CIS 4930 Mobile Networks - Final Project Proposal - February 28 2020

Title: Detecting Depression in Individuals via Mobile Devices, and Potential Solutions

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Motivation:

Depression is a prevalent issue in today's world that affects 264 million people globally (source: WHO). Depression is especially prevalent in developed first-world nations, and in youths from teenagers to young adults. One of the leading causes for depression is a lack of social support among peers.

In depressed individuals, their illness may manifest in social isolation. Symptoms of some (but not all) depression may be not talking to close friends and family, falling out of physical routine, getting very little and poor sleep quality, and avoidance of public situations. These symptoms are measurable by an individual's mobile device, and significant variations in the device's usage patterns may be able to detect signs of mental unwellness. Such applications can be seen when looking at how mobile device usage at night is related to sleep disturbance, which is a partial mediator of electronic media use at night and depressive symptoms [6]. Additionally, when put in text-restricted periods of time, individuals feel this period of time as disconnected, lonely, and isolated [7]. Such feelings of disconnect are important in today's society because social isolation and loneliness are correlated, and both are linked to depression in young adults [8]. Scenarios like above are direct reasons for using mobile devices to determine possible symptoms of depression.

This study aims for the following goals: to build upon existing work, theories, and evidence on a correlative link between depression and the above behavior; to determine how those symptoms are measurable from a mobile device; and to develop a prototype software that can detect depression and take helpful countermeasures against mental illness.

Related Work:

1. “Daylio Journal”, a mobile application by Relaxio s.r.o. on the Apple App Store [1]

A mobile application that keeps track of activities you have done throughout the day, eating habits, and how you are feeling. It utilizes this data to identify any anomalies in the number of activities or mood. It nudges the user to keep up with activities and journal their daily life. We will borrow the idea of identifying anomalies in the recorded data. We initially planned for our data to be automatically-recorded and tracked, but due to some operating system restrictions of the most up-to-date iOS and Android software, we may also utilize self-reported data from our users.

2. “Sleep Cycle: smart alarm clock”, a mobile application by Sleep Cycle AB on the Apple App Store [2]

A mobile application that users run before going to sleep and place near their pillow. The phone’s accelerometer detects motion to determine when the user falls asleep, and what REM cycle they are for durations of time. Using that data, it reports the user’s sleep quality graphed over weekly and monthly periods. Because sleep quality is highly correlated to mental health and depression (K. Demirci, M. Akgönül, and A. Akpinar) (S. Lemola, N. Perkinson-Gloor, S. Brand, J. F. Dewald-Kaufmann, and A. Grob), we may use similar sleep-depression analytics in our application.

3. “Microsoft MyAnalytics”, a component of the Windows 10 Operating System by Microsoft Corporation [3]

As of January 2019, Microsoft introduced a new component of their Windows 10 OS which tracks usage of applications and their purposes (e.g. communication, email, Internet, productivity). The user receives monthly emails that focus the data into metrics of focus, wellbeing, collaboration, personal productivity, networking, and more. Although the inner workings of their data analysis is not publicly-available, their ability to transform measurements of user behavior into reports of user wellbeing and focus is very similar to our project. We have reached out to Microsoft Corporation to learn more about the MyAnalytics app, and how we might be able to improve our own.

4. “Health”, a built-in application on iOS 8 and later for the iPhone by Apple Inc. [4]

The built-in Health app on Apple’s iPhone tracks fitness data, combined with measurements taken from the optional Apple Watch, and analyzes usage of other applications on the iPhone. Health initially tracked fitness (e.g. steps taken, calories burned, duration of workout, heart rate, etc.) but has since been expanded to more aspects of mental health, including the category “Mindfulness” which tracks the amount of “mindful minutes” the user spends per day over time. This application is the most similar to what we would like to develop, but has the advantage of having full access to the device’s operating system, whereas our third-party app does not. We have reached out to Apple Inc. to learn more about the Health app, and how we might be able to improve our own.

5. “Calm”, a mobile application by Calm.com on the Apple App Store [5]

This mobile application is similar to a combination of the previously-mentioned Daylio Journal [1] and Sleep Cycle [2] apps. It also tracks long-term patterns in user-reported data that determines overall mental health.

Proposal Body:

A. Problem Statement: What is the correlation between depression and relatively reduced socializing (which in our case will be measured through number of text messages, encounters, sleep schedule, and daily routines)?

B. Evaluation Metrics:

1. Number of texts sent per day, number of texts received per day, average values over time, and deviations of 1 standard deviation below the average. We initially planned for this to be automatically-recorded, but due to restrictions in the iOS and Android operating systems, we may need for this number to be self-reported (a last-case-scenario due to inaccuracies with self-reported data, but possibly unavoidable with the two most popular mobile OS/devices).

2. Number of non-unique Bluetooth encounters per day, average value over time, and deviations of 1 standard deviation below the average. We may utilize the BLE Scanner app shown in class, developed by the graduate student Mimona.

3. Time/location coordinates per week by wi-fi checkpoints, and deviations of more than 1 week off schedule

4. The time of night when the user stops using their mobile device (measured by sleep mode for periods of longer than 4 hours from the

timeframe of 8:00 PM - 11:00 AM). This may be measured and analyzed in a similar method to the Sleep Cycle app [2] mentioned in Related Work.

C. Investigated Parameter Space:

Our group will primarily investigate university students who either have depression or don't. Having both groups investigated will help us determine which metrics are strong indicators of depression. The primary reason for investigating only university students is due to the convenience of recruiting participants to our project. Additionally, university students fall under the "young adult" category in which many studies use most of. While users of mobile phones that feel stress from its high accessibility show to be a risk factor for depressive symptoms [9], university students are a great sample population due to its high usage of mobile phones.

D. Methodology:

Our group intends to write our own software for mobile devices which will measure the above metrics (text frequency, encounters, routines, sleep patterns) as well as performing the statistical modeling on-device.Text frequency will be measured because studies have shown that the frequency used of a smartphone was most correlated inversely with depression [10], meaning low frequency usage of a smartphone suggests higher symptoms of depression. Text is a huge factor with potential to detect depression due to depressed peoples' tendency to use more first person singular pronouns with negative emotion words and fewer first person plural pronouns with positive emotion words when compared to non-depressed people while texting [11].With increased smartphone usage reported, positive correlations were found in individuals with addictive tendencies with their mobile phone and depression levels, anxiety levels, and sleep quality [12].

E. Scenarios:

Given that our thesis is true (depression is linked to isolation), we will develop the app for more data gathering, potential machine learning to unique behaviors, and possibly production. If the thesis is not true (depression is not linked to isolation) we will still have disprove a theory.

F. Expected Results:

We expect there to be a correlation between depression and isolation. We also expect this type of depression to be measurable from a mobile device standpoint, and for our proposed software to be able to counteract these symptoms or provide aid.

References:

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