Automation of detection of social network mental disorders – A review

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Abstract. Recent years have seen a growing association between social media use and mental disorders. Experts opine that excessive use of social media sites has reached alarming levels, leading to Social Network Mental Disorders (SNMD). The Social Networking Sites (SNS) usage generates massive amount of complex data, which is difficult to analyze, find patterns within and make predictions manually, in turn making it difficult to detect SNMD in the SNS users. The paper summarizes the studies involved in the detection of mental disorders due to prolonged use of social networking sites and provides means of understanding an accurate predictive platform using data mining techniques to build machine-learning framework complementary to the conventional detection methods. We present an in-depth survey of the proposals that included the subtypes of SNMD in the SNS users – Cyber relationship addiction, Net compulsion, Information overload addiction, Cyber sex addiction and Computer addiction. The researchers bring forth models that integrate data mining techniques, Natural Language and computer vision programming tools, with social media and behaviour sciences, providing promising results. Data mining approaches to detect SNMD despite being challenging, are effective and can be used as an efficient tool. The challenges and issues related to automate the detection process is also analyzed in the paper. Thus we present that the automation of detection of SNMD in SNS users has potential to improve the existing health care systems.

Keywords: Social Networking Sites, Mental disorders, Machine-learning framework, Automation.

1. Introduction

A social network is defined as a web-based service that enables users to interact with people, known and unknown. Social networks allow people to create their user profile, articulate a network of people with whom they desire to share access to their profile, information, news, status updates, comments, photos, and other types of content. The most famous social networking sites are Facebook, YouTube, Instagram, Twitter, LinkedIn, WhatsApp, Pinterest, Reddit, Ask.fm, Tumblr and Flickr (eBizMBA, 2019) [1]. Social networking is swiftly progressing and is more prevalent amongst the youth irrespective of their geographical location, background and age.

The strong community feeling and appropriateness, promoted by social networking, likely encourages strength and confidence which in turn helps individuals to get accustomed to demanding situations. Whilst social networking does benefit many users, the benefits attained are reliant on media literacy. Due to the rapid developments in smart phones and tablets, several social networking users depend mostly on their mobile devices to access their favourite sites. According to the Venturebeat survey-2016, Facebook has 1.65 billion monthly active users out of which 1.51 billion are monthly mobile users. Facebook has also shared that it now has 1.09 billion daily active users and 989 million mobile daily active users [2].

Research finds that anxiety, depression, dishonesty, isolation, defensiveness, no sense of time, unable to keep schedules, euphoric feeling whilst online, neglecting daily routine, agitation,
aggressiveness, avoiding social and face to face interactions are various symptoms prevalent in users who stay online for longer periods of time. These symptoms reflect what is termed as Social Network Mental Disorder (SNMD). Whilst the symptoms of these disorders are passive and not detected at an early stage, the corresponding medical treatment is deliberately delayed causing further damage to a patients’ mental health.

1.1 Scope of this study
This study examined the pre-existing surveys which explored the mining of the social media to predict the state of mental illness among the social networking sites users. Some of these are discussed as follows: Wongkoblap et al (2017) provided a systematic review of researches on mental health disorders in the era of social media [3]. Khan et al. (2018) summarizes the analysis of most commonly used approaches used for prediction of depression in the social networking sites users [4]. Garcia-Ceja et al (2018) focused on the survey of mental health monitoring with multimodal sensing and machine learning [5]. Pirjade et al (2018) explored the social network mental healthcare system using machine learning techniques [6]. Rahman et al (2018) scrutinized the literature on detection of mental health using online social network and focused on the machine learning techniques employed in its detection [7]. Shatte et al (2019) discussed the methods and applications of machine learning in the mental health [8].

The above mentioned surveys had focused on studies related to detection of mental health state of the online users using machine-learning algorithms. To the best of our knowledge none has considered the survey of potential of data mining techniques for automation of detection of subtypes of SNMD which are recently noted and explored by the researchers. The automation of detection of SNMD is a recent trend for researchers in order to safeguard the mental health of the SNS users. Therefore, this survey covered the span of last five years (2015 – till date) mainly recent researches in the year 2018 and 2019. Table 1 shows the comparison of the existing surveys with the proposed survey.

| Authors                  | Year | Description                                                                 | Merits                                                                                     | Demerits                                                                                           |
|--------------------------|------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Wangkoblap et al.[3]     | 2017 | Provided a systematic review of researches on mental health disorders in the social media era. | Detailed review and findings of the data mining techniques for predictive analytics in mental health of the online users. | Covered very few studies of predictive models based on real social networks.                      |
| Khan et al.[4]           | 2018 | Surveyed studies that detected mental state of users using social media.     | Explored studies related to prediction of mental health state through traditional methods, social media and deep learning. | Focused only on the detection of depression, a particular mental health state.                     |
| Garcia-Ceja et al.[5]    | 2018 | Described research work in mental health monitoring system using machine learning and multimodal sensors. | Illustrated the use of technology for automation of mental health monitoring systems for few types of mental disorders. | Presented only a subset of works for few mental cases but did not included exhaustive review of specific cases. |
| Prijade et al.[6]        | 2018 | Described the mining of web social data to                                  | Detailed survey of what users face when they are                                          | The methodology adopted in the study                                                              |
effectively distinguish SNMDs excessively involved with internet and also discussed the advantage and disadvantages of the studies. was not explored in details.

| Rahaman et al.[7]  | 2018 | Provided a survey on detection of mental health using online social network. | Illustrated machine learning algorithms employed in detection of mental health using social networking sites. | Mention of the findings and results of the studies not covered in details. |
|--------------------|------|-----------------------------------------------------------------|-------------------------------------------------|-----------------------------------------------------------------|
| Shatte et al.[8]   | 2019 | Synthesized the literature on machine learning and big data applications for mental health. | Highlighted the use of machine learning in detection, diagnosis, prognosis, treatment and support for public mental health. | Studies using social networking sites data for detection of mental disorders not covered in details. |
| Proposed Review    | -    | To provide an overview of the application of data mining techniques in automation of mental disorders detection in the social networking sites users. | Detailed study about detection of types of mental disorders among social networking sites users and explored the emerging data mining techniques for automation of detection of SNMD. | --- |

1.2 Contribution of the Paper
In this paper, we investigate the role of data mining techniques in the automation of SNMD detection. Following are the major contribution of this paper:

- We present a comprehensive review of recent studies of use of data mining techniques in the detection of SNMD.
- We also discussed the five subtypes of SNMD and presented a review of recent literatures relevant to the types of SNMD.
- Finally this paper explored the research challenges in the automation of SNMD detection and also mentioned few issues which need to be investigated before considering applying the concept in the existing mental health care systems for the online users.

1.3 Organization of paper
Rest of the paper is structured as follows. In the next section components of the social network mental disorder is discussed followed by summary of the studies covering the automation of detection of SNMD. Lastly before the discussion of conclusion, we illustrated the challenges in the amalgamation of technology and detection of SNMD.

2. Components of Social Network Mental Disorder
Mental disorders manifest in several ways that cover various degrees and areas of internet usage. Most of the mental disorders due to the prolonged use of internet can be grouped into following categories [9] [11]:

- **Net Compulsion / Internet Addiction:** Too much time spent in online gaming, trading, gambling often leads to financial loss and can also hinder professional life and may develop mental health issues like depression.
- **Information Overload / Information Glut:** It includes consistent seeking large amount of online information which makes difficult to separate fact from friction. It also comprises constant online browsing, checking user status and newsfeeds that lead to lesser social...
interactions with friends and family and results in inefficiency and decreased productivity at work.

- **Cyber Relationship Addiction**: Virtual relationships with social network connections grow to be serious which result in neglecting real life friends and family.
- **Cyber Sex Addiction**: It also includes compulsive - obsessive need to find sexual gratification and compel users to surf porn sites which in turn has a detrimental effect on real-life relationships.
- **Computer Addiction**: Compulsive game playing on computer online/offline without realizing its health hazards.

In this paper we showed that mining data from social networking sites and developing a machine learning framework has potential to automate the process of detection of SNMD among SNS users. We present a general framework of the automatic processes employed in various literature and studies, in Figure 1.

![General Framework of Automation of SNMD](image)

**Figure 1. General Framework of Automation of SNMD**

3. Literature Review

In the following section we present a review of few research findings on predicting and diagnosing prevalence of mental disorders in SNS users using data mining techniques.

According to various studies the mental health of internet users is at risk. The detection of mental state of the Internet users by exploiting the features from multimedia contents through Natural Language Processing computer vision and multimodal sensing techniques is challenging and developing fast to complement the psychiatrist’s prognosis. In a development in this area a highly integrated multimodal signal system for mental health prediction was proposed and tested by Zhou D et al (2015). The researchers explored the multi-model approach to monitor and manage mental health by integrating computer vision, data mining, social media and behavior sciences. For sentiment analysis, a natural language Programming
tool was employed to discover sentiments of users. The researchers concluded that the proposed system provided quite promising results and was able to infer a user’s current mental state [10].

In a research Suhai H H et al (2018) proposed a machine learning framework namely Social Network Mental Disorder Detection (SNMDD) that uses social network data to accurately identify potential cases of SNMDs. In order to improve the accuracy of detection, researcher also explored multi-source learning in SNMDD and a newer SNMD based Tensor model. Binary supervise vector machine was used to detect three types of SNMDs namely Cyber Relationship addiction, Information overload and Net compulsion. The authors concluded that SNMDD is promising for identification of potential SNMD cases in the OSN users [11]. Islam R et al (2018), in a study used Face book data and applied K-Nearest Neighbour classification technique for detecting depressive emotion in online network users[12]. Song J et al (2018), explored the benefits of analyzing social big data and applied association analysis method of data mining and decision tree to gather content on the risks of sexting in Korean youth[13].

Mining of online social behavior has potential to identify the social network delusion (SND) for mental illness, was explored by Hinge T et al (2018) by employing machine learning framework. Researchers used multisource data analysis for predicting SND cases and studied the users’ relationship with other users through ‘feeling score’ feature to increase accuracy [14]. Anu Kc et al (2018), proposed that mining online social behavior provides a platform to monitor the addictive usage of the users. Authors used face book and twitter data and performed sentiment analysis using Natural language tool kit and Deep Neural Network [15]. Deep Neural Network, a data mining technique was used by J Jia (2018) and Y Wang et al (2019) to detect sexual orientation by extracting facial images and to compute mental health by harvesting social media respectively[16][17].

In a study by Meghana M (2019), potential SNS users were automatically identified and labelled as virtual relationship addicted, obsessive online gaming and information glut addicted. The study employed a multi source learning model SNMDI (Social Network Mental Disorders Identification) and implemented Tensor based model to improve the accuracy of its findings [18]. In a similar study, Jenisha et al (2019) detected Disorders using machine learning algorithms, Support Vector Machine (SVM) and Naive Bayes [19]. In a furthermore study by Dubey S et al (2019), another Supervised Learning with Amoeba Optimization (SLAO) was proposed to improve the precision of the SNMD model[20].

We also explored the study of psychiatric disorders prevalent in the Social Network world. In one of its kind recent study by Cacheda F et al (2019), proposed two machine learning approaches to label potential Major Depressive Disorder (MDD) in SNS users. The social network analysis was achieved by Random forest classifier with two threshold functions and also through two independent Random forest classifiers to identify depressed and non-depressed SNS users[21]. In another study, an automated system of psychological disorders detection (PDD) was proposed by Nalinde P B et al (2019), that extracts online social behavior of Face book users and can identify the disorder at an early stage. Naïve Bayes classification, a machine learning technique, was employed to recognize and categorize psychological disorder states of the users [22]. Rukumanikhandhan C et al. (2019), attempted to automatically identify the probable online users with SNMDs. The machine learning framework proposed by the authors used binary SVM to classify the three types of SNMDs-Cyber relationship addiction; Net compulsion and Information overload addiction. A Tensor technique was used for deriving latent features from the OSN logs to improve accuracy [23].

The feasibility of machine learning methods to detect Internet addiction was explored by Di Z et al (2019) by using large dataset of Chinese college students. The data was collected using personality questionnaires and analysis was achieved by using data mining techniques SVM and Fuzzy Neural Networks [24]. Wongkoblap A et al (2019) investigated the social network data through Multiple Instance Learning (MIL) and modeled the symptoms of depression, a mental health issue prevalent in users of social networking platform. In another study, authors predicted the social network users with depression and highlighted that training a MIL model via Long Short-Term Memory and gated recurrent unit can improve the accuracy of prediction of social network users with depression [25][26]. Kamaruddin N et al (2019)
developed an engine with three machine learning approaches Multilayer Perceptron, Naive Bayes, and Random Forest to recognize porn addiction in the Indonesian teenagers [27].

In a recent study, Purwandari B et al (2020) aimed to predict Internet addiction disorder among undergraduate youth of Indonesia University which impacts negatively on their mental health. The SVM with radial basis function (RBF) kernel was employed as a machine learning method to perform analysis of their web browsing histories for prediction [28]. In another recent study, Desai D B et al (2020) discussed the effects of mobile games on male adolescents using data mining techniques. The review study concluded that data mining techniques like classification, association, neural networks can be used to find effects of mobile game playing on adolescents [29]. Table 2 provides a tabular summarization and comparison of above works, highlighting the pros and cons of each.

Table 2: Relative comparison of existing approaches for SNMD

| Author          | Year | Description                                                                 | Data Collection platform                                                                 | Data mining technique                           | SNMD type                  | Merits                                                                                          | Demerits                                                                 |
|-----------------|------|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------------|---------------------------|------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|
| Zhou D et al.   | 2015 | Tracked the mental health of the social media users through sensors and used machine learning techniques to build model. | Extracted time series signals while participants were actively involved in social online media. | Computer Vision, Multi class classifier (Logistic Regression), SVM | Net Compulsion             | Handled diverse noisy multimodal data and established a connection between mental health state and computers as tool. | Since participants were aware, the study data may become biased.          |
| Suhai HH et al.[11] | 2018 | Developed an automated model by exploiting social network data and identifying the SNMD cases. | Questionnaires Face book and Instagram online logs                                       | Multi-source semi supervised technique TSVM and Tensor | Cyber Relationship, Information overload, Net Compulsion | Presented an innovative machine learning model to detect SNMD cases and also extracted latent features from SNS logs. | Sentiments as feature was not explored and also users may behave differently on different SNS which may result in biased results. |
| Islam R et al.  | 2018 | Studied depression problem in Face book users using Classification technique. | Face book                                                                               | KNN                                          | Net Compulsion             | Exhibited the capability of SNS data as source to measure and detect depression among users. | Challenges related to the implementati on not mentioned.                |
| Song J et al.[13] | 2018 | Proposed to forecast the risks of sexting in Korean children.               | Mining Social big data                                                                    | Association analysis and Decision tree          | Cyber Sex Addiction        | A novel study to gather real content which highlights the risk of sexting from social media. | Challenges related to the implementati on not covered in detail.        |
| Authors    | Year | Description                                                                                                                                                                                                 | Methods                                                                                             | Challenges                                                                                          |
|------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| Hinge T et al. | 2018 | Developed a Social network delusion (SND) model which has potential to identify the SND cases by mining the online social behaviour.                                                      | Facebook, Instagram, Chatting Apps, Multisource learning                                            | The model incorporated sentiment score to increase the accuracy of detection                        |
| Anu KC et al.[15] | 2018 | Described the use social network data to mine the addictive behaviour of the users.                                                                                                                     | Face book and Twitter, Naive Bayes, Natural language tool kit for sentimental analysis               | Employed Neural deep learning algorithms which are based on time series analysis and can recognize patterns from real world data. |
| Jia J [16] | 2018 | Presented a broad view of mental health computing via harvesting social media.                                                                                                                              | Mining social media, Multi-modal detection model CNN, LDA                                            | Constructed a set of benchmark real-world datasets, identified discriminating feature groups, and discussed effective multimodal detection models. |
| Y Wang et al.[17] | 2019 | Discussed the advantage of Deep neural networks over humans in detection of sexual orientation using facial images.                                                                                           | Mining facial images online, Deep Neural network, Logistic regression                                | Presented comparison of human judges with algorithms and found that algorithms perform better with higher accuracy in detection process |
| Meghana M et al.[18] | 2019 | Aimed to analyze data mining techniques to identify three types of SNMD.                                                                                                                                  | Online Logs, Multi-source learning algorithm and Tensor based model                                  | Discussed the challenges faced in online SNS data and presented the importance of choosing efficient data mining technique. |


| Researchers | Year | Methodology | Data Sources | Machine Learning Models | Disorder Detection Methods | Challenges/Issues |
|------------|------|-------------|--------------|-------------------------|---------------------------|------------------|
| Jenisha et al. [19] | 2019 | Developed a machine learning based model using certain usage patterns as the independent variables to predict the SNMD | Face book data | SVM, Naive Bayes | Cyber relationship, Information overload and Net compulsion | Mentioned few actionable insights about the application of the model as tool for diagnosis and also mentioned in details the performance matrix of the model. Implementational challenges not mentioned in details. |
| Dubey S et al. [20] | 2019 | Proposed a AI framework to express social network mental disorder detection | OSN Logs | SLAO | Cyber relationship, Information overload and Net compulsion | Highlighted the comparison of SNMDD model with SLAO model. Lacks details of Feature extraction. |
| Cacheda F et al. [21] | 2019 | Proposed social media network data use to detect Major depressive disorder | Data extracted from Reddit | Random forest classifier | Net compulsion | Performed thorough analysis of the extracted data and applied two machine learning algorithms to improve accuracy of detection. Issues of data collection and implementation not discussed. |
| Nalinde P B et al [22] | 2019 | Developed a machine learning framework by exploiting the OSN logs to identify possible cases of disorder | Facebook data | Naive Bayes | Net Compulsion | Framework recognized the psychological state of the users accurately and in addition recommended hospitals on map for the further treatment. Latent features not explored. |
| Rukumani-khandhan C et l.[23] | 2019 | Proposed to automatically identify the potential online users as SNMDs | Online social network logs | Binary SVM | Cyber relationship, Net compulsion, Information overload | Challenges for SNMD detection discussed and authors proposed a tensor technique for deriving latent features from multiple OSNs. Implementation of model with result is not discussed in detail. |
| Year | Authors          | Methodology                                                                 | Data Sources                                                                 | Challenges                                                                 |
|------|------------------|------------------------------------------------------------------------------|----------------------------------------------------------------------------|---------------------------------------------------------------------------|
| 2019 | Di Z et al [24]  | Detection of Internet addiction disorder in Chinese college students using SVM | Personality questionnaire, SVM                                               | A larger dataset with inclusion of participants of different ages will provide more general result. |
| 2019 | Wongko -blap A et al. [25] | Developed a deep learning model to predict the social network users with depression | Facebook, Multiple Instance Learning                                         | The model was trained by less users and the data set was imbalanced.       |
| 2019 | Wongko -blap A et al. [26] | Developed a multiple instance learning model with Long Short-Term Memory and gated recurrent unit | Facebook, Multiple Instance Learning                                         | The dataset was not reflection of real world population of probable online users with depression. |
| 2019 | Kamarud -din N et al [27] | Developed an engine to recognize the potential porn addicts | EEG device, psychological questionnaire, Multilayer Perceptron, Naive Bayes, Random Forest | The participants may suppress or exaggerate their addiction level which may not produce accurate result. |
| 2020 | Sahoo D et al [28] | Proposed a machine learning framework to detect psychological stressed users communal network. | Tweets from communal network, Element graph combined with Convolution Neural Network | Challenges not discussed in details.                                      |
4. Challenges in automated detection of SNMD

In recent years the amalgamation of data mining techniques and health care systems has been a research interest for researchers and clinicians. Based on the literature, we have identified key research challenges related to the automated detection of mental disorders and presented them step-wise in Figure 2. Before considering applying the models in real life scenarios as tools to complement the existing systems these research challenges need to be investigated and taken care of:

- **Feature Extraction**: With the rapid increase in the social networking sites, it is a challenge to choose a suitable social networking platform for extraction of factors contributing towards the SNMDs. Managing the quality of online data and absence of established diagnostic criteria for SNMD is a challenge due to the biases associated with data collection process. Also the researcher has to consider online data collection protocols and ethical issues like sharing, disclosure and privacy of data [3] [11].

- **Feature Selection**: Identification and analyzing the features and indicators of mental disorders through the logs and status updates of the online users is significant. A good feature selection improves the accuracy of detection of SNMD. Harmonizing the data for the SNMD automation process requires a great collaboration between the researcher and health practitioners or clinicians [14].

- **Feature Analysis**: Since prediction of mental health state is a sensitive issue for online users, selection of data mining techniques to develop an accurate and efficient machine learning framework is a key challenge for detection of SNMD. Predicting and classifying the online users as potential SNMDs requires substantial background and it is possible, if a best fit data mining algorithm is suitably employed to develop a machine learning framework in order to automate the process of detection of SNMD [3].

- **Output and Interpretation**: In order to utilize the model in real world health scenarios, it is crucial to improve the performance of the models for the accurate identification and classification of SNS users as potential SNMDs [21] [23] [24].
5. Conclusion

In this paper, we provide insights about the application of data mining techniques in the detection of probable Social Network Mental Disorder cases among the social networking sites users. The studies mentioned in this paper exploit the symptoms associated with mental illness observable on social networking sites and present varied automated methods to identify the SNS users at risk. Most of the studies have been conducted by considering the personal and social features of SNS users and employing data mining techniques like SVM, Decision tree, Random forest, Naïve Bayes classifier and K-Nearest Neighbours classification. Natural Language processing, computer vision and multimodal sensing, deep neural network tools were also employed. The associated literature mentions that these techniques are developing fast and has potential to complement a psychiatrist’s prognosis. Investigating mental health issues using social networking sites has some inherent problems and we presented the challenges a researcher may face during the automation process of SNMD detection. Thus this review study opens up the idea of newer cutting-edge analysis and data mining techniques that researchers may employ, to develop efficient and better predictive monitoring models for mental health associated issues. In future they may complement the existing screening processes adopted by health practitioner to identify probable SNMD cases among the SNS users.

Abbreviations: SNMD-Social Network Mental Disorder, OSN-Online Social Network, SNS-Social Networking Sites, SLAO-Supervised Learning with Amoeba Optimization, SVM-Support Vector Machine, TSVM- Transductive Support Vector Machines, KNN-K Nearest Neighbour, CNN-Convolutional Neural Network, LDA- Linear Discriminant Analysis, EEG-Electroencephalogram

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