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Moodee: An Intelligent Mobile Companion for Sensing Your Stress from Your Social Media Postings

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Abstract

In this demo, we build a practical mobile application, Moodee, to help detect and release users' psychological stress by leveraging users' social media data in online social networks, and provide an interactive user interface to present users' and friends' psychological stress states in an visualized and intuitional way. Given users' online social media data as input, Moodee intelligently and automatically detects users' stress states. Moreover, Moodee would recommend users with different links to help release their stress. The main technology of this demo is a novel hybrid model - a factor graph model combined with Deep Neural Network, which can leverage social media content and social interaction information for stress detection. We think that Moodee can be helpful to people's mental health, which is a vital problem in modern world.

Figure 1: Workflow of the application

Introduction

Nowadays, psychological stress has become a severe threat to public health. Excessive stress may cause many mental and physical health problems such as insomnia, cancer, depressions etc., or even suicide. Existing stress detection methods are mainly face-to-face interviews, self-report psychological questionnaires and wearable physiological sensors. However, these methods are usually labor-consuming, time-costing and hysteretic.

While with the development of social networks like Twitter and Sina Weibo, people are willing to share their daily events and moods, and interact with friends through the social networks. Detecting stress from users' social media data maybe a feasible way.

In this paper, we present **Moodee**, a practical mobile application based on a novel hybrid model of factor graph model combined with a deep neural network (DNN), to automatically detect one's psychological stress states from social media data. A user just need to log into her/his social media account by OAuth2 protocol, to let Moodee get access to users' public social media data. Moodee will analyze and extract features from users' social media data, and get users' detailed stress states and the stress sources based on our proposed model. The main technical contributions of Moodee are:

1) We design a convolutional neural network (CNN) with cross autoencoders (CAE) to generate user-level content attributes from tweet-level content attributes.

2) We define a partially-labeled factor graph (PFG) to combine social interaction attributes with user-level content attributes for stress detection.

APP Interface and workflow

The input of Moodee is users' social media data, and the output is users' stress states, including stress level, stress keywords and stress sources (work, social, affection, physiological and others). In this demo, we formalize stress level into 0-100, with 0-40 to be non-stressed, 40-60 to be moderate stressed(normal), 60-100 to be highly stressed. As shown in Figure 1, the workflow of Moodee consists of the following steps: 1) Log into users' social media accounts, and authorize moodee to access the public data in social networks. 2) Moodee would analyze the input data, based on an our model. Moodee would show how stressed the user is in different states (colors, expressions etc.). Moodee would get stressed if the user is stressed, and vise versa. 3) According to users' stress levels, Moodee would also recommend to users different links to the psychological counselling centers, soothing music or articles to help release their stress. 4) A user can check the detailed stress report by click into the

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”Data” page, including the stress level, stress keywords as well as history stress states recently, in form of easy-to-read diagrams. 5) A user can also check the stress states of his/her friends on the social media platforms, with the permission of friends.

Model Framework

There are several challenges exist in psychological stress detection: **1) Data missing problem.** Social media data is usually composed of text, emoticons, images and social interactions. It is a typical cross-media data, in that some modality of the social media data maybe missing in real social networks. **2) Time-series data modeling problem.** Stress is a continuous state that can last for days. We need to analyze users' postings in time-series to decide whether a user is stressed. **3) Data sparsity problem:** Users with high stress tend to reduce their activities on social networks. Can we leverage social interaction, including interaction content and structure patterns, to enhance stress detection?

To tackle these challenges, we propose a novel hybrid model by **combining a factor graph model with a deep neural network (DNN)** (Lin and et al 2014b). We address the solution through the following two key components. 1) We design a convolutional neural network (CNN) with cross autoencoders (CAE) to generate user-level content attributes from tweet-level content attributes. 2) We define a partially-labeled factor graph (PFG) to incorporate all three aspects of user-level attributes for users' psychological stress detection.

The workflow of the model is described as following. Firstly, we extract attributes from each tweet of the user and form tweet-level content attributes. We use the tweet-level attributes defined in (Lin and et al 2014a). The tweet-level content attributes are fed into cross autoencoders (CAEs) (Lin and et al 2014a). The CAEs are embedded in a convolutional neural network (CNN) (Lin and et al 2014b) that will integrate attributes from CAEs into the uniform user-level content attributes by pooling each attribute map. The user-level content attributes, user-level statistical attributes, and user-level social interaction attributes form the user-level attributes together. We use the user-level attributes that are defined in (Lin and et al 2014b). The user-level attributes of a user at time t are denoted by x_i^t (i=1,2,$\cdots$). The stress state of each user at time t is denoted by y_i^t (i=1,2,$\cdots$), respectively. The user-level attributes and the stress states are connected by an attribute factor, while stress states of different users are connected by social factors. Stress states of the same user at adjacent times are connected by dynamic factors. By calculating the factors, we can finally derive all users' stress states over different weeks.

We test the proposed model on a real-world social network, Sina Weibo, with more than 36000 weeks of data. As for the ground truth of the experimental data, we use a sentence pattern labeling method. We collect tweets containing sentence patterns like "*I feel stressed this week*" and "*I feel stressed so much this week*" as the weekly stressed state label, and tweets containing "*I feel relaxed*" and "*I feel non-stressed*" as the non-stressed state label. These sentence patterns has be shown to be reliable in (Lin and et al 2014b).

Table 1: Comparison of efficiency and effectiveness using different models (%).

Method	Acc.	Rec.	Prec.	F1	CPU time
LRC	76.18	87.94	78.58	83.00	39.43s
SVM	72.58	87.39	75.16	80.82	≈10min
RF	77.73	89.63	79.35	84.18	67.71s
GBDT	79.75	82.99	85.90	84.43	262.86s
FGM	91.55	96.56	90.44	93.40	≈20min

Table 1 shows the experimental results. We see that the proposed FGM gains superior results against comparative methods, which verifies that our proposed model can effectively leverage the social interaction and social structure attributes for stress detection. Compared the state-of-the-art methods, our proposed model achieves an overwhelming performance, which improves the detection performance by up to 9% on F1-score. These results demonstrate that our proposed model is effective.

Conclusion

In this demo, we build a practical mobile application, Moodee, to help detect users' psychological stress states from social media data based on a novel model. Moreover, according to users' stress levels, Moodee would also recommend to users different links to the psychological counselling centers, gyms or travel agencies to help release their stress. We think that Moodee can be helpful to people's mental health. The demonstration video of Moodee can be accessed at: https://youtu.be/A4YWEoOBLhA .

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