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Weather Monitoring System

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Abstract: *To predict something we need some background study to understand the pattern. On earth, every phase of human life is influenced by nature. As we cannot avoid the natural changes and conditions, we have chosen to minimize their effect on our lives. Therefore, to achieve this we need to know the weather conditions beforehand, to make things work according to the changes in the environment. Here comes the role of prediction. To carry out prediction, accurate classification of data is required. The main objective of this project is to create a model which will predict the weather correctly. Agriculture is the field that is most influenced by the weather. So, in this project, we have extended our scope to provide regional guidelines to farmers depending upon the classification done. This paper explores the details of this project*

Keywords: Weather Prediction, Temperature, Pressure, Humidity

I. INTRODUCTION

In recent years, the world has witnessed rapidly changing environmental conditions. Weather conditions affect all the major areas. Sudden Changes in the environment are a great concern for agriculture [2] so, weather forecasts are essential. Weather forecasting is the task of predicting future weather conditions [5]. Weather forecasting plays a very vital role in many fields. Weather forecasting plays an important role in meteorology [2] traditionally; weather prediction was done by physical models of the atmosphere. The present state of the atmosphere is monitored here by monitoring the present state using the mathematical equation and some algorithm modules we can predict the future values[5]. But to make it easier and more reliable, it can be done by making use of available technology. Machine learning can come to aid when it comes to weather forecasting or prediction as it is more robust and does not need a clear understanding of the physical process of forecasting as rightly stated in [5]. Thus, in this project, we have implemented 2 machine learning algorithms to do the weather prediction. Along with the prediction we have also included the classification of the weather depending on the predicted value. As discussed, weather forecasting plays a vital role in different fields, agriculture is one of the major fields where weather prediction would be very much beneficial. So, the scope of the following project is expanded for the application of this forecasting in agriculture. Depending on the result of the weather-predicting model, we will be generating some important guidelines for the farmers in that region, so that they will be aware of it and would take necessary actions.
This paper further discusses which are machine learning algorithms used, how they are implemented, and the results and accuracy of those algorithms.

II. LITERATURE REVIEW

In [1] the paper "Analysis of Weather Prediction uses Machine Learning & Big Data" by Shubham Madan, the prediction of weather was done by using big data processing and machine learning. The minimum temperature, maximum temperature, minimum humidity, and maximum humidity are some of the attributes used for future prediction. The algorithms used are linear regression and support vector machine. To check the accuracy of the given project the author has mentioned the 'root mean squared' method.
In [2], the paper "Weather Forecast Prediction: An Integrated Approach for Analyzing and Measuring Weather Data" by Munmun Biswas, Tanni, and Sayantanu Barua in the year 2018, the author has proposed a methodology of weather prediction using machine learning algorithms like 'Chi-square' for prediction and 'Naïve-Bayes' for classification. The attributes used in this implementation were, 'outlook, temperature humidity, and wind'. The weather was simply classified into 'Good' or 'Bad'. The author used a nonlinear methodology for predicting the future values with the help of minimum temperature.

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In [3], the paper "Weather Prediction Based on Fuzzy Logic Algorithm for Supporting General Farming Automation System" published by Aris Pujud Kurniawan, Agung Nugroho Jati, Fairuz Azmi at the 5th International Conference on Instrumentation, Control, and Automation (ICA) in the year 2017. They built a weather prediction system using the fuzzy logic algorithm to support general automation in the farming sector. They took the data from the weather service provider and Wunderground. Their system also collects data from a rain sensor and soil moisture sensor and using fuzzy logic it decides whether to water the plants or not. It is mentioned that the whole system has been tested by observing the plants every day and the model if there are any errors or not. They have tested the system 33 times in eighteen days with a 100% accurate result.

In the paper “Automated Weather Event Analysis with Machine Learning” by Nasimul Hasan, Md. Taufeeq Uddin, Nihad Karim Chowdhury [4], the authors have discussed the classification of weather using a machine learning algorithm C4.5. C4.5 is a statistical classifier used to build a decision tree for classification in which C4.5 evaluates the goodness of a test using an information theory-based formula choosing the test with the maximum amount of information from the set of examples. In their experiments, they found that C4.5 classified three weather events e.g. normal, rain, and fog with f-score of 0.979, 0.84, and 0.845, respectively, on the LA weather set

In the paper "Machine Learning Applied to Weather Forecasting" published by Mark Holmstrom, Dylan Liu, and Christopher Vo in the year 2017 [5] they built a weather prediction model using 'linear regression' and 'functional regression' algorithms to predict the different factors affecting the weather. Later, they used '4- fold forward chaining time-series cross-validation' to check the accuracy of the model. After the completion of the model, they compared their model with the 'professional weather forecasting services and as a result, both linear regression and functional regression were outperformed by 'professional weather forecasting services. But after a certain period, the discrepancies or error rate in their model decreased significantly.

Above, the related work of our project is discussed. As mentioned above there are various machine learning algorithms implemented on different data sets for the prediction of weather as well as for classification along with its accuracy measures. This literature survey helped us to learn which algorithms can be used and which would be most suitable for our project.

III. PROPOSED SYSTEM

The methodology used in this project for the prediction of weather and its classification comprises of usage of two machine learning algorithms- Linear Regression and Support Vector Machine (SVM) respectively. The block diagram depicts the machine learning approach to the implementation of the project. Fig.1.

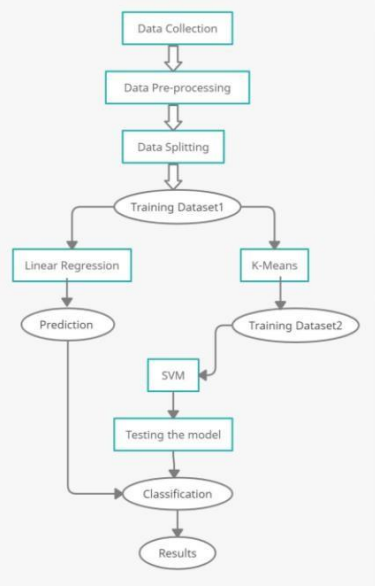

Fig.1. Block diagram of the methodology

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Steps followed for implementation of this project:

Data collection

The data set used for this project was collected from the Kaggle site[ref]. It is the historic weather data of Delhi city in India. This data set has comprised a total of 5 columns i.e. 5 weather attributes and 1421 data tuples. This dataset was processed to get the desired dataset.

Data Preprocessing

The data pre-processing was done on the raw dataset starting with feature selection. This feature selection was done manually based on the literature survey and research. The selected feature that affects weather the most are mentioned in the table1 along with their unit.

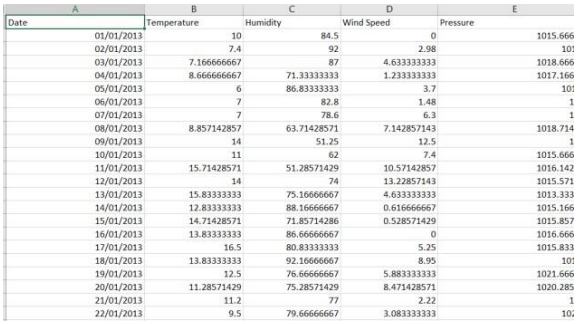
TABLE 1 Attributes and their units

SR NO	Attribute	Unit
1	Temperature	C
2	Wind Speed	Km/p
3	Mean Humidity	%
4	Mean Pressure	hPa

After the feature selection, data cleaning was done by removing the null values followed by the removal of outliers by using the interquartile range (IQR) method. In the IQR method, the dataset was divided into 4 equal parts and the quartiles are Q1, Q2, and Q3.

Q1 represents the 25th percentile of the data. Q2 represents the 50th percentile of the data. Q3 represents the 75th percentile of the data.

Then all the data points below 1.5*Q1 and 1.5*Q3 are the outliers and are dropped from the dataset and the dataset is cleaned. Fig.2. shows the data set after the data pre-processing.



Date	Temperature	Humidity	Wind Speed	Pressure
01/01/2013	10	84.5	0	1015.666
02/01/2013	7.4	92	2.98	101
03/01/2013	7.166666667	87	4.633333333	1018.666
04/01/2013	8.666666667	71.33333333	1.233333333	1017.166
05/01/2013	6	86.83333333	3.7	101
06/01/2013	7	82.8	1.48	1
07/01/2013	7	78.6	6.3	1
08/01/2013	8.857142857	63.71428571	7.142857143	1018.714
09/01/2013	14	51.25	12.5	1
10/01/2013	11	62	7.4	1015.666
11/01/2013	15.71428571	51.28571429	10.57142857	1016.142
12/01/2013	14	74	13.22857143	1015.571
13/01/2013	15.83333333	75.16666667	4.633333333	1013.333
14/01/2013	12.83333333	88.16666667	0.616666667	1015.166
15/01/2013	14.71428571	71.85714286	0.528571429	1015.857
16/01/2013	13.83333333	86.66666667	0	1016.666
17/01/2013	16.5	80.83333333	5.25	1015.833
18/01/2013	13.83333333	92.16666667	8.95	101
19/01/2013	12.5	76.66666667	5.883333333	1021.666
20/01/2013	11.28571429	75.28571429	8.471428571	1020.285
21/01/2013	11.2	77	2.22	1
22/01/2013	9.5	79.66666667	3.083333333	102

Fig.2. Data set after pre-processing

C. Linear Regression

It is a supervised machine learning algorithm, the most basic type of regression. It is the statistical model that analyzes the linear relationship between a dependent variable with a given set of independent variable(s). In the project, simple linear regression was used to predict the individual attribute of the dataset. For this 75% of the dataset was the training dataset i.e. used for training the model and the remaining 25% was used to test the dataset.

Equation of simple linear regression, $y = b0 + b1\ x$ (1)

Y - dependent variable X - independent variable

b1 - slop of the regression line b0 – Y-intercept

D. K-Means Clustering

K-means algorithm is an iterative algorithm that tries to partition the dataset into K pre-defined distinct non- overlapping subgroups (clusters) where each data point belongs to only one group. It tries to make the intra-cluster data points as similar as possible while also keeping the clusters as different (far) as possible. The dataset that we used for this project is unlabeled. That is K-means algorithm was used to make the clusters in our dataset. To decide the number of clusters the elbow method

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was used. In the elbow method, we choose the number from where a linear descent is seen in the elbow-shaped graph plotted. In our case, it is 4 i.e. 4 number of clusters is the optimum number of clusters. The graph for the elbow method is shown in Fig3

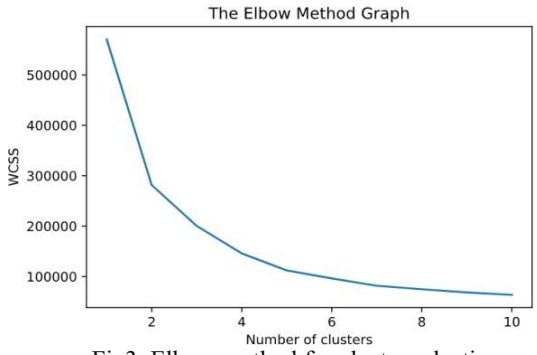

Fig3. Elbow method for cluster selection

E. Support Vector Machine

Support Vector Machine is an algorithm widely used in classification objectives. In SVM hyperplanes are decision boundaries that help classify the data points and we are looking to maximize the margin between the data points and the hyperplane. Once the clustering is done, in the output, we get the labeled dataset as shown in fig 4.

This data is passed to the SVM algorithm. SVM algorithms use a set of mathematical functions that are defined as the kernel. The kernel function used for the classification of this weather data is „Polynomial kernel". The function of a polynomial function is:

$$k(xi, xj) = (xi. xj + c)\, d \qquad (2)$$

It is suitable for this project because of its high accuracy and its efficient application in multiclass classification. Multiclass or multinomial classification is the problem of classifying instances into one of three or more classes. The results of this implementation and its analysis are discussed further.

IV. RESULT AND ANALYSIS

After the implementation of the methodology proposed above the results is discussed below along with its analysis and output. The linear regression model successfully predicted the real values of all the attributes with some error. This was tested against the test data which was formed at the train-test split. As the regression model used in this project was simple, the method used for checking the accuracy was the R-Squared method. The formula, for R-Squared:

R2=R-squared (R2)

R-Squared is a statistical measure of fit that indicates how much variation of a dependent variable is explained by the independent variable(s) in a regression model.

is a measure that represents the proportion of the variance for a variable that is explained by associate variable quantity or simply variables used in a regression model. In

Table II the r-squared values of all the attributes are shown.

Attributes	R-squared value
Temperature	0.9488
Humidity	0.7157
Pressure	0.9527

R-squared values vary from 0 to 1 and are normally stated as percentages from 0% to 100%. If R-squared is 100% it means that all movements of the dependent variable are completely explained by movements in the independent variable.

Generally, the values an R2 value above 0.7 is considered a good r2 reading whereas a value above 0.9 shows an excellent accuracy.

The implementation of K-means was done to get different clusters in the dataset. As a result, 4 different clusters were obtained- labeled as 'Clear', 'cold', 'cloudy', 'partly cloudy. Fig 4 Shows 4 different clusters.

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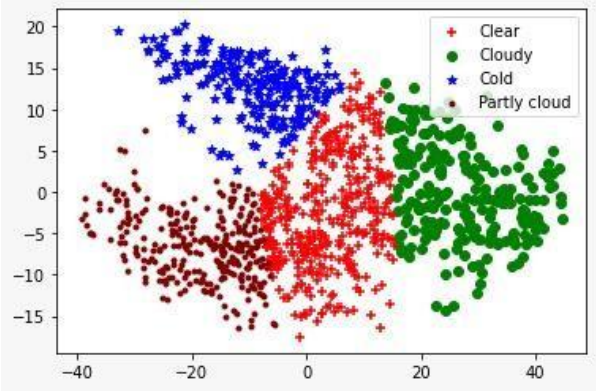

Fig 4 Clustering Details

The implementation of SVM was done on the dataset obtained from clustering and again split into Train and test datasets with proportions of 80% and 20% respectively. Fig 5 shows the hyper plane between the classes.

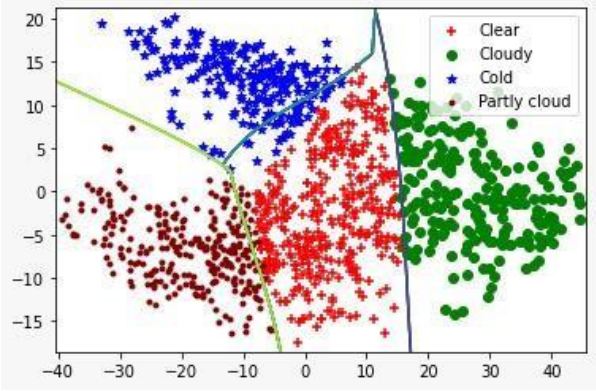

FIG 5 – Classification of classes and hyperplane between them

As all the kernels of SVM were implemented, the results and accuracy for each of them were calculated using the confusion matrix method.

Confusion matrix calculations:

Accuracy = (TP + TN)/ (TP + TN + FP + FN).

Precision is a proportion of the accuracy given that an explicit class has been predicted.

Precision = TP/ (TP + FP)

Recall = Sensitivity = TP / (TP + FN) Where,

TP- numbers of true positive FP-numbers of false positive. TN-numbers of true negative.

FN- numbers of a false negative.

The accuracy of all the kernels is mentioned in TABLE 3:

Kernel	Accuracy
Polynomial	96%
RBF	18%
Sigmoid	18%

From the table, the polynomial Kernel for SVM is the most accurate the in-detail accuracy metrics and confusion are mentioned in Fig 4.

From the above result, the confusion matrix explains the number of true positive, true negative, false positive, and false negative.

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V. CONCLUSION

According to all the results discussed in the paper, we conclude that prediction and classification of weather can be done using machine learning algorithms mentioned in this methodology i.e. Linear regression and SVM. The prediction was done based on weather attributes like temperature, pressure, humidity, and wind speed, and the weather was classified into 4 classes: Cloudy, Partly Cloudy, Sunny, and Cold. The linear regression model could perform the prediction with an accuracy of 94%, 95%, and 71% for temperature, pressure, and humidity, respectively. Also, the classification done based on SVM performs with an accuracy of 96% for polynomial kernels while for other kernels it performs poorly. Further, this prediction and classification data can be used for the generation of some regional instructions for the farmers for agricultural benefits.

REFERENCES

[1] Shubham Madan, Praveen Kumar, Seema Rawat, Tanupriya Choudhury, "Analysis of Weather Prediction using Machine Learning & Big Data," International Conference on Advances in Computing and Communication Engineering (ICACCE-2018) Paris, France 22-23 June 2018.
[2] Munmun Biswas, Tanni Dhoom, Sayantanu Barua "Weather Forecast Prediction: An Integrated Approach for Analyzing and Measuring Weather Data" International Journal of Computer Applications (0975 – 8887) Volume 182 – No. 34, December 2018.
[3] Aris Pujud Kurniawan, Agung Nugroho Jati, Fairuz Azmi "Weather Prediction Based on Fuzzy Logic Algorithm for Supporting General Farming Automation System," International Conference on Instrumentation, Control, and Automation (ICA) Yogyakarta, Indonesia, August 9-11, 2017.
[4] Nasim Hasan, Md. Taufeeq Uddin, Nihad Karim Chowdhury" Automated Weather Event Analysis with Machine Learning,".
[5] Mark Holmstrom, Dylan Liu, Christopher Vo, "Machine Learning Applied to Weather Forecasting" Stanford University (Dated: December 15, 2016).
[6] J. Wu, L. Huang, and X. Pan, "A novel Bayesian additive regression trees ensemble model based on linear regression and nonlinear regression for torrential rain forecasting," in Computational Science and Optimization (CSO), 2010 Third International Joint Conference on, vol. 2. IEEE, 2010, pp. 466–470.
[7] Mr. Sunil Navadia, Mr. Jobin Thomas, Mr. Pintukumar Yadav, Ms. Shakila Shaikh, "Weather Prediction: A novel approach for measuring and analyzing weather data", International conference on I-SMAC (IoT in Social, Mobile, Analytics, and Cloud), (I-SMAC 2017), IEEE, pp 414-417.
[8] Imran Maqsood, Muhammad Riaz Khan, and Ajith Abraham, "An ensemble of neural network for weather forecasting", Neural Comput & Applic (2004) 13: 112–122.
[9] Youguo Li, Haiyan WU "A Clustering Method Based on K-Means"
[10] www.kaggle.com