

SNS Based Predictive Model for Depression

Jamil Hussain¹, Maqbool Ali¹, Hafiz Syed Muhammad Bilal¹, Muhammad Afzal¹,
Hafiz Farooq Ahmad², Oresti Banos¹, and Sungyoung Lee¹(✉)

¹ Department of Computer Engineering, Kyung Hee University Seocheon-dong,
Giheung-gu, Yongin-si, Gyeonggi-do 446-701, Republic of Korea
{jamil, maqbool.ali, bilalrizvi, muhammad.afzal,
oresti, sylee}@oslab.khu.ac.kr

² Department of Computer Science,
College of Computer Sciences and Information Technology (CCSIT), King Faisal University,
Alahssa 31982, Kingdom of Saudi Arabia
hfahmad@kfu.edu.sa

Abstract. Worldwide the Mental illness is a primary cause of disability. It affects millions of people each year and whom of few receives cure. We found that social networking sites (SNS) can be used as a screening tool for discovering an affective mental illness in individuals. SNS posting truly depicts user's current behavior, thinking style, and mood. We consider a set of behavioral attributes concerning to socialization, socioeconomics, familial, marital status, feeling, language use, and references of antidepressant treatments. We take advantage of these behavioral attributes to envision a tool that can provide prior alerts to an individual based on their SNS data regarding Major Depression Disorder (MDD). We propose a method, to automatically classify individuals into displayer and non-displayer depression using ensemble learning technique from their Facebook profile. Our developed tool is used for MDD diagnosis of individuals in addition to questioner techniques such as Beck Depression Inventory (BDI) and CESD-R.

Keywords: Mental illness · Depression · Social networking sites · Facebook · Content analysis

1 Introduction

Recently, use of a social network increased exponentially as according to pew [24] report of 2014, 74% of online adult use SNS beyond them 40% use mobile. SNS provides a platform through which people share information in very cost effective way and easily express their opinions that enable research groups to investigate a numerous aspects of human behaviors and psychological concerns [16]. Among these platforms, Twitter and Facebook are mostly used as social sensor for collection of individual's daily life activities, feelings, and emotions. Changes in individual's life events can easily be detected from the recorded human behavior data of several years on these platforms, which leads to reveal the mental illness.

Mental illness, the major contributor in disability worldwide. It disrupts the individual's mood, cognitive and language styles, ability to work, and routine activities.

Some individuals might not even know what's going on, especially in initial episode of psychosis.

Mental illnesses classified into depression, anxiety, bipolar disorder, obsessive-compulsive disorder (OCD), borderline personality disorder, schizophrenia, and post-traumatic stress disorder (PTSD) and others. Depression is the most common mental illness having symptoms like sadness, depressed mood, tiredness, sleep problem, losing interest in activities, poor concentration, reduce energy in work, guilt feeling, and suicidal attempt. Mostly adults are effected by depression that declines individual's working capabilities and recurrent episodes lead to suicidal attempt. Annually almost 1 million lives are lost due to suicide, which translates to 3000 suicide deaths every day and on average every 40 seconds 1 person dies from suicide. More than half of all suicides occur below the age of 45 years[1].

Globally, medical resources are utilize to overcome the consequences of mental illness. Recently, WHO and its members take actions to cope with mental illness and conducted survey in 17 countries which highlighted more than 450 million people are the victims of mental illness [1]. The annual statistical results revealed from multiple reports show that only in North America males have 3 to 5 % and females have 8 to 10% depression cases [2]. Still, there is insufficient global support and service for exposing the mental illness [3].

A comprehensive assessment to diagnose the episodes of psychosis and symptoms of depression is the foremost step towards plotting a recovery strategy. However for assessment of depression, medical science is still incompetent and no trustworthy techniques have been formulated that should be relied upon. The traditional approaches are questionnaire based, patient's self-reported or behaviors mentioned by their closed ones; care providers are unable to get the complete picture of depressed person using patients' self-reporting in one place at one time. For example questionnaires depend on a person's memory which are subject to high degree of inaccuracy [21].

To address these challenges, currently SNS are used as a tool, to find and predict behaviors and disorders in individuals [4-13][16-17][21], which overcome the problems of patients' self-reporting unintentionally. SNS recodes the routine activities and happening in a naturalistic way and hence is less vulnerable to memory bias or experimenter demand effects [16]. It provides a means for capturing behavioral attributes that are relevant to an individual's thinking, mood, communication, activities, and socialization. The emotion and language used in SNS postings may indicate feelings of worthlessness, guilt, helplessness, and self-hatred that characterize major depression. By mining the SNS user's activities, we get closer to the natural behavior of the users, way of thinking, and mental state of health.

We propose a tool that analyze users Facebook activities in automated manner, to detect and diagnose depression. Through their Facebook activities over a period preceding the onset of depression.

Existing approaches don't cover all the SNS influencing attributes. Usually a subset of attributes have been used to identify the sign and symptoms of depression. To get an accurate and precise diagnoses of causes and illness we proposed a comprehensive tool which cover all majors SNS inducing attributes related to depression risk factors. Attributes like gender, marital status, socioeconomic status, familial factors, personality, life events, and others are directly related to Facebook features [22].

The proposed tool classifies individuals using ensemble learning technique that identifies depressive symptom-related features from user’s Facebook activities. The tool can be utilized by individuals in order to track their daily life activities to reveal depression at initial stages. It can also be used by Psychologists/Psychiatrist for depression detection and diagnosis of patient, additional to questioner techniques such as Beck Depression Inventory (BDI) [14], CESD-R [15].

2 Methodology

A brief description of eachmodules of our system architecture that shown in Fig.1 are described in below section.

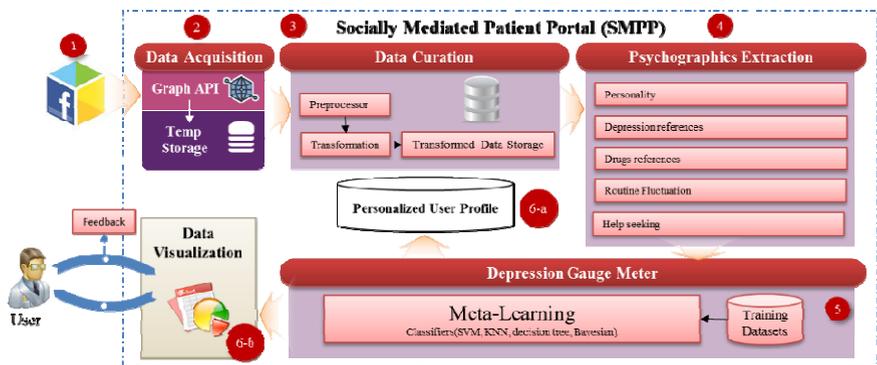


Fig. 1. System Architecture

2.1 Data Acquisition Module (DCM)

It gathers data from Facebook using graph API. It has data fetching engine and store data temporary using session variable. In order to collect data, a Facebook APP is created and registered, called Socially Mediated Patient Portal (SMPP). It is a PHP-based web tool that uses the Facebook Graph API, which uses URL-based queries to return result sets such as status updates, gender, comments, likes, photo, video and many more.

2.2 Data Curation Module (DCrM)

Data transformations are done by DCrM that is used by Psychographics Extraction Module. Sub modules are preprocessor and transformed-data storage. Preprocessor used temporary data stored in session variables and transformed it into normalized form that have no noisy, missing information and errors.

2.3 Psychographics Extraction Module (PEM)

PEM consists of many sub-modules, which used third party APIs such as Apply Magic Sauce (AMS)API [19],AlchemyAPI [20] and own Sentiment classifiers for Personality, Religious Views, Sexuality, Profession, Depression reference, Drugs references, Ego-network, Engagement and Help seeking information's extraction. AMS API predicts users' psycho-demographic traits based on Facebook Like IDs as input data along with our own personality model that based on Facebook like ID's , status updates, photos, demographics, videos, friendlist and others. Through AMS API we can predict the personality of a user using Big5 model, where Big5 model has correlation with personality disorder [18] and personality disorder is a subset of mental illness.

According to DSM-V criteria for depression, we classify the user posting into 9 categories in order to predict the depression references. The ego-network focuses on number of friends, number of followers and communication through comments. The fluctuation alarms the change in condition of the user which ultimately indicates the presence of or chances of mental illness. Multimedia classifier uses the uploaded images, status updates and user likes as input to predict the drug related references. The help seeking classifier gets user likes as input to check help seeking pages related to depression.

2.4 Depression Gauge Meter (DGM)

Depression Gauge meter is the key module in our system that accumulate the information extracted from PEM. Ensemble Learning technique, a type of meta-learning technique, is used in conjunction with other learning algorithms i.e. SVM, KNN, decision tree, Bayesian, to improve the performance.

Training datasets were made manually then labeled it according to DSM-V criteria against 9 features. Firstly we train the model using train dataset, and then applied the train model on users' Facebook profile through web application. To predict the existence of depression, our tool fetches the values of 9 features from user's Facebook profile and then trained model predicts.

2.5 Data Visualization Module (DVM)

It is used to portrait intellectual knowledge from classified data. It uses many Javascript data visualization libraries such as Google Graph, D3.js, JQuery for visualization. It visualizes analyzed data as map, chart, graph and tables. It reveals many hidden patterns regarding the user lifestyle. We also provide a user feedback functionality in order to validate the classified results.

3 Implementation of Socially Mediated Patient Portal (SMPP)

A web based tool is developed, in order to perform depression test according to DSM-V criteria, user must be subscribed to Facebook SMPP APP to fetch its profile data based on login permissions. The home page of portal gives the Facebook personal analytics based on user's Facebook profile data to assess on the basis of DSM-V criterion for a depression symptoms or Major Depressive Disorder (MDD).

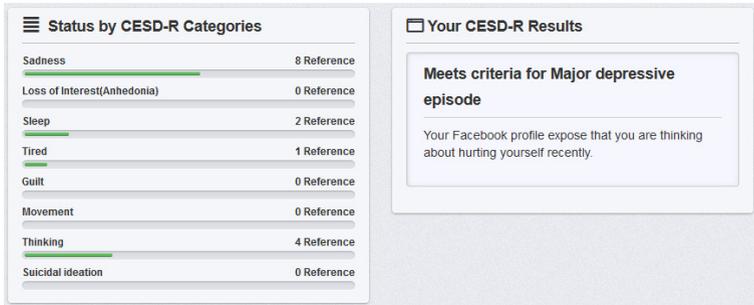


Fig. 2. User posting classification by CESD-R Categories and CESD-R result

The results in Fig. 2, reflects that subject user's posting have many depressive references. To cross check the results of the tool we perform peer review of the subject on the basis of well-defined standard questionnaires designed by [15]. It depict that the 53.66% of postings are in the category of sadness. The sleeping category is on the basis of usage of late night activities on Facebook which is 13.33%. The 26.66% posts represent that subject is confused about its rational while 6.66% characterizes the exhaustion state of the subject.

4 Conclusion and Future Work

We developed a tool that potentially used Facebook as a trustworthy source for detecting depression patterns in individuals. It is an individual-centric predictive model that analyze a subject's Facebook activities, and provide onset alerts if there is abnormalities in subject behavior. It considered multiple attributes of Facebook that are directly associated with depression risk factors. The evaluation indicates that depressed subject posts many depression references and also have small ego-network. To extend the current work we will consider multimedia posting as well as drug usage references to get more precise and accurate diagnosis of mental illness.

Acknowledgments. This work was supported by the Industrial Core Technology Development Program (10049079, Development of Mining core technology exploiting personal big data) funded by the Ministry of Trade, Industry and Energy (MOTIE, Korea).

References

1. World Health Organization: WHO-Incidence and prevalence of mental illness. World Health Organization (2014). http://www.who.int/mental_health/en
2. Andrade, L., Caraveo, A.: Epidemiology of major depressive episodes: Results from the International Consortium of Psychiatric Epidemiology (ICPE) Surveys. *Int J Methods Psychiatr Res.* **12**(1), 3–21 (2003)
3. Detels, R.: The scope and concerns of public health. Oxford University Press (2009)
4. De Choudhury, M., et al.: Predicting Depression via Social Media. ICWSM (2013)
5. De Choudhury, M., Counts, S., Horvitz, E.: Social media as a measurement tool of depression in populations. In: Proceedings of the 5th Annual ACM Web Science Conference. ACM (2013)
6. Moreno, M.A., Jelenchick, L.A., Kota, R.: Exploring Depression Symptom References on Facebook among College Freshmen: A Mixed Methods Approach. *Open Journal of Depression* **2**(03), 35 (2013)
7. Moreno, M.A., et al.: Feeling bad on Facebook: Depression disclosures by college students on a social networking site. *Depression and anxiety* **28**(6), 447–455 (2011)
8. Park, M., Cha, C., Cha, M.: Depressive moods of users portrayed in twitter. In: Proceedings of the ACM SIGKDD Workshop on Healthcare Informatics, HI-KDD (2012)
9. De Choudhury, M.: Role of social media in tackling challenges in mental health. In: Proceedings of the 2nd International Workshop on Socially-Aware Multimedia. ACM (2013)
10. Farnadi, G., et al.: How well do your facebook status updates express your personality? In: Proceedings of the 22nd Edition of the Annual Belgian-Dutch Conference on Machine Learning, BENELEARN (2013)
11. Rahman, M.M.: Mining Social Data to Extract Intellectual Knowledge. arXiv preprint arXiv:1209.5345 (2012)
12. Troussas, C., et al.: Sentiment analysis of Facebook statuses using Naive Bayes classifier for language learning. In: 2013 Fourth International Conference on Information, Intelligence, Systems and Applications (IISA). IEEE (2013)
13. Moreno, M.A., et al.: Associations between displayed alcohol references on Facebook and problem drinking among college students. *Archives of pediatrics & adolescent medicine* **166**(2), 157–163 (2012)
14. Steer, R.A., et al.: Use of the Beck Depression Inventory for Primary Care to screen for major depression disorders. *General hospital psychiatry* **21**(2), 106–111 (1999)
15. Center for Epidemiologic Studies Depression Scale Revised Online Depression Assessment. <http://cesd-r.com/cesdr/> (accessed November 14, 2014)
16. De Choudhury, M.: Can social media help us reason about mental health?. In: Proceedings of the Companion Publication of the 23rd International Conference on World Wide Web Companion. International World Wide Web Conferences Steering Committee (2014)
17. Qiu, L., et al.: Putting their best foot forward: Emotional disclosure on Facebook. *Cyberpsychology, Behavior, and Social Networking* **15**(10), 569–572 (2012)
18. Costa Jr., P.T., McCrae, R.R.: Personality disorders and the five-factor model of personality. *Journal of Personality Disorders* **4**(4), 362–371 (1990)
19. Apply Magic Sauce. <http://applymagicsauce.com> (accessed October 15, 2014)
20. AlchemyAPI. <http://www.alchemyapi.com> (accessed: January 2, 2015)
21. Gannon, M.: Facebook profile may expose mental illness (2013)
22. Dobson, K.S., Dozois, D.J.A. (eds.): Risk factors in depression. Academic Press (2011)
23. Pew Research Center's Internet and American Life Project. <http://www.pewinternet.org/> (accessed December 20, 2014)