Role of Machine Learning in Diagnosis and Recovery from Depression

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Abstract

Depression is a global health problem. The demand for solving mental illness and recovery from other mental health issues is rising day by day. The World Health Organization (WHO) and its members paid attention to take action in this global problem. Nowadayswe can assemble any type of information about anyone from social media. It has become a global platform where its users express all their feelings, emotions and opinions. Different people suffer from speech disorder due to some sudden shock like stroke or depression. Proper analysis of the reason behind depression can lead to a quick recovery from it. Speech therapy is a widely known solution for restoring someone's original ability to speak properly and explain. Artificial Intelligence (AI) has hugely drawn attention of academic sector and industry for its efficiency in different areas of research over the last few decades. Being one of the driving forces of Industry 4.0 paradigm, it is resulting in automation, analytics and development of improved product strategies in various sectors throughout the world. In various state-of-the-art literature, machine learning techniques have been applied in diagnosis of depression and treatment for it. In this chapter, existing works in the concerned area have been reviewed and analysing different loopholes found in those, a probable future direction for the research has been provided [17].

Keywords: Mental Health, Personalized healthcare, Depression treatment, Deep Learning, Convolutional Neural Network

1. Introduction

Depression is one kind of mood disorder; it creates a persistent feeling of sadness.TheCenters for Disease Control and Prevention (CDC) declares that 8.2 percent of adults had depression, which leads to less productivity. There are many kinds of mental disorder like major depression, persistent depression, manic depression, depressive depression, psychosis depression, perinatal depression, premenstrual dysphoric disorder, seasonal depression, situational depression, atypical depression. In adulthood, these students who suffer from major depression often experience less than minimum educational and occupational accomplishment which cause correspondingly low income, early marriage (before 18) and parenthood, and marital dissatisfaction. Severe depression gives a more negative outcome. According to the World Health Organization (WHO) major depressive disorder is the leading cause of disability among people aged 15 to 44 years (WHO,2012). This becomes a major problem for society. To solve this social problem we need to detect the depression from the primary stage and have to cure it.so, we have to find the symptoms of depression like to much mood swings, aggressiveness, in this research we proposed a system which will analyse the total activity of that person and calculate their depression level through machine learning.

1.AMotivation

Depression is a common illness in today's world, not less than 264 million people worldwide suffer from some form of depression. Depression should not be confused with usual mood fluctuations, empty feeling or short-lived emotional outbursts that occur as a response to challenges faced in every-day life, but when these occurrences are long-lasting and have moderate or severe intensity, it may become a serious health issue. This condition is known as depression. This might cause significant mental and physical suffering to the affected person and that might lead to functioning poorly at work, at school or cause problems in their family life. If depression is left untreated for long then it often

leads to suicidal thoughts or attempts. Nearly 810,000 people die each year due to suicide which is caused by extreme depression. Suicide is one of the leading causes of death in teenagers as well as adults below the age of 30.

Depression is caused due to complex combinations of social, psychological, biological as well as financial factors. Life events such as childhood adversity, loss of loved ones, poor academic performance, financial loss, marital problems, and unemployment contribute to and may accelerate the development of depression. Although depression has high severity, it is one of the most treatable of mental disorders. Effective treatments for depression do exist but several barriers to effective mental health care make it quite inaccessible for almost 76% to 85% of low-income and middle-income families from economically backward countries [20]. Several existing barriers to effective mental health care include a lack of resources, lack of properly trained health-care providers and the social stigma associated with mental disorders. Another barrier to effective care is the people in lives in far awayfro the mental hospital, people having problem in walking and moving, and persons who do not prefer leaving their location [15]. Online - based assistance of special physicians or doctors could also be ready to treat a bigger number of patients and waiting queue for psychological treatment are often minimized during this way [18]. Surveys wiped out Australia specify that suicide ratio are more in rural areas than in cities, and fewer people in rural locations—mainly young men—search for help having psychological ailments [16, 17]. Another barrier to effective care is inaccurate medical assessment. In countries of all income levels, if the health-care providers aren't trained enough, people that are depressed are often not correctly diagnosed while others who don't have the disorder are often misdiagnosed and prescribed antidepressants which can have negative effects. At present, cases of depression, mental health issues, and suicides caused due to depression are on the rise globally. A World Health Assembly resolution passed in May 2013 called for a comprehensive, coordinated response from all countries towards addressing and finding solutions to the problems caused due to mental health issues [20].

1.1. Types and Symptoms of Depression

Depression can be categorized into three types based on the number and severity of symptoms. The categories are mild, moderate or severe. A person with mild depression may experience some difficulty in continuing their work and maintaining their social life whereas a person suffering from severe depression might cease to function completely and start abusing drugs or start to show suicidal tendencies. Another classification is made based on the person affected having or not having maniac behaviour during their depressive episodes. If untreated, both types of depression can be chronic and result in relapses into the depressive phase.

1.1.1. Recurrent depressive disorder

A person suffering from this type of depression experiences repeated depressive episodes. The affected person shows a general loss of interest and enjoyment and reduced energy towards almost all activities for almost two-three weeks, insomnia or abnormal sleep cycles, anxiety, loss of appetite, very low self-esteem and poor concentration towards work [14].

1.1.2. Bipolar affective disorder

A person suffering from this type of depression experiences both depressive and manic episodes separated by a period of normal behaviour. The manic behaviour exhibited by the person includes

hyperactivity, inflated self-esteem, sudden urges to eat a lot, difficulty in speech and decreased need for sleep.

1.2. Contributing factors and Prevention of Depression

Depression is caused due to a complex combination of social, psychological and biological factors. People who have gone through adverse life events (psychological trauma, physical trauma, marital problems, death of a family member, unemployment, etc.) are more likely to develop depression. Depression can lead to more stress and disfunction to the affected person and cause the person to become even more depressed, just like a vicious cycle. Several other factors such as some social media platforms may act as a catalyst to depression. It has also been observed that physical health and depression are interrelated. For example, cardiovascular diseases can cause depression and the other way around.

It has been observed that prevention programs often reduce depression. School-based programs for the enhancement of positive thinking in children and adolescents as well as counselling and interactions with mental-health specialists are a few examples of effective community approaches to prevent depression. Interventions for parents of children with behavioural problems may reduce parental depressive symptoms and improve outcomes for their children. There are numerous online platforms which will store data for screening patient information. It also helps doctors for decision-making purposes. Recently different researches are finished preventing the recurrence of depression. Exercise programs for the elderly could also be effective in depression prevention.

1.3. Diagnosis and treatment of Depression

Although depression and other mental health problems are very concerning, there exist several methods in which effective treatment can be provided to the affected people. Most mild to moderate depression can be treated with psychological therapies, some of the available psychological treatments are behavioural activation, interpersonal psychotherapy, and cognitive behavioural therapy. In cases of severe depression, both psychological, as well as antidepressant-based treatment methods like tricyclic antidepressants (TCAs) and serotonin reuptake inhibitors (SSRIs), are used. Health-care providers should keep in mind that prescribed antidepressants may have adverse effects and, in some cases, result in the affected person getting addicted to the antidepressant. Antidepressants must not be used for treating depression in children and should not be considered as the primary type of treatment in adolescents and even if they are to be used, it should be done extra caution.

1.4. Impact of Depression

Depression and mental disorders associated with it can have a very negative effect on all aspects of an affected individual's life. It can dramatically reduce productivity and effectiveness, ruin relationships with family and friends, reduce the affected person's self-esteem and confidence by such a degree that renders them unable to participate within the community. Research has shown that mental health is strongly related to the physical health of an individual and vice versa, so when a person is depressed for a significant amount of time it might cause cardiovascular diseases, constant headaches, loss of appetite, etc. Most suicide cases are caused due to depression. Depression affects all genders and every section of the society, young and old, rich and poor of every single country. Depressed people typically have subsequent symptoms:

- Loss of enjoyment in most activities.
- Constantly feeling tired or lethargic.
- Hypersensitivity and emotional vulnerability.

- Being easily distracted, inattentive and forgetful.
- Inconsistent sleep patterns, insomnia.
- Appetite and weight changes.
- Very low sex drive.
- Very low self-esteem, constant feelings of guilt.
- Constant feelings of self-blame, feeling like an outcast, paranoia.
- Being pessimistic about the future.
- Persistent thoughts of suicide.
- Alcohol or drug consumption.
- Being angry and irritable.
- Physical pain or health disorders (e.g. Headache, digestive problems).

As a scientific discipline, epidemiology is of significant importance to health sciences. The seven purposes of the epidemiology of mental disorders can be described as

1) Understanding the magnitude of the mental disorder

2) Understanding the factors that cause mental disorders
3) Calculating the risk associated with the particular mental disorder
4) Monitoring the historical trends surrounding the disorder
5) Deriving a complete clinical picture of the situation.
6) Identification of new syndromes associated with the disorder.
7) Studying treatment utilization in the community.

2. Literature survey

Because the presence of any known evidence, mental illness can be very difficult to detect along with other Health related problems like Heart attack, Covid, etc. Today physiologist or specilized doctors use the PHQ-9 and PHQ-2 factors of the Patient Health question answer Form for identification of depression [10, 11].

The main purpose of this article is to supply symptoms of the patients with mental disease using ML logic and produce the foremost accurate output. Also studied predicting PTSD, schizophrenia patients, bipolar disease, depression as domains during which ML techniques were deployed for diagnosis of depression treatment [12, 13].Table 1 analyses and compares different existing depression detection and recovery methods. Table I. Comparative analysis of the existing depression detection methods

Ref No.	Objective	Method	Performance	Features	Drawback(s)
[1]	Methods of early detection of MDDs based on machine learning.	Tree-based algorithms: 1) random forest (RF) 2)independent	Method: Random ERDEa5::18.51 ERDE50:15.20 F measure:0.20	In comparison with the state-of-the-art detection models, dual models are able to improve	1)the classifier requires enough evidence which causes a delay. 2) An individual combination of

		RF classifiers, It has types of features: textual 1)similarity, 2)semantic similarity, 3)WFs.	Precision: 0.12 Recall: 0.00 Method: all depressed ERDEa5: 21.67 ERDE50:15.03 F measure:0.23 Precision: 0.13 Recall: 1.00 Method: non-depressed ERDEa5::18.51 ERDE50:15.20 F measure:0.20 Precision: 0.12 Recall: 0.00	performance up to more than 10%.	WFs did not lead to improved results and becomes crucial for the positive model 3) The less strict evaluation of false negatives using WFsERDE$_{50}$ metric.
[2]	Depression detection using DASS-21 scale.	DASS-21 is a categorical conception of psychological disorders. Anxiety and stress are measured by a 4point scale which contains three sub scale. Exploratory Factor Analyses (EFA), Receiver Operating Characteristic	Anxiety in women with a sensitivity of 79.1% Anxiety in women with a specificity of 77.0% at the optimal cut off of >33, 26/221 (11.8%) women were depressed; 24/221 (10.9%) was suffering from anxiety disorder, 7/221 (3.2%) with co-morbid depression and an anxiety disorder. All total, 43/221 (19.5%) met	Comprehensibility and psychometric properties of the Depression, Anxiety and Stress Scale as a screening instrument for depression in women.	Generalization of the findings to Slavonic languages requires further research. Due to the relatively small size of the research sample an unexpected limit, It also did not further verify the results.

		(ROC)	diagnostic criteria for at least one of the mental disorders		
[3]	Depression Detection via Harvesting Social Media: A Multimodal Dictionary Learning Solution	Data Collection, Data Pre-processing, Feature Extraction, Multimodal Depressive Dictionary Learning: Uni-modal Dictionary Learning, Multimodal Joint Sparse Representation	1) depressed users are more likely to post tweets (+44% on average) between 23:00 and 6:00 2) Depressed users have 0.37 positive words and 0.52 negative words in their per tweet 3) Depressed users use depression symptom words 165% (0.061 per tweet).	WDL achieved better performance than NB by 10%, MSNL and the presented MDL outperformed WDL by 5% to 8%. The MDL method surpassed the WDL method by 3%	It measures only the benchmark depression and well-defined discriminative depression-oriented feature groups,
[4] [15]	Interpretable Depression Detection from Social Media.	Feature Networks 1)Depressive Symptoms 2)Ruminative Thinking 3)Writing Style 4)Sentiments 5)Post-level Attention	Word Frequency Polarity, anxiety 2233 neg, meds 1229 neu, Medication 934 pos, disorder 698 neg, psychiatrist 382 neu, adderall 320 pos, Suicidal 316 neg, Disability 145 neg, Abusive 136 neg, insomnia 131 neg	Based on the RSDD training set, it used GloVe for embedding word vectors and GRU. Adam optimizer and weighted loss for imbalance between depressed and control groups.	It can't explain mental disorders (like dementia, schizophrenia, and bipolar disorder). This model uses smaller training data as input as it has limited computing power, showing lower performance than the state-of-the-art model.
[5]	In college students, depression is the result of	Based on AU14 theory	out of the 79, 38 were correctly classified as positive and the	1) gabor filters 2)using an SVM classifier for	The most accurate action unit one for depression detection depicted

	social change due to the emergence of the internet, smart phones and different social media sites.		remaining 41 were wrongly classified. Accuracy of 64.38%. Error percentage is quite low – 35.62%. Positive emotion - 61.32% negative emotion- 70.36%. Precision which depicts how close different samples are to each other is 80.26%.	classification of facial features. 3) depression is calculated by the negative emotions present in the entire video.	as AU14. Based on this theory, the current study proposes a system that will be trained with features of happy, neutral, contempt and disgust faces.
[6]	Utilizing Neural Networks and Linguistic Metadata for Early Detection of Depression Indications in Text Sequences	Dataset, Task and Evaluation Criteria, LINGUISTIC METADATA: Word and Grammar Usage, Readability, Emotions and Sentiment, Metadata Feature Summary NEURAL NETWORK MODELS	The models corresponding to the name of a word embedding refer to a CNN using this embedding as input vectorization, the models named "MetaLR"refertoth elogisticregression basedonmetadata, and the final four results were obtained by calculating the mean of the metadata probabilities and the neural network output.	Results are compared to the best published results during the eRisk 2017 task as well as other results obtained after the ground truth was released. The scores of each model are reported according to ERDE5,ERDE50, and F1, which are the official scores of this task, and also based on the newly proposed ERDE% 20, ERDE% 50, and Flatency.	
[7]	Predictive Model for Detection of Depression Based on	1)The initial questionnaire to collect the information of the test	Older Adult 1)Age :69	Uses of fuzzy rules for recognizing the behavior pattern of adults from	No comparisons with other models based on several data mining

	Uncertainty Analysis Methods	subjects;2) mobile applications designed with the FIWARE 3)Data Cleaning and Discretization 4) Statistical Grouping of Data Subset by Variable	HIGH Level %:0% MEDIUM LEVEL%: 37.7% NULL Level%: 62.3% Depression Level (Based on the Highest Level in Percentage): NULL Questionnaire (Level of Depression) Yesavage Test: NULL 2)Age :61 HIGH Level %: 71.2% MEDIUM LEVEL%: 28.8%	their daily activities.	techniques., Didn't analyse any other machine learning techniques such as neural networks, decision trees, and vector support machines
[8] [19]	Detection of depression and mental illness in Twitter	Machine learning Using sentiment analysis through bayes Theorem	Precision: 0.9 Recall: 0.43902439024390 244 F-score: 0.59016393442622 95 Accuracy: 0.87562189054726 37	Categorized the data between positive tweets and depressive tweets by some keywords. Like ''Day'', ''happy'', ''haha'', ''cool'', ''nice'', ''home'', ''funny'', ''amazing'', ''welcome'' for positive tweets and ''symptom'',''suffer'','' hard'', ''issue'', ''bipolar'', ''suffering'',''emotional'', ''food'',	It can't clean the data in the case of an annotated dataset.

					''illness'', ''hate'', for depressive tweets	
[8]	Analyzing and Predicting Mood of Depression Patients	Data used from VU Unobtrusive Ecological Momentary Assessment Pilot Study Data. And the data can be split into two components: mood as assessed by the participants and logged smartphone sensor data.	Can predict depression 64% correctly	1)Uses of ARIMA models based on the autocorrelation and partial autocorrelation functions. 2) Uses di erent algorithms to predict mood. 3)Machine learning algorithms were applied to construct models, random forest and regression trees were used to construct linear models.	Naive method performs better than ARIMA. More training data is able to make better predictions Low performance on prediction for individuals.
[9] [18] [16]	Objective Assessment Depressive Symptoms with Wearable Sensors Data	ML& uses of models like 1)Feature Transformatio n and Selection 2)HDRS Imputation Based on Survey Data		1)Physiological Signals 2) Phone Passive Usage Data 3)Interactive Surveys 4)Clinical Measure	If any patients have no observed data in the training phase some interdependency will occur.

3. Machine learning methods

In this section, the machine learning architectures applied in recovering various disorders due to depression and sudden shock will be described.

Some popular algorithms applied to predict and prevent depression in this paper are discussed below.

a.   Random Forest Algorithm

It is a supervised   algorithm which is used for categorization as well as regression . Working procedure of Random Forest Algorithm (as shown in Fig.1):

Step 1: Select random data sample from defined dataset.
Step 2: The algorithm will produce a decision tree for each sample in the dataset.
Step 3: For each decision tree , a prediction result will be generated.
Step 4: Voting of the target sample will be achieved for every prophesied result.

 Step 5: Choose that value which has got maximum vote as the predicted final result.

The diagram of Random Forest Algorithm has been depicted in the figure below(Fig 1).
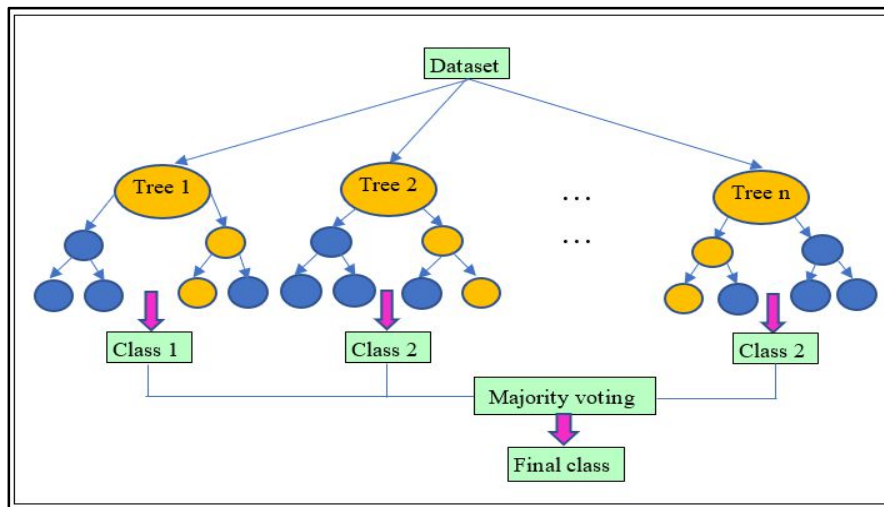
Fig. 1.Working mechanism of Random Forest

b.   Support Vector Machine (SVM)

It is a supervised machine learning algorithm that is used to implemented in classification as well as in regression, but it is most popular as a binary classifier in the existing works of suicide ideation detection and prevention, which classifies the new data points using a hyperplane separating the class 1 and class 2 data points. The working mechanism of SVM is shown in Fig.2.
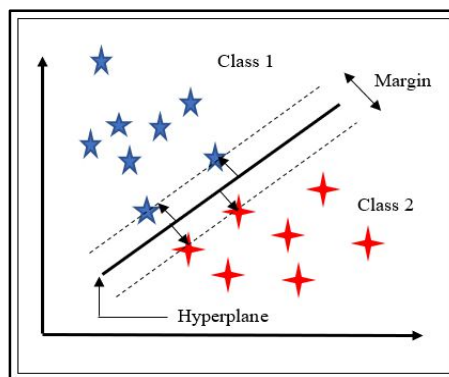

Fig. 2.Working mechanism of Support Vector Machine

c.   k Nearest Neighbor (k-NN)

The kNN algorithm in ML is used to resolve categorization as well as regression problems. It has been mostly used as classifier in the suicide prediction and prevention models of existing literature where distance from every neighbor of a datapoint is measured and the number of nearest datapoints is denoted by a variable k based on the assumption that similar datapoints reside close to each other. The decision of classifying the new data point is taken according to the minimum distance it has with its neighbors. Fig. 3shows the working mechanism of the said process.
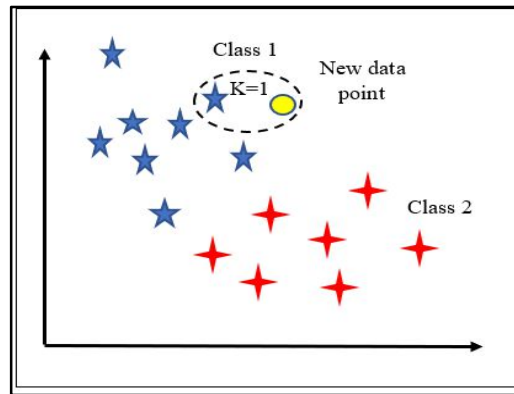

Fig. 3. Working mechanism of k Nearest Neighbour

d.   Decision Tree Algorithms

Decision trees are constructed by an algorithm which splits a dataset based on some conditions. The working mechanism is shown in Fig.9. Here in suicide prediction approaches, decision tree has been applied in the questionnaires to find the subject's mental condition.
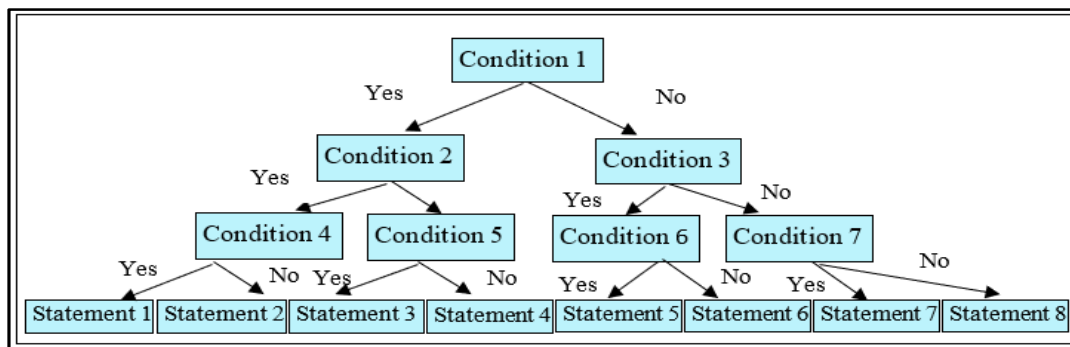

Fig.4.Working mechanism of Decision Tree

4. Conclusion

This paper provides an analytical overview of the existing literature. Detection as well as prevention is very necessary factor for an issue like suicide, specially when depression works behind the death. With the blessings of technologies like machine learning or data analytics, clinical management of depression across diagnostics and evaluation has witnessed a paradigm shift in recent times.

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