Using passive sensing to predict depression

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Abstract. Depression is a common mental health issue that affects people's thoughts, behaviours, and feelings. However, depression can often be under-diagnosed or under-treated. Early identification of depression can help to reduce the severity of the condition. Passive sensing, which captures data through mobile applications and wearable devices, has been shown effective in monitoring and identifying mental health problems, including depression. This paper explores the efficacy of mobile applications and fitness trackers to identify signs of depression among 48 adults in a three-week study. The paper investigates the efficacy of passive sensing to predict depression, assesses differences in the behaviour between people without depression and people with symptoms of depression, and explores which sensor data can accurately predict depression. The results from this paper will contribute to the existing literature and practice on early identification of depression.

Keywords: Grouping · Loneliness · Mobile sensing · Passive sensing · Smartphone

1 Introduction

Depression is a common mental health condition that affects people's thoughts, feelings and behaviour [1]. It is estimated that approximately 280 million people across the world suffer from depression [2]. Depression is often not diagnosed in a timely manner [3], but early detection and intervention in depression can help to avoid many negative impacts of depression [4]

Passive sensing has been shown to be a promising approach in identifying mental health problems, including depression. Passive sensing captures data through mobile phone applications and wearable devices, such as fitness trackers, with minimum effort from participants. According to the Diagnostic and Statistical Manual of Mental Disorder [DSM5], depression is associated with lower physical activity, and mood and sleep disturbance. Some of these behaviours can be captured through passive sensing with smartphone applications and wearable devices. An indicative example is Narziev et al. study [5], who used smartphone and smartwatch applications to identify depression in 20 participants through behaviours associated with depression, including physical activity, sleep levels, mood and food intake. The results from this study showed that behavioural data from passive sensing through smartphones and wearable devices was correlated with participants' activity, sleep and mood as they were assessed through self-reported data. Another study by [6] used the

StudentLife dataset to explore whether a smartphone application can predict different outcomes on 48 university students. The authors found correlations between depression and sensing data, especially for sleep, communication and location data, meaning the number of places that people visited during the ten-week study.

This paper explores the accuracy of passive sensing, collecting behavioural data for people's physical activity, sleep, and communication patterns, to predict depression. The paper also investigates behavioural differences between people who experience symptoms of depression with people without depression, such as differences in sleep quality. Another aim of the paper is to assess which behavioural features can accurately predict loneliness.

2 Methodology

Table 1. Sensor data from AWARE and FitBit

Mobile application	**Sensor Data**
AWARE	Calls (incoming and outgoing)
	Text messages /9incoming and outgoing)
	Locations (number of visited places)
	Bluetooth (detecting nearby devices)
FitBit	Physical activity (number of steps, light/fair/very active)
	Sleep duration and sleep quality score
	Heart rate

2.1 Dataset

Data was collected from 48 adults, 18 years old or older. We collected data for three weeks through the AWARE and FitBit applications (Table 1). Participants were installed these two mobile applications in their phones and were asked to wear a fitness tracker for three weeks. Data on participants' demographic characteristics was also collected, including their age, gender, occupation, level of education, and marital status. At the beginning of the study, we asked participants to complete the short version of the Geriatric Depression Scale [GDS;7) to assess feelings of depression. GDS scores vary from 0 to 4 indicating no depression symptoms, 5-8 indicating mild symptoms of depression, 9-11 indicating moderate depression, and 12-15 indicating severe depression. For the purposes of this study, we categorised people with GDS scores from 0 to 4 in a group of people without depression, and people with GDS scores from 5 to 15 in a group of people who experience depression symptoms. This categorization was decided because we are interested in identifying depression at an early/mild stage. This study gained ethical approval from the Social Research Ethics Committee at University College Cork, and the General Data Protection Regulation at University College Cork.

2.2 Data Processing and analysis

The average performance of each behavioural feature was calculated for the three-week study duration. We will use machine learning techniques, including logistic regression models and XGBoost,

to assess the accuracy of behavioural data to predict depression. Behaviour differences between the group of people without depression and the group of people who experience symptoms of depression will be assessed using statistics analysis (independent samples t-tests and chi-squared analysis). Finally, Binomial regression models will be used to explore which of the behavioural features could accurately predict depression.

3 Expected Results

This paper will explore the efficacy of wearable technology, mobile applications and fitness trackers, to predict depression. The paper will show differences in behaviours between people with and without depression, and it will explore which of these behaviours can accurately indicate depression.

4 References

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