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Air Quality Index Class prediction using Data Mining Techniques

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Abstract: ***India, Being a developing country focuses on industrial and personal development. An increasing number of industries and vehicles produces various harmful chemicals as their byproducts. Nowadays the fresh air of the environment is getting polluted due to the generation of various harmful particles, biological molecules, and other poisonous elements.Air pollution can be determined by the organisations with using Index based parameter of Air Quality.Index holds several parameters for poisionous and harmful elements contains in apolluted air. In this research work, the main focus is on scrutiny of air pollution data of delhi by using data mining techniques and also build an efficient model for class wise prediction of air pollution data.***

Keywords: Data Mining, Support Vector Machine, Generalized Linear Model (GLM), Recursive Partitioning and regression tree (RPART), Air pollution.

I. INTRODUCTION

In India the advancement in the field of industrialization and urbanization is very rapidly and the level of air pollution is been increasing to high level. Air pollution can be defined as existence or initiation of a liquid, solid, and gases in the environment which have noxious effects on human health's and animals and environment. Two types of sources responsible for air pollution namely are natural sources and and different types of human activities.

However, mostly air pollutants are generated due to human activities like fossil fuels, coal, and oil, the release of noxious gases and materials from industeries and vehicles. Such harmful substances are carbon dioxide, nitrogen dioxides, carbon monoxide, Sulphur oxide, solid particles, benzene.

Currently supervising and scrutinizing air quality level is a very crucial issue to have a good and healthful life, and it also very important task.

By applying data mining techniques air quality level can be analyzed, so that apt actions can be taken for reduction of air pollution. And Data mining can be used for air pollution prediction of AQI levels and also for forecasting of AQI. AQI is a "Air Quality index", it holds a numerical value which shows the level of pollution in regions or area.

Data mining is an approach of excerpting essential knowledge from very huge amount of data set. The main purpose behind the Data mining methods is to mine the information data from a large collection of data and change it into an explainable framework for additional use. Data mining can be used for Prediction, forecasting, Classification and Optimization and for generating frequent patterns set.

II. LITERATURE REVIEW

In 2017 Ranjana Waman Gore et.al., proposed an approach in which Naïve Bayes and J48 classification algorithm are used for analyzing the air quality levels. The accuracy of dataset by using Naïve Bayes was 86.66% and the accuracy with J48 decision tree algorithm was 91.99%. And author also justify that J48 algorithm gives more accurate results than Naïve Bayes algorithm[1].

In 2018 Dr. Sandhya P proposed a method in which author aim is to predict the PM2.5 by using random forest, Naïve Bayes, and decision tree algorithm[2].

In 2018 Bonny Paulose et.al., proposed mainly focused on analysis of air quality of Delhi and also find the reason behind the pollutants that cause air pollution by using K-means clustering algorithm. And the author showed that AnandVihar, RkPuramand, Punjabi Bagh are one of the mostly polluted regions[3].

In 2018 Ranjana Gore et.al., proposed In this research paper author used Random forest and multiclass classifier classification algorithms for analysis of air quality. The author also showed that multiclass classifier is superior than random forest[4].

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III. RESEARCH METHODOLOGY

In this research paper three classifiers are used for analyzing and predicting the air quality levels. Figure 2. Shows the proposed methodology of research work.

A. Dataset

The data is collected from Central Pollution Control Board (CPCB) and data.gov.in. This dataset contains the attributes are Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), Particulate Matter (PM_{10} and $PM_{2.5}$), Ozone (O_3), Carbon monoxide (CO), Ammonia (NH_3), Benzene(C_6H_6), Temperature and Humidity. From these attributes AQI value is calculated. Air quality Index can be calculated as
The equation for calculating the sub-index (I) for a contaminant concentration (Cc)

I = [(Ih-Il)/(Bh-Blow)] (Cc-Blow) +Il

Where,

Bh ->Breaking point concentration larger or equal to given concentration

Blow ->Breaking point concentration lesser or equal to given concentration

Ih -> AQI value according to Bh

Il -> AQI value according to Blow

Cc -> Contaminant concentration

AQI= Max of sub index (SO_2, NO_2, PM_{10}, $PM_{2.5}$, O_3, CO, NH_3, C_6H_6)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Date	State	City	Location	SO2	NO2	PM10	PM2.5	O3	CO	NH3	C6H6	Temperat	Humidity	AQI	Class
2	1/11/2017	Delhi	Delhi	Nizamudc	14	25	189	45	19	2.3	35	2.8	24.6	67	159	3
3	2/11/2017	Delhi	Delhi	Nizamudc	14	24	156	111	30	1.5	32	2.9	24.5	68	270	4
4	3/11/2017	Delhi	Delhi	Nizamudc	16	26	200	89	56	1.9	35	3.9	25	67.7	196	3
5	4/11/2017	Delhi	Delhi	Nizamudc	14	24	156	59	31	0.5	41	2.6	23	66	137	3
6	5/11/2017	Delhi	Delhi	Nizamudc	17	23	189	45	35	6	38	4.3	24.6	59.3	159	4
7	6/11/2017	Delhi	Delhi	Nizamudc	16	40	156	56	20	0.7	68	4.1	24.7	63.8	137	3
8	7/11/2017	Delhi	Delhi	Nizamudc	21	35	178	101	23	0.8	118	5.9	22.3	75.5	236	4
9	8/11/2017	Delhi	Delhi	Nizamudc	20	22	200	101	30	1.9	128	7.1	22.4	69.4	236	4
10	9/11/2017	Delhi	Delhi	Nizamudc	14	38	135	54	35	3.5	141	6.1	22.6	64.6	123	3
11	10/11/2017	Delhi	Delhi	Nizamudc	17	50	150	101	20	4	207	6.2	23.3	57.9	236	4
12	11/11/2017	Delhi	Delhi	Nizamudc	20	45	100	56	27	5	186	7.5	22.3	63.7	137	3
13	12/11/2017	Delhi	Delhi	Nizamudc	14	29	200	180	24	6.7	32	6.7	21.9	63.2	346	5
14	13/11/2017	Delhi	Delhi	Nizamudc	17	42	200	120	25	11.7	127	4.8	22.2	61.9	300	4
15	14/11/2017	Delhi	Delhi	Nizamudc	20	33	300	129	21	2.4	48	3.2	21.8	55.1	306	5
16	15/11/2017	Delhi	Delhi	Nizamudc	18	57	123	56	37	1.5	48	3.1	21.8	60.8	115	3
17	16/11/2017	Delhi	Delhi	Nizamudc	16	50	101	78	18	1.2	45	3.6	20.4	62.1	160	3
18	17/11/2017	Delhi	Delhi	Nizamudc	13	53	150	121	18	0.8	28	2.7	20.8	61.9	300	4
19	18/11/2017	Delhi	Delhi	Nizamudc	15	34	316	124	26	0.7	26	2.6	20.4	56	303	5
20	19/11/2017	Delhi	Delhi	Nizamudc	15	42	235	113	24	0.7	27	1.8	19.4	45.2	276	4
21	20/11/2017	Delhi	Delhi	Nizamudc	13	46	249	101	24	0.8	31	2.1	18.7	44.3	236	4
22	21/11/2017	Delhi	Delhi	Nizamudc	17	56	214	110	25	0.9	36	3.2	19	45.2	266	4

Figure.1 (Delhi Data set)

After that dataset is divided into 5 classes according to the range of AQI.

Class	AQI range	Air quality level
1	0 to 50	Good
2	51 to 100	Satisfactory
3	101 to 200	Moderate
4	201 to 300	Unhealthy
5	301 to 400	Very Unhealthy

Table 1. Class Allocation to AQI

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IV. PROPOSED METHODOLOGY

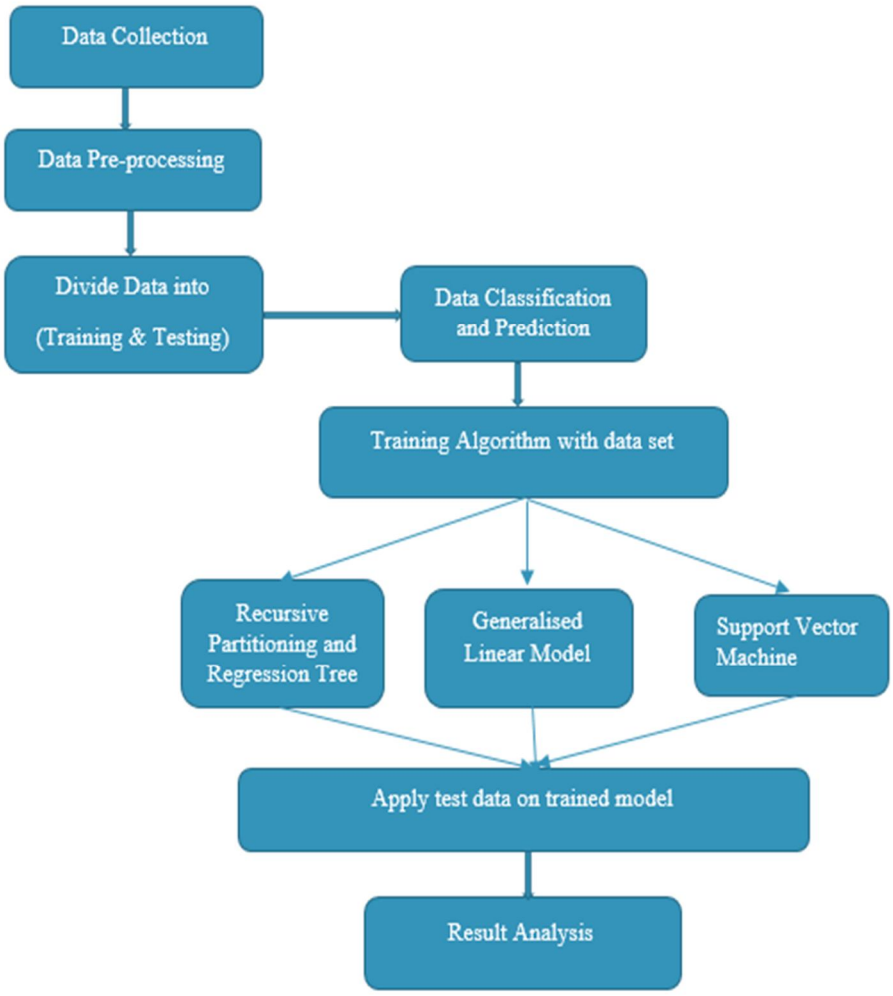

Figure.2 (Workflow of Proposed Methodology)

1) *Data Collection:* Raw Data generated every year contains lots of information about the air pollution, in this work data of few areas of delhi are gathered.
2) *Data Preprocessing:* This step makes the data ready to be processed. Processes include handling of noisy values, removal of redundant values. Selection of proper attributes, etc.
3) *Data Splitting:* For training of the model certain amount of data is required.similarly for testing and validation the remaining amount of data is provided. Data Splitting includes the ratio in which training data and testing data is separated.
4) *Classification:* Classification is the process of classifying data into class labels. These labels are generated on the basis of parameters[6].
5) *Prediction:* Predictive approaches are applied to determine the valid functions on the basis of their continuity[6].

The classification and predictive approaches tested for air pollution data are as follows:

a) *RPART*: RPART is a *"Recursive Partitioning and Regression Tree"*. The RPART approach classifies the data on regression models. It includes 2 step procedure, the output can be depicted as a binary tree.
b) *Generalized Linear Model*: Generalised linear model, applicable to the data contains numerical as well as the continuous target variable. The approach computes the response of the explanatory variable by modeling a linear function along with the error term associations.
c) *Support Vector Machine:* Support Vector Machine is a discriminatory classifier. SVM generates the hyperplane of data. Support vector machine is a supervised learning approach of classification[5].

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V. EXPERIMENT

Figure no. 3,4 and 5 shows the prediction of class on the basis of SO_2, NO_2, PM_{10}, $PM_{2.5}$, O_3, CO, C_6H_6, NH_3, or AQI and Temperature and humidity by using the Recursive Partitioninng & Regression Tree (RPART), Support Vector Machine and Generalized Linear model.

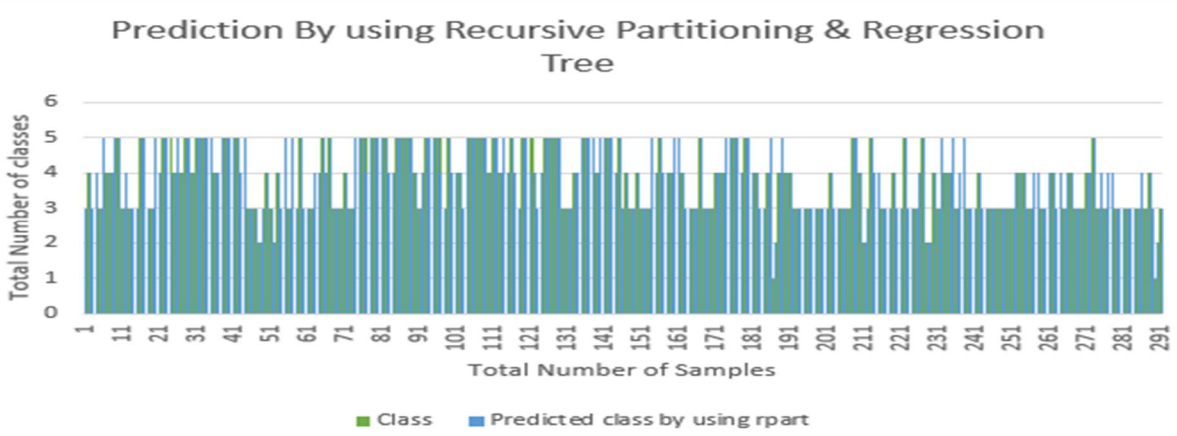

Figure.3 Prediction of Classes By Using Recursive Partitioning & Regression Tree

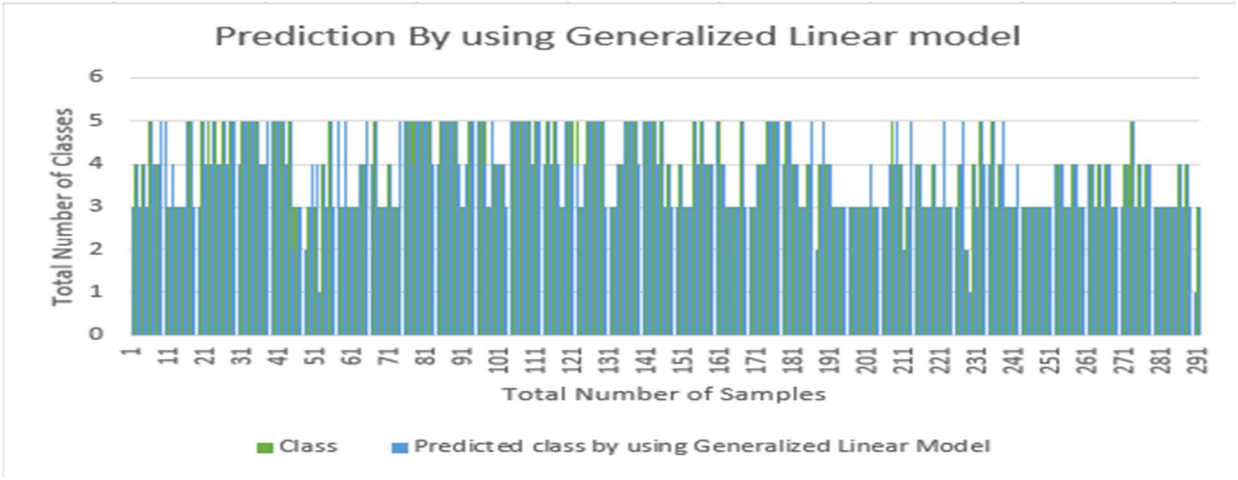

Figure.4 Prediction of Classes By using Generalized Linear Model

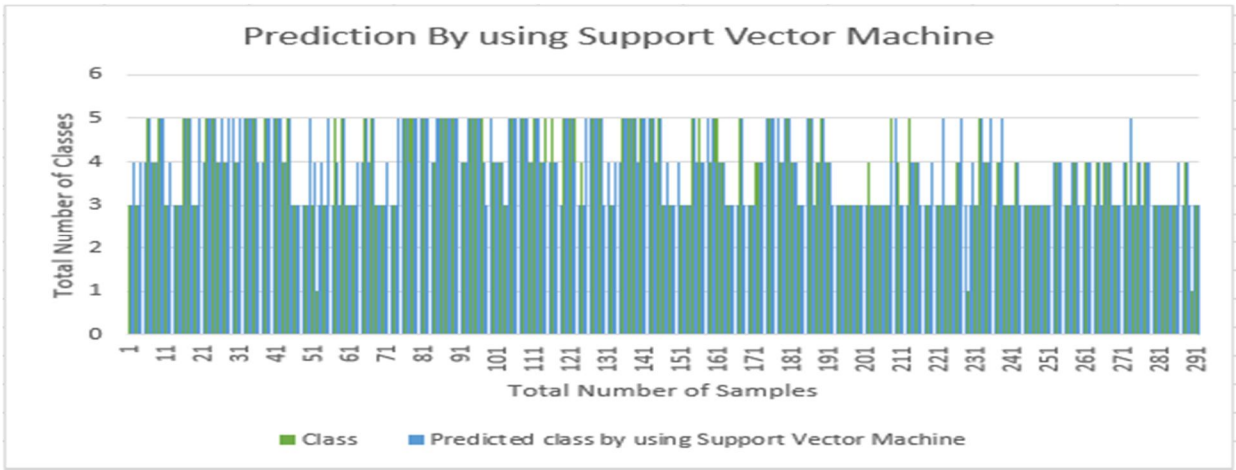

Figure. 5 Prediction of Classes by using Support Vector Machine

Figure no. 6, 7, 8 describes the comparison among actual and predicted class by using above described three classification algorithms.

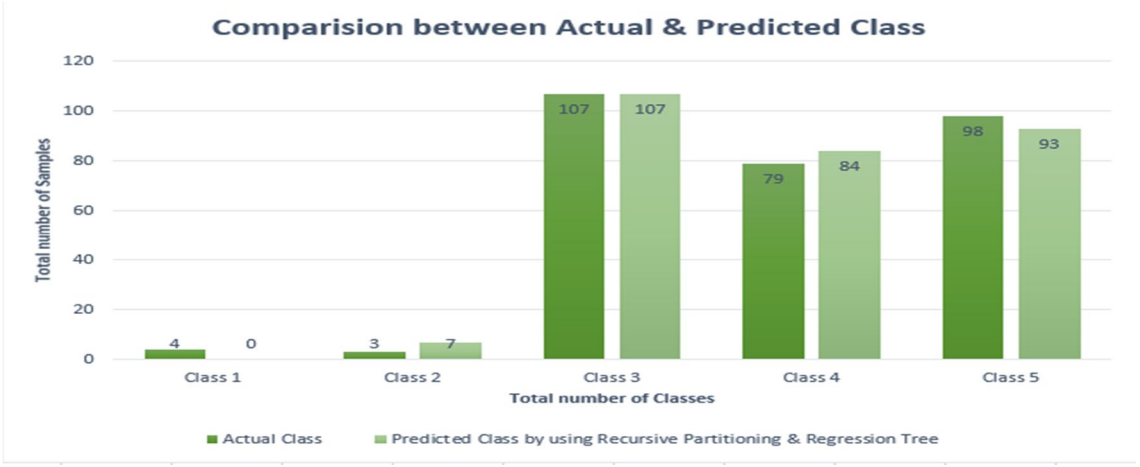

Figure. 6 Comparison between Actual & Predicted Class using Recursive Partitioning & Recursive Partitioning

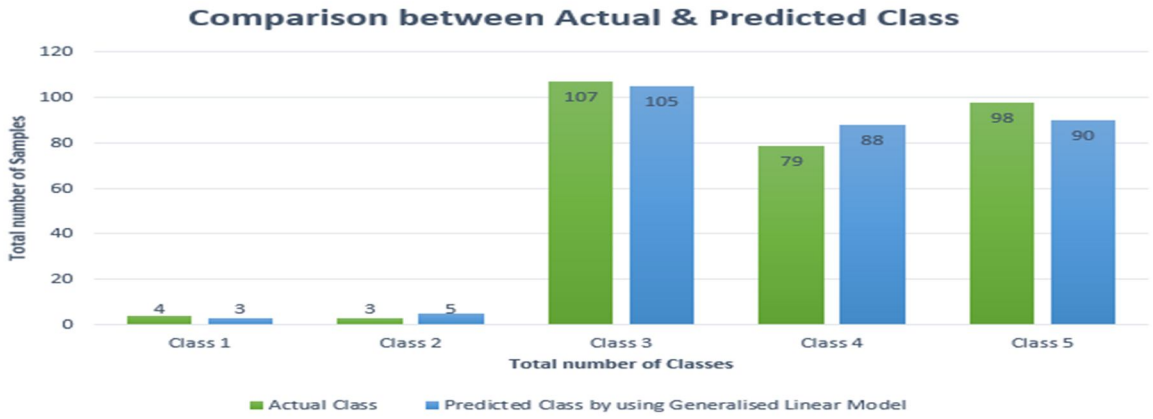

Figure.7 Comparison between actual and Predicted classes by using Generalized Linear Model

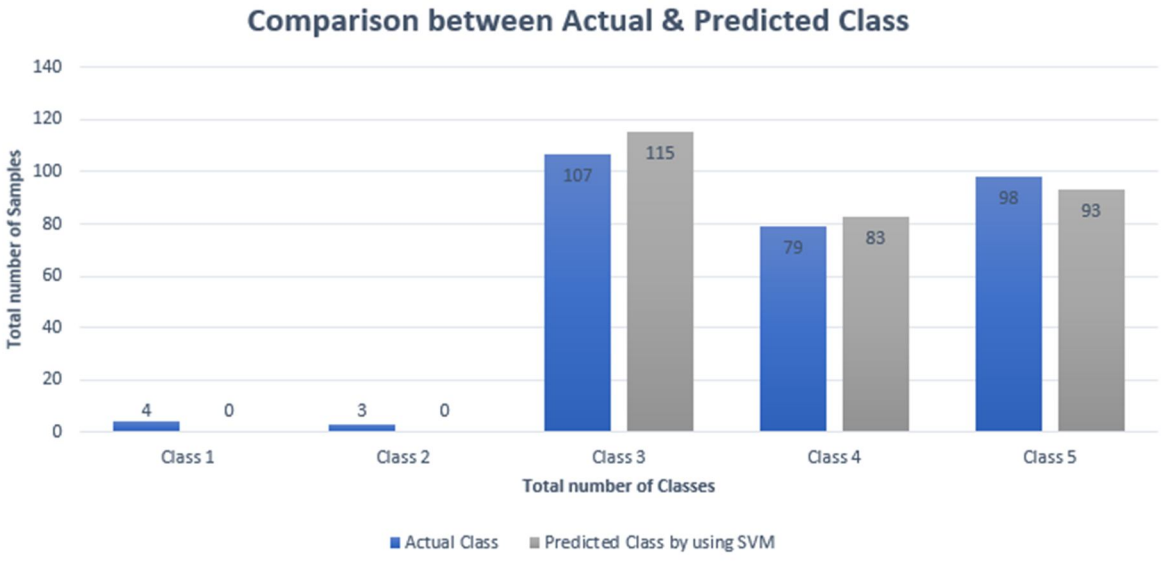

Figure.8 Comparison between actual & predicted classes by using Support Vector Machine

VI. RESULTS

Figure number 9 depicts the accuracy of Recursive Partitioning & Regression Tree, Support Vector Machine and Generalized Linear Model classifier, and table 2 depicts the accuracy and error values among these classifiers.

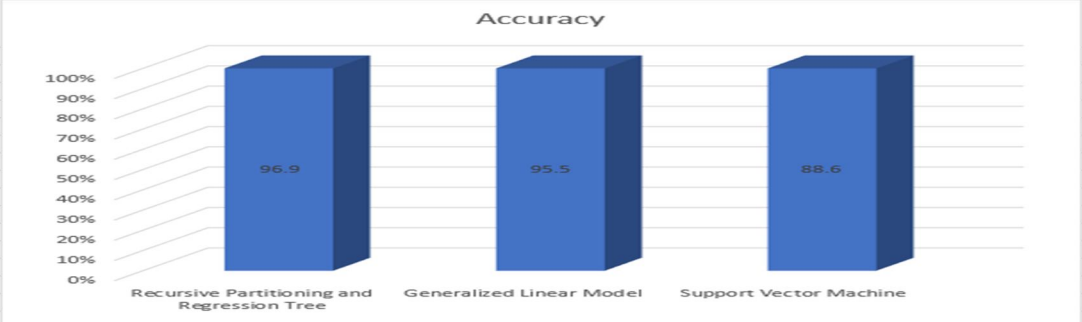

Fig. 9 Accuracy comparison

Classification Algorithm	Accuracy	Error
Recursive Partitioning & Regression Tree	96.9 %	3.1%
Generalized Linear Model	95.5%	4.5%
Support Vector Machine	88.6%	11.4%

Table 2. Accuracy and Error values

VII. FUTURE WORK

The accuracy of this model can be more enhanced or increased by using existing optimization techniques by slight parameters tuning or feature selection algorithms and by using machine learning approaches. These classifiers can also give more accurate results on India air pollution data set.

VIII. CONCLUSION

Now-a-days air pollution is increasing very rapidly in India and it is very harmful to human beings and animals also for our environment. That's why analysis of air pollution is necessary. In this research work three classifiers are used namely are Recursive partitioning & Regression Tree (RPART), Generalized Linear model and Support Vector machine. The accuracy of Recursive Partitioning& Regression Tree is 96.9% and error rate is 3.1%, and the accuracy of Generalized Linear model and Support vector machine are 95.5% and 88.6%. Hence this study shows that Recursive partitioning & regression tree is more accurate in comparison of other two classifier for prediction of class label according to the values of SO_2, NO_2, PM_{10}, $PM_{2.5}$, O_3, CO, C_6H_6, NH_3, AQI.

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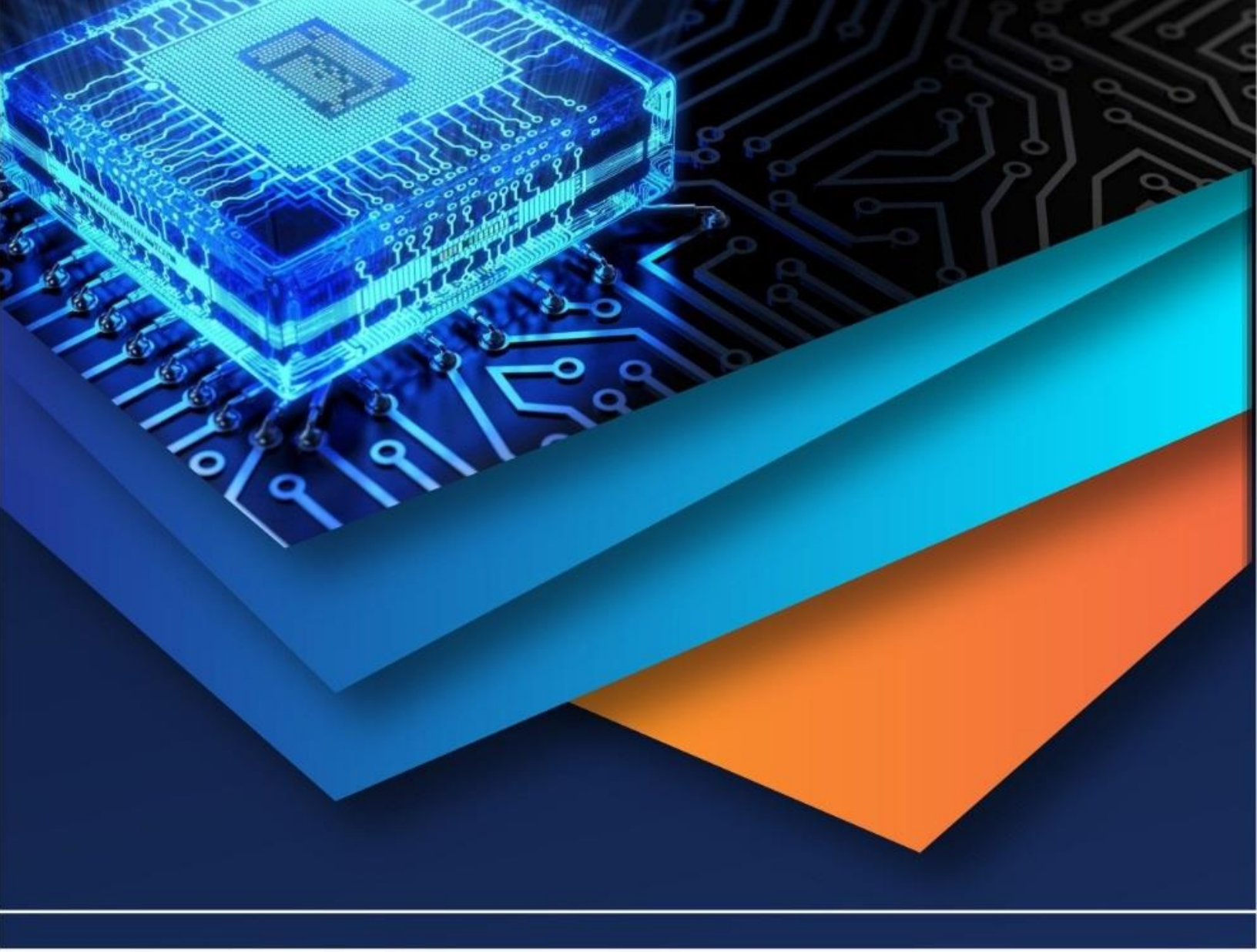

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