PREDICTION OF STARTUP FUNDING

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I. INTRODUCTION

The dataset contains information about various startup companies in various cities of India. It also has information about the investment type, industry vertical and the amount funded for them. Our task is to predict the funding amount for the testing data. Prediction of this funding amount varies corresponding to the investment type and the city in which the startup is located. Funding amount prediction can help a lot of upcoming startups to plan their proceedings accordingly. There can be several reasons like inefficient planning, inefficient way of using the funds, lack of good team to work, insufficient funds, etc. which leads to failure of startup. This work aims to create a machine learning model for predicting the range of funding that can be expected by the organization based on many important factors that play a major role in all stages of a startup. It is very important to increase the success rate of startups. It helps in predicting the future of startups by involving machine learning and increases the productivity and decrease the failure percentage.

This paper aims at building models for predicting the amount of funding the startup can receive. The machine learning algorithms will help to handle such cases more effectively. This work mainly aims in guiding to build the model which predicts the range of funding a startup can expect far before the implementation process. We used the concepts of find S algorithm, random forest classifier and linear regression to predict the funding amount. A summary of previous work is presented below.

II. PREVIOUS WORK

The machine learning includes supervised, unsupervised and semi supervised learning. The supervised learning provides many different regression and classification techniques to implement a machine learning model based on the labelled data. The existing solutions for this problem of predicting the startup funding which includes all the algorithms are briefly explained .

a) Find S algorithm

The find S algorithm is a basic concept learning algorithm in machine learning. The find S algorithm finds the most specific hypothesis that fits all the positive examples. We have to note that the algorithm considers only those positive training example. The find S algorithm starts with the most specific hypothesis and generalizes this hypothesis each time it fails to classify an observed positive training data. Hence, the find S algorithm moves from the most specific hypothesis to the most general hypothesis.

b) Random Forest

Random Forest classifier is the collection of multiple independent decision trees. The disconnected decision trees are formed by taking different starting nodes. The initial nodes are selected based on the Gini index and many different criteria. the individual trees are built independent of the other trees. when an unknown data item is given to the model, the individual outputs of the decision tree is send to a optimizer which finds the maximum favourable class label and gives it as the output. As the output of multiple trees is considered the accuracy of the model is expected to be high and resist the underfitting and overfitting problems. This algorithm is very robust and handles the highly imbalanced classes very effectively.

c) Linear Regression

The simple logistic regression is built by plotting the graph of the dataset and then forming the boundaries separating the different classes. This is inefficient when the data is linearly inseparable and very sensitive to the underfitting and overfitting problems. It uses a stage-wise fitting process.

LIMITATIONS

The main limitation for our dataset is that there are many categorical variables. So we are supposed to give more preference to classifiers rather than regressors which gave us less accuracy than expected. We tried the best possible ways to increase the accuracy while using classifiers.

ASSUMPTIONS

There are many categorical variables in the dataset. For linear regression model, since the regressor takes only

numerical values, we encoded few categorical data columns as numbers. Finally, we train the model using these encoded columns and predict the funding.

III. PROPOSED SOLUTION

a) *Pre-Processing*

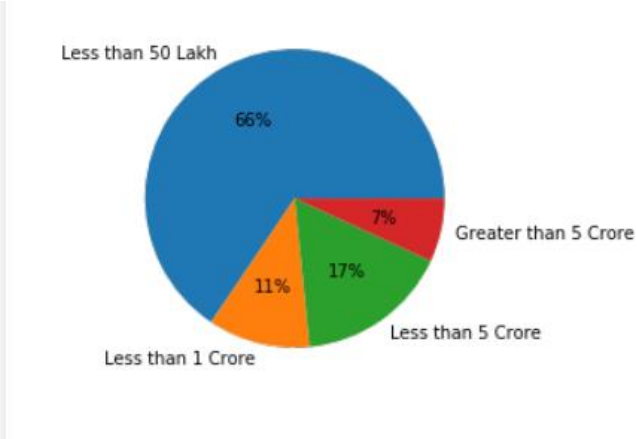
Data Pre-processing is one of the essential steps in building machine learning models. It involves transforming the collected data into consistent and understandable format. The consolidated raw data may include some outliers, values that are out of range, few missing values, error values and soon. without handling such error will lead to wrong results. The quality of data directly proportional to the accuracy of the model. While training the model the ambiguity raises due to redundant and unimportant data. This makes the necessity of data pre-processing before training the model. This can take considerable amount of time to pre-process. This data pre-processing step includes activities like cleaning the data, transforming the data, selecting the instance, extracting the required features, normalizing the data if it is not within the acceptable range. Thus pre-processed data can be used for training the model.

For our dataset, we used Data Cleaning and Data Reduction techniques. Rows having at least one null value are deleted since they are categorical variables and cannot be replaced by mean of that column. Two columns which are irrelevant and are not useful for predicting the funding amount are deleted.

b) *Data visualization*

Data visualization is the graphical representation of information and data. By using visual elements like charts, graphs and maps, data visualization provides an accessible way to see and understand trends, outliers and patterns in the data.

First Visualization :- Start-up Funding Trends

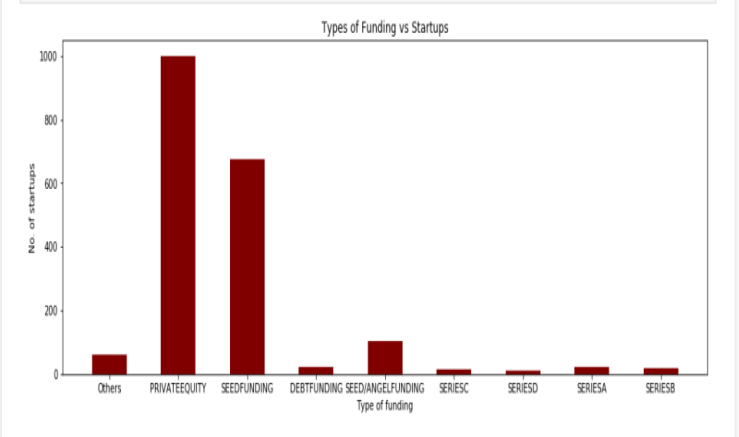


1) It is seen that, in the chosen dataset around 66% of the start-ups are allotted with less than 50 lakh rupees.

2) We can also see that only around 7% of the start-ups are funded with more than 5 crores rupees.

3) Also start-ups with less than 1 crore and less than 5 crore funding are 11% and 17% respectively. 4) From this chart, it can be observed that most of the start-ups are funding with less that 50 lakh rupees.

Second Visualization :- Types of Funding v/s No of Start-ups



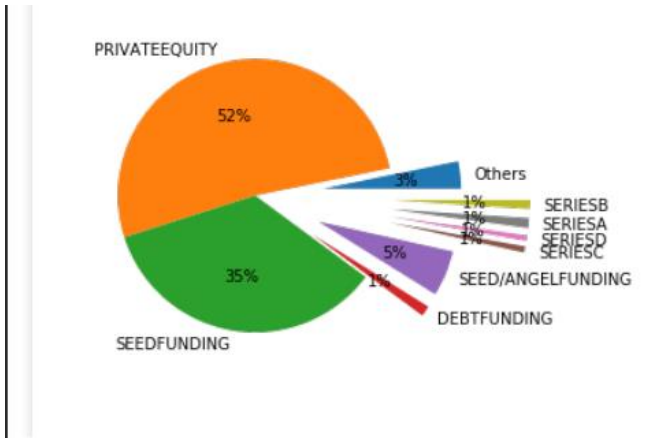
1)From the above graph we can see that majority of the start-up funding is from Private Equity.

2) Also a fair amount of start-ups are funded by Seed Funding type of funding.

3) Most of the other start-ups are funding in small portions by Debt Funding, Angel Funding, Series A,B,C,D types of funding.

4) So here most of funding is from either Private Funding or Seed Funding with the former being a majority.

Third Visualization :- Types of Funding v/s No of Start-up

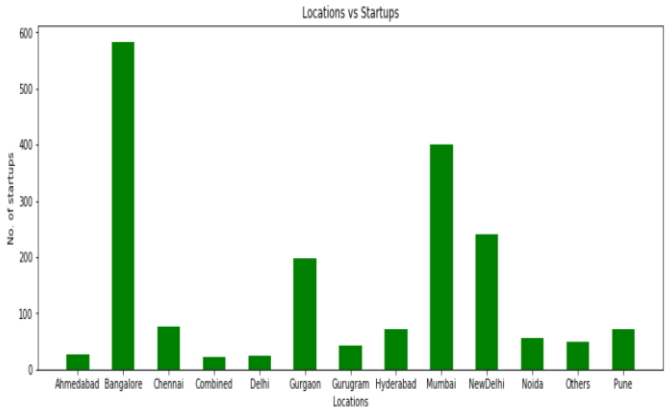


1) From the above graph we can see that around 52% of the start-up funding is from Private Equity. 2) Also a fair amount(35%) of start-ups are funded by Seed Funding type of funding.

3) Most of the other start-ups are funding in small portions by Debt Funding, Angel Funding, Series A,B,C,D types of funding.

4) So here most of funding is from either Private Funding or Seed funding with the former being a majority.

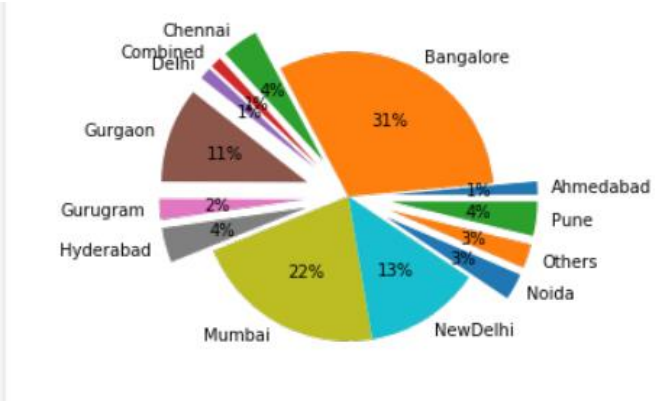
Fourth Visualization :- Types of Funding v/s Start-up Location



1) From the above graph, we see that most of the Start-up are emerging from lot of developing city like Bangalore, Mumbai, New Delhi, Gurgaon .

2) Also we can infer a lot of start-ups are founded from these cities.

Fifth Visualization :- Types of Funding v/s Start-up Location



From the pie-chart we can see that

1)31% start-ups from Bangalore

2)22% start-ups from Mumbai

3)13% start-ups from New Delhi

4)11% start-ups from Gurgaon

c) *Building the model*

1) *Random Forest*

Random forests are used to solve classification problems, regression problems that operate by building multiple decision trees at training time and the output of new data item is obtained by calculating median or mode of the results of all individual trees. Decision trees are more likely sensitive to the overfitting problem but this approach will handle such cases intelligently. Basically 2collected and final output is given based on some strategy to increase the rate of accuracy of prediction.

Here we are performing Random Forest to find the amount for our given test data. We achieved this by label encoding the categorical features and then fitting the model with the relevant features and our goal is to predict the amount for the given features.

2) *Find S algorithm*

The find S algorithm is a basic concept learning algorithm in machine learning. The find S algorithm finds the most specific hypothesis that fits all the positive examples. We have to note that the algorithm considers only those positive training example. The find S algorithm starts with the most specific hypothesis and generalizes this hypothesis each time it fails to classify an observed positive training data. Hence, the find S algorithm moves from the most specific hypothesis to the most general hypothesis.

Here we are using the find S Algorithm to predict the values. Here we are storing the training and testing data in a

list and then implementing the Algorithm. In this model we are considering the features city, industry vertical and amount from the training data to predict the amount for the given test data containing the features city, industry vertical .

3) *Linear Regression model*

The simple logistic regression is built by plotting the graph of the dataset and then forming the boundaries separating the different classes. This is inefficient when the data is linearly inseparable and very sensitive to the underfitting and overfitting problems. It uses a stage-wise fitting process.

This model uses linear regression by taking in all the relevant features i.e. 'Industry Vertical', 'City Location' and 'Investment Type' doing prediction on them by label encoding then so a to fit the model. Our Aim is to predict the amount for a test data containing these feature values.

d)*Model Evaluation*

We use three models that are Find S, Random Forest and Linear regression. We see that our Find S model has the best predictions as shown by the Mean Absolute percentage error. The random Forest gives us a lot of error and shows us that it is not fit for handling a data like this and moreover it requires a lot of computation power and time and is quite inefficient in this scenario. The Linear regression model has considerable amount of error but not as much as the random forest error and it is also moreover requires lesser computation power and can be said to be better than the random forest model. Label encoding has enabled us to fully use the capabilities of our dataset to the fullest to extract and predict to a very close value. The Find S model predicts very efficiently and effectively.

IV. RESULTS

The results for the model building for training are as follows:-

1) Find S algorithm

```
error= 9.988932803911418 %
accuracy= 90.01106719608859 %
```

Out[22]:

	Actual	Predicted
0	2000000	6000000.000
1	200000	4550000.000
2	1000000	3840000.000
3	120000	3220000.000
4	165000	2783571.429
5	150000000	21185625.000
6	2200000	19076111.111
7	10000000	14384307.692
8	25000000	15142571.429
9	400000000	40799733.333
10	2000000	36129176.471
11	50000000	34966368.421
12	900000	33263050.000
13	25000000	32869571.429
14	10000000	31830045.455
15	1000000	29231708.333
16	1250000	28112440.000
17	5000000	27223500.000
18	35000000	26886107.143
19	10000000	26593700.000

This model is giving high accuracy since it finds a specific hypothesis that fits all the positive examples. We have to note that the algorithm considers only those positive training example. The find S algorithm starts with the most specific hypothesis and generalizes this hypothesis each time it fails to classify an observed positive training data thus giving high accuracy. Here we take the mean of the most matching data with respect to our training dataset and then predict the value.

2) *Random Forest*

```
Root Mean Squared Error: 116045113.8479745
Mean Absolute Error: 30116290.374677002
Mean Squared Error: 1.346646844798936e+16
```

Random Forest is mostly used for classification tasks. It can also be used for regression tasks. Random Forest can't extrapolate. It can only make a prediction that is an average of previously observed labels. In other words, in a regression problem, the range of predictions a Random Forest can make is bound by the highest and lowest labels in the training data. This behaviour becomes problematic in situations where the training and prediction inputs differ in their range and/or distributions. This is covariate shift and it is difficult for most models to handle but especially for Random Forest, because it can't extrapolate. Therefore, we got high RMSE value and this model is not fit for predicting funding.

3) *Linear Regression model*

```
Root Mean Squared Error: 45237358.660685755
Mean Absolute Error: 23517965.13657666
Mean Squared Error: 2046418618595520.5
```

Here, Linear Regression model is giving a high RMSE value. Usually, LR model gives low RMSE value but that was not the case here. This is because, the variables in this dataset are categorical and we encoded them as numbers. The prediction would be more accurate only when there are numerical variables.

V. CONCLUSIONS

From the results , it is evident that Find S model is the best for predicting startup funding. We saw that Random Forest and Linear Regression model are giving high error value whereas Find S is giving an accuracy of 90.01% . Therefore, the best fit model is Find S.

The reason why the other 2 models are having considerable error is because our data has no correlation and this is evident by the PCA analysis. Since RandomForest and Linear Regression are regression models they work well with correlated data and since our data is uncorrelated we are getting considerable amount of errors .

a) Contributions **:-**

Jeshwanth Reddy – Random Forests and PCA

V Manas Advaith – Find S algorithm and managed team

Nama Naga Hitesh – Linear Regression model and data cleaning

Suhas -- PCA and EDA visualization

b) *Working Experience* :-

It was a very good learning experience for us to work with various machine learning models and learn insights from them. It was fun to evaluate each model and then try methods to improve the accuracy and decrease the error rate.

c) *References* :-

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ii) Breiman. L. for Random forests. Mach. Learn., 45(1):5 – 32, Oct. 2001.

iii) kaggle.com for startup funding data.

iv) Pesu academy pdfs for information about machine learning models.