

Research Article

Performance Assessment of Certain Machine Learning Models for Predicting the Major Depressive Disorder among IT Professionals during Pandemic times

P. M. Durai Raj Vincent ¹, Nivedhitha Mahendran ¹, Jamel Nebhen ², N. Deepa ¹,
Kathiravan Srinivasan ¹ and Yuh-Chung Hu ³

¹School of Information Technology and Engineering, Vellore Institute of Technology (VIT), Vellore 632 014, Tamil Nadu, India

²Prince Sattam Bin Abdulaziz University, College of Computer Engineering and Sciences, P.O. Box: 151, Alkharj 11942, Saudi Arabia

³Department of Mechanical and Electromechanical Engineering, National I Lan University, Shenlung Road, Yilan City 26047, Taiwan

Correspondence should be addressed to Yuh-Chung Hu; ychu@niu.edu.tw

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Major depressive disorder (MDD) is the most common mental disorder in the present day as all individuals' lives, irrespective of being employed or unemployed, is going through the depression phase at least once in their lifetime. In simple terms, it is a mood disturbance that can persist for an individual for more than a few weeks to months. In MDD, in most cases, the individuals do not consult a professional, and even if being consulted, the results are not significant as the individuals find it challenging to identify whether they are depressed or not. Depression, most of the time, cooccurs with anxiety and leads to suicide in few cases, among the employees, who are about to handle the pressure at work and home and mostly unnoticed such problems. This is why this work aims to analyze the IT employees who are mostly working with targets. The artificial neural network, which is modeled loosely like the brain, has proved in recent days that it can perform better than most of the classification algorithms. This study has implemented the multilayered neural perceptron and experimented with the backpropagation technique over the data samples collected from IT professionals. This study aims to develop a model that can classify depressed individuals from those who are not depressed effectively with the data collected from them manually and through sensors. The results show that deep-MLP with backpropagation outperforms other machine learning-based models for effective classification.

1. Introduction

In the present day pandemic scenario, where people always complain about stress, pressure, and anxiety, major depressive disorder is commonly seen as a leading mental disorder across the globe. When someone appears to have intense feelings such as sadness and distress for a considerable period, they might have major depressive disorder [1]. It has high impacts on mental and physical activities to the one suffering from it; also, there is a higher risk of suicide [2]. Those who have been suffering from MDD tend to feel uninterested in doing the activities they enjoyed doing once.

Also, it affects their moods and behavior and finds difficulty in doing day-to-day activities. Most of those who die by killing themselves are found to have mental disorders that are treatable, mostly only due to depression they are doing so. The suicide rate is said to be around 15% among depressed people [3]. Major depressive disorder is a treatable mental disorder that appears when the individual is too stressed out because of various reasons of one's life including hormonal changes [4].

Major depressive disorder is termed as comorbid [5], that is, a medical condition that tends to occur, and it is a tedious task to identify whether the individual is suffering

from MDD or not. In many cases, the individual who is depressed would be reluctant to consult a professional because of the undertrained workforce and resources; it is difficult to diagnose and continue further treatment for it [6]. Therefore, in this paper, we have tried to apply machine learning techniques to distinguish between depressed and nondepressed individuals, mainly focused on IT professionals. IT professionals are majorly working on targets and failing to meet the target brings a lot of stress, leading to depression. On the other side, it will be difficult to diagnose those depression-affected people as the work style would not allow them to realize the reality. So, it is necessary to bring a system that would allow them to analyze themselves without much human intervention easily. That is why we are trying to bring out a machine learning-based model to help out the needy.

The introduction of smart bands has reduced the burden on the data collection process. Smart wearables can track the key factors that are required for measuring the health status of every individual. This would help handle this scenario as the usage of such devices is growing gradually. This work majorly depends on the data collected from the smart devices and the questionnaire collected from the employees. The data are handled in a way that the depressed person would be identified without much human intervention. The usage of sensors helps determine the status of the employees. This would be helpful among the IT employees as they would self-assess themselves without meeting a doctor.

When it comes to building a machine learning-based model, the necessity is to consider neural network-based approaches, which is also part of the machine learning paradigm. An artificial neural network is vaguely modeled from the human brain consisting of a functional unit called neurons or nodes, just as in the brain. Neurons or nodes are highly interconnected elements, which are the processing elements, and operate parallel [7]. The neural network's behavior is the capability to learn, recall, and implement them on unforeseen data [8]. Due to its ability to improve its performance over every iteration, it is possible to produce the result most accurately. Specifically, in the binary class classifications, this approach would produce the expected results.

Deep multilayer perceptrons are gaining its momentum due to the kind of structure it uses, and the backpropagation algorithm is very popular due to the availability of high-end computing facilities [9]. So, in this depression model, we will be using deep multilayer perceptrons with a back-propagation approach for producing the results more efficiently. Also, the comparison of results will be presented to show the proposed model's superiority over the other approaches [10]. Table 1 depicts the list of abbreviations used in the manuscript.

Among many previous works, it was aimed to study and understand the stress level manually. In the past, not many works targeted work-based stress and its implications on developing major depressive disorder, and among those, no works involved only IT professionals in their study. This work involves a complete model that will do prediction modeling with the most successful questionnaire-based

TABLE 1: List of abbreviations used in the manuscript along with their full form.

| Abbreviations | Full form |
|---------------|--|
| MDD | Major depressive disorder |
| SVM | Support vector machine |
| HRN | Heart rate normalized |
| HRV | Heart rate variability |
| ARIMA | Autoregressive integrated moving average |
| kNN | K-nearest neighbor |
| CFS | Correlation-based feature selection |
| MLP | Multilayer perceptron |
| ReLU | Rectified linear unit |
| ROC curve | Receiver operating characteristic curve |

method. Here, the whole process involves the data collection to preprocessing it and building a machine learning-based prediction model that is something new that we are trying to develop in this work. The main root cause for carrying out this research is to analyze its impact on IT employees during the pandemic, especially when they carry out their work from home. In addition to this, the highlights of this work are given as follows.

The key contributions of this work are summarized as follows:

- (a) In this paper, we are proposing a model to detect major depressive disorder among IT professionals
- (b) The required data are collected from the questionnaire and sensors, including a pulse rate measuring sensor and a sleep pattern assessing sensor
- (c) In this model, the collected data will be checked for anomalies, and the preprocessing steps with a data analysis approach would ensure the quality of the data used in this model
- (d) The proposed binary classification model would be expected to produce the maximum possible effective results, which will be more than 98%
- (e) Also, this model will be a noble initiation on addressing one of the important issues due to the lifestyle changes, especially among the IT professionals and this is going to be a very rare study that involves only IT employees during pandemic times
- (f) This would be also helpful for an individual to assess themselves without any human intervention

The remaining portion of the paper is structured as related work, proposed methodology, results and discussion, and conclusion.

2. Related Works

Stress followed by depression is something very commonly happening problem in recent days. In a study [11], the authors have analyzed the problem of predicting major depressive disorder and generalized anxiety disorder using a novel machine learning pipeline to reanalyze data from an observational study. Another study was conducted to assess the possibility of anxiety and depression in the parents'

offspring having a history of anxiety and depression [12]. The results show that the progeny with parents having anxiety or depression are more likely to suffer from the same than the offspring with parents who do not have anxiety or depression [13]. A comparison was made between the healthy individuals and those who have MDD based on interpersonal and adaptive domains. The findings showed that individuals with MDD performed considerably lower than the health concerns in all the domains such as adaptive functioning, adaptive competence, perceptive competence, functional ability, and interpersonal functioning [14]. An investigation on the major depressive disorder and bipolar disorder was carried out [15], and on the other side, the major depressive disorder-based impact on sleep apnea patients was analyzed [16, 17].

The hospital Anxiety and Depression Scale is used in France to assess the level of stress, and basically, it is a questionnaire that is the most widely used approach to estimate the stress level. This kind of questionnaire approach was used to assess the stress level among the French employees where fourteen parameters were considered, which comprises both to test the anxiety and depression [18]. The participants were majorly involved in industries such as telecommunications, petroleum, and aeronautics. Stress analysis among banking employees was done across the countries from the Middle East to Africa [19]. It is also understood that job status is one of the prime reasons for getting stress. Among various factors, job security played a major role in that and was found in the study. More than four thousand employees from Iran participated in a study based on four questionnaires to analyze the somatic syndrome [20].

Data collected from smartphones are analyzed to predict depression among undergraduate students. The hourly mood throughout a week was analyzed when the participant visits various places. Data were collected through sensors available in the smart bands and smartphones. SVM-based approach was proposed to analyze the signals to analyze the MDD [21]. Inputs through EEG signals were collected for this MDD model, which was successfully deployed with machine learning-based approaches. In another attempt machine learning-based approach was proposed to predict panic disorder [22]. This model was mainly proposed to distinguish panic disorder from other types of anxiety-based disorders clearly. Again, SVM-based approach was used in this model to produce the appropriate results [23]. Ensemble-based classifier was proposed for analyzing the quality of life cycles [24]. Predictive modeling based on machine learning was proposed to analyze depression from health records [11]. How depressed people would return to work after prolonged treatment and its effectiveness was discussed [25]. A study on the impact on occupational-related stress was discussed from the country Ghana [26].

Machine learning plays a vital role in prediction or estimation, and among these, artificial neural networks play an important role in solving real-time problems. A weighted average ensemble model was proposed for handling MDD [27]. In this analysis [28], the authors have analyzed heart rate variability to distinguish between diastolic heart failure

and systolic heart failure patients. They have implemented the nearest neighbor and deep multilayered perceptron classifiers in evaluating the performances of classification. The two classifiers were implemented with two measures, such as HRN (heart rate normalized) and HRV (heart rate variability), and the results show that a deep multilayered perceptron performs better than the nearest neighbor with higher accuracy [29].

In this experimental analysis [30], the authors have proposed a model to predict the coal prices by employing a deep multilayered perceptron with three hidden layers and having 3,11,3 neurons in each layer, respectively. The results show that the proposed method performs better than the autoregressive integrated moving average model (ARIMA). In this study [31], the authors have proposed an ensemble-based deep multilayered perceptron effective in analyzing stock market trends and predicting when to buy and sell the stocks. A deep-MLP-based approach was proposed [32] to handle the issue on roller bearing, and it was successfully addressed, and in another case [33], it was able to distinguish between COVID and non-COVID patients successfully.

Feature selection is used to play an important role in choosing the right parameters for effective model building. Pearson correlation-based feature selection approach was proposed for proper document classification problems [34]. A classical feature selection approach was proposed for blood cell disease recognition [35], and a robust feature selection approach was proposed for the application based on welding defects detection [36]. The importance of optimization was illustrated [37], and a hybrid approach of feature selection was proposed for the application related to agriculture [38].

Section 3 presents the proposed model, and the algorithm and the steps are presented in this section.

3. Proposed Model

As part of the data collection process, we have chosen 1032 IT professionals whose average age is 38. Followed by this, a questionnaire has been framed using the Hamilton rating scale for depression [39]. The data have been collected using that questionnaire form, and the questionnaire consists of 22 attributes, and using the range given by the Hamilton scale, the depression levels are calculated. Along with the questionnaire, the participants' data were collected from the smart band they were wearing. Heart rate monitoring is an important parameter that was considered during the data collection process. The participants were wearing the smart bands for about two weeks for the data collection process. Among the participants, about 60% are men and the remaining are women.

The data have been cleaned and reduced to relevant features using preprocessing and feature selection techniques. Then, deep multilayered neural network has been implemented to handle the collected data. The methodology includes three processes: preprocessing, feature selection, and applying artificial neural network-based deep multilayered perceptron with the backpropagation approach for the prediction process.

Preprocessing of data is essential as the data collected has its anomalies in missing information to wrong entries. Handling these is very important since the sample size considered in this work is optimal, and every information present is vital to building an effective model. So, in handling the missing information in the data collected from the IT professionals, kNN imputation techniques [40, 41] have been employed in this work. It consists of finding the closest K records and calculating the weights based on the distance computed using one of the distance calculation methods such as Manhattan, Euclidean, and Minkowski. Also, the input data are thoroughly analyzed, and all the categorical values are converted to numerical values with the help of a data label encoder. Since for handling data using machine learning approaches, it is desirable to have this conversion for effective data processing.

Usually, the source dataset consists of any number of attributes that may or may not be relevant to the classification process [42, 43]. The irrelevant attributes which depend on other attributes reduce the prediction accuracy. To overcome this and also to reduce the dimension of the feature, a feature selection technique must be implemented. A correlation-based feature selection technique is used in this work, which helps to find the features' subsets. CFS considers different attributes, and the correlation below the given threshold will be considered as part of this approach.

This study's data are collected from IT professionals; it consists of 22 features and 1032 samples. The data are cleaned for missing values with the help of K-nearest neighbor approach. Handling missing values is critical since it will affect the prediction power of the model. Also, features that are not related or dependent features will impact accuracy. Therefore, it is necessary to select only the required features to improve the developed model's accuracy further. The details of 22 features considered initially for this study are listed in Table 2.

We have applied the correlation-based feature selection approach to shortlist the required number of features. The initial number of features considered are 22, which is then reduced to 12. The chosen feature includes sleeping pattern, mood during work and other time, interest towards eating, weight, happiness quotient, level of concentration at work, and heart rate during the work and nonwork time. The duration of sleep is monitored with sensors and through questionnaires, whereas the heart rate inputs are completely dependent on the sensors available in the smart band and sleep monitoring. Even though these inputs are recorded, further inputs like in between wakeup details are recorded manually. The algorithm used for feature selection is presented in Algorithm 1 and the details of chosen features are listed in Table 3.

This approach helped remove some of the redundant features, which in turn helps to predict the outcome much more accurately. For classification of the individuals with a deep multilayered perceptron, this is employed in two phases. A deep multilayered perceptron consists of one or more hidden layers: the layers consisting of neurons between input and output. In the first phase, perceptron is trained without backpropagation, and in the second phase, the

TABLE 2: Features of data samples.

| Sl. No | Features |
|--------|---|
| 1 | Age |
| 2 | Gender |
| 3 | Falling asleep during work |
| 4 | Reduction in food intake |
| 5 | Increase in food intake |
| 6 | Untime wakeup |
| 7 | Ability to enjoy with the team |
| 8 | Bad mood frequency |
| 9 | Irritated towards work |
| 10 | Uneasiness at work |
| 11 | Any relation between mood and time at work |
| 12 | Weight decreased recently |
| 13 | Weight increased recently |
| 14 | Sleeping more than the usual |
| 15 | Anxiousness during work |
| 16 | Concentration/decision-making during work |
| 17 | View of my future at my work place |
| 18 | Suicidal thoughts |
| 19 | Symptoms in body language |
| 20 | Alarming symptoms |
| 21 | Heart rate recorded average from sensors |
| 22 | Sleep pattern recorded average from sensors |

TABLE 3: Features for the MDD model.

| Sl. No | Chosen features |
|--------|---|
| 1 | Decreased weight within last two weeks |
| 2 | Suicidal thoughts |
| 3 | Sleeping more than the usual |
| 4 | Alarming symptoms |
| 5 | Reduction in food intake |
| 6 | Anxiousness during work |
| 7 | Concentration/decision-making during work |
| 8 | Irritated towards work |
| 9 | Uneasiness at work |
| 11 | Heart rate recorded average from sensors |
| 12 | Sleep pattern recorded average from sensors |

perceptron is trained with backpropagation. The functional unit of the neural network is called neurons or nodes. A perceptron is formed by combining several neurons into a layer. A perceptron has four components: input, bias, weights, activation function, and output [38]. Every neuron in the network is connected through a connection link, and each connection link consists of weight. The weight has information about the input signals. Bias indirectly impacts the output and helps in calculating the net input. There are two types of bias: one is a positive bias, which increases the network's net input, and the other one is a negative bias, which decreases the network's net input. Then, the activation function is applied on the net input to calculate the neural network's output, called as step function [44].

In phase one, the neural network is implemented without any backpropagation. The second phase is implemented with backpropagation. Backpropagation is also called a backward propagation of errors. The error which has been calculated in the output layer is again propagated

```

Input:  $X$  – training inputs,  $N$  – the list of inputs,  $D$  – number of features,  $F$  – feature finder
       $n$  – features 1 to  $n$ 
Procedure
   $S = 0$ 
   $n = 1$ 
  while  $|S_n| < D$  do
    if  $|S_n| < D - 1$  then
       $S_n = \text{CBF}(S_{n-1}, X, F)$ 
    else
      select the highest level feature  $S'$  to  $S_{n-1}$ 
    exit
     $n = n + 1$ 
  exit while
Output:
   $S$  – selected feature set.

```

ALGORITHM 1

backward and distributed to all the neurons in the network so that new weights would be updated. The following equations show the calculation of net input, activation function, and the perceptron weight adjustments after applying backpropagation. Figure 1 shows the architectural diagram of the proposed deep-MLP model. Figure 2 represents the process flow of the deep-MLP network.

The net input or preactivation function is

$$PA = \sum_{k=1}^n Wt_k I_k + b, \quad (1)$$

where PA is the preactivation function, Wt is the weight associated with the connection link, I is the inputs ($I_1, I_2, I_3, \dots, I_n$), and b is the bias. The activation function is

$$A(I) = \begin{cases} 1, & I \geq 0, \\ 0, & I < 0. \end{cases} \quad (2)$$

If the input from the neuron $I \geq 0$, then the output is 1, and if the input $I < 0$, then the output is 0. It can be written as

$$Z = A \sum_{k=1}^n Wt_k I_k + b. \quad (3)$$

To the perceptron weight adjustment, the weights are updated after applying the backpropagation algorithm. The new weight after adjusting is given by

$$\Delta Wt = L \times P \times I, \quad (4)$$

where ΔWt is the updated weight value, L is the learning rate, P is the predicted output, and I is the input data.

The process involved in the deep multilayer perceptron-based approach, which is to be used in this model-building exercise, is illustrated in the algorithm part. The whole process involved in this is the updation of weights after every iteration, which will tune the network to produce relevant results. Activation functions like the ReLU approach will help this algorithm normalize the output within the range (Algorithm 2).

In the supervised learning-based problem considered, the model is trained each time to calculate the error value deviation. According to the error value, the backpropagation approach will update each weight value, taking hundreds of iterations to prepare the network as part of the training process. Data preparation for building a model based on machine learning approaches requires the holdout method for model building and validation of results. The collected data after undergoing the preprocessing steps will be divided into 80:20 ratio for training and testing. Section 4 presents the results and discussion part in detail.

4. Results and Discussion

Predicting depression is a binary classification issue that classifies whether the person is depressed or not (0 or 1). For classifying the patients, we have used the deep multilayered perceptron. Also, to insist on the importance of the backpropagation, we have implemented deep-MLP without backpropagation in phase 1 and with backpropagation in the second phase and tabulated the results in Table 4. The phase 1 output of deep-MLP, without backpropagation, is shown in Figure 3, and the phase 2 deep-MLP, after applying the backpropagation, is shown in Figure 4. We can see the 12 important features given as the input for further processing in the input layer. The hyperparameters we chose in our deep-MLP are hidden layers, number of nodes per layer, activation function, and the learning rate. The values of the hyperparameters are determined using the Bayesian optimization technique. The Bayesian optimization technique iterates the data through 5 folds, and the average of each parameter is considered the final value for the model. Thus, our chosen hyperparameters' final values are hidden layers are 4 and the learning rate is 0.02, and number of nodes per layer 57. We used the ReLU as the activation function and the cross-entropy cost function to check the model's error rate.

In backpropagation, the gradient error function is estimated based on the weights. The total loss will then be

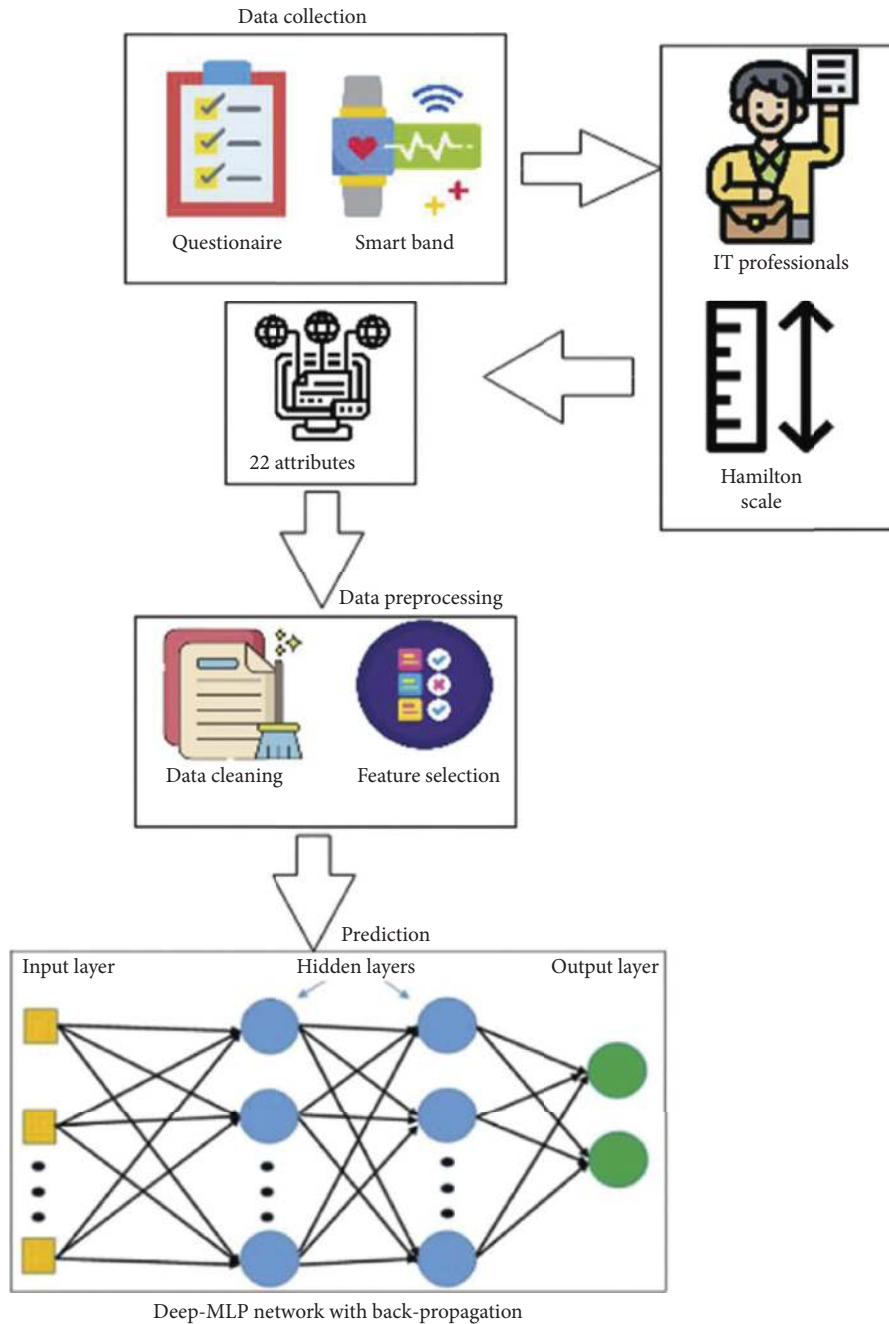


FIGURE 1: Architectural diagram of the proposed deep-MLP model.

propagated backward, and the weights will be updated. From the results, the importance of backpropagation is quite visible. The comparison of results between the deep-MLP with and without backpropagation is shown in Figures 5 and 6. The line in red color is the actual values, and the line in blue color is the predicted values. The figure clearly shows a considerable difference between the actual and predicted values. Figure 5 shows the actual vs. predicted value before applying the backpropagation algorithm, and Figure 6 shows the results after applying the backpropagation. The predicted values in the blue color overlap the actual values, which are red lines, which imply that the algorithm predicted almost all

the outcomes correctly. The plot consists of only a few records out of 1032 records in the dataset.

We have first evaluated the model with the help of three performance metrics: error rate, steps, and accuracy. All three metrics show that the deep-MLP with backpropagation outperforms the deep-MLP without backpropagation. Figure 7 shows the number of steps involved to classify the depressed and not depressed before backpropagation, it was 16,395, and then it is 2253. Moreover, Figure 8 shows the error rate without backpropagation; it is noted that the error rate is 30.43 before applying backpropagation, and the error rate after backpropagation has been hugely decreased to

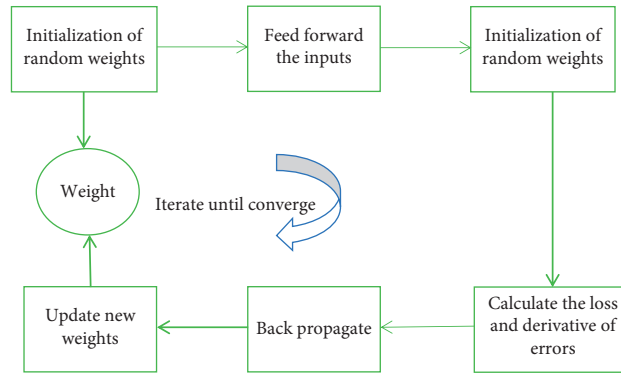


FIGURE 2: Process flow of deep-MLP network perceptron.

Input. The selected features from the correlation-based feature selection
 Initialize the values of weights, biases, and the learning rate (α)
 Do
 For every input do Feedforward:
 Process the inputs one by one: $a_i = x_i$, where i value lies between 1 and n , 'n' stands for the total number of samples
 Output: $b_i = \text{bias} + \sum_{i=1}^n a_i \cdot w_i$
 output calculation with the activation function:

$$A = \begin{pmatrix} 1 & \text{if } b_i > \theta \\ 0 & \text{if } -\theta \leq b_i \leq \theta \\ -1 & \text{if } b_i < -\theta \end{pmatrix}$$

 Adjust weight and bias:
 if $b \neq t$, if 'b' not equals to target 't' then update the weights
 $w_i \text{ new} = w_i \text{ old} + \alpha t_{ai}$
 bias new = bias old + αt
 if $b = t$, Stopping condition
 Gradient descent calculation with respect to each error due to the selected weights w_i
 $E(w) = 1/2 \sum_i \sum_{j \in y} (t_i^j - b_i^j)^2$
 Where t_i^j, b_i^j are the initial target value and the obtained output
 Repeat the similar calculation and updation of new weights continues at the hidden layer
Output. Classification results and error rate.

ALGORITHM 2

TABLE 4: Performance analysis of Deep-MLP.

| Model | Accuracy | Error rate | Steps |
|----------------------------------|----------|------------|--------|
| Deep-MLP: before backpropagation | 0.928 | 30.43 | 16,395 |
| Deep-MLP: after backpropagation | 0.988 | 4.52 | 2253 |

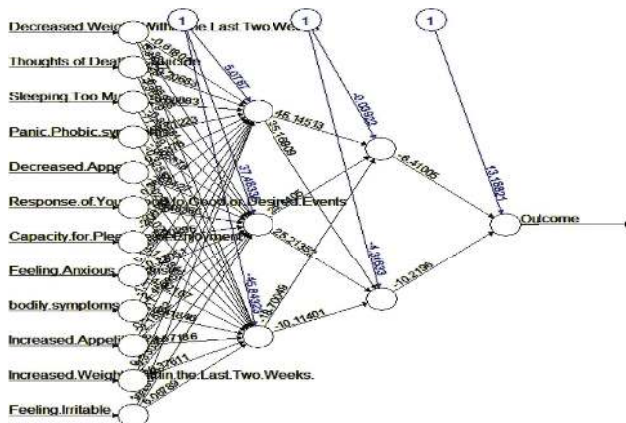


FIGURE 3: Deep-MLP network before BP.

4.52. Correspondingly, Figure 9 shows the accuracy of the deep multilayered perceptron before backpropagation learning, it was 0.92865, and after implementing backpropagation, it got higher to 0.987837, which is a considerable increase in the accuracy of classification. In all the three evaluation metrics used, the deep-MLP model with backpropagation outperforms the other. With this, we can understand the importance of backpropagation in the deep-MLP model. Table 3 shows the comparison between the two approaches.

These outcomes show that the necessity to have the backpropagation based approach to consider over the other. Furthermore, the proposed approach is considered for further evaluation with the other well-known approaches discussed in the literature. Here, we have considered the

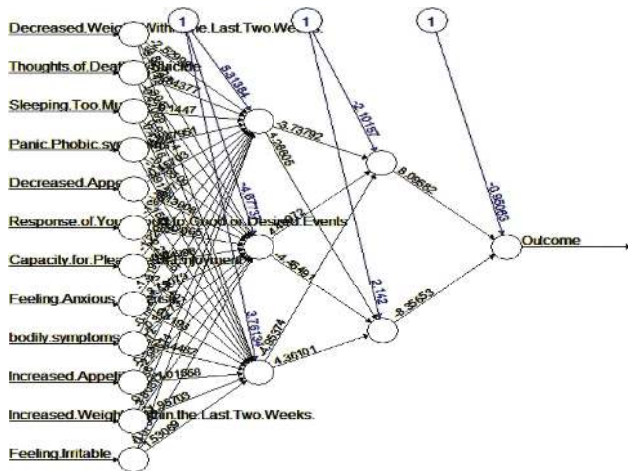


FIGURE 4: Deep-MLP network after BP.

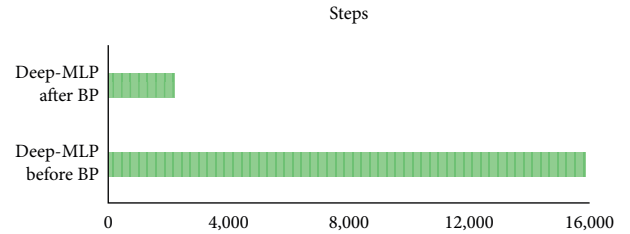


FIGURE 7: Steps before and after BP.

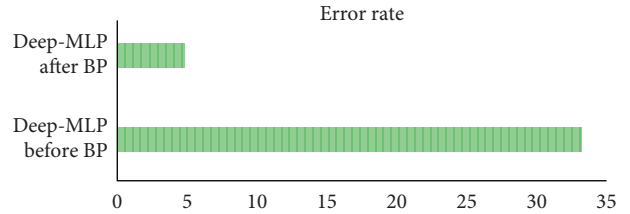


FIGURE 8: Error rate before and after BP.

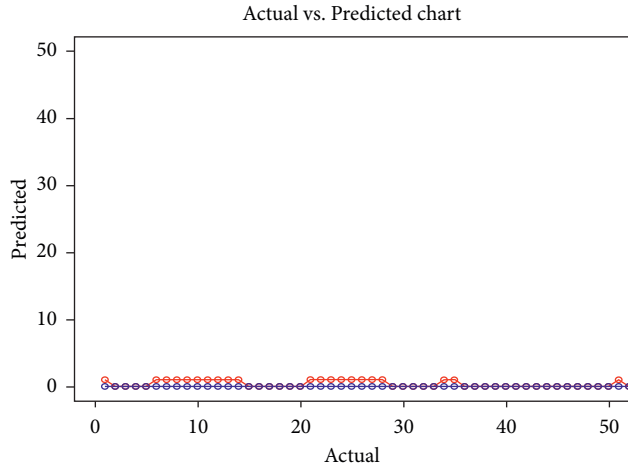


FIGURE 5: Actual vs. predicted before BP.

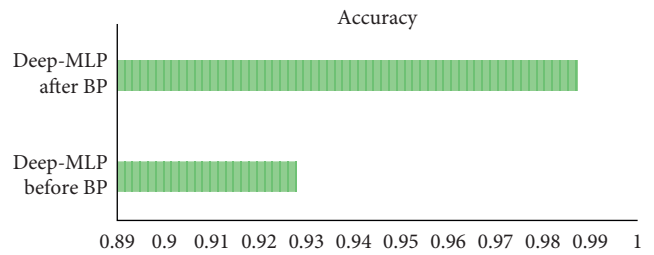


FIGURE 9: Accuracy before and after BP.

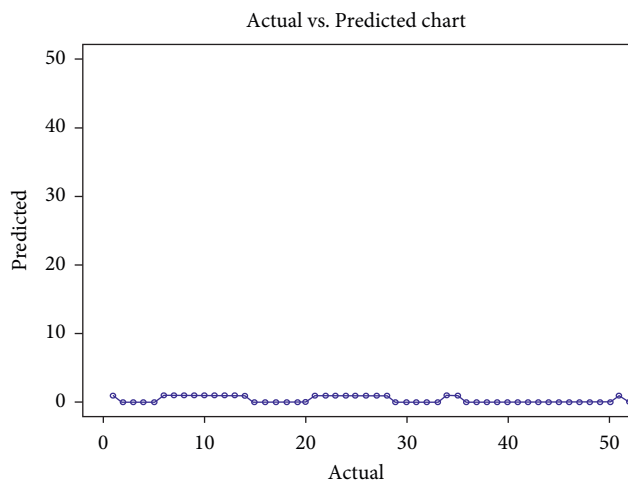


FIGURE 6: Actual vs. predicted after BP.

TABLE 5: Performance measurement analysis.

| Performance measurement metric | Definition | Formula |
|--------------------------------|---|---|
| Accuracy | Accuracy defines the capability of the proposed model to correctly classify the output | $\frac{\text{True negative} + \text{true positive}}{\text{total samples}}$ |
| Sensitivity | Sensitivity is about verifying the identification of positive outcomes from the proposed model | $\frac{\text{True positive}}{\text{true positive} + \text{false negative}}$ |
| Specificity | Specificity is about verifying the identification of negative outcomes from the proposed model | $\frac{\text{True negative}}{\text{true negative} + \text{false positive}}$ |
| F-measure | F-measure is helpful in identifying the outcomes of precision with the recall of the proposed model | $2 \times \frac{(\text{precision} \times \text{recall})}{(\text{recall} + \text{precision})}$ |

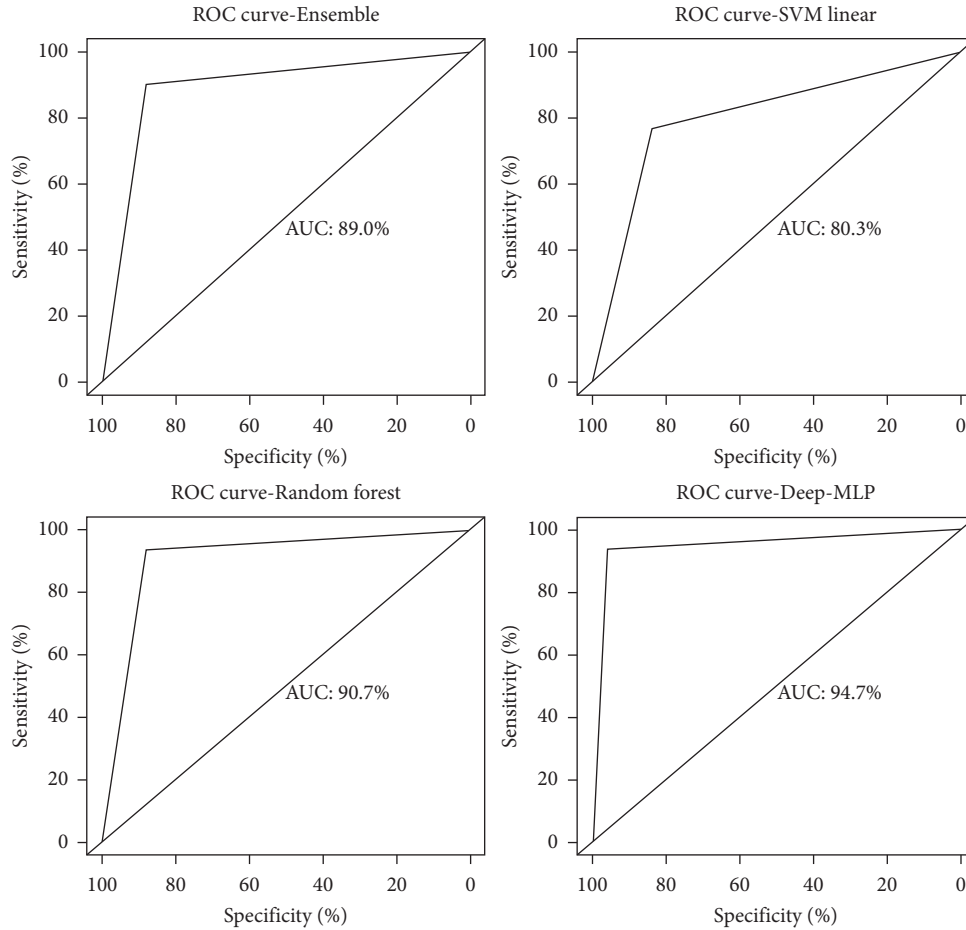


FIGURE 10: ROC curve of the different approaches including the proposed deep-MLP network.

performance metrics such as accuracy, sensitivity, specificity, and F -measure to compare with the other approaches. The definition of the metrics is given in Table 5.

There are three other approaches considered in this work for the purpose of comparison. These approaches are particularly considered for this comparison as these were proposed in other approaches that were considered during literature. The ROC curve shows the specificity measurement of each approach. Figure 10 shows that the proposed model with deep-MLP has better accuracy compared to the other approaches.

The different approaches considered for the comparison of results with the proposed model are the support vector machine-based approach and the random forest-based approach. With these, an ensemble model is also considered for the comparison of results. The results are tabulated in Table 6. The results show that the deep-MLP approach considered for this model performs better than the other proven approaches discussed in the literature.

From accuracy to F -measure, the results show that the outcomes are better for the proposed model, requiring the desired results for the proper classification. The detailed graphs are presented in Figures 11 to 14 for a better interpretation of the results.

TABLE 6: Performance analysis of deep-MLP with other machine learning models.

| Models | Accuracy | Sensitivity | Specificity | F -measure |
|-------------------------------|----------|-------------|-------------|--------------|
| SVM (linear) | 0.862 | 0.824 | 0.871 | 0.863 |
| Random forest | 0.849 | 0.807 | 0.878 | 0.881 |
| Ensemble (SVM, random forest) | 0.905 | 0.877 | 0.896 | 0.907 |
| Deep-MLP | 0.988 | 0.924 | 0.947 | 0.965 |

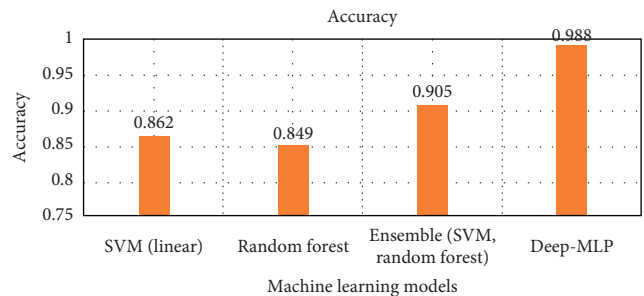


FIGURE 11: Comparison between deep-MLP and other models in terms of accuracy.

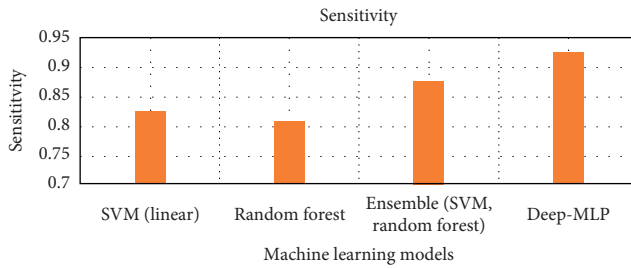


FIGURE 12: Comparison between deep-MLP and other models in terms of sensitivity.

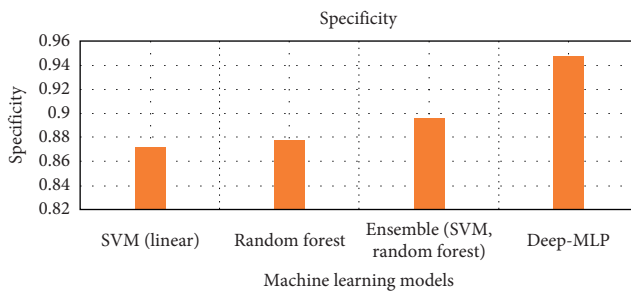


FIGURE 13: Comparison between deep-MLP and other models in terms of specificity.

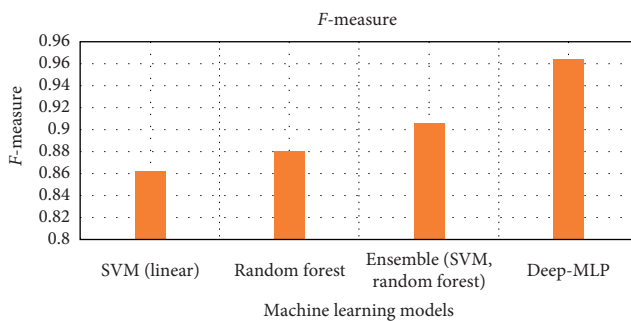


FIGURE 14: Comparison between deep-MLP and other models in terms of F -measure.

With the results obtained, the proposed model for assessing the IT employees has shown the better results, and the model can be considered for the real-time purposes. The considered sample size is sufficient for this model building exercises which also produces the results in a considerable manner.

5. Conclusions

MDD is one form of depression, which is comorbid. The diagnosis of any depression is tough for clinicians because of its subjectiveness. There are many methods to determine whether the individual is suffering from depression or not, using real-time brain images to questionnaire-based approaches. Recording brain images is expensive and a time-consuming one, which is also not a viable option for many. Thus, in this work, we have tried to build a classification-based model that can classify the IT employees into depressed and nondepressed

categories. We have also compared the results of deep multi-layered neural network perceptrons with backpropagation and without backpropagation in classifying the depressed and nondepressed individuals from the collected samples of IT professionals. The data are collected from IT professionals through a standard questionnaire and also with the sensors connected with them through smart bands during the pandemic times. The accuracy of the model is improved when developed with the necessary features. Therefore, a CFS technique on the cleaned data reduces the feature dimensions. The first phase was without backpropagation, just the feed-forward deep-MLP, and in the second phase after feedforward, backpropagation is applied, and the weights are adjusted accordingly, and the process is iterated until convergence is reached. From the experimental results, we have also compared with the other proven approaches such as SVM and other ensemble-based models in terms of accuracy and other performance-oriented measures. This model's presented results are unique, which handled only the samples collected from the IT employees and did the appropriate classifications. In the future, we would experiment with this model that can be enhanced for the other professions, especially among the underprivileged who face many challenges comparatively with others.

Data Availability

The data used to support the findings of this study have not been made available so as to ensure the privacy and anonymity of the persons involved.

Conflicts of Interest

The authors declare no conflicts of interest.

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