A regression model for Happiness Score

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***Abstract*-The Assignment focuses on creating a linear regression and Multilayer perceptron for Happiness Score dataset.Report presents 1. Preparation of the data 2.Features used in the model 3.RMSE of linear regression model 4. Training a multilayer perceptron 4.Comparing the modeling errors with different features and parameters**

I. Problem Formulation

The goal of the assignment is to predict Happiness score using linear regression model and Multilayer perceptron model. To achieve this below steps are followed:

1. Preparation of data and choosing features
2. Preparation of data and dividing into training and testing dataset
3. Building linear regression model
4. Calculating RMSE of linear regression model
5. Training multilayer perceptron
6. Calculating RMSE of MLP
7. Comparing RMSE of both the built models
8. Adjusting the parameters of MLP to achieve comparable performance as linear regression model in terms of RMSE

II. Methods

Preparation of Data:

The provided dataset contained the happiness scores of about 156 countries, and the metrics used to determine these scores. The data for a period of 5 years was provided(2015-2019). Upon comparison of the metrics used for arriving at the ranks for different years, it was found out that only six metrics were common between the datasets. Thus, the given dataset was prepared accordingly. The metrics used are as follows:

- Happiness score
- GDP
- Life Expectancy
- Freedom
- Generosity
- Perception of Corruption

It was also observed that the dataset for the year 2018 had a missing field for one of its metrics and thus, the row corresponding to the data(Row 21 of the 2018 dataset) has been omitted. The resulting datasets were combined using Python, to create a single list of data(.csv file) in the ascending order of the years in which these data were recorded. Final dataset used for the project is present in the CombinedData_all.csv file.

The size of the dataset is 782*8(where the first two columns contain information about the overall rank and the name of the country and the third column represents the happiness scores).

The data was split for training and testing of the models. The split was 80-20, where 80% of the data is used to train the models and the remaining 20% is used for testing. The data was split randomly using Python thus ensuring that no single year contributes more to the testing phase, thus, ensuring proper functioning of the models.

Linear Regression Model:

In this model we are predicting the happiness score using the five selected features (*gdp, life_expectancy, freedom, generosity, corruption and generosity*) .

This is a Multivariate Linear Regression problem.

Hypothesis for this model is given by :

$$h_\theta(x) = \theta_0 + \theta_1 x_1 + \theta_2 x_2 + \cdots + \theta_n x_n$$

where, n=5
and x is the input

We are using LinearRegression model provided by sklearn[1]

Multilayer Perceptron model:

The goal of formulating this Multi-Layer perceptron is to arrive at a model which can perform on par compared to the Multivariate Linear Regression model.Sklearn.neural_network MLPRegressor [2] model has been used. A Multi-Layer Perceptron model with one hidden layer was chosen for this application. The model has five input neurons, 100 neurons in the hidden layer and one output neuron. This was arrived at based on different test cases run by varying the metrics used in the hidden layer and the execution of the program. The metrics that were varied are as follows:

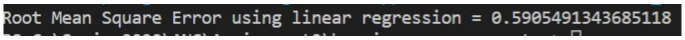
- Number of neurons in the hidden layer
- Activation function
- solver
- batch_size

The results of the analysis are as shown in results section

III. Results

Linear Regression Results:

The RMSE value for the linear regression model:



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Root Mean Square Error using linear regression = 0.5905491343685118
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Figure 1: RMSE for linear regression model

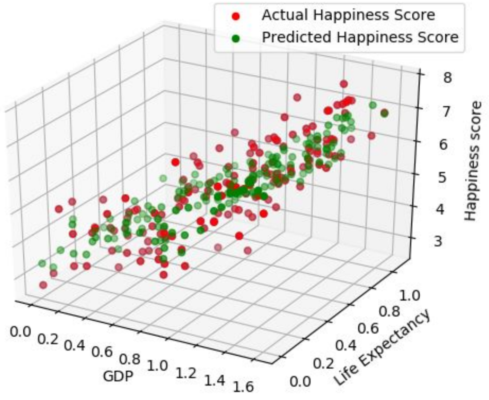


Figure 2: Plot between gdp, life_expentency and Happiness score

Figure 2 shows Happiness score corresponding to the 2 features (*gdp, life_expentency*). This is a 3d figure , *gdp* is x-axis , *life_expentency* is y-axis and *happiness score* is z-axis

Multi-layer Perceptron Results:

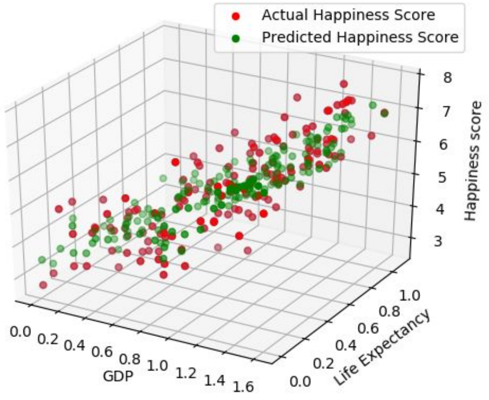
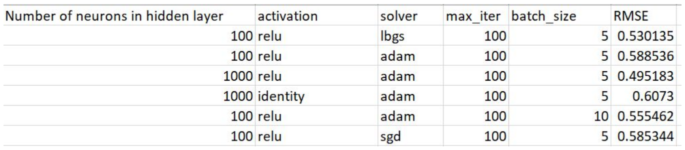


Figure 3: Plot between gdp, life_expentency and Happiness score



Number of neurons in hidden layer	activation	solver	max_iter	batch_size	RMSE
100	relu	lbgs	100	5	0.530135
100	relu	adam	100	5	0.588536
1000	relu	adam	100	5	0.495183
1000	identity	adam	100	5	0.6073
100	relu	adam	100	10	0.555462
100	relu	sgd	100	5	0.585344

Figure 4:Analysis of different Hidden Layer Metrics

From the Figure 3 , we can observe that the multi-layer perceptron with the following parameters works as comparable to the linear regression model:

Parameters:

1. Number of neurons in hidden layer:100
2. Activation function:Rectified Linear Unit(RELU)
3. solver:sgd (stochastic gradient descent)
4. max_iter=100
5. batch_size=5

RMSE obtained with this RMSE is 0.5855344

In addition to this , we can observe that the RMSE can be further decreased using different parameters.

IV. Conclusions

We discussed linear regression models and Multilayer perceptrons . Compared the RMSE for both the models, we have observed that MLP models can produce low RMSE values when the right parameters are chosen .

References

[1]https://heartbeat.fritz.ai/implementing-multiple-linear-regression-using-sklearn-43b3d3f2fe8b

[2]https://scikit-learn.org/stable/modules/generated/sklearn.neural_network.MLPRegressor.html#sklearn.neural_network.MLPRegressor