - 100,000 (8)
- 100,001 - 150,000 (9)
- 150,001 - 250,000 (10)
- More than 250,000 (11)
- Prefer not to say (12)

Answer If What currency is your household income in? Euro (EUR) Is Selected

Q29.6 What is your annual household income in
${q://QID36/ChoiceGroup/SelectedChoices}? (before tax)

- 0 - 5,000 (1)
- 5,001 - 10,000 (2)
- 10,001 - 20,000 (3)
- 20,001 - 30,000 (4)

- 30,001 - 40,000 (5)
- 40,001 - 50,000 (6)
- 50,001 - 75,000 (7)
- 75,001 - 100,000 (8)
- 100,001 - 150,000 (9)
- 150,001 - 250,000 (10)
- More than 250,000 (11)
- Prefer not to say (12)

Answer If What currency is your household income in? Indian Rupee (INR) Is Selected
Q29.7 What is your annual household income in
${q://QID36/ChoiceGroup/SelectedChoices}? (before tax)
- 0 - 20,000 (1)
- 20,001 - 40,000 (2)
- 40,001 - 60,000 (3)
- 60,001 - 80,000 (4)
- 80,001 - 100,000 (5)
- 100,001 - 150,000 (6)
- 150,001 - 200,000 (7)
- 200,001 - 300,000 (8)
- 300,001 - 400,000 (9)
- 400,001 - 600,000 (10)
- More than 600,000 (11)
- Prefer not to say (12)

Answer If What currency is your household income in? Japanese Yen (JPY) Is Selected
Q29.8 What is your annual household income in
${q://QID36/ChoiceGroup/SelectedChoices}? (before tax)
- 0 - 1,000,000 (1)
- 1,000,001 - 2,000,000 (2)
- 2,000,001 - 3,000,000 (3)
- 3,000,001 - 4,000,000 (4)
- 4,000,001 - 5,000,000 (5)
- 5,000,001 - 6,000,000 (6)
- 6,000,001 - 8,000,000 (7)
- 8,000,001 - 12,000,000 (8)
- 12,000,001 - 20,000,000 (9)
- 20,000,001 - 30,000,000 (10)
- More than 30,000,000 (11)
- Prefer not to say (12)

Answer If What currency is your household income in? Mexican Peso (MXN) Is Selected
Q29.9 What is your annual household income in
${q://QID36/ChoiceGroup/SelectedChoices}? (before tax)

- 0 - 25,000 (1)
- 25,001 - 50,000 (2)
- 50,001 - 75,000 (3)
- 75,001 - 100,000 (4)
- 100,001 - 125,000 (5)
- 125,001 - 150,000 (6)
- 150,001 - 200,000 (7)
- 200,001 - 300,000 (8)
- 300,001 - 500,000 (9)
- 500,001 - 750,000 (10)
- More than 750,000 (11)
- Prefer not to say (12)

Answer If What currency is your household income in? Russian Ruble (RUB) Is Selected
Q29.10 What is your annual household income in
${q://QID36/ChoiceGroup/SelectedChoices}? (before tax)

- 0 - 100,000 (1)
- 100,001 - 200,000 (2)
- 200,001 - 300,000 (3)
- 300,001 - 400,000 (4)
- 400,001 - 500,000 (5)
- 500,001 - 600,000 (6)
- 600,001 - 800,000 (7)
- 800,001 - 1,200,000 (8)
- 1,200,001 - 2,000,000 (9)
- 2,000,001 - 3,000,000 (10)
- More than 3,000,000 (11)
- Prefer not to say (12)

Answer If What currency is your household income in? South Korean Won (KRW) Is
Selected
Q29.11 What is your annual household income in
${q://QID36/ChoiceGroup/SelectedChoices}? (before tax)

- 0 - 5,000,000 (1)
- 5,000,001 - 10,000,000 (2)
- 10,000,001 - 20,000,000 (3)
- 20,000,001 - 30,000,000 (4)

- 30,000,001 - 40,000,000 (5)
- 40,000,001 - 50,000,000 (6)
- 50,000,001 - 75,000,000 (7)
- 75,000,001 - 100,000,000 (8)
- 100,000,001 - 150,000,000 (9)
- 150,000,001 - 250,000,000 (10)
- More than 250,000,000 (11)
- Prefer not to say (12)

Answer If What currency is your household income in? US Dollar (USD) Is Selected
Q29.12 What is your annual household income in
${q://QID36/ChoiceGroup/SelectedChoices}? (before tax)

- 0 - 10,000 (1)
- 10,001 - 20,000 (2)
- 20,001 - 30,000 (3)
- 30,001 - 50,000 (4)
- 50,001 - 70,000 (5)
- 70,001 - 100,000 (6)
- 100,001 - 150,000 (7)
- 150,001 - 200,000 (8)
- 200,001 - 250,000 (9)
- 250,001 - 350,000 (10)
- More than 350,000 (11)
- Prefer not to say (12)

Answer If What currency is your household income in? Other (please specify) Is Selected
Q29.13 What is your annual household income in the currency you previously specified?
(before tax)
- The amount is (1) _____
- Prefer not to say (2)

Q30 Your personality may influence the types of apps you like. In this final section, we ask about your personality.Here are a number of personality traits that may or may not apply to you. Please rate the extent to which the pair of traits applies to you, even if one characteristic applies more strongly than the other.1 = Disagree strongly 2 = Disagree moderately 3 = Disagree a little 4 = Neither agree nor disagree 5 = Agree a little 6 = Agree moderately 7 = Agree strongly see myself as:
_____ Extraverted, enthusiastic (1)
_____ Critical, quarrelsome (2)
_____ Dependable, self-disciplined (3)
_____ Anxious, easily upset (4)

_____ Open to new experiences, complex (5)

_____ Reserved, quiet (6)

_____ Sympathetic, warm (7)

_____ Disorganized, careless (8)

_____ Calm, emotionally stable (9)

_____ Conventional, uncreative (10)