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IMPROVISED DEEP NEURAL NETWORK USING EAGLE STRATEGY OPTIMIZATION FOR AGRICULTURE LAND DROUGHT PREDICTION

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Abstract: The advancement in the field of agriculture is more essential to forecast the yield loss and the drought monitoring to discover possible intervention areas. The machine learning models plays a vital role in the process of agriculture to detect the anomaly of droughts to avoid the crop yield loss by monitoring rainfall, temperature and moisture. Though there are many prediction models are available, deep knowledge about the pattern of climatic condition is very essential to improve the drought prediction. Thus, this paper concentrated on developing an enriched prediction model which optimize the performance of the Deep Neural Network by inducing the intelligence of the eagle strategy to fine tune the parameters values which influence the accuracy of prediction model. The simulation results proved that the Enriched Eagle Strategy based Deep Neural Network predict the presence of Drought in eight different districts all over India, compared to the other conventional prediction models.

Keywords: Agriculture, Drought, Prediction, Eagle Strategy, Deep Neural Network, Machine Learning.

I. INTRODUCTION

From the ancient period farming or agriculture is considered as important culture in India. As there is a tremendous increase of industries consequences to global warming and India's climatic condition is also drastically changed and affects the agriculture field for farming [1]. Among several issues related to efficient crop growth maximization, drought prediction is of serious reputation to initial cautionary for drought managements [2]. The most instantaneous significance of agriculture drought is a fall in crop production which is due to poorly distributed and inadequate rainfall. Every year, most of the regions of India face the hazardous of drought which greatly affect farmers. So, early season prediction on drought occurrence could help to better alleviate the negative consequence of drought [3]. To perform precise agriculture, drought prediction needs to acquires the information related to rainfall, temperature and pressure for its decision-making model to increase the crop growth by utilizing available resource in a better way without affecting the environment.

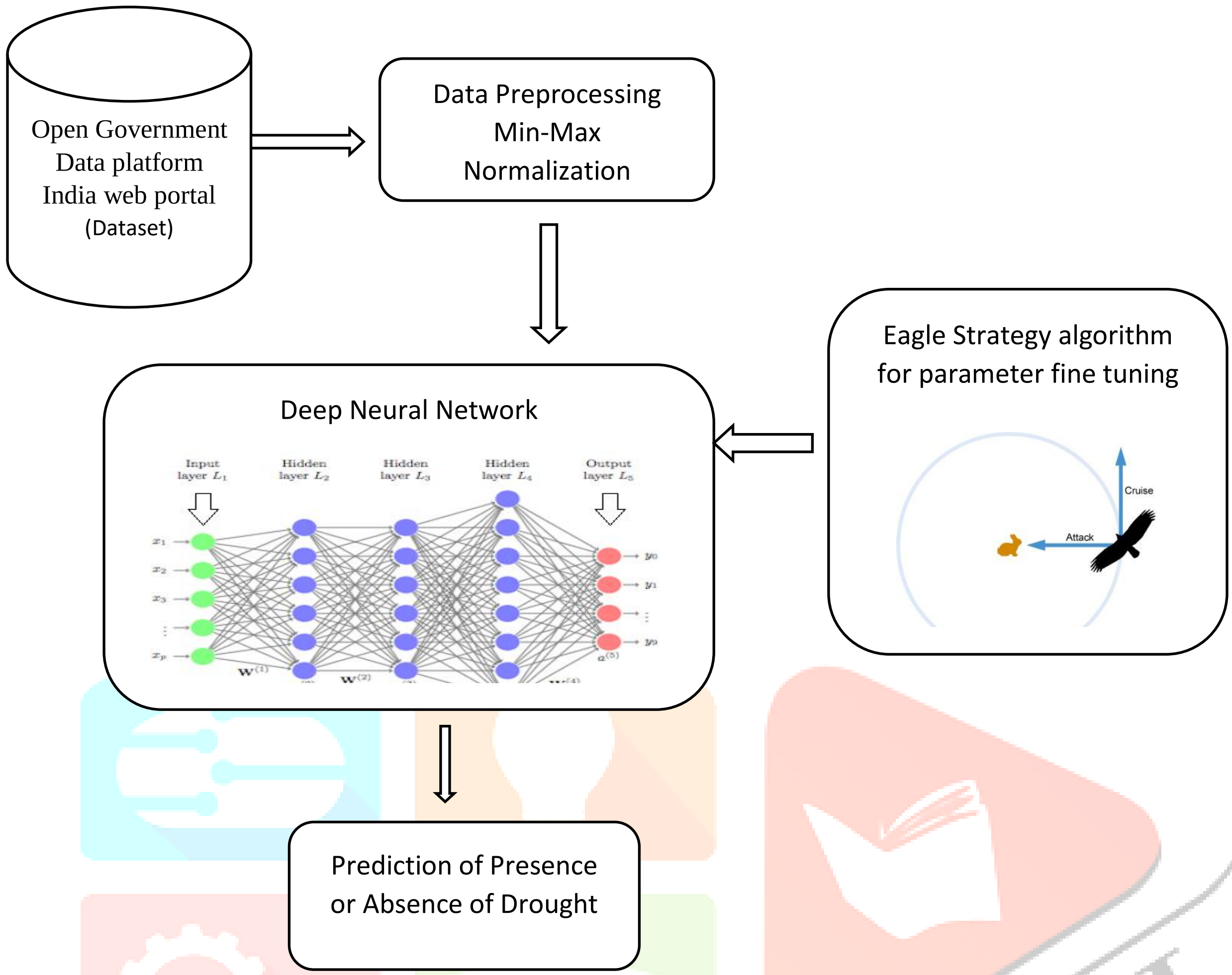
In this work deep learning model-based drought prediction in agriculture land by monitoring the climatic condition of the eight different districts in India.

Related Work

Michael et al [4] in their work developed a logistic regression and sub-gradient based support vector machine to classify the drought. The log cost function and the primal estimator are used in their work.
Zikang et al [5] developed a new agriculture drought index by estimating the irrigation demand and supply of water. They stated that water deficit index-based irrigation produces high correlation compared to the soil moisture anomaly index.
Louise Caroline et al [6] they conducted two different analyses based on the characterization of drought and the standardized precipitation-based indexing. The prediction of drought on the agriculture land is done using the decision tree and random forest classifier.
Chrisgone et al [7] constructed artificial neural network which overcome the drawback of the conventional greedy search algorithm for drought classification. In this work general additive method is used to reduce the space cardinality of the model.
Rhe et al [8] presented a drought prediction model using standardized precipitation index along with multiquadric spline interpolation approach. They validated this metric using three different classification models, extremely randomized trees, decision tree and random forest using remote sensing data.

II. METHODOLOGY: ENRICHED EAGLE STRATEGY BASED DEEP NEURAL NETWORK FOR PREDICTION OF AGRICULTURE DROUGHT

The proposed work Enriched Eagle strategy based Deep Neural Network (EES-DNN) is developed to precisely predict the agriculture drought to enhance the crop cultivation in India. In this work the dataset is collected from eight different districts all over India, they are Nagpur, Latur, Aurangabad, Solapur, Nashik, Amaravati, Pune and Yavatmal. The dataset of drought agriculture land attributes are district, month, year, rainfall, average rainfall, temperature, average temperature, pressure and average pressure.
The proposed work initially performs data preprocessing to normalize the dataset as it comprised of various types of data like numeric or characters. This work used min-max normalization to convert the values of all attributes in the dataset to a same range of value such as 0 to 1. The preprocessed data is fed as input to the deep neural network of predicting presence or absence of drought in a specific area. The deep neural network functionality is boosted in this research work by introducing nature inspired behavioral approach of Eagle strategy algorithm. This algorithm fine tunes the parameters involved in deep neural network to produce better accuracy in agriculture drought predication.



Overall Framework of the Enriched Eagle Strategy Optimization based Deep Neural Network for Prediction of Agriculture Drought

Preprocessing

The agriculture dataset is normalized using min-max process to convert all the value of attributes which are in different range to a common range of value between 0 and 1. This is because the prediction value will be influenced with the high range of value and to treat all the attributes with equal importance the min-max process is applied to overall value.

$$\textbf{Norm} = \frac{Att - \min(Atti_{i..n})}{\max(Atti_{i..n}) - \min(Atti_{i..n})}$$

Where n refers to number of records in the dataset, min and max are minimum and maximum value of a specific attribute range of values respectively.

Eagle Strategy Optimization

Eagle Strategy based optimization comprised of two different stages [11], it is developed based on its foraging behaviour. They use Levy flights to fly and search their prey to overcome both global and local optimization while

searching. The global searching is achieved through levy walks and local search is achieved by adapting differential evolution. The levy walk of global search is the first stage which is characterized using the fourier transform as shown below

$$F_N(k)=e|-N|k|^{\beta}|$$

In the second stage the local search is done using the differential evaluation which includes all the evolutionary operations which are vectorized. The most promising area is determined more prominently using differential evolution for local search. It handles discrete, continuous and discontinuous variable more effectively.

Deep Neural Network

Deep learning which is also referred as Deep structure learning belong to the family of machine learning approaches specifically related to Artificial neural network [9]. Artificial Neural Network (ANN) is developed based on the inspiration of biological systems information processing and the communication of distributes nodes presented in the neural network of the biological brain. In Deep Neural Network which belong to the Deep learning architecture inherits the multiple hidden layers in the network. The traditional linear perceptron is not considered as a universal classification model which has one hidden layer with non-polynomial activation function. The Deep Neural Network is a modern variation with unbounded layer of hidden layers which retains the universality to retain its heterogenous connectivity model [10].

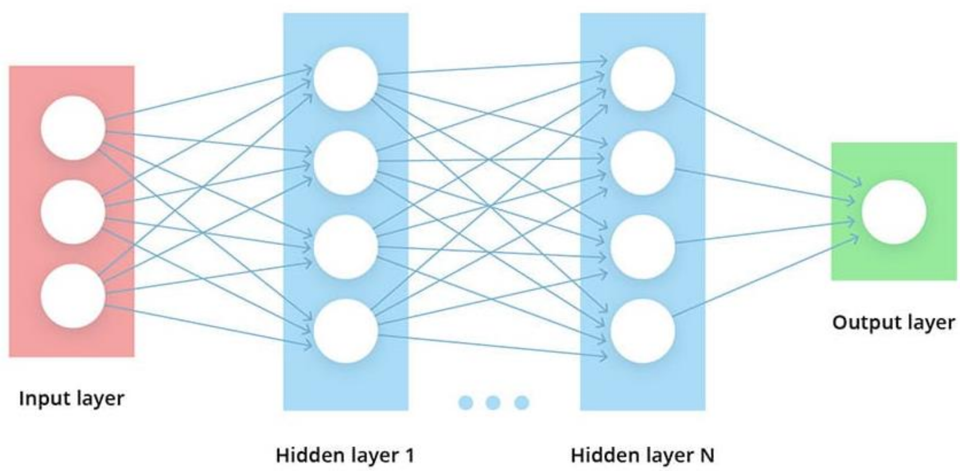


Figure: Simple Structure of Deep Neural Network

Deep neural network consists of multiple layer between the input layer and its output layer. These layers comprised of several nodes, and each layer is interconnected with the links and they are assigned with parameters like weight and biases which influences the process of the network. The simplified structure of the DNN is shown in the figure.

Based on the human brain filtering process the deep learning also mimic the functionality of it. It has the ability to work on huge volume of dataset to produce accurate results and they perform the binary classification in agriculture dataset the presence or absence of drought is delivered as output. The basic components of the Deep Neural Network are the first layer is knowns as the input layer which receives data from the real time dataset here it is agriculture dataset with climatic condition of each district as input.

The last layer is output layer which produce the presence or absence of the drought in a specific area.

The intermediate layers are known as hidden layer which plays the important role during the training process that makes the network learn about the input pattern.

All the three types of layers are interconnected to its previous and preceding layer with the link associate them. Each layer comprised of set of nodes which is referred as neurons which are interconnected to each other. The nodes or neurons are responsible for processing the data and propagating the input data received from its preceding layers. Each neurons strength depends on the value of the weight, bias and the activation function.

III. ENRICHED EAGLE STRATEGY OPTIMIZATION BASED DEEP NEURAL NETWORK (EES-DNN)

The Conventional Deep Neural Network component values are assigned in a random manner, they are done in a trial and error basis. The accuracy of the DNN depends on the values assigned to the parameters which involves in prediction process. Hence to overcome this problem this proposed model constructed an enriched Deep Neural Network work model by adapting the intelligence of the eagle strategy. The EES-DNN comprised of two different phases they are training and testing phase. During training phase, the input data along with its class label are used to make the network model learn about the pattern of the input data.

The conventional model assigns the weights and bias value in a random manner using backpropagation in a trail and error manner. When the data is received through the input layer, it is passed to hidden layer which process the input data with the weights and bias assigned on each hidden node, after applying activation function, the processed data is passed to the output layer. The output layer produces the output as either presence or absence of drought. The back-propagation model compares the expected output and the observed output, if the difference among them is high then it propagates back to the hidden layer and reassign the value of the hidden nodes, and reprocess takes place, this is continued till the error is reduced to the accepted range. This may increase the computation complexity; time consumption and the accuracy of the network will be very less.

Thus, this drawback is handled in EES-DNN by using the eagle's foraging behaviour to assign the values to the weights and bias to produce optimized result compared to the conventional deep learning. In eagle strategy, the global optimization of the value assignment is done using the levy's walk and the local optimization is done using the differential equations. The fittest values are assigned to the weights and thus it produces more accurate results by reducing the error rates.

The agriculture drought prediction is accomplished very prominently in this work as it enhances the process of both training and testing phase. During the testing phase, the records without labels are passed, the model will produce the output with the knowledge of learning process. The figure illustrates the proposed work fine-tuning the parameters of the DNN to enrich its prediction process.

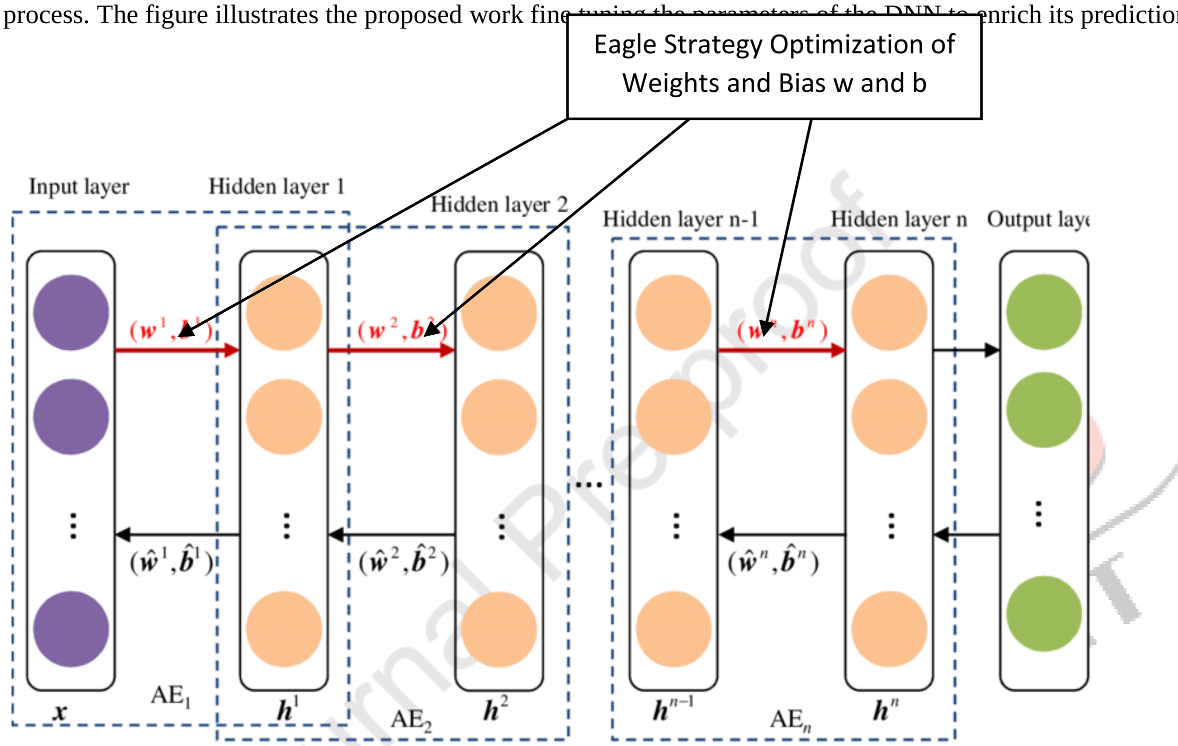


Figure Fine-tuning the values of Weights w and bias of each layer using Eagle strategy Optimization

IV. EXPERIMENTAL RESULTS

This section discusses about the performance analysis of Enriched Eagle Strategy based Deep Neural Network (EES-DNN) implemented using python code. The agriculture drought prediction dataset comprised of climatic condition of eight distinct districts of all over India with 11 attributes with 1536 instances [12]. The performance of the proposed EES-DNN is compared with Artificial Neural Network (ANN), Multi-Layer Perceptron (MLP) and traditional Deep Neural Network (DNN). The evaluation metrics used for performance analysis is accuracy, precision, recall and F-Score.

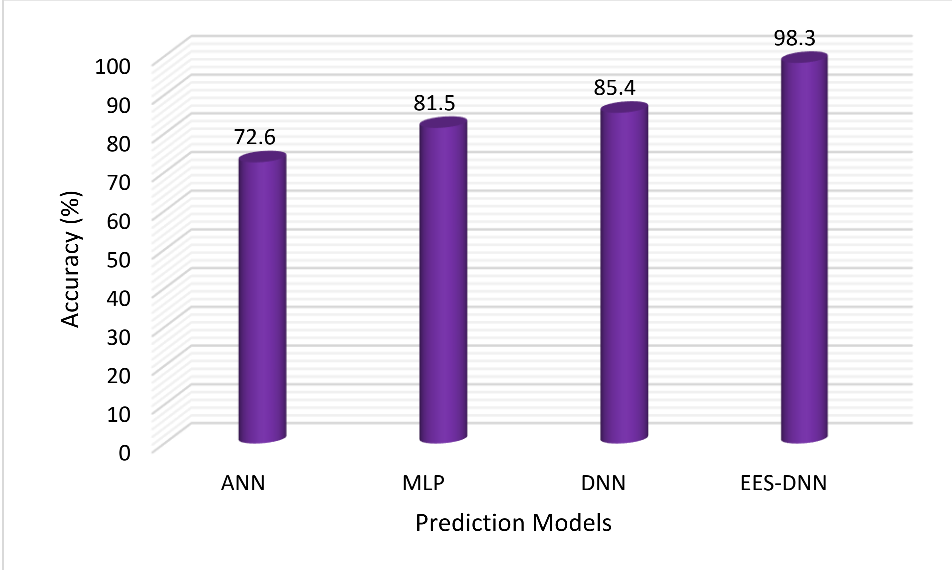


Figure: Comparison based on Accuracy

The figure depicts the performance comparison of four different drought prediction models. The result shows that the accuracy of the proposed EES-DNN produced highest accuracy rate while comparing the other three prediction models ANN, MLP and DNN. This is because the parameters used in EED-DNN is fine-tuned using the eagle strategy.

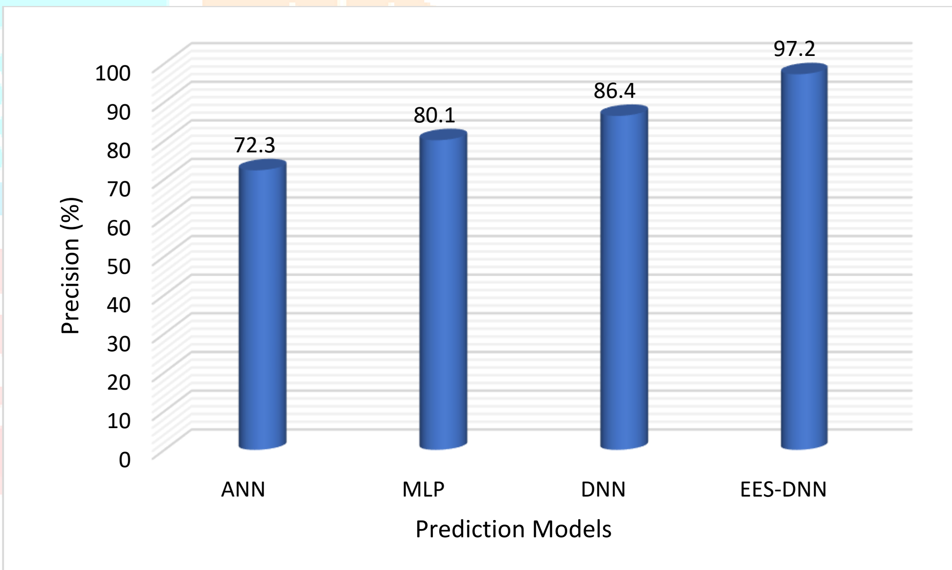


Figure: Comparison based on Precision

The Figure illustrates that the proposed EES-DNN achieves higher precision rate compared to ANN, MLP and DNN. The drought prediction in agriculture field greatly help the farmers in their decision-making system and to improve the crop cultivation. Based on the received information about the climatic condition like temperature, air pressure and rainfall the prediction models work. The EES-DNN better performs because it does not assign the weight values as random manner the behaviour of eagle strategy algorithm improves the Deep Neural Network prediction system.

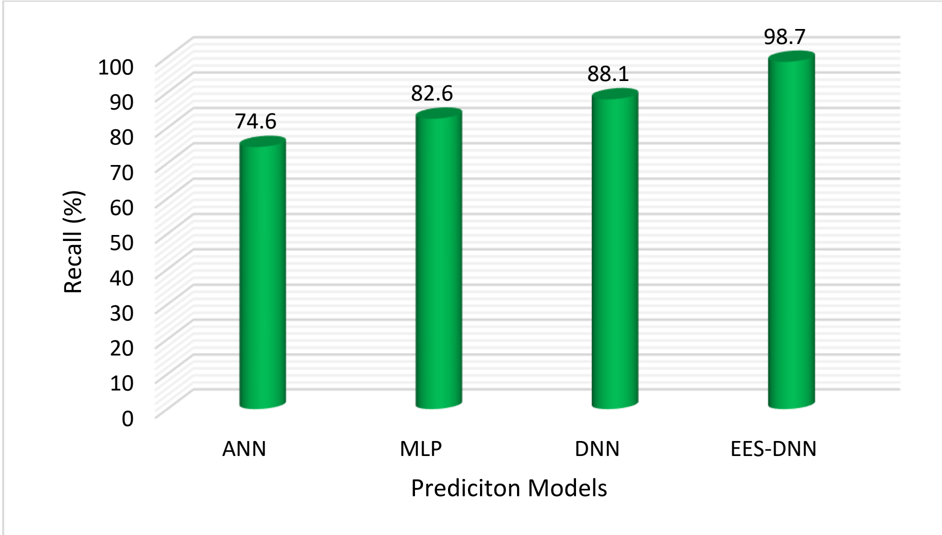


Figure: Comparison based on Recall

The performance comparison based on the Recall rate for four different prediction models are shown in the figure. The ANN, MLP and conventional DNN produce less recall compared to proposed EES-DNN, because they assign the parameters such as weight and bias values in a random manner during back propagation and they terminate their prediction when there is no change in the error values, but EES-DNN induce the knowledge of eagle strategy to assign the parameter values.

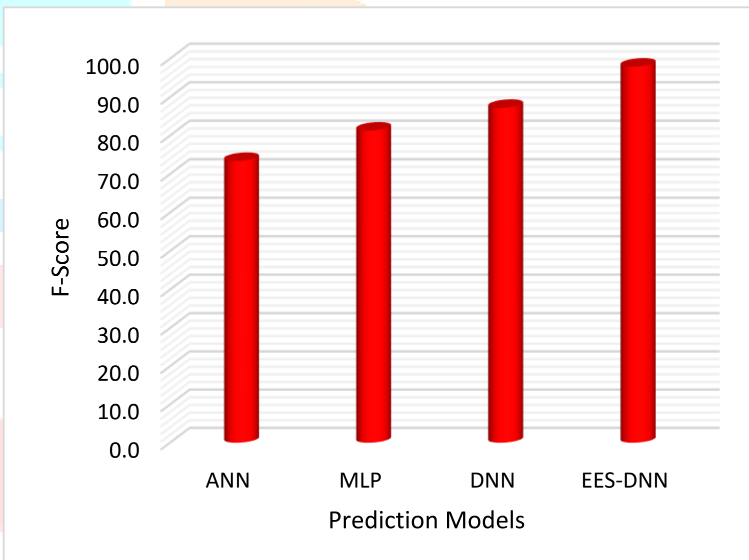


Figure: Comparison based on F-Score

The figure depicts the F-score obtained by ANN, MLP, DNN and EES-DNN to predict the drought of the agriculture field. The earlier prediction will help the farmers to improve their crop yielding rate. It is observed from the results that EES-DNN predict the drought presence or absence with the climatic conditions more precisely than the other three prediction models.

V. CONCLUSION

This paper focuses on developing an enriched deep learning model to improve the accuracy of predicting the agriculture land drought prediction. This work used eight different districts all over India climate conditions and the process is applied based on learning the pattern of each year's crop yielding strength based on the temperature, rainfall and pressure. The deep neural network has the inherit filters to discover the important features and the parameters involved in prediction process are fine-tuned using the metaheuristic behavioral model known as Eagle Strategy. Using the foraging behaviour of the eagle's the best suited values are assigned to the weights and bias of the hidden nodes in DNN. The simulation results proved that EES-DNN accomplish better accuracy while comparing the traditional classification models ANN, MLP and DNN.

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