Evaluating Number of Days Needed to Predict Anxiety by Using Smartphone

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***Abstract*— The purpose of this research was to predict the anxiety state by analyzing the behavioral log data of smartphones, such as acceleration, rotation, light, on-off of display, and usage history of applications. In our experimental results, we found that we can predict the anxiety change in accuracy of more than 0.8.**

Keywords—mental health, smartphones, anxiety

I. INTRODUCTION

Lately, interest in mental health has increased. As of December 2015, companies with more than 50 workers are required to assess workers' stress, according to Japanese law [1]. Maintaining workers' mental health has since been the focus. However, currently, stress is assessed once or twice a year through a questionnaire, and no continuous assessment has been conducted.

To enable continuous stress assessment without cost incurrence by workers, some researchers have focused on estimating the mental state through use of smartphones. Gruenerbl et al. have proposed the method to detect whether participants are depressive or not depressive [2]. Canzian et al. have predict whether participants will be more depressive than their normal state in future by proposing eight feature values extracted from the mobility data of GPS sensor in smartphones [3]. Since many people equip themselves with smartphones on a daily basis, use of smartphones as sensors can be less burdensome to users.

In past studies it was suggested that mental states are reflected not only in smartphone sensor values, but also in the usage history of smartphone applications. In order to estimate the mental states by smartphone, it is necessary to extract feature values from the sensor logs and application history. The feature values should reflect the daily smartphone usage and have the relationship between mental states. Extracting such feature values is the challenging point in this research.

We focus on anxiety in this research. That is because anxiety disorder is early-onset, and complications often arise. We propose the several feature values which is supposed to be related to anxiety from the sensor logs and application history of smartphones, and we aim to predict the next day's anxiety state change from smartphones.

II. PROBLEM STATEMENT

We adopt the total score of State-Trait Anxiety Inventory (STAI) [4], which is composed of 20 four-choice questionnaires as the correct data of anxiety value. We collected participant's data for 30 days. We ask participants to answer STAI once a day, and we link the STAI score with the sensor logs and application history of smartphones each day.

In this research, we predict whether STAI score increases or decreases next day. This is because we assume that anxiety value is relative, and the important thing is the change of anxiety value. When we predict the anxiety change, it is important to know how many explanatory data is enough. Therefore, we set the 7 types of input data which is 1day explanatory data, 2days explanatory data, to 7days explanatory data. For example, when we predict whether anxiety value of 19th March increase or decrease, are sensor logs and application history of only 18th March enough? Or are those of both 17th and 18th March necessary? We want to investigate that.

III. Proposed Method

We use sensor logs data such as acceleration, rotation, light, on-off display, and usage history of smartphone applications as explanatory variables. We list the proposed feature values. We calculate all feature values of each day.

1) Average accaleration
2) Variance acceleration
3) Average of brightness
4) Variance of brightness
5) The ratio that brightness is lower than 300 lux.
6) The ratio that brightness is 300-1000 lux.
7) The ratio that brightness is higher than 1000 lux.
8) The ratio that screen is on.
9) The ratio of texting while walking
10) The ratio of access time to smartphones
11) The number of start of the applications
12) The max number of start of the applications when separating the day into 1hour sections
13) The average time of using applications
14) The standard validation time of using applications

We perform multiple regression analysis using both sensor data and the usage history of applications as explanatory variables, and the STAI score as the target variable. Explanatory values are the proposed feature values, and the target values are the STAI score change (increase or decrease). The number of explanatory values is different from the dataset. The number of days of explanatory values is ranged from 1 to 7. We prepare the 7types of dataset of each participants.

Participants are 7 students which include 5 males and 2 females.

IV. Evaluation

We adopt F-value [5] as the accuracy of anxiety change prediction. F-value is widely used in the field of machine learning.

We show the graph of the relationship between F-value and the number of days of explanatory variables in Figure I.

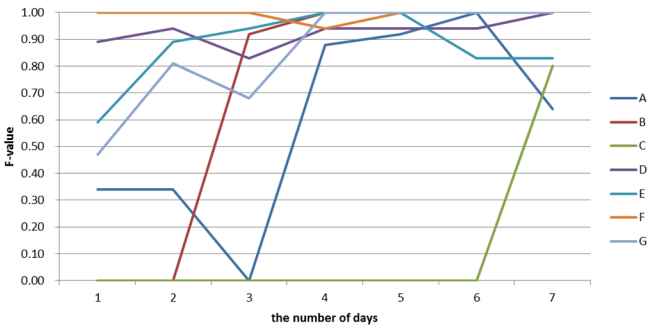

FIGURE I. Graph of Relationship between the Numbers of Days of Explanatory Values and F-value

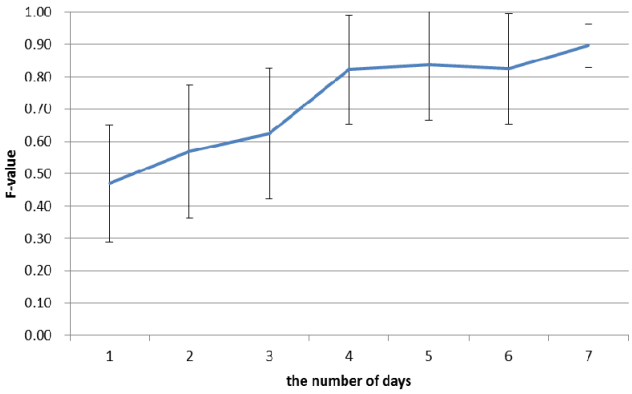

FIGURE II. Graph of Relationship between the Numbers of Days of Explanatory Values and Average of F-values

We show the graph of the relationship between the numbers of days of explanatory variables in FIGURE II.

From the FIGURE I, we discover that F-values are different between participants, but about all participants, when the numbers of days of explanatory variables increases, F-value increases. That is the common trend.

From the FIGURE II, when we include the 7 days explanatory variables, the average F-value is beyond 0.9.

V. Conclusion

In this research, we focused on the prediction anxiety state by using sensor logs and application history of smartphones, and we designed the feature values which reflect the anxiety state.

We prepare the 7 types of dataset whose number of explanatory variables are ranged from 1 day to 7days. We performed the multiple regression whose target variable was whether STAI score increases or decreases next day, which means anxiety becomes stronger or weaker. From the result, we discovered that when we consider the 6days explanatory variables, we could predict the anxiety change in accuracy of more than 0.8. Average accuracy was about 0.9.

In future, we want to collect more participants' data, and propose the more proper feature values from smartphones to predict anxiety change.

References

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