

The role of users impulsiveness in detecting mobile phone excessive dependence: A feature selection analysis

Research-in-Progress

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Abstract

With the advancement of information and communications technologies, and the booming of mobile apps, mobile phone addiction is on the rise. The current approach to detect mobile phone excessive dependence is through the amount of phone usage, including duration, times picking up the phone and etc. However, literature on addiction suggests that impulsive action is also a key indicator of addictive behavior. Thus, this study proposes that the impulsive behavior rather than the amount of usage can be a better predictor of mobile phone dependence. With longitudinal phone usage data collected from 60 users, this study has identified that the minimum time interval between two pickups describes mobile phone dependence better than the amount of usage. Planned future analysis and potential contributions are discussed.

Keywords: mobile phone dependence, impulsivity, feature selection

Introduction

With the advancement of information and communication technologies (ICT), and the booming of mobile apps, mobile phone addiction is on the rise. According to a survey on smartphone owners' mobile surfing behaviour, the time people spent on mobile phone has doubled from 2012 to 2016 (Deloitte, 2017). Mobile phone addictions are found to cause many mental and psychological health problems including depression, spine problems, dry-eye disease and insomnia (Thoméé et al. 2011). It may also affect peoples' study or work performance, and their personal relationships (Salovaara et al. 2011).

The first step of providing intervention to mobile phone addition is to understand users' level of dependence on their phone. This is usually done through analysing users' amount of phone usage. For example, to address the negative consequences related to excessive phone usage, both iOS and Android platform have introduced new functions to help users understand and take control of the time they spend interacting with their mobile phones. The *ScreenTime* on iOS creates detailed daily and weekly activity reports that show the total time a person spends in each app they use, their usage across categories of

apps, how many notifications they receive and how often they pick up their phone. However, mobile phone is now used for many different purposes, including self-learning, health-tracking, traffic inquiry, and work-related tasks. Longer duration of usage may not imply the users are addicted to mobile phones.

In this study, we are proposing new features to describe mobile phone dependence based on addiction literature. Addiction was initially used to describe the uncontrollable and irrepressible actions driven by the impulsion (Pollak 197), usually related to drug consumption. With the advancement of digital technologies, it has been used to explain the uncontrollable and irrepressible actions to use Internet, social media, games and phones. According to the definition of addiction, the impulsive actions are the driver of addiction and overuse is just the consequence. We are interested to find out how to represent the impulsivity in phone usage so that can better describe mobile phone excessive dependence.

Through a field study with a self-developed Android app, we have collected 60 users' detailed phone usage data over a month. Different features were created to describe the amount of usage and impulsive actions. Through features selection analysis, we will look at which feature describes users' mobile phone dependence better. The rest of the paper is organised as follows: the theoretical background on addiction and mobile phone excessive dependence will be discussed first. The detailed information on research design will be presented next. Descriptive data and feature selection results will then be discussed, followed by discussion, limitations and future research plan. The study will bring a novel perspective to understand mobile phone addiction and provide insights on designing intervention programs.

Theoretical Background and Literature Review

Addiction and Mobile Phone Excessive Dependence

Addiction is considered by the World Health Organisation as dependence – the continuous use of something for the sake of relief, comfort or stimulation – which often causes cravings when it is absent (Malhotra and Yinayak 2017). Impulsiveness is a trait that has been shown to be a strong predictor of various maladaptive behaviours – including the problematic use of mobile phones – and related to reduced self-control and decision-making skills. It is defined as a predisposition toward rapid, unplanned reactions to internal or external stimuli without the capacity to assess the consequences of their actions, either for themselves or for others (Horvath et al., 2016). In the literature, there are two types of addictions: behavioural addiction and substance addiction (Griffiths, 2017). Behavioral addiction does not involve any physical object or substance, and the physical signs of drug addiction are also absent in behavioral addiction.

There are many new forms of addictions in the digital era, including Internet addition, social network sites addition, computer games and mobile phone addiction (Weinstein 2010; Kuss and Griffiths 2011; Ko et al. 2012; Kwon et al, 2016). It is still disputable whether they belong to behavioural addition or substance addiction as it involves a physical object (e.g. phone) and also the behavioral that stimulating a person (e.g., playing games). Many studies believe that addiction is a disease which requires psychological and psychiatric treatment (Pollak 1970). The mechanism of Internet addiction is considered similar as drug or alcohol dependency (Kandell 1998). Social network sites dependence was found to have similar symptoms as substance dependence (Young 1999). Studies on constant game playing report that the activity will generate pleasure and reinforce the release of dopamine in the user's brain, which works as a reward system to further trigger the playing behaviours (Thalemann et al, 2007). The literature has also brought up the concept of mobile phone excessive dependence to describe an early form of addition. It refers to the excessive use of mobile phones and applications installed on the phone (Kwon et al., 2016). In the context of medicine, mobile phone excessive dependence is also considered as a chronic mental disease triggered by the neurological predisposition (de la Puente et al, 2007).

The Detection of Mobile Phone Excessive Dependence

The detection of mobile phone excessive dependence was largely adopted from the literature on Internet addiction, game addiction (Lemmens et al., 2009) and social media addiction (Van den Eijnden et al. 2016). Similar as the diagnosis of these addictions, psychometric instrument is the most widely used tool for diagnosing mobile phone excessive dependence (Lemmens et al., 2009; Van den Eijnden et al. 2016), which usually requires the involvement of psychiatrists for survey administration. However, respondents may have high resistance to answer survey questions, especially when they are sensitive, such as “Have you regularly lied to your parents or friends about the amount of time you spend on social media?” in the Social Media Disorder Scale (Van den Eijnden et al., 2016).

With the development of smart phones, the phone itself can collect a lot of information on users’ activities and behaviours, which makes it possible to have an unobtrusive way to describe users’ level of phone dependence. For example, the number of apps used per day, the ratio of SMSs to calls, the number of apps used every time when users pick up the phone, and the length of non-event initiated sessions are found to be useful for detecting problematic usage (Shin and Dey 2013). Nonetheless, the current analytical methods tend to use the amount of usage as indicators of addictive phone usage.

As discussed earlier, addiction is not just about the amount of usage, but also driven by uncontrollable and irrepressible actions caused by impulsion. The detection of addictive behaviour should also take consideration of the impulsivity of users. People addicted to something impulsively act on powerful urges to experience the pleasure of their addiction. Thus, in this study, we will explore how we can model impulsivity of a user and detect excessive phone usage behaviour.

In the context of our study, impulsivity can be interpreted as users’ urge to check the mobile phone. One indicator that is often used by researchers is the frequency of phone usage. It is also referred as the number of pickups for the iOS screen time function. However, it is still somewhat related the amount of usage too. In this study, we are proposing the time interval between phone pickups reflects the urge of using the application. In addition, the average daily min time interval between two consecutive pickups indicates the extent of the urge to use the phone.

Methodology

We have developed an Android-based application to collect users’ detailed phone usage data and apply feature selection analysis on the data collected. A pre-study survey was also administered to the participants to collect some basic demographic information, and assess their level of dependence to the mobile phone, to social media apps, and game apps using validated instruments.

The App Development

An Android app was developed to retrieve mobile phone usage data from Android Service Native API. The data collected by Android Service are quite detailed, including usage duration for each app during any time period, the timestamps for moving an app into the foreground or background and other usage logs. Data are fetched through Android API by our app on a daily basis. The data collected include Usage Duration for each app, Data Consumption for each app, and Usage frequency for each app and Timestamp for opening and closing all apps.

The Pre-study Questionnaire

The survey questionnaire collects users’ demographic information including gender, age and relationship status. It also consists of a set of questions to assess users’ addition to mobile phone with Smartphone Addiction Inventory (Lin, et al., 2014).

Among all kinds of app that are used on mobile phone, social app is a major category that are likely to cause phone addiction. Social network addiction has long been identified as a major health threat in the digital age (Van den Eijnden et al. 2016). More than one-third of the world’s population, which is 2.5 billion people, now access social media services via mobile devices each month (Kemp, 2017). Thus,

it is important to consider the effect of social apps addiction separately. The instrument used is Social Media Addiction Scale (van den Eijnden et al., 2016).

We also want to investigate the addition to gaming apps separately, thus users are also asked to answer questions from Game Addiction Scale (Lemmens et al., 2009) in the pre-study survey.

Participant Recruitment

University students were invited to participate in the study through various channels, including emails and notice board. Interested participants were required to fill-in the pre-study questionnaire before installing the app. Participant consent form and participant information statement were given to them before the start of the study. They were requested to stay in the study (with the app installed) for at least a month. Ethics approval was obtained from the researchers' institute prior to the data collection.

We have excluded users with less than two weeks' usage data for the data analysis. There are altogether 60 users with valid data. 39 of them are male users and 21 are female users. 35 out of the users are aged between 21-24, while 25 of them were aged 25 or above. There are 25 users single, 7 married and 26 in a relationship.

Data Analysis

Descriptive statistics

We have processed the raw usage data collected via Android APIs. It consists of timestamp of opening or closing an application, the name of the application name and the type of action performed (i.e., opening or closing). It also captures the data used for each app between two timestamps. Each action refers to an event in our analysis. Those events that were created for using our own application were excluded from the analysis. The average number of records generated by the users is shown in the following table. As users stay for different period of the study (on an average of 49 days), the number of events generated by them are different. The shorted duration of usage is 14 days, while the longest is 112 days. On average, there are 33050 records for the users who stay in the study for more than two weeks. Thus, the dimension of the total dataset for analysis is 33050 * 60 data records. More information on the dataset is shown in Table 1 below.

Table 1. Statistics of Raw Dataset

	Mean	Standard deviation	Min.	Max.
Duration of Usage (Days)	49.26	34.78	14	112
Number of Records	33050	30510	1440	127021

Survey results

Each users will be labeled as either addition or non-addition for phone usage, social media usage and game usage. Due to page limit, the detailed calculation is not presented. We follow strictly with the method given in the instruments used. The diagnosis result for all 60 users is shown in Figure 1 below. We can find that the percentage of being labelled as addictive users for Social Media Addiction Scale (van den Eijnden et al., 2016), SPAI (Lin, et al., 2014) and Game Addiction Scale (Lemmens et al., 2009) are 20%, 25% and 31.67% respectively.

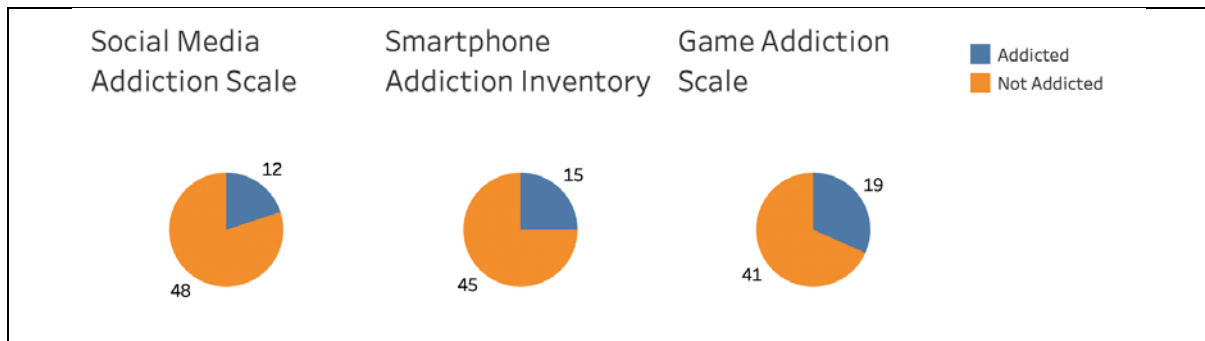


Figure 1. Survey results

Features selections

Feature selection method is often used to identify a subset of features that can best describe the current dataset without redundant ones. Feature selection algorithm are used when the data contains some redundant or irrelevant features which can be removed with an acceptable level of incurring the loss of information (Bermingham, et al., 2015). For this study, this method can be applied to find out the features that are closely related to the classes, in order to find an approach to predict the class of the object with selected features. The features with highest correlation with addiction label can be considered as predictors for mobile phone excessive dependence.

In the literature, the amount of usage is usually considered as indicators of addiction behavior. Thus, we created four features related to usage: daily total usage duration (Feature 1), daily pickups (i.e. frequency of using the phone) (Feature 2), daily total data usage (Feature 3), daily maximum usage session (Feature 4),

We also calculated the feature reflecting users’ impulsivity, daily minimum time interval between two pick-ups (Feature 5). It is measured by average daily shortest time interval between two consecutive phone pick-ups.

As shown in Figure 2 below, the result shows that the minimum time interval between two pick-ups best describes the overall mobile phone addiction diagnosed by SPAI (Lin, et al., 2014), followed by daily total data usage.

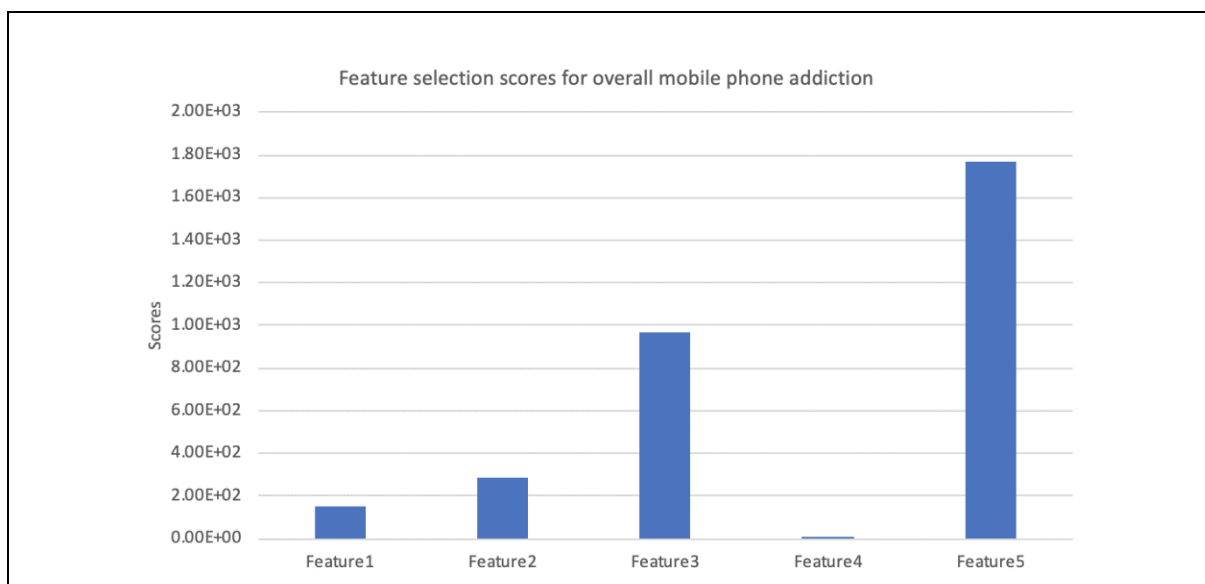


Figure 2. Feature selection for overall mobile phone addiction

We further performed the features selection for two app categories: social and game, as these two categories of apps can cause addictive behavior themselves. The categorisation of the apps were based on the label in the Android store.

For all the social apps, we created the following five features: daily total usage duration (Feature 1), daily frequency (i.e. frequency of initiating a session with social app) (Feature 2), daily total data usage (date used by social apps) (Feature 3), daily maximum usage session (Feature 4), daily minimum time interval between two social app sessions (Feature 5).

The feature selection results (Figure 3) show that min time interval between two social apps sessions is still the feature best describes social media addiction diagnosed by Social Media Disorder (van den Eijden et al, 2016) followed by data usage.

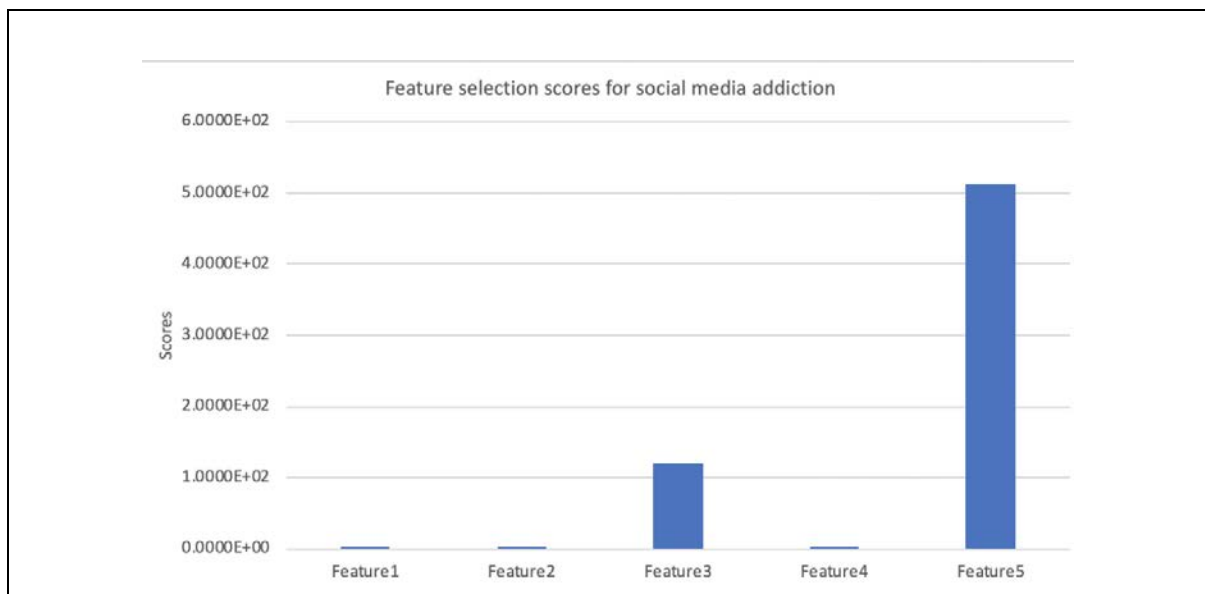


Figure 3. Feature selection for social app addiction

For all the gaming apps, we created the following five features: daily total usage duration (Feature 1), daily frequency (i.e. frequency of initiating a session with gaming app) (Feature 2), daily total data usage (date used by gaming apps) (Feature 3), daily maximum usage session (Feature 4), daily minimum time interval between two gaming app sessions (Feature 5).

The feature selection results (Figure 4) also show that min time interval between two gaming apps is still the feature best describes game app addiction calculated based on Game Addiction Scale (Lemmens, Valkenburg, & Peter, 2009). The second best feature is the daily total usage duration.

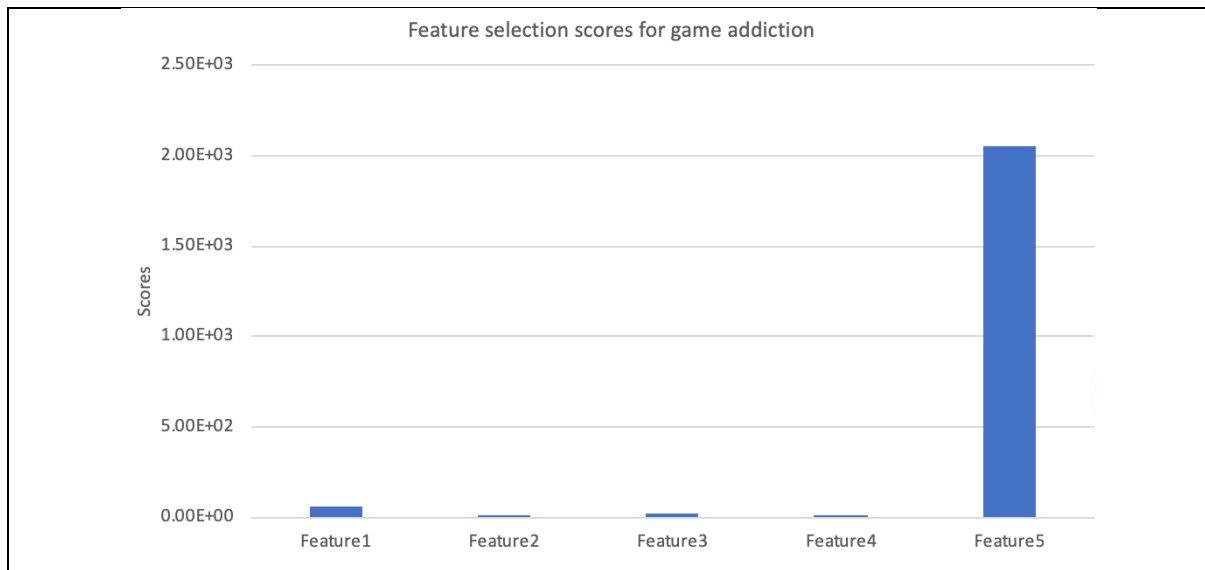


Figure 4. Feature selection for game app addiction

Discussion on the Preliminary Finding

The preliminary finding from this research-in-progress paper shows that the shortest time interval between two pickups best describes users' excessive dependence on mobile phone, social app addition and gaming app additions. This feature reflect that the extent to which users can control the urge to use the phone again after they finish the earlier session. This confirms with our prediction that mobile phone excessive dependence is not just correlated with the total amount of usage, but also the impulsivity related to the usage.

We believe that mobile phone dependence is a more complicated issue than substance addiction. Mobile phones are used for many purposes, including health tracking, traffic guide, work-related tasks, and etc. It is hard to identify the boundary between mobile phone excessive dependence and the increasing need to use it, if we just look at the amount of usage.

Limitations and Future Plan

As a research-in-progress study, there are a few limitations that we are trying to address in the next phase of the study. Firstly, only Android-based application was developed to collect phone usage data. It may limit the generalisability of the results to iOS users. To address the limitation, we are also implementing iOS version in order to collect more data. Secondly, the participants are university students, and thus are not able to represent the general population. We are also trying to recruit more participants in older age group. Thirdly, only one feature on impulsive behaviour is calculated. We are reviewing the literature and working on more features describing the impulsive behaviour. Lastly, we use one instrument to assess phone addiction, social media addiction and game addiction respectively. Other instruments should also be used to have a triangulated validation of the ground truth for future analysis.

Conclusion

The study aims to explore the role of impulsive action in understating mobile phone excessive dependence. With detailed usage data collected from 60 mobile phone users, we found that the minimum time interval between two pickups describe users' dependence to mobile phone better than other features on the amount of usage. We also found that users' dependence to social apps can be better described by the minimum time interval between two social app sessions. Similarly, game app dependence can be better described by the minimum time interval between two game sessions. The study contributes to the advancement of unobtrusive diagnosis method of mobile phone excessive dependence. The study also contributes to the addiction literature by revealing the unique characteristics of addiction on digital devices.

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