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Graduate Admission Chance Prediction Using Deep Neural Network

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***Abstract*—Every year many students apply for graduate admission to different universities. To select an applicant, each university has different selection criteria such as GRE score, CGPA, research background, statement of purpose, letter of recommendation, university rating etc. There are some web applications as well as some consultancy services for suggesting the appropriate university based on students' portfolio. These help to give an idea which universities should be applied for admission. But they have limitations because humans are incapable of considering all the conditions and universities. Moreover, web applications have accuracy problems. In this study, we have proposed a deep neural network (DNN) to predict the chance of getting admitted to a university according to the students portfolio. All the selection criteria are considered here to predict the chance of admission. The DNN model has been compared with existing methods in terms of different performance metrics including mean squared error (MSE), root mean squared error (RMSE), mean absolute error (MAE), R-squared score. It has shown the most promising result that includes R-squared score of 0.8538 and MSE of 0.0031. The proposed method has also outperformed all the existing methods in each benchmark.**

***Index Terms*—Deep Neural Network, Graduate Admission Prediction, Machine Learning**

I. Introduction

Every year, a large number of international students go for graduate admission which is a really very competitive and complex process as the number of applicants are increasing. To enrich their knowledge, getting admitted into a university for higher studies is very essential for an undergraduate student. To get admitted, a student has to fulfil some criteria, also have to sit on exams and get excellent results which is a hectic task. After doing great on the exam, they have to apply for admission. It becomes a difficult task for the students to choose the appropriate universities according to their profile and they fall into conundrum as they are inexperienced. For this, they have to collect different information about the admission process with great difficulties. They have to choose such universities so that their portfolio meets admission requirements also, having a high probability of getting admitted. To make the task easier of doing a shortlist of universities for application, there are some consultancy services which are costly and time consuming.

A consultancy service by humans may have erroneous direction and also a probability of bias by some universities. Moreover, it is difficult to cover all the universities to give proper suggestions.It can cause two types of errors, either applied for the higher standard universities compared to the personal excellency or applied for the lower standard universities compared to the personal excellency. They feel depressed and failed. Both of them will be the waste of resources and time. Hence, it is essential to have an efficient and accurate guidance system for graduate admission to save resources and time, moreover to get admitted in the most deserved university. From these difficulties, we get our motivation to develop such a system to lessen the barrage regarding university selection. However, an efficient machine learning technique may have a potential role to accomplish such a promising task. In this study, we have proposed a graduate admission prediction system using deep neural networks (DNN) which has performed more accurately and efficiently compared to the existing methods.

II. Literature review

AlGhamdi et al. [1] have used machine learning approaches including linear regression, logistic regression along with

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decision tree for predicting the chances of getting admitted where logistic regression has shown the lowest RMSE of 0.072 among them.

Acharya et al. [2] have presented a comparative study of machine learning regressors including linear regression, support vector machine, decision tree and random forest for predicting the probability of chances of graduate admission where linear regression has achieved the great R-squared score of 0.725.

In study [3], authors have presented a random forest model for graduate admission prediction with great data visualization. The proposed method have obtained R-squared score of 0.8412

Bag [4] have conducted an analysis with benchmarking of three regression algorithms for predicting graduate admission chances. Among them linear regression has obtained a promising score R-squared score of 0.8229.

Chakrabarty et al. [5] have applied gradient boosting regression which is an ensemble model with feature selection technique for predictive analysis of graduate admission. By using random forest regressor, features importance have been obtained. Six features among the seven have been selected for the model also achieved an optimistic R-squared score of 0.8405.

III. Proposed Methodology

To complete the study, the graduate admission dataset has been splitted into training dataset and testing dataset. Data normalization has been performed to accelerate the training process of the DNN model. Using the training dataset, the DNN model has been trained with optimal hyperparameter. It has been assessed through some standard benchmarkings. The outcomes of the DNN model have also been compared with the existing methods. Steps are shown using a flow chart in Fig. 1.

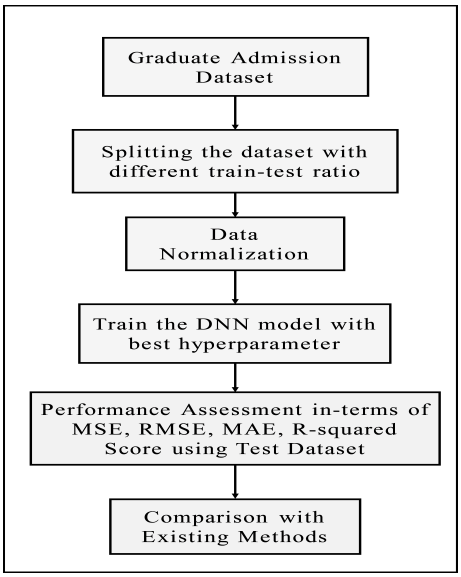

Fig. 1. Proposed methodology

A. Dataset

The dataset is openly accessible from kaggle [6] uploaded by Mohan S Acharya. It contains 500 instances including 7 features and 1 target variable. Dataset has no missing cells and duplicate rows hence doesn't require any preprocessing to impute missing as well as remove duplication. Some properties of the dataset are shown in table I.

TABLE I
Properties of Graduate Admission Dataset

Features	Description	Importance
CGPA	Out of 10	0.7985
GRE Score	Scale: 340 Min: 290 Max: 340	0.0814
TOEFL Score	Scale:120 Min: 92 Max: 120	0.0383
SOP	Out of 5	0.0301
LOR	Out of 5	0.0251
University Rating	Out of 5	0.0132
Research	Bolean value	0.0134
Chance of Admit	Range: 0 to 1 Min: 0.34 Max: 0.97	Output

B. Normalization

It is a preprocessing technique which is used to transform all the numeric features into a common scale without deforming and losing information. It is not necessary for all dataset. It is used when features of a dataset have a wide variety of ranges such as one feature ranges from 0 to 10 and another feature ranges from 100 to 10000. Without normalization these varieties of range can create problems in the learning process of machine learning (ML) algorithms and also makes the process slower. Normalization can avoid these problems. To train a model, training dataset have to pass through the normalization process as well as using the same scale testing dataset also have to pass through the process. There are several methods of normalization such as z-score, min-max, logistic, lognormal, tah etc. In the present study, the min-max method has been used that rescales the column to the interval of [0,1]. The mathematical expression of min-max normalizer is:

$$rescaled\,data = \frac{x - min(x)}{max(x) - min(x)} \tag{1}$$

Where, x is the column required to normalize.

C. Deep Neural Network (DNN)

Artificial intelligence (AI) is a trending topic in the age of cutting-edge technologies. It is going to be used extensively for every automated system. Machine learning is a branch of it. If we dive in more deeply, then the deep neural network comes here. DNN is an artificial neural network (ANN) which

is inspired by biological neurons. Each biological neuron is approximately connected with other 10000 neurons where the connection is established through dendrite and synapse.

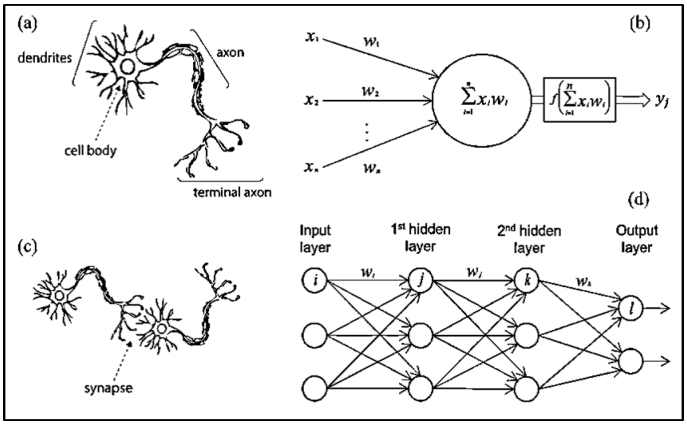

Fig. 2. **(a)** a single biological neuron; **(b)** an artificial neuron;**(c)** connection between biological neurons;**(d)** a deep neural network model [7].

A neuron receives signal through dendrite and sends to the next connected neuron through synapse when it is electrically excited. ANN also has the same attribute. It consists of 3 types of layer including input layer, hidden layer and output layer. Each layer consists of some nodes. Each node of a layer is connected to all the nodes of a successive layer similar to the biological neuron. When the hidden layer of an ANN contains multiple layers it is called DNN. Each node has an activation function similar to the excitation mechanism of neurons. Each connection between nodes has a parameter called weight that is multiplied with the output of the first node and sends to the next node. Weight of each connection is required to be optimized for better accuracy. The optimization process is performed through the back-propagation method where error of the output layer is transferred back to the input layer. By optimizing weights, error is reduced.

D. Performance Metrics

For the assessment of regression tasks, there are some prominent benchmarks including Mean Squared Error (MSE), Root Mean Squared Error (RMSE), Mean Absolute Error (MAE) and R-squared score or Coefficient of Determination. The mathematics of each benchmark is given below.

$$MSE = \frac{\sum(Y_{actual} - Y_{predict})^2}{N} \tag{2}$$

$$RMSE = \sqrt{\frac{\sum(Y_{actual} - Y_{predict})^2}{N}} \tag{3}$$

$$MAE = \frac{\sum(Y_{actual} - Y_{predict})}{N} \tag{4}$$

$$R - squared\ score = 1 - \frac{MSE(model)}{MSE(baseline)} \tag{5}$$

IV. Implementation

To get better outcome, DNN is required to train optimally through tuning the hyperparameter. Through a number of trials, the obtained best parameters of the DNN model are given in table II.

TABLE II
BEST HYPERPARAMETERS OF DNN MODEL.

Input Layer	Hidden Layer	Output Layer	Model
7 nodes	**5** hidden layers, **60** nodes/layer, Activation Function: **ReLu**, Weight initializer: **HeNormal**	**1** node, Activation function: **ReLu** Weight initializer: **Uniform**	Optimizer: **Adam**, Loss function: **MAE**, Epoch: **250**

All the features of the graduate admission dataset have been used as input that means the input layer has to contain 7 nodes. In the present study, the DNN model has 5 hidden layers with 60 nodes in each layer. For each node ReLu activation has been used. HeNormal initializer has been used as the hidden layers weight initializer. The DNN model has to predict the chances of admission, that's why the output layer has 1 node. ReLu, uniform initializer have been used as the activation function and output layer weight initializer respectively.

V. Result & discussion

For experimentation purpose, the admission prediction dataset has randomly been splitted into different ratios that includes 8:2, 7:3 and 6:4 for creating training and testing dataset. The assessment scores in different benchmarks of the proposed model with different train-test ratios have been shown in table III.

TABLE III
ASSESSMENT RESULTS OF THE DNN MODEL WITH DIFFERENT TRAIN-TEST RATIOS.

Phase (Size)	MSE	RMSE	MAE	R-squared Score	Dataset Size
Training (80%)	0.0024	0.0495	0.0296	0.8728	80%
Testing (20%)	0.0031	0.0553	0.0368	0.8538	20%
Training (70%)	0.0022	0.0472	0.0286	0.8843	70%
Testing (30%)	0.0031	0.0557	0.0400	0.8491	30%
Training (60%)	0.0024	0.0490	0.0274	0.8751	60%
Testing (40%)	0.0035	0.0590	0.0409	0.8307	40%

DNN has shown the excellent result using the ratio of 8:2 which has achieved MSE, RMSE, MAE and R-squared score of 0.0031, 0.0553, 0.0368, 0.8538 respectively.Comparison of obtained results of train-test ratios have been shown graphically in Fig. 3 and 4. A comparative study of the proposed method with existing state-of-art models has been performed in terms of MSE, RMSE, MAE and R-squared score which is reflected on the table IV.
By observing the statistical analysis, it can be said that the proposed model has outperformed over the existing methods.

TABLE IV
COMPARATIVE STUDY OF DNN WITH EXISTING METHODS.

Literature	Models	MSE	RMSE	MAE	R-square Score	Test Dataset
AlGhamdi et al. (2018)	Logistic Regression	0.0052	0.0720	-	-	20%
	Linear Regression	0.0058	0.0760	-	-	
	Decision Tree Regression	0.0121	0.1100	-	-	
acharya et al. (2019)	Linear Regression	0.0048	-	-	0.7249	25%
	Support Vector Regression	0.0072	0.0851	-	0.6440	
	Decision Tree Regression	0.0087	-	-	0.5013	
	Random Forest Regression	0.0058	0.0763	-	0.6602	
Sujay S (2019)	Linear Regression	-	-	-	0.8412	20%
Bag (2020)	Linear Regression	0.0034	0.0580	0.0409	0.8230	15%
	Random Forest Regression	0.0038	0.0610	0.0424	0.8010	
	Decision Tree Regression	0.0080	0.0890	0.0637	0.5790	
Chakrabarty et al. (2020)	Gradient boosting regression	0.0032	0.0570	0.0438	0.8405	20%
Proposed Method	Deep Neural Network	**0.0031**	**0.0553**	**0.0368**	**0.8538**	**20%**

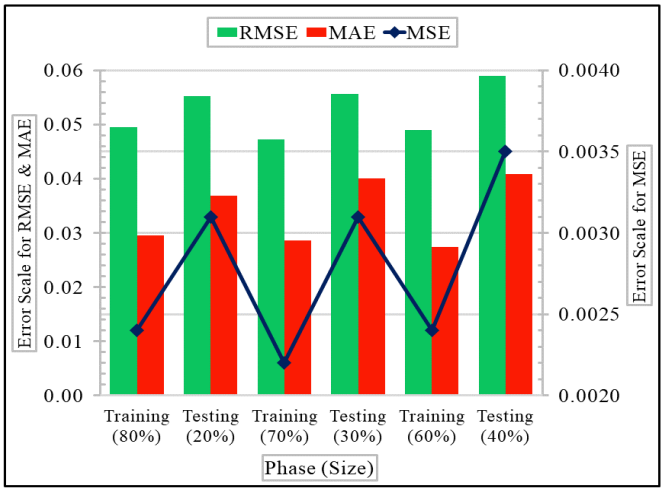

Fig. 3. Graphical representation of MSE, RMSE and MAE for different train-test ratios of DNN.

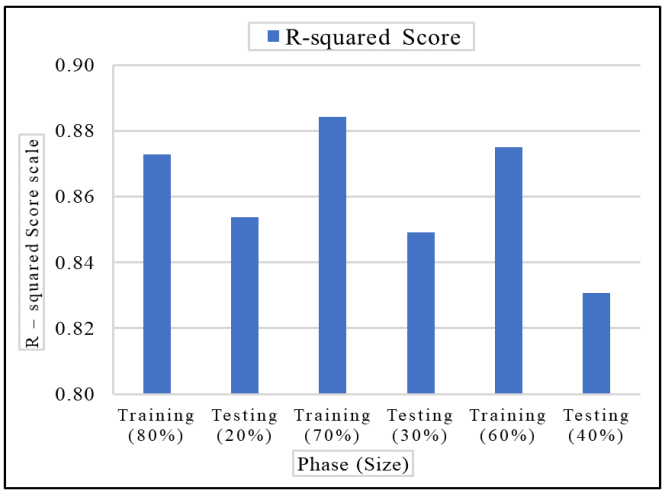

Fig. 4. Graphical representations of R-squared score for different train-test ratios of DNN.

VI. CONCLUSION

We have proposed a DNN model for predicting the chance in graduate admission. Because of different ranges of data, the normalization process has been used here to resize all of them to a common scale that will speed up the training process. We have experimented with different train-test ratios using tuned hyperparameters. It shows that the proposed model has performed well using the ratio of 8:2. The DNN model shows an optimistic outcome in every benchmark and has also outperformed the existing methods. It has been successfully experimented that a DNN model can identify complex data patterns more accurately than other ML methods. According to statistical analysis, it can be said that the proposed method is more accurate, beneficial and efficient that will save both the time and resources. Moreover, it will help a student to get admitted to his/her dream university. However, in future, apart from the factors considered in the paper, some other criteria such as local regulations e.g. regulation in USA or Canada as well as State Level criteria may also be taken into consideration to improve the accuracy of the model.

REFERENCES

[1] A. AlGhamdi, A. Barsheed, H. AlMshjary, and H. AlGhamdi, "A machine learning approach for graduate admission prediction," in *Proceedings of the 2020 2nd International Conference on Image, Video and Signal Processing*, 2020, pp. 155–158.

[2] M. S. Acharya, A. Armaan, and A. S. Antony, "A comparison of regression models for prediction of graduate admissions," in *2019 International Conference on Computational Intelligence in Data Science (ICCIDS)*. IEEE, 2019, pp. 1–5.

[3] S. Sujay, "Supervised machine learning modelling & analysis for graduate admission prediction."

[4] A. Bag, "A comparative study of regression algorithms for predicting graduate admission to a university."

[5] N. Chakrabarty, S. Chowdhury, and S. Rana, "A statistical approach to graduate admissions' chance prediction," in *Innovations in Computer Science and Engineering*. Springer, 2020, pp. 333–340.

[6] M. S. Acharya, "Graduate admission 2," https://www.kaggle.com/mohansacharya/graduate-admissions?select=Admission_Predict_Ver1.1.csv, (Accessed 30 July 2020).

[7] K. Suzuki, *Artificial neural networks: architectures and applications*. BoD–Books on Demand, 2013.