Rainfall Forecasting using Machine Learning Techniques

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Abstract- Rainfall prophesies essentially resolves in the scientific research fields of both meteorological and hydrological environment. Rainfall prediction is very much important for analyzing crop production, usage of water resources as well as pre-planning resources. Nevertheless, numerical forecasting techniques outcomes generate low prediction exactness for rainfall forecasting at most of the times. In this research, Machine learning methods ignore the effects of physical variables in upstream or other downstream regions, allowing predictive accuracy to fluctuate in different areas. Moreover, Machine Learning techniques namely linear regression, Support vector machine are primarily used to enhance the overall forecasting accuracy for the rainfall through statistical analysis using data mining approach. Along with that, this paper introduces detection accuracy used by various scientists for evaluating the overall performance by calculating metrics such as accuracy, recall, r2-score.

Keywords: Rainfall forecasting, Prediction, Machine learning technique, Numerical forecasting, Linear regression.

I. Introduction

Forecasting rainfall is accommodating to stay away from deluge (flood) which saves human being properties and lives. Additionally, it assists in running water resources. In order to support farmers, rainfall is the major source to control their crops better which effects leads to increase in growth of our country's wealth. Changeability in rainfall timing and its amount makes rainfall prediction a demanding mission for meteorological researchers. Urmay shah et.al [1] explained the prediction of rainfall through machine learning approaches based on evaluating metrological parameters. The experimental test exemplifies that predicting metrological specifications and boundaries can be carried through ARIMA and Neural Networks which makes the work pre-eminent in addition with better accuracy compare with Random forest algorithm. Amit kumar & Leo Breiman et. al [2] implemented machine learning techniques for weather forecasting. Here, analyzing data to bring back practical information and target through data mining and machine learning techniques. SunYoung Lee et.al [3] examines that divide and conquer method used to partition the regions

into four different areas and the problem solving is independently in different regions. This technique is applicable for emergency conditions and also long term management of unhygienic regions. Debasish Basak [4] endeavored support vector regression to minimize the generalization error so as to enhance the performance of the model. The suggestion behind is computing linear regression function along with high dimensional feature space, SVR achieves good results. Chowdari k.k et.al [5] anticipates superior perceptive of climate as well as weather carried out by spatial-temporal mining. This paper goes well for various case-studies for simulation and analysis for cyclone prediction, rainfall prediction and temperature prediction. Pinky saika Dutta et.al [6] collected dataset from the year (2007-2012) proposed data mining technique such as Multiple Linear Regression for forecasting rainfall in monthly basis in Assam. Moreover the investigational consequence shows forecast model depends on multiple linear regression indicates adequate accuracy.

II. Literature survey

Kavitha Rani et.al [7] proposed prediction of rainfall implemented through multilayer Perceptron Neural Network (MLP-NN) and SARIMA. For model evaluation, statistical parameters such as Correlation co-efficient, Root Mean Square Error, Mean Absolute Error, and BIAS would be utilized to construct the relationship between two different models. MAI Navid et. al [8] anticipated Multiple Linear Regression as well as ANN were carried out for forecasting rainfall in Bangladesh for crop productivity. However, the investigation can be analyzed through statistically generates suitable outcomes. Aakash Parmar et.al [9] explained non-linearity of data rainfall generates better outcomes through Artificial Neural Network. Furthermore, comparison of predicting rainfall by diverse scientist can be tabulated. Xinguang He et.al [10] calculated monthly rainfall forecasting approached by Multiple Linear Regression and Multiple Resolution Analysis that performs well and generates better results. Alex J Cannon and Ian G Mckendry et.al [11] described the calculation of rainfall depressed for elucidating bendy non-linear techniques and the graphical sensitivity investigation can be appropriate for ANN. Sensitivity with non-linear relationship generates good to both ANN and multiple linear regression. Divya Chauhan et. al [12] investigates the weather prediction especially by mining techniques such as K-means clustering and decision tree estimates the final test outcomes with high calculation accuracy among other data mining techniques. D Ramesh et. al [13] the author analyzed crop yield prediction using density based clustering and multiple linear Regression modus operandi for east Godavari district in Andhra, India. Among other machine learning technique, MLR and clustering shows better results for enhancing performance. J. Refonna et.al [14] analyzed that linear regression model helpful for forecasting rainfall by mentioning features such as temperature, humidity etc. M Kannan et.al [15] identifying the forecasting climate can be processed through Fuzzy logic, ANN, data handling methods. The prediction can be calculated by using system of equations which may forecast the

development of worldwide environment along with distinctive (atmospheric) circumstances.

III. Data collection

Basically in machine learning techniques, data collection is the flow of collecting and extracting information like feature, variables etc. from the datasets, in an eminent systematic way that has capability for testing and evaluate the concepts, models, finally generate the outcomes. In this survey, datasets collected from Kaggle website from the year 1901 -2015 in India mainly Andaman& Nicobar Islands to predict rainfall forecast through calculating the periodic and also annual rainfall.

3.1 Data Pre-processing

Data Pre-processing is the major part in data mining technique deals with the following steps as:

1. Data cleaning (scrubbing)
2. Data integration (merging)
3. Data transformation (conversion)
4. Data reduction (summarization) and
5. Data discretization (resampling).

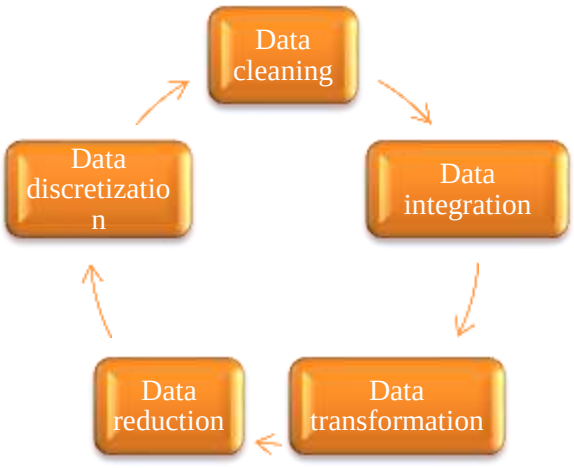

Figure 1. Steps in Data Pre-preocessing

IV. Algorithm used in proposed work

This proposal addresses regression issues for predicting continuous values namely calculating rainfall forecasting for every month i.e periodic prediction in addition with annual prediction.

To solve the regression issues, ensemble gradient boosting with decision tree algorithm and linear regression models are used.

4.1. Gradient Boosting algorithm

Gradient Boosting is a strategy for changing over fragile (weak) data into tough (strong) data. This trains the model very continuing, sequential, effective, and stabilizer approach for enhancing the performance in a well-manner. Here boosting algorithm refers how the two algorithms recognize the drawbacks of weak model mainly decision tree algorithm. In this proposal, gradient boosting performs the regression model using loss function as follows:

$$y = ax + b + e \quad (1)$$

Where e as error symbol refers to loss

The loss function means evaluation of how good is model's coefficients which are at appropriate original information. A reasonable consideration of loss function mainly depends on what we are trying to optimize. Moreover, ensemble gradient boosting regressions develop the overall performance through accuracy detection of the domain.

4. **2. Decision Trees algorithm**

Decision tree learning is one among the prescient cut methodologies used in insights, information handling and AI. Decision Tree algorithm comes under supervised machine learning approaches adopted with classification issues by taking decision to generate better outcomes. It is extensively used for Inductive conclusion. Major issue is

handling training dataset with missing features. Here, decision tree is applied for finding the classification issues while forecasting rainfall both periodical/ annual.

4. 3. Linear Regression

To address the tackle in regression, linear regression approach is utilized in this work. Regression is one of the models mainly identifying regression issues in machine learning for predicting real value. Eg: forecasting rainfall. In statistical analysis, linear regression is a linear representation for designing the correlation between dependent variable (y) and independent variable (X).

The general equation for finding linear regression is

$$y = b_0 + b_1 * X_1 \quad (2)$$

Whereas X-independent variable;
y- dependent variable.

In this proposal, rainfall prediction is calculated between annual rainfall and periodic rainfall through multiple linear regression models.

More than one exploratory variables performs in the equation refers to multiple linear regression

$$y = b_0 + b_1 * X_1 + b_2 * X_2 + ... + b_n * X_n \quad (3)$$

V. Error/performance calculating metrics in proposed work

5. 1. Root Mean square (RMS)

The Root Mean Square (RMS) is a habitually utilized proportion of the contrasts between utility (test and populace esteems) anticipated by a model and the qualities really watched. ... On the off chance that the RMS for the test set is a lot higher than that of the preparation set, all things considered, you've gravely over fit the information.

$$RMS = \sqrt{\frac{a_1^{\,2} + a_2^{\,2} + a_3^{\,2} ..... + a_n^{\,2}}{n}} \quad (4)$$

Root Mean Square means squaring all the numbers in the set and calculates the arithmetic mean, eventually taking the result as square root.

5.2. Root Mean Square Error (RMSE/RMSD)

Root Mean square Error (RMSE) may be regular thanks to realize error of a model in predicting quantitative knowledge. This tells U.S. heuristically that RMSE is thought of as some quite (normalized) distance between the vector of foreseen prices and therefore the vector the ascertained value.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N} (\mathrm{Pr}edicted_i - Actual_i)^2}{N}} \quad (5)$$

Where as

Predicted- Unknown value; Actual-known value

To validate the investigational outcome, RMSE is usually used in regression analysis, forecasting, and climatology.

5. 3. Mean absolute error (MAE)

In statistical point of view, mean absolute error is the ratio of error between corresponding observations expressing the same phenomenon. To determine MAE, calculate absolute errors $|y_j - \hat{y}_j|$, then join them; finally divide it by number of errors. The MAE could be a linear score which suggests that each one the individual variations area unit weighted equally within the average

$$MAE = \frac{1}{n}\sum_{j=1}^{n} | y_j - \hat{y}_j | \quad (6)$$

Here, y_{j-} predicted value; $y_j^{\wedge -}$ expected value; n- number of errors. $|y_j - y_j^{\wedge}|$- absolute errors

5. 4. Accuracy: Accuracy is defined as the number of accurate predictions divided by total number of input samples (data).

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN} \quad (7)$$

5. 5. Confusion matrix: Confusion matrix is frequently used to depict the performance of the classification model on a set of sample data for which the correct (true) values are known. Confusion matrix mainly realizes the overall performance of the algorithm.

Table 1. Confusion matrix

	Class 1 Predicted	Class 2 Predicted
Class 1 Actual	TP	TN
Class 2 Actual	FP	FN

VI. ARCHITECTURE DIAGRAM

The architectural diagram shows the skeleton of the work that we have done in this proposal.

The steps for predicting rainfall like periodic (every six months) and annual (year wise) rainfall are shown in figure 2.

Selection: Selection is the procedure of choosing historical weather dataset for rainfall forecast**.**

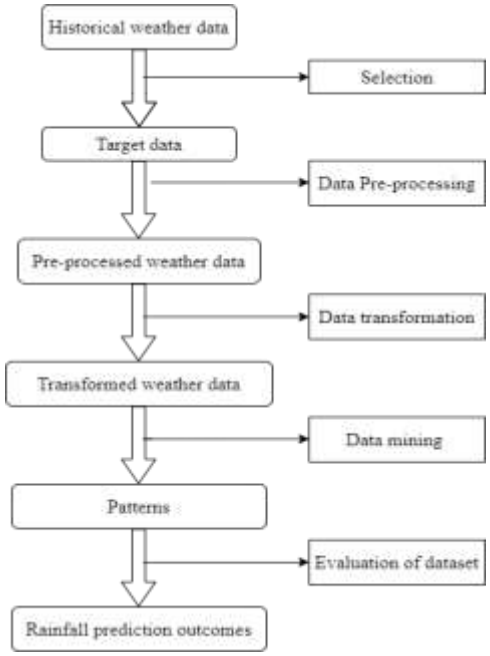

Figure 2. Architecture diagram for forecasting rainfall

Data Pre-processing: Removal of irrelevant features such as repeated values, null values, etc.

Data transformation: Process of converting one format into another format. It is a primary aspects of most data management and integration

Data mining: Extracting usable patterns from the large amount of dataset

Evaluation of dataset: Validate the information by using dataset to predict the outcomes.

6.1 Structural design for rainfall Prediction using Linear Regression model

The architecture demonstrates the prediction of rainfall forecast in various regions specifically in metrological and

geographical areas.

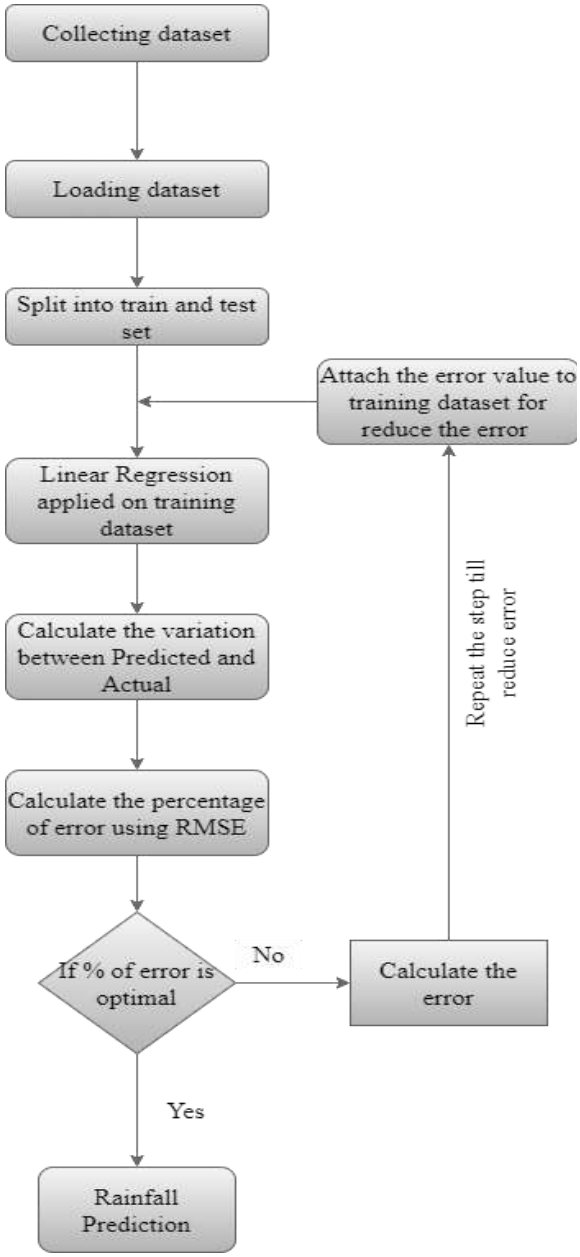

Figure 3. Structural design for rainfall prediction

The first and foremost step is collecting the data, loading the dataset for training and testing procedure to train and test the model. In this work, the machine learning algorithm such as linear regression applied for training dataset. After chosen algorithm, calculate the relationship between actual value and the predicted value, and then calculate the percentage of error using Root Mean Square Error (RMSE). If the error percentage is optimal, then predict the rainfall forecast, otherwise calculate the error percentage. Combine the error value to the training set until the error is reduced/ eliminated.

6.2 Procedure for rainfall prediction using linear regression:

Step 1: Collecting dataset

Step 2: Loading dataset for train the model

Step 3: Split the dataset into training and testing phase.

Step 4: Linear regression model applied for training stage.

Step 5: Calculate the variation between expected and predicted values.

Step 6: Calculate the % of error using RMSE

Step 7: If % of error is optimal, then predict the rainfall forecasting, otherwise add the obtained error to the training phase for further step.

Step 8: Repeat the step still getting no error.

6.3 Program for finding minimum and maximum forecasting rainfall in periodically/annually based on various regions.

```
d2=data.drop(['SUBDIVISION','YEAR','ANNUAL','
Jan-Feb','Mar-May','Jun-Sep','Oct-Dec'],axis=1)
k=((d2.head().sum()))
month=list(d2.head())
print("Months are: ",month)
print(k)
s=0
for i in d2.sum():
   s=s+i
print("Total recorded rainfall in these 12 months",s)
probability=list(k/s)
print(probability)
```

```
max_rainfall=max(probability)
for i in range(len(month)):
    if probability[i]==max_rainfall:
        print("Maximum Rainfall will be in the month
of",month[i])
min_rainfall=min(probability)
for i in range(len(month)):
    if probability[i]==min_rainfall:
        print("Minimum Rainfall will be in the month
of",month[i])
```

From the above program, this paper concludes that the maximum rainfall will be the month of June and minimum rainfall will be the month of March.

6.4 Python program for comparing Actual and predicted value to calculate metrics

```
actual [], predicted[]:
for i in range test_y
if i>2000:
        actual. append (“high”)
else
        actual. append (“low”)
for i in range pred
if i>2000:
        predicted. append (“high”)
else
        predicted. append (“low”)
accuracy = accuracy_score (predicted, expected)
matrix=confusion_matrix (predicted,expected)
clas= classification_report (predicted, expected)
print (“accuracy”)
```

VII. Experimental Analysis

7.1 Implementation of algorithm

The proposal will utilized Python 3.6 to set up multiple linear regression approach for predicting rainfall forecast. We establish incorporated OS user interface task in python 3.6 and each and every in-built function such as numpy for numerical calculation, pandas package for data analysis along with data structure tool. Importing the dataset format as follows:

```
import os;
import numpy as np;
import pandas as pd;
from pandas import read_csv;
from matplotlib import pyplot as plt;
from sklearn linear_model import
linearRegression;
```

7.2 Description of dataset

Data frame range index: 4116 entries; ranges from 0 to 4115; Data column specifies 19 column

7.3 Description of Nomo graph for annual and periodic rainfall

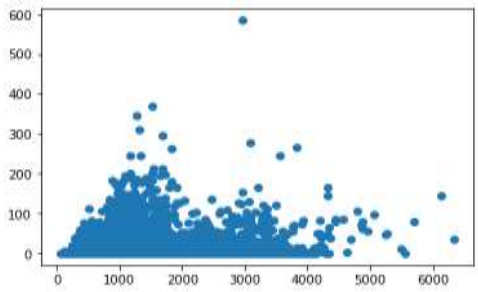

Figure 4 Nomo graph for annual and January attributes

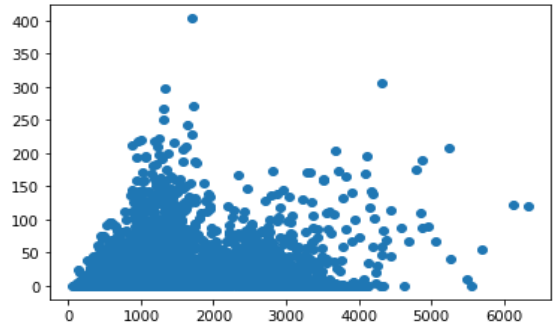

Figure 5. Nomo graph for annual and February attributes

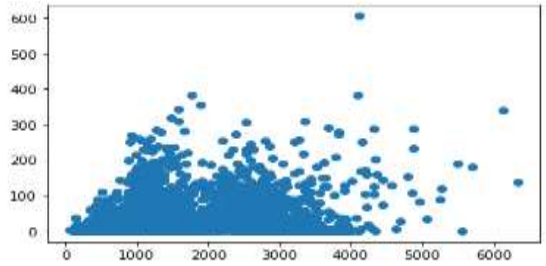

Figure 6. Nomo graph for annual and March attributes

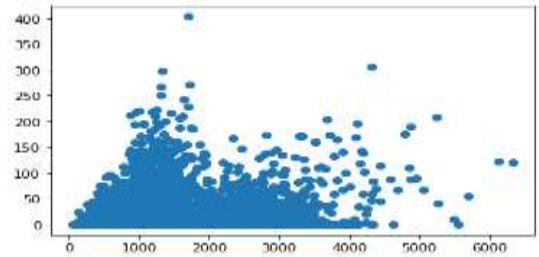

Figure 7. Nomo graph for annual and April attributes

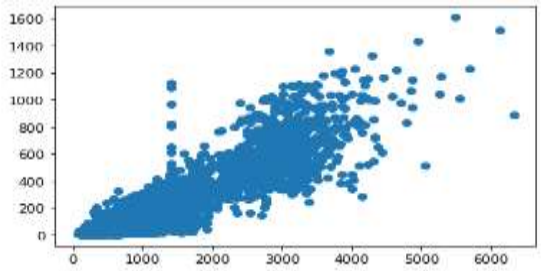

Figure 8. Nomo graph for annual and May attributes

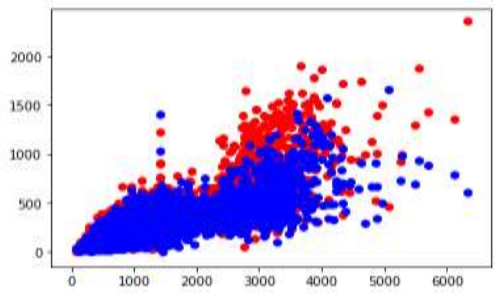

Figure 9. Nomo graph for annual and June attributes

The Nomo graph illustrates the annual rainfall prediction furthermore September to December months is predicted.

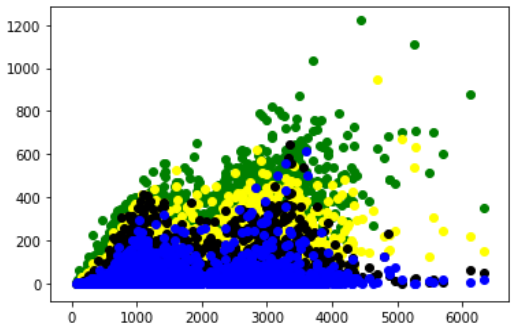

Figure 10. Nomo graph for annual and September-December attributes

The following table illustrates the prediction of rainfall annually (year wise) and also periodically (month wise) by measuring the metrics like mean, standard deviation, minimum value, maximum value includes count also. By taking survey of rainfall in India, maximum and minimum rainfall can be forecasted done through statistical analysis of machine learning techniques.

Maximum rainfall – Jun

Minimum rainfall - Mar

	count	mean	std	min	25%	50%	75%	max
YEAR	4116.0	1958.218659	33.140898	1901.0	1930.000	1958.00	1987.000	2015.0
JAN	4116.0	18.957329	33.569044	0.0	0.600	6.00	22.125	583.7
FEB	4116.0	21.805325	35.806396	0.0	0.600	6.70	26.800	403.5
MAR	4116.0	27.359197	46.925176	0.0	1.000	7.90	31.225	605.6
APR	4116.0	43.127432	67.798192	0.0	3.000	15.70	49.825	595.1
MAY	4116.0	85.745417	123.189974	0.0	8.600	36.70	96.825	1168.6
JUN	4116.0	230.234444	234.568120	0.4	70.475	138.90	304.950	1609.9
JUL	4116.0	347.214334	269.310313	0.0	175.900	284.90	418.225	2362.8
AUG	4116.0	290.263497	188.678707	0.0	156.150	259.50	377.725	1664.6
SEP	4116.0	197.361922	135.309591	0.1	100.600	174.10	265.725	1222.0
OCT	4116.0	95.507009	99.434452	0.0	14.600	65.75	148.300	948.3
NOV	4116.0	39.866163	68.593545	0.0	0.700	9.70	45.825	648.9
DEC	4116.0	18.870580	42.318098	0.0	0.100	3.10	17.700	617.5
ANNUAL	4116.0	1411.008900	800.986632	62.3	808.450	1125.45	1635.100	6331.1
Jan-Feb	4116.0	40.747786	59.265023	0.0	4.100	19.30	50.300	699.5
Mar-May	4116.0	155.901753	201.096692	0.0	24.200	75.20	196.900	1745.0
Jun-Sep	4116.0	1084.724769	706.881054	57.4	574.375	882.25	1287.550	4536.9
Oct-Dec	4116.0	154.100487	166.678751	0.0	34.200	88.80	212.600	1252.5

Figure 11. Annual Record

To create a histogram, the primary step is to bin the values means segregate the complete set of values into series of intervals. Here bins=10 for calculating every month rainfall forecasting. The following chart shows the visual aid of rainfall dataset from (Jan-Dec) from the year 1901-2015.

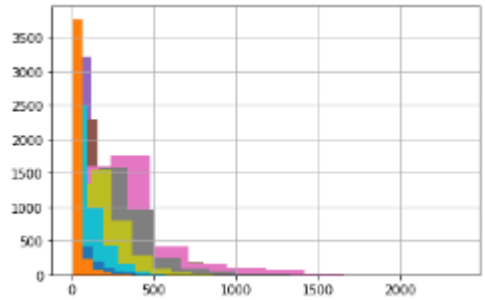

Figure 12. Histograms showing the data from attributes (JANUARY to DECEMBER) of the years 1901-2015

The below bar chart indicates the forecasting rainfall of all the states once a year.

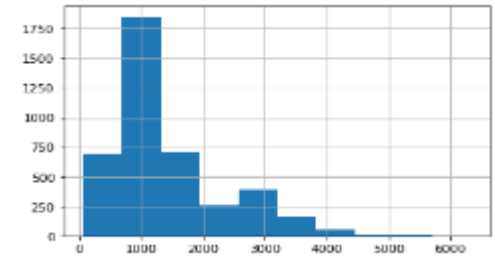

Figure 13. Histogram showing the annual rainfall of the all states

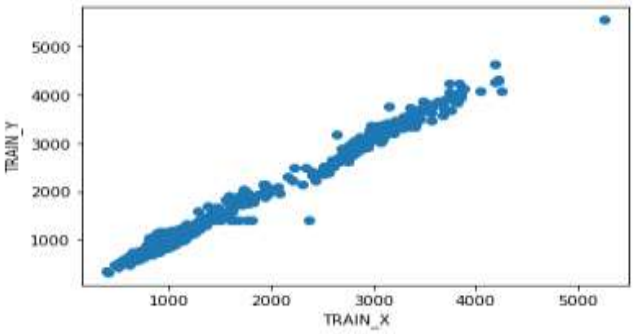

Figure 14. Linear Regression between annual rainfall

The above graph demonstrates the linear regression model between annual rainfall. This shows the training phase where horizontal label as TRAIN_X, vertical label as TRAIN_Y too.

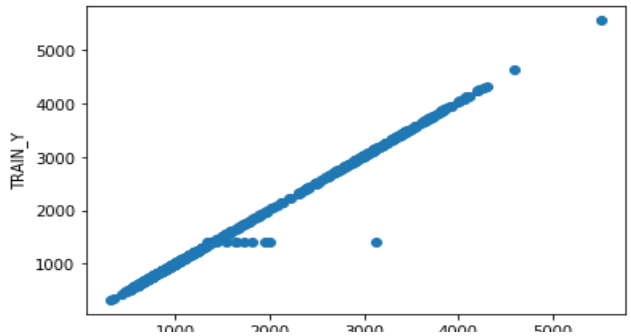

Figure 15. Linear regression model between annual rainfall

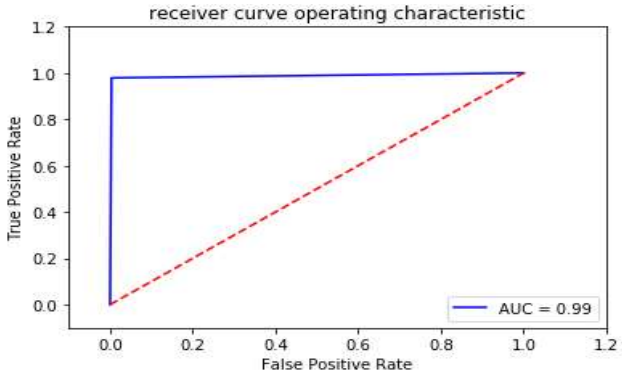

Figure 16. Receiver curve operating characteristic for finding accuracy

This graph shows the receiver curve operating characteristic (feature) between false positive rate and true positive rate for identifying accuracy as 99.8% to enhance the overall performance of forecasting rainfall.

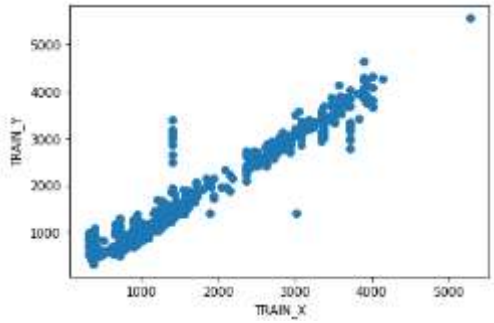

Figure 17. Linear Regression model

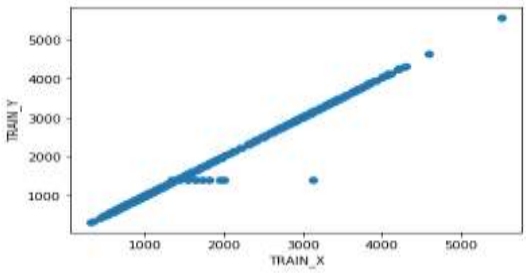

Figure 18. Linear model Ridge (α=0.5)

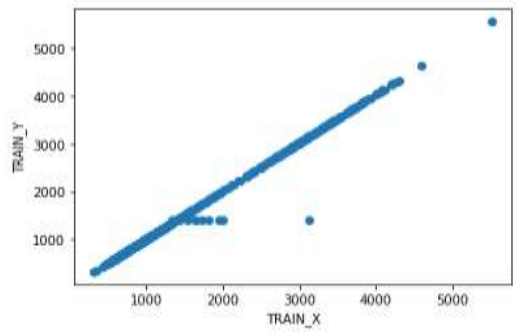

Figure 19. Linear model RidgeCv (α=np.logspace)

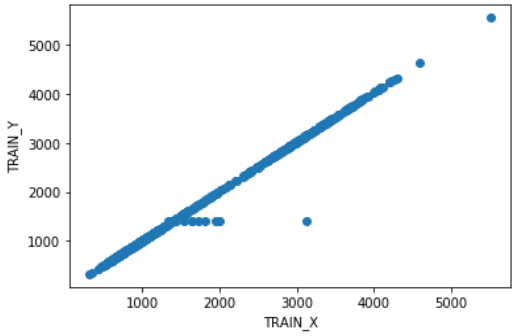

Figure 20. linear Regression model LassoLars (α=0.1)

The ROC curves are constructive visual tool for comparing two classification models i.e Gradient boosting and Decision tree classifier. ROC curves derived from signal detection theory for analzing radar images. The below ROC performs the relaionship between expected value and predicted value for calculating the accuracy in rainfall forecasting.

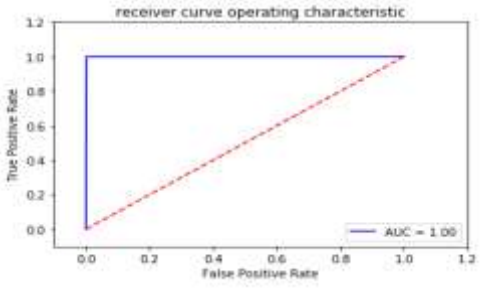

Figure 21. Accuracy prediction in ROC representation

Table 2. Error values calculated for every ML algorithm

Errors	Gradient boosting	Decision tree	Linear model	Linear model-ridge (α=0.5)	Linear model-log space	Linear model-LassoLars (α=0.1)
MSE	14080.017	59828.275	4971.9646	4971.9646	4971.818	5147.9286
RMSE	118.659	244.598	70.512	70.512	70.511	71.749
MAE	84.485	141.0669	14.591	14.591	14.600	20.879
R2_score	0.9871	0.9454	0.995	0.995	0.995	0.995

Table 3. Accuracy estimation for reinforce performance.

S.No	Algorithm	Accuracy	Accuracy in %
1	Gradient Boosting Regression	0.9915	99.15%
2	Decision Tree Regression	0.9793	97.93%
3	Linear Regression	0.9975	99.75%
4	Linear model. Ridge(α=0.5)	0.9975	99.75%
5	Linear model. RidgeCv(α=np.logspace)	0.9975	99.75%
6	Linear model. LassoLars (α=0.1)	0.9987	99.87%

The following figure 22 and Table 3 illustrates the estimation of accuracy to maximize strength, in addition with overall performance of the model. However, this proposal used three machine learning models explicitly gradient boosting regression, decision tree, and linear regression model. Among three machine learning techniques, linear regression finds the error using certain error metrics such as RMSE, MSE etc which outperforms experimental outcomes showing improved performance as a result of forecasting rainfall.

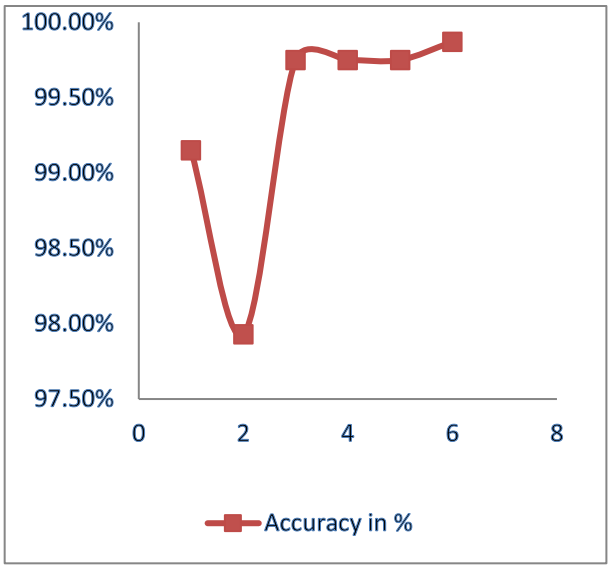

Figure 22. Comparison of accuracy between different machine leaning technique.

7.4 Comparison of ML techniques for rainfall forecasting.

This proposal measured accuracy by comparison of machine learning models approached by different authors for forecasting rainfall. By the result of comparison, it reveals that our proposed work exposed better accuracy as 99.8% to develop overall performance of the model.

Table 4. Comparison of ML techniques for rainfall forecasting

S.No	Author	Model used	Rainfall forecasting (Accuracy)
1.	Urmay Shah et.al [1]	Random forest	70.50
2.	PS Dutta et.al [6]	Regression model	52
3.	M. Kannan et.al [15]	Regression model	63
Proposed work		Linear regression model	99.8

VIII. CONCLUSION AND FUTURE WORK

This Proposal has introduced a synchronized rainfall learning model which utilized Artificial Intelligence calculations to group rainfall information whichever to check the exactness of rainfall expectation. We employ high-level language and establish the multiple linear regression tasks. In data mining approach, constructing data analysis is very straightforward using this high-level language. The novel proposed algorithm namely ensemble gradient boosting, decision tree, linear regression mainly multiple linear regression for forecasting rainfall both periodic calculation (every six months) and annual (once a year) prediction through metrics namely Mean squared error, Root mean square error, Mean absolute error and r2 score. Determining minimum and maximum rainfall prediction totally recorded for 12 months can be established using probability function. The classification tackles can be solved through the calculation of metrics such as precision, recall, and f1-score. In this proposal, linear regression model shows better accuracy of 99.8% to enhance the overall performance of forecasting rainfall in different regions. In Weather outlook, it is really accommodating with enormous accuracy score and in rainfall likewise it provides moderately large forecasts. In future scope, we want to build our work in Weather, Storm forecasts and Crop yield with the rainfall forecast.

IX. References

[1] Urmay shah, Sanjay Garg, Neha sisodiya, Nitant Dube, Shashikant Sharma "Rainfall prediction: Accuracy enhancement using machine learning using forecasting techniques" International Conference on Parallel, Distributed, and Grid Computing Pg: 20-22, December 2018 (conference).

[2] Amit Kumar Agarwal, Manish Shrimali, Sukanya Saxena, Ankur Sirohi, Anmol Jain "Forecasting using Machine learning" International Journal of Recent Technology and Engineering, ISSN: 2277-3878, volume-7 Pg: 38-41. April 2019 (Journal).

[3]Sunyoung Lee, SungZoon choo, Patrik M. Wong "Rainfall prediction using Artificial Neural Networks" Journal of Geographic Information and Decision Analysis, vol. 2, no. 2, Pg: 233 - 242, 1998. (journal)

[4] Debasish Basak, Srimanta Pal, and Dipak Chandra Patranabis "Support vector regression" Neural Information Processing-Letters and Reviews, Pg: 203-224, October-2007. (article)

[5] Chowdari K K, Girisha R, and K C Gouda "A study of rainfall over India using data mining", International conference of Emerging Research in Electronics, Computer Science and Technology (ICERECT), 2015 (conference).

[6] PS Dutta and Hitesh Tahbilder "Prediction of rainfall using data mining technique over assam" Indian Journal of Computer Science and Engineering, Pg: 85-90, April-May 2014 (Journal)

[7] Kavitha Rani B, Govardhan A, "Rainfall Prediction using data mining techniques: A survey" International Journal of Computer science& Information Technology (IJCS&IT) Pg: 23-30, 2013 (Journal).

[8] MAI Navid, and NH Niloy "Multiple Linear Regression for Predicting Rainfall for Bangladesh", Science publishing group, Pg: 1-4, 2018 (Journal).

[9] Aakash Parmar, Kinjal Mistree, Mithila Sompura "Machine Learning techniques for rainfall prediction: A review" International conference on Innovations in Information

Embedded and Communication system (ICIIECS), 2017, (Conference).

[10] Xinguang He, Haude Guan, Xinping Zhang and Craig T. Simmons "A wavelet based multiple linear regression model for forecasting monthly rainfall", International Journal of Climatology, Pg: 1898-1912, 2014 (Journal)

[11] Alex J Cannon, Ian G Mckendry "A graphical sensitivity analysis for statistical climate models: Application to Indian monsoon rainfall prediction by ANN and Multiple Linear Regression", International Journal of climatology. Pg: 1687-1708, 2002 (Journal).

[12] Divya Chauhan, JawaharThakur "Data mining techniques for weather prediction: A review", International Journal of Recent and Innovation Trends in Computing and Communication, Pg: 2184-2189, 2014 (Journal).

[13] D Ramesh, B Vishnu vardhan "Analysis of Crop yield prediction using data mining techniques", International journal of Research in Engineering &Technology, Pg: 470-474, 2015 (Journal).

[14] J. Refonna, M. Lakshmi, Raza Abbas, Mohammad Raziulla "Rainfall Prediction using Regression Model", International Journal of Recent Technology and Engineering, vol-8, issue-2S3, July 2019, Pg: 543-546(Journal)

[15] M.Kannan, S.Prabhakaran, and P.Ramachandran "Rainfall Forecasting Using Data Mining Technique", International Journal of Engineering and Technology Vol.2 (6), 2010, Pg: 397-401 (Journal).