

Mental Health Prediction Using Machine Learning

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Abstract

Mental health problems are one of the major concerns of the 21st century in the field of healthcare. One of the major reasons behind this problem is lack of awareness among masses. Our aim with this paper is to help people realize that they might be suffering from some kind of mental problem like depression, anxiety, ptsd, insomnia by making them aware of their symptoms using Machine learning. In order to apply the machine learning algorithms, data was collected from individuals of varied ages, professions, sex and lifestyle through survey form consisting of questions, which are often used by psychologists to understand their patient's problem in detail.

We believe implementation of such a system could help us prevent potential "Mental health epidemic" and give people easy access to diagnosis.

Keywords: MENTAL HEALTH PREDICTION, MACHINE LEARNING ALGORITHMS, DEPRESSION, ANXIETY, PTSD, INSOMNIA.

1. INTRODUCTION

Mental health problems are not new to mankind. References to mental illness can be seen throughout history, as early as 5th century BC. But in the modern world the problem is more common. According to government statistical data out of the whole population of India, 130 million people could be suffering from some kind of mental illness. The main reason behind such a huge number of people suffering from mental illness is our crumbled healthcare system along with no adequate support from the government towards this issue. In India topic of mental health is still considered a taboo that's why only 8 to 10 percent people are able to get some kind of treatment for their problems and rest gets unnoticed which could be a possible reason for high suicide rates. Doctors have found out that almost 35 percent of the people who seek medical help could be suffering from depression, post-traumatic stress disorder (Ptd), anxiety, insomnia, bipolar disease, etc. Another big factor that contributes to the problem is lack of affordability. A large amount of India's population is living below the poverty line, these people don't have access to proper shelter, food, water, medication, etc. For them proper treatment of mental illness is still a distant dream. Even for the top 10 percent of the population, treatment is costly.

According to world health organization data India has 0.75 psychologist and psychiatrist per 100,000 people, when compared to Argentina which is a world top leader in this has 106 psychologists per 100,000

people. To overcome this potential epidemic of mental illness, the government has to take some strong and necessary steps towards healthcare, providing a sufficient budget towards mental health.

To diagnose a patient's problem, the doctor may ask the patient to fill out a questionnaire. The nature of these questions could be situational and objective. In our paper we are trying to predict the following problems.

- 1) Depression- is a disorder that directly affects the person's emotions, making it difficult for them to function in daily life. When a person is going through a prolonged sadness and hopelessness it can be diagnosed as depression.
- 2) Anxiety- is described as feeling of nervousness along with a sense of excessive worry towards a future scenario. In some serious cases it can also cause rapid heart rate, shortness of breath.
- 3) PTSD- post traumatic stress disorder(ptsd) is a psychological disorder characterized by failure to recover after experiencing or witnessing a terrifying event.
- 4) Insomnia- it is a common sleep disorder that disrupts a person's ability to fall asleep or stay asleep or cause them to wake up early and not be able to get back to sleep.

2. RELATED WORK

There has been many studies and researches where people have been predicting mental health problems like depression and anxiety using the algorithms of machine learning, like decision tree, support vector machine, random forest and convolution neural network for the collection and classification of data from blog posts. For converting text into meaningful vectors like Bag-of-words, topic modeling etc. these techniques are used. In some cases, python programming has also been used for modeling experiments, with the best result among all the classifiers [2] being generated by CNN with the accuracy of 78 percent. In one study 470 seamen were questioned about their occupation, socio-economic background and health condition along sixteen other parameters like age, weight, family earning, marital status, etc. Different machine learning algorithms like logistic regression, naïve bayes, random forest, Catboost and SVM were applied for classification [7]. On getting the result Catboost showed the highest accuracy and precision of 82.6 percent and 84.1 percent respectively. Sau et al. (2017) manually collected data from the Medical College and Hospital of Kolkata, West Bengal on 630 elderly individuals, 520 of whom were in special care. After applying different classification methods Bayesian Network, logistic, multiple layer perceptron, Naïve Bayes, random forest, random tree, J48, sequential random optimization, random subspace and K star they observed that random forest produced the best accuracy rate of 91% and 89% among the two data sets of 110 and 520 people, respectively. For feature selection and classification, WEKA tool was used in [1]. Change in heart rate, change in blood pressure and acoustics of speech [8],[3] are some of the symptoms of depression and weak emotional state. Diagnosis of Ptsd through speech has been done in recent times. A typical. A typical speech-based PTSD diagnostic system consists of three components including data acquisition, feature extraction and classification [6]. In the data acquiring stage a patient is asked questions and the speech dialogue of that patient is recorded. The feature extraction component then processes the speech data and extracts features for the classification component to predict whether or not the subject being interviewed has any level of PTSD. Though other modalities such as EEG, fMRI and MRI were also studied for PTSD diagnosis [5], [4], the data collection process for these modalities is expensive and cannot meet the growing need. Speech is non-invasive and the interview can be conducted remotely via telephone or recording media so that privacy of the patient is strictly protected, making the speech-based method an ideal diagnostic tool for diagnosis and treatment monitoring. In January 2019

research was published about insomnia being predicted through ML algorithms where fourteen parameters were considered. Multiple classification algorithms were applied like DT, random forest, etc. among all the models SVM came out to have the best accuracy of 91.634 percent and the f measure score was 92.13. They have further applied to a dataset of 100 patients where the SVM comes with a good accuracy of 92%. They have declared mobility problems, vision problems as primary factors [9]. The objective of this research paper is to help people understand about their problems and give doctors an overview into their patient’s psyche. All of this could only be possible when we use models with the most accuracy.

3. DESIGN

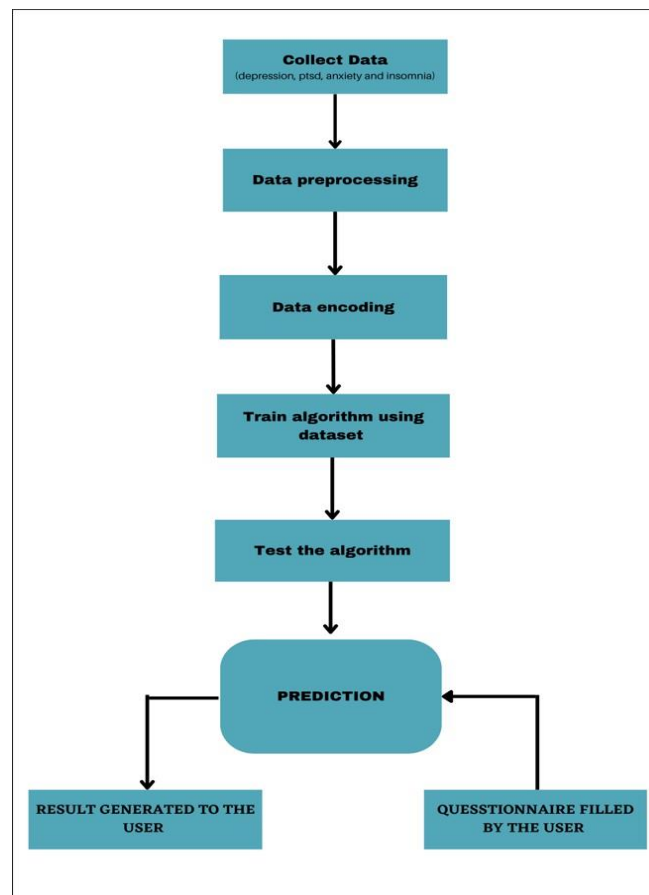


Fig -3.1: Block Diagram

The system goes through multiple stages before the final value could be predicted accurately. These stages are data collection, data preprocessing, data encoding, training and testing of the algorithm. Once the desired accuracy is obtained, we can integrate the system with an application for real world use.

4. MACHINE LEARNING ALGORITHMS

To ensure the best possible working of machine learning algorithms it needs to work with some key parameters. Each and every task requires a different model based on the type of data and work is being dealt with. Hence, it is crucial to adjust the model’s parameters to increase its utility and accuracy. In our work we have tried to ensure to tune all the models with adequate parameter values and plump for the foremost value for our models.

Once the right parameters are selected, we move towards applying machine learning algorithms on our collected dataset of depression, anxiety, Ptsd, insomnia. The collected dataset is usually split into two subsets namely training and testing. It is done to avoid overfitting. In an ideal situation the training and testing dataset is split in the ratio of 80:20

i.e., 80 percent of it goes for training the model and the rest 20 percent is used to test the accuracy of the model. Through research we have selected the following machine learning algorithms to find the best possible algorithm that could give us the most accuracy.

- A) Random forest (RF): It is an algorithm that comes under supervised form of learning. The working principle is to create multiple decision trees and all of them are combined to get precise predictions. Hence, it is considered a popular machine learning algorithm.
- B) Decision tree (DT): A decision tree comes under supervised learning algorithms where data is continuously split according to the parameter. The tree consists of two things i.e., decision nodes and leaves. Decision node is the stage where data is split and all the choices made are the leaves.
- C) Logistic regression (LR): Is also a part of supervised learning algorithms group used for solving the classification problem. Logistic regression model works with binary variables like 0 and 1, yes and no, etc. It uses sigmoid function or logistic function which is a complex cost function.
- D) Support vector machine (SVM): is a prominent algorithm used for both regression and classification. The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. This best decision boundary is called a hyperplane. SVM chooses the extreme points/vectors that help in creating the hyperplane. These extreme cases are called support vectors, and hence the algorithm is termed as Support Vector Machine.
- E) K-nearest neighbor (KNN): Also known as a lazy or nonparametric algorithm. The algorithm is actually based on feature similarity. The prediction is done according to the calculation of the nearest data points. As it stores all of the training data, it can be computationally expensive when working on a large dataset.
- F) Naive bayes (NB): It is a classifier which is based upon conditional probability models. These classifiers are a set of classification algorithms that are based on Bayes Theorem. It's a group of algorithms where a common principle is shared between them. In our study, we have applied Gaussian Naïve Bayes.

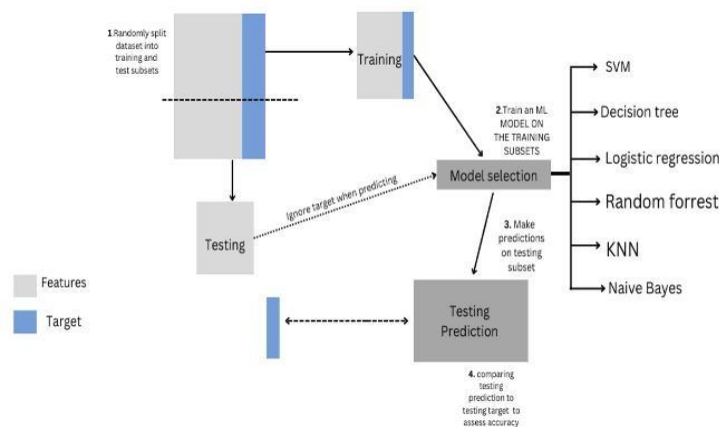


Fig -4.1: Methodological Framework

5. IMPLEMENTATION

The initial step is data collection. We have tried to collect data from different places. There was no standard dataset available which could match our requirements. Hence, we had to collect all the data ourselves. We made a survey form for each disease and distributed, both online and offline for people to fill it. The nature of our questions was objective and situational. We also included people who are currently suffering from some kind of mental illness and are seeing doctors for it and taking some kind of medications. Once the data collection is done, the user's response is converted using numeric values of 0 to 3, and in some cases 0 to 4. Once we had enough data collected, it was moved to preprocessing and is split into two subsets i.e., training and test data sets.

It is important to fill out the missing values in the dataset or modify it to increase the quality of the dataset. Once the preprocessing of data is completed, it then moved to feature extraction thenceforth prediction of mental illness.

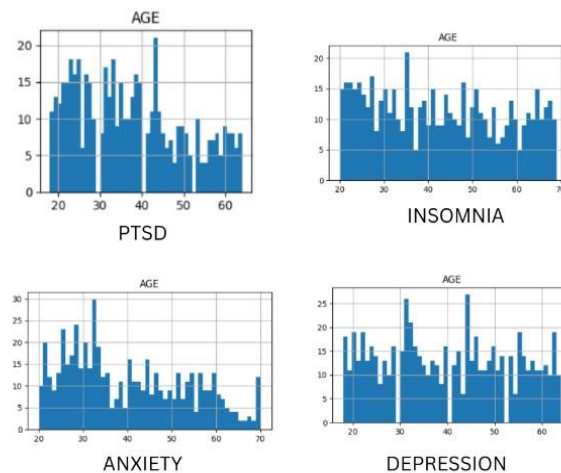


Fig -5.1: Dataset Overview

6. WORKFLOW OF THE SYSTEM

In order to put our work in real world use we have deployed our work on web applications. In our application users can take a test for whichever disease out of the four they want, based on the inputs received, our model predicts the severity of the problem they are facing.

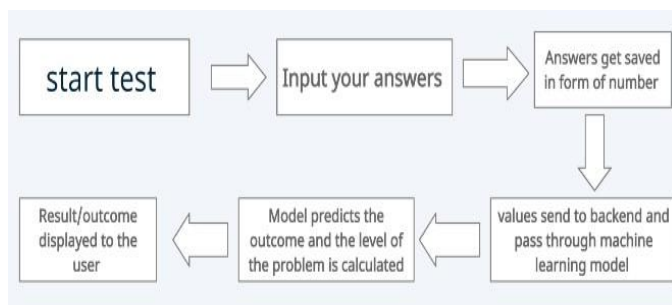


Fig -6.1: Data Flow Diagram



Fig -6.3: Result Page

7. RESULTS

Take a free mental health test

Our short online mental health evaluations will help you determine if you should seek help from a licensed mental health professional to address mental health issues.

Anxiety

Anxiety is a feeling of fear, dread, and uneasiness. It might cause you to sweat, feel restless and tense, and have a rapid heartbeat. It can be a normal reaction to stress.

Take Test

Depression

Depression (major depressive disorder) is a common and serious medical illness that negatively affects how you feel, the way you think and how you act.

Take Test

Insomnia

Insomnia is a sleep disorder in which you have trouble falling and/or staying asleep. The condition can be short-term (acute) or can last a long time (chronic).

Take Test

PTSD

Post-traumatic stress disorder (PTSD) is a mental health condition that's triggered by a terrifying event—either experiencing it or witnessing it causing nightmares.

Take Test

MORE THAN HALF THE DAY
 NEARLY EVERYDAYS

6. Feeling bad about yourself - or that you are a failure or have let yourself or your family down

NOT AT ALL
 SEVERAL DAYS
 MORE THAN HALF THE DAY
 NEARLY EVERYDAYS

7. Trouble concentrating on things, such as reading the newspaper or watching television

NOT AT ALL
 SEVERAL DAYS
 MORE THAN HALF THE DAY
 NEARLY EVERYDAYS

8. Moving or speaking so slowly that other people could have noticed. Or the opposite - being so fidgety or restless that you have been moving around a lot more than usual.

NOT AT ALL
 SEVERAL DAYS
 MORE THAN HALF THE DAY
 NEARLY EVERYDAYS

9. Thoughts that you would be better off dead, or of hurting yourself.

NOT AT ALL
 SEVERAL DAYS
 MORE THAN HALF THE DAY
 NEARLY EVERYDAYS

SUBMIT

Fig -6.2: Test Page

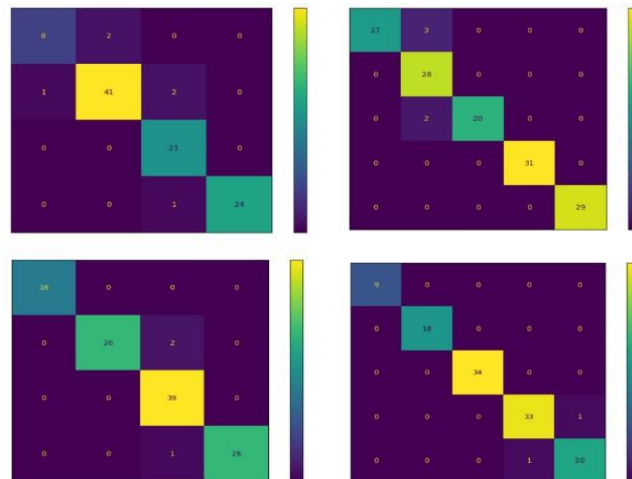


Fig -7.2: Confusion Matrix

In order to achieve high accuracy with the model the data needs to be properly cleaned and preprocessed until it is well fitted. To do this we used python libraries like NumPy, pandas and matplotlib. In order to get the best result for our work we had to pass each of our datasets through multiple ML algorithms like logistic regression, SVM, random forest, k-neighbors etc. Example: - for anxiety, we ran the above-mentioned algorithms and achieved accuracy of 97.27%, 94%, 81%, 80% etc. respectively. Same was the case for the other three diseases which had different levels of accuracy. For our system we chose the algorithm which gave us the true and highest accuracy. We also tried to finetune the hyperparameter to check if the accuracy could be increased more.

DISEASE	ALGORITHM WITH HIGHEST ACCURACY	ACCURACY
DEPRESSION	SVM	96.15%
PTSD	SVM	94%
INSOMNIA	LOGISTIC REGRESSION	98%
ANXIETY	LOGISTIC REGRESSION	97.27%

Fig -7.1: Model with Highest Accuracy

8. CONCLUSION AND FUTURESCOPE

We believe we were able to achieve a good accuracy for each of the four diseases. furthermore, in future we can add more disease and combine multiple method along with questionnaire to make this process more robust and stronger.

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