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Forest Fire Prediction using Machine Learning

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Abstract: Forest Fire Prediction is a key component of forest fire control. This is a major environmental problem that decreases resources such as water that causes global warming and water pollution. Fire Detection is a key element for controlling such incidents. Prediction of forest fire is expected to reduce the impact of forest fire in the future. It plays a major role in resource allocation, mitigation and recovery efforts. Forest fire prediction system is based on predictive modeling that predicts the fire on the basis of weather conditions that user provides as an input to the system.
This project presents a description and analysis of forest fire prediction methods based on machine learning and discusses about a comparative study of different models for predicting forest fire such as Decision Tree Classifier, Random Forest Classifier .We use Flask framework to develop web application and imported the NumPy and Panda's modules to access and perform operations on data sets. We have taken several data sets and train the system in order to predict the fire by taking Temperature, Oxygen, Humidity as parameters to the system.

I. INTRODUCTION

Forest fires are a matter of concern as a result, they cause in depth injury to surroundings, property and human life. Hence, it's crucial to notice the fire at Associate in nursing earlier stage. One of the most reasons of the incidence of forest fire in heating as a result, the increasing in average temperature of the world. The main motivation for forest fire prediction is to provide proper resource allocation and to help in best possible way to fire-fighters of Fire Management team. Forest fires are a matter of concern as a result the cause in depth injury to surroundings, property and human life. Hence, it's crucial to notice the fire at Associate in nursing earlier stage.

One of the most reasons of the incidence of forest fires is heating as a result, the increasing in average temperature of the world. The opposite reasons are because of lightning, throughout thunderstorms, and human negligence. Annually a mean of 2 million acres of the forest within the India get destroyed because of the wildfires. In the Asian nation forest fires have exaggerated by hundred and twenty-fifth between the years 2016 and 2018. Nowadays, there are numerous technologies for fireplace models to predict the unfold of fires, like physical models and mathematical models. These models are upon knowledge assortment throughout forest fires simulations, and sciences laboratory experiments to specify and predict fireplace growth in several areas. Recently, simulation tools are wanted to predict forest fires, however simulation tools round-faced some issues like the accuracy of the computer file and the simulation tool execution time.

The machine learning could be a sub-branch of a computing (AI) to be told computers side outline.

1) The main motivation for forest fire prediction is to provide proper resource allocation and to help in best possible way to fire-fighters of Fire Management team.
2) The main factors of fire are Meteorological conditions and the climatic information is get from nearby sensors which are fused in the closest meteorological stations.
3) Land with a possible high fire risk has many indicators that can be used to measure the forecast by closely evaluating the indications.
4) Every year, fire destroys millions of hectares of land. These fires have burned vast areas and generate more carbon monoxide than total vehicle traffic.
5) Monitoring potential danger areas and early warning of fire can greatly reduce response time, as well as the potential for damage and fire-fighting costs.

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A. Objective

The main objective of this project is to determine whether to know the fire will occur or not given weather features like oxygen, temperature and humidity. To know this we used the machine learning based methods such as Random Forest Classifier, Decision Tree Classifier and other classification techniques to figure out whether the fire will occur or not.

B. Overview of the Project

Here we proposed a fire prediction project data mining techniques are widely used in developing decision support system for forest fire prediction through a set of weather conditions data sets. We propose a new knowledge based system for forest fire prediction using decision tree algorithm, random forest algorithm by having these we can increase accuracy and also gives result fast and predict easily. Enhancing the prediction level of fire at earlier stage this can save the resources from damage. This project presents a description and analysis of forest fire prediction methods based on machine learning and discusses about a comparative study of different models for predicting forest fire such as Decision Tree Classifier, Random Forest Classifier .We use Flask framework to develop web application and imported the NumPy and Panda's modules to access and perform operations on data sets. We have taken several data sets and train the system in order to predict the fire by taking Temperature ,Oxygen ,Humidity as parameters to the system.

II. BACKGROUND STUDY

Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitlyprogrammed. Machine learning focuses on the development of computer programs that for themselves. For example, medical diagnosis, image processing, pre-diction, classification, etc. The intelligent systems built on machine learning algorithms have the capability to learn from past experience or historical data.

A. Working of Machine Learning

Machine learning algorithm has two tracks: Training, Testing. Prediction of a fire by using weather conditions and history machine learning technology is striving from past decades. Machine Learning technology gives an immeasurable platform in the prediction phase. So that environmental issues can be resolved efficiently. We are applying machine learning to maintained complete weather conditions data. Machine learning technology which allows building models to get quickly analyze data and deliver results faster, with the use of machine learning technology.

B. Advantages of Machine Learning

Machine Learning can review large volumes of data and discover specific trends and patterns that would not be apparent to humans. For instance, for an e-comerce website like Amazon, it serves to understand the browsing behaviors and purchase histories of its users to help cater to the right products, deals, and reminders relevant to them. It uses the results to reveal relevant advertisements to them.

III. LITERATURE SURVEY

Many researchers have used machine learning techniques like KNN, SVM and Decision trees to develop Forest Fire Prediction strategies.

George E. Sakr et al. (2017) [1] in their paper they have predicted the fire using artificial intelligence. Forest fire risk forecast algorithm is built on support vector machines. Lebanon data were used for the application of the algorithm and has proven the ability to correctly estimate the risk of fire.

Divya T L et al. (2018) [2] in their paper they have predicted the fire using image mining technique. The proposed model uses the satellite images for forest fire prediction.

K.Clarke et al. (2019) [3] in their paper they have predicted the fire using remote sensing based on different machine learning and artificial techniques. Nizar hamadeh laris et al. (2019) [4] in their paper they have predicted the fire using artificial neural network. Temperature, relative humidity, and wind speed are among the parameters. These parameters force Artificial Neural Networks to evolve in order to anticipate forest fires. Mukhammad Wildan Alauddin et al. (2021) [5] in their paper they have predicted the fire using linear regression. Temperature, humidity, wind, and rain are among the factors involved. Different techniques such as gauss-jordan, gauss-seidel, and least-squares are used to calculate various linear regression coefficients. Comparative analysis of the methods is done and the results are discussed.

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A. Existing System

The increasing growth of machine learning , computer techniques divided into traditional methods and machine learning methods. This section describes the related works of psychosocial instabilities are described with the help of traditional methodologies and how machine learning methods are better than traditional methods. Unlike traditional programming, machine learning is an automated process. It can increase the value of your embedded analytics in many areas, including data preparation, natural language interfaces, automatic outlier detection, recommendations, and causality and significance detection .The existing method in this project has a certain flow and also Support Vector Machine algorithm is used for model development. Support Vector Machine algorithm does not perform very well when the data set has more noise that means target classes are overlapping. In cases where the number of features for each data point exceeds the number of training data samples, the SVM will underperform. But it requires large memory and result is not accurate.

B. Limitations of Existing methods

1) By using Support Vector Machine algorithm in the existing method it shows the result with low efficiency.
2) It takes more time to get the results.
3) It will not able to perform on high complex data.
4) By using this algorithms it consumes more resources than others.

IV. SYSTEM ANALYSIS

The proposed system uses few Machine Learning Algorithms Such as Random Forest, Decision Tree. We use Flask Framework to build our Web Application, and imported the NumPy and pandas modules to access and perform operations on sets. We take several data sets and train the system in order to predict the Forest Fire by taking weather conditions as input. In this system we try to provide the people with an application which can predict the Forest fire with high accuracy. As a result they show percentage of improvement and also increases in performance. The highest increment was noticed for previous works which was about correctly predicting whether the fire will occur or not. User gives the required weather conditions as input. The model predicts the output and give results to the Output Screen.

A. Architecture

The architecture section provides an overview of the high-level design and structure of the software system. This section describes the overall organization of the system, the key components and modules, and the interactions between them. Architecture serves as a blueprint for a system. It provides an abstraction to manage the system complexity and establish a communication and coordination mechanism among components.It defines a structured solution to meet all the technical and operational requirements, while optimizing the common quality attributes like performance and security. Further, it involves a set of significant decisions about the organization related to software development and each of these decisions can have a considerable impact on quality, maintainability, performance, and the overall success of the final product.

1) Data set

A data set is a collection of data. In the case of tabular data, a data set corresponds to one or more database tables, where every column of a table represents a particular variable, and each row corresponds to a given record of the data set in question. The data set lists values for each of the variables, such as for example height and weight of an object, for each member of the data set. Data sets can also consist of a collection of documents or files. Dataset is collected from Kaggle, it contains two files one is for training dataset and other one is testing data set.

a) *Training Data Set:* The training data is the subset of the original dataset, which is used to train or fit the machine learning model. Firstly, the training data is fed to the Machine Learning algorithms, which lets them learn how to make predictions for the given task.
b) *Testing Data Set:* Once we train the model with the training dataset, it's time to test the model with the test dataset. This dataset evaluates the performance of the model and ensures that the model can generalize well with the new or unseen dataset. The test dataset is another subset of original data, which is independent of the training dataset.

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2) Attribute Selection

Attribute Selection is a well-known problem in the field of machine learning technique. Its allows probabilistic classification and shows promising results on several benchmark problems. Attribute selection is a task of choosing a small subset of features that is sufficient to predict the target labels well. Attribute Selection is one of the core concepts in machine learning which hugely impacts the performance of your model. The data features that you use to train your machine learning models have a huge influence on the performance you can achieve. Attribute selection and Data cleaning should be the first and most important step of your model designing. An attribute selection measure is a heuristic for choosing the splitting test that "best" separates a given data partition, D, of class-labeled training tuples into single classes. If it can split D into smaller partitions as per the results of the splitting criterion, ideally every partition can be pure (i.e., some tuples that fall into a given partition can belong to the same class).Conceptually, the "best" splitting criterion is the most approximately results in such a method. Attribute selection measures are called a splitting rules because they decides how the tuples at a given node are to be divided. The attribute selection measure supports a ranking for every attribute defining the given training tuples. The attribute having the best method for the measure is selected as the splitting attribute for the given tuples. If the splitting attribute is constant-valued or if it is restricted to binary trees, accordingly, either a split point or a splitting subset should also be decided as an element of the splitting criterion. The tree node generated for partition D is labeled with the splitting criterion, branches are increase for each result of the criterion, and the tuples are isolated accordingly. There are three famous attribute selection measures including information gain, gain ratio, and gini index.

a) *Information Gain:* Information gain is used for deciding the best features/attributes that render maximum data about a class. It follows the method of entropy while aiming at reducing the level of entropy, starting from the root node to the leaf nodes.

b) *Gain Ratio:* The information gain measure is biased approaching tests with several results. It can select attributes having a high number of values. For instance, consider an attribute that facilitates as a unique identifier, including product ID

c) *Gini Index:* The Gini index can be used in CART. The Gini index calculates the impurity of D, a data partition or collection of training tuples.

3) Reduces Overfitting

You can prevent overfitting by diversifying and scaling your training data set or using some other data science strategies, like those given below.

a) *Early Stopping:* Early stopping pauses the training phase before the machine learning model learns the noise in the data. However, getting the timing right is important; else the model will still not give accurate results.

b) *Pruning:* You might identify several features or parameters that impact the final prediction when you build a model. Feature selection—or pruning—identifies the most important features within the training set and eliminates irrelevant ones. For example, to predict if an image is an animal or human, you can look at various input parameters like face shape, ear position, body structure, etc. You may prioritize face shape and ignore the shape of the eyes.

c) *Regularization:* Regularization is a collection of training/optimization techniques that seek to reduce overfitting. These methods try to eliminate those factors that do not impact the prediction outcomes by grading features based on importance. For example, mathematical calculations apply a penalty value to features with minimal impact. Consider a statistical model attempting to predict the housing prices of a city in 20 years. Regularization would give a lower penalty value to features like population growth and average annual income but a higher penalty value to the average annual temperature of the city.

d) *Ensembling:* Ensembling combines predictions from several separate machine learning algorithms. Some models are called weak learners because their results are often inaccurate. Ensemble methods combine all the weak learners to get more accurate results. They use multiple models to analyze sample data and pick the most accurate outcomes. The two main ensemble methods are bagging and boosting. Boosting trains different machine learning models one after another to get the final result, while bagging trains them in parallel.

e) *Data Augmentation:* Data augmentation is a machine learning technique that changes the sample data slightly every time the model processes it. You can do this by changing the input data in small ways.

4) Improves Accuracy

The model development cycle goes through various stages, starting from data collection to model building. But, before exploring the data to understand relationships. It's always recommended to perform hypothesis. I believe this is the most underrated step of predictive modeling. Let's dig deeper now and we'll check out the proven way to improve the accuracy of a model:

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a) *Add More Data:* Having more data is always a good idea. It allows the "data to tell for itself" instead of relying on assumptions and weak correlations. Presence of more data results in better and more accurate machine-learning models.
b) *Treat Missing and Outlier Values:* The unwanted presence of missing and outlier values in the training data often reduces the accuracy of a trained model or leads to a biased model. It leads to inaccurate predictions. This is because we don't analyze the behavior and relationship with other variables correctly. So, it is important to treat missing and outlier values well.
c) *Feature Engineering:* This step helps to extract more information from existing data. New information is extracted in terms of new features. These features may have a higher ability to explain the variance in the training data. Thus, giving improved model accuracy.
d) *Feature Selection:* Feature Selection is a process of finding out the best subset of attributes that better explains the relationship of independent variables with the target variable.
e) *Multiple Algorithms:* There are many different algorithms in machine learning, but hitting the right machine learning algorithm is the ideal approach to achieve higher accuracy. But, it is easier said than done.
f) *Algorithm Tuning:* We know that machine learning algorithms are driven by hyperparameters. These hyperparameters majorly influence the outcome of the learning process. This is the most common approach found majorly in winning solutions of Data science competitions
g) *Cross Validation:* To find the right answer to this question, we must use the cross-validation technique. Cross Validation is one of the most important concepts in data modeling. It says to try to leave a sample on which you do not train the model and test the model on this sample before finalizing the model.

5) *Reduces Training Time*

Prefetch the data by overlapping the data processing and training. The prefetching function in machine learning data overlaps the data pre-processing and the model training. Data pre-processing runs one step ahead of the training, as shown below, which reduces the overall training time for the model.

6) *Processing on Data*

Data preprocessing is a process of preparing the raw data and making it suitable for a machine learning model. It is the first and crucial step while creating a machine learning model. When creating a machine learning project, it is not always a case that we come across the clean and formatted data. And while doing any operation with data, it is mandatory to clean it and put in a formatted way. So for this, we use data preprocessing task. Data mining is the process of analyzing ,extracting data and furnishes the data as knowledge which forms the relationship between the available data. Some of data techniques include association, clustering, classification and prediction.

It involves below steps:

a) *Get the Dataset:* To create a machine learning model, the first thing we required is a dataset as a machine learning model completely works on data. The collected data for a particular problem in a proper format is known as the dataset.
b) *Importing Libraries:* In order to perform data preprocessing using Python, we need to import some predefined Python libraries.

These libraries are used to perform some specific jobs. There are three specific libraries that we will use for data preprocessing, which are:

- *NumPy:* NumPy Python library is used for including any type of mathematical operation in the code. It is the fundamental package for scientific calculation in Python. It also supports to add large, multidimensional arrays and matrices.
- *Pandas:* The last library is the Pandas library, which is one of the most famous Python libraries and used for importing and managing the datasets. It is an open-source data manipulation and analysis library.

c) Importing the Datasets: Now we need to import the datasets which we have collected for our machine learning project. But before importing a dataset, we need to set the current directory as a working directory.
d) *Handling Missing data:* The next step of data preprocessing is to handle missing data in the datasets. If our dataset contains some missing data, then it may create a huge problem for our machine learning model. Hence it is necessary to handle missing values present in the dataset.

There are mainly two ways to handle missing data, which are:

- *By deleting the particular row:* The first way is used to commonly deal with null values. In this way, we just delete the specific row or column which consists of null values. But this way is not so efficient and removing data may lead to loss of information which will not give the accurate output.
- *By calculating the mean:* In this way, we will calculate the mean of that column or row which contains any missing value and will put it on the place of missing value. This strategy is useful for the features which have numeric data such as age, salary, year, etc. Here, we will use this approach.

e) Encoding Categorical Data: Categorical data is data which has some categories such as, in our dataset; there are two categorical variable, Country, and Purchased. Since machine learning model completely works on mathematics and numbers, but if our dataset would have a categorical variable, then it may create trouble while building the model. So it is necessary to encode these categorical variables into numbers.

f) Splitting the Dataset into the Training set and Test set: In machine learning data preprocessing, we divide our dataset into a training set and test set. This is one of the crucial steps of data preprocessing as by doing this, we can enhance the performance of our machine learning model.

g) Feature Scaling: Feature scaling is the final step of data preprocessing in machine learning. It is a technique to standardize the independent variables of the dataset in a specific range.

System Architecture

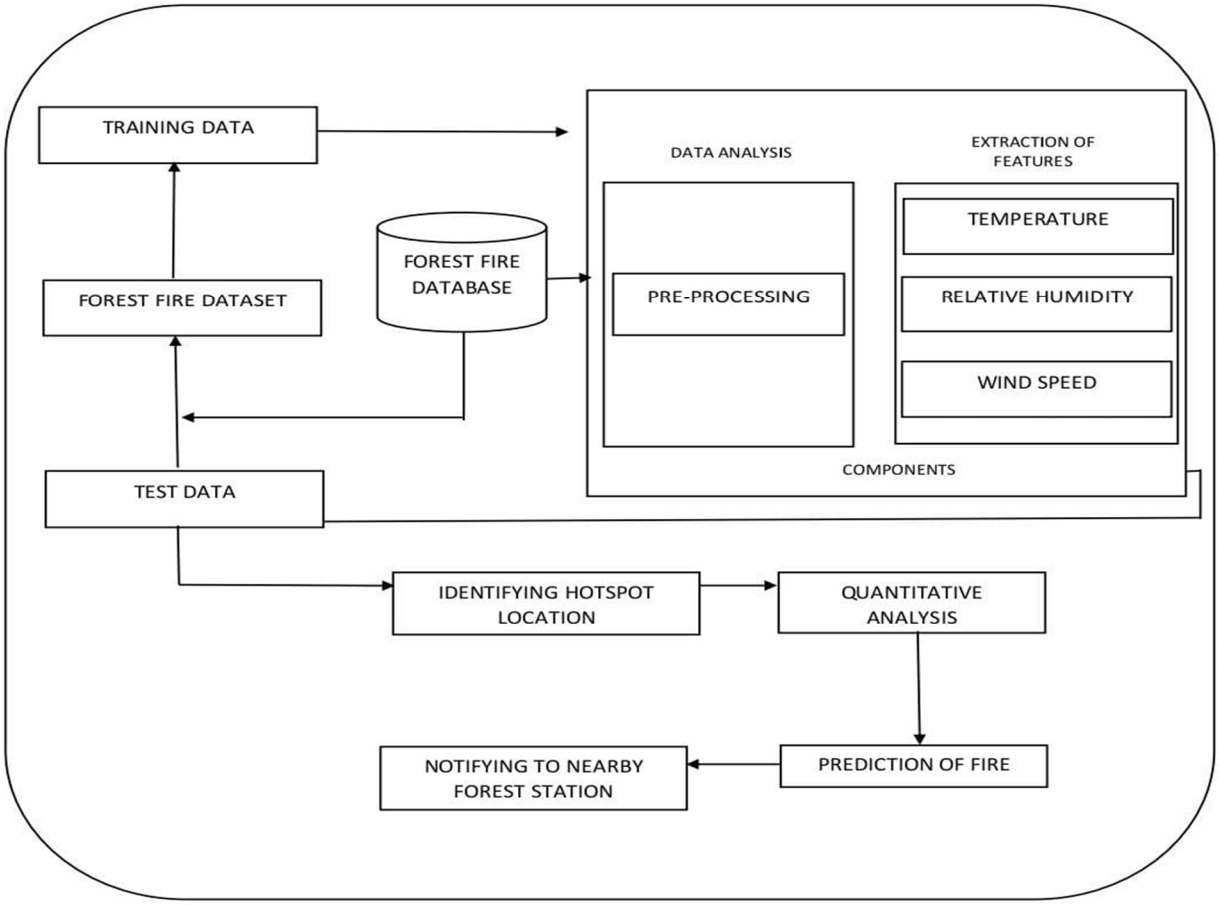


Figure 4.1 System Architecture

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h) Classification Techniques: Classification is the process of recognizing, understanding, and grouping ideas and objects into preset categories or "sub-populations." Using pre-categorized training datasets, machine learning programs use a variety of algorithms to classify future datasets into categories. Classification algorithms in machine learning use input training data to predict the likelihood that subsequent data will fall into one of the predetermined categories. Classification Techniques are classified into two categories, they are:

- *Decision Tree:* It basically builds classification models in the form of a tree structure. The dataset is broken down into smaller subsets and gets detailed by each leave.
- *Random Forest:* It run efficient on large datasets, since all compute can be split and thus it is easier to run the model in parallel.

B. Features of Proposed System

In our predicted model , ten features have been evaluated to make this comparison more unique. Our introduced algorithms were conducted the obtained outcomes were compared to other works to show the percentage of improvement , while decrease in performance also noted in one occasion Random Forest. The highest increment was noticed for previous work which was about correctly predicting whether the fire will occur or not to know this we used the machine learning based methods such as Random Forest ,Decision Tree to figure out.

1) Feasibility Study

Preliminary investigation examines project feasibility, the likelihood the system will be used to the organization. The main objective of the feasibility study is to test the Technical, Operational and Economical feasibility for adding new modules and debugging old running system. All systems are feasible if they are given unlimited resources and infinite time.

2) Technical Feasibility

To determine whether the proposed system is technically feasible, we should take into consideration the technical issues involved behind the situation. Technical feasibility center on the existing computer system and to what extent it can support the proposed addition. Python and its libraries are technology software which are used to develop Data Analytics. So, there is no need for additional purchase of any software and theseare open source software which are freely available in Internet.

3) Operational Feasibility

Proposed projects are beneficial only if they can be turned out into information systems that will meet the user's operating requirements.

4) Economic Feasibility

To decide whether a project is feasible, we have to consider various factors as:

a) Cost benefit analysis
b) Long-term returns
c) Maintenance cost

The proposed system is computer based. It requires average computing capabilities which is very basic requirement and can be afforded by an organization; it doesn't incur additional economic overheads, which renders the system economically feasible. Unlike traditional development workflows, the machine learning feasibility study phase is used to dig into the data and quickly conduct experiments to establish baseline performance on a task. Feasibility studies are common across industries and disciplines. They are an important project planning tool that can help you identify points of failure in a project before any money or time gets invested. I would argue that feasibility studies are particularly useful for machine learning projects because Machine Learning projects are generally experimental in nature.

They can fail for many reasons, some of which can be identified upfront with a feasibility study.The main goal of feasibility studies is to assess whether it is feasible to solve the problem satisfactorily using ML with the available data. We want to avoid investing too much in the solution before we have: Sufficient evidence that a solution would be the best technical solution given the business case.

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C. *Advantages of Proposed System*

1) It provides higher accuracy.
2) We find that by combining these two data the accuracy rate can reach high.
3) To the best of our knowledge, none of the existing work focused on both algorithms.
4) By using these algorithms there is much time saving comparing to other one.
5) We leverage not only the structured data but also the text data of weather conditions based on the proposed random forest and decision tree algorithms.

V. SOFTWARE AND HARDWARE REQUIREMENTS

A. *Software Requirements*

Coding language: Python
Platform: PyCharm
Framework: Flask
Packages: NumPy, Pandas

B. *Hardware Requirements*

Processor : Intel i5
RAM : 8GB
Hard Disk : 128 GB
Operating System: Windows 8 required

VI. SYSTEM DESIGN

UML stands for Unified Modeling Language. UML is a standardized general purpose modeling language in the field of object-oriented software engineering. The standard ismanaged, and was created by the Object Management Group.

The goal is for UML to become a common language for creating models of object oriented computer software. In its current form UML is comprised of two major components: a Meta-model and a notation. In the future, some form of method or process may also be added to; or associated with UML.

The Unified Modeling Language is a standard language for specifying, Visualization, Constructing and documenting the artifacts of software system, as well as for business modeling and other non-software systems.

The UML represents a collection of best engineering practices that have proven successful in the modeling of large and complex systems.

The UML is a very important part of developing objects oriented software and the software development process. The UML uses mostly graphical notations to expressthe design of software pro jects.

A. *Goals*

The Primary goals in the design of the UML are as follows:

1) Provide users a ready-to-use, expressive visual modelling Language so that they can develop exchange meaningful models.
2) Provide extendibility and specialization mechanisms to extend the core.
3) Be independent of particular programming languages and development process.
4) Provide a formal basis for understanding the modelling language.
5) Encourage the growth of OO tools market.
6) Support higher level development concepts such as collaborations, frameworks,patterns and components.
7) Integrate best practices.

B. *Activity Diagram*

Activity diagram is another important diagram in UML to describe the dynamic aspectsof the system. Activity diagram is basically a flowchart to represent the flow from oneactivity to another activity. The activity can be described as an operation of the system.

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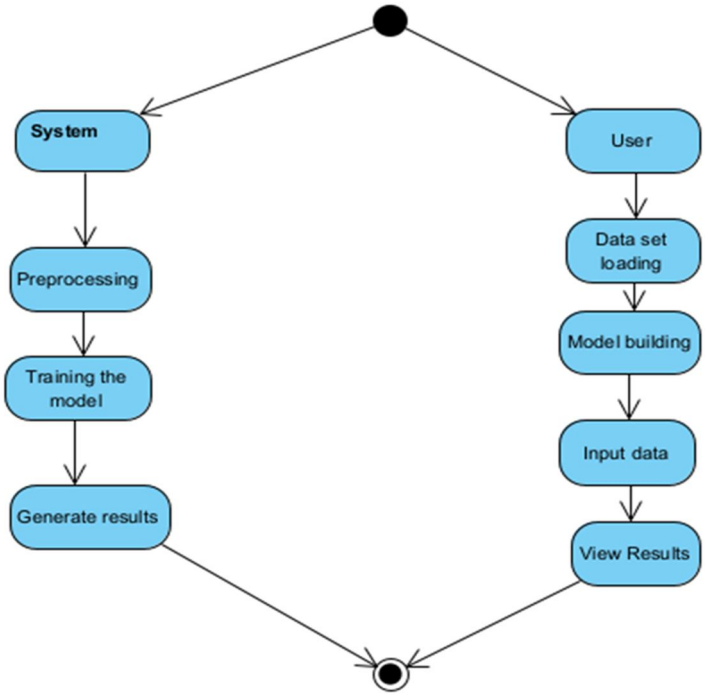


Figure 6.1 Activity diagram

In the above figure 6.1 ,the user will enter his basic details like weather conditions and the Algorithms like Decision Tree(DT),Random Forest(RF) will train the model and then results will be given on the user interface.

C. Use Case Diagram

A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted.

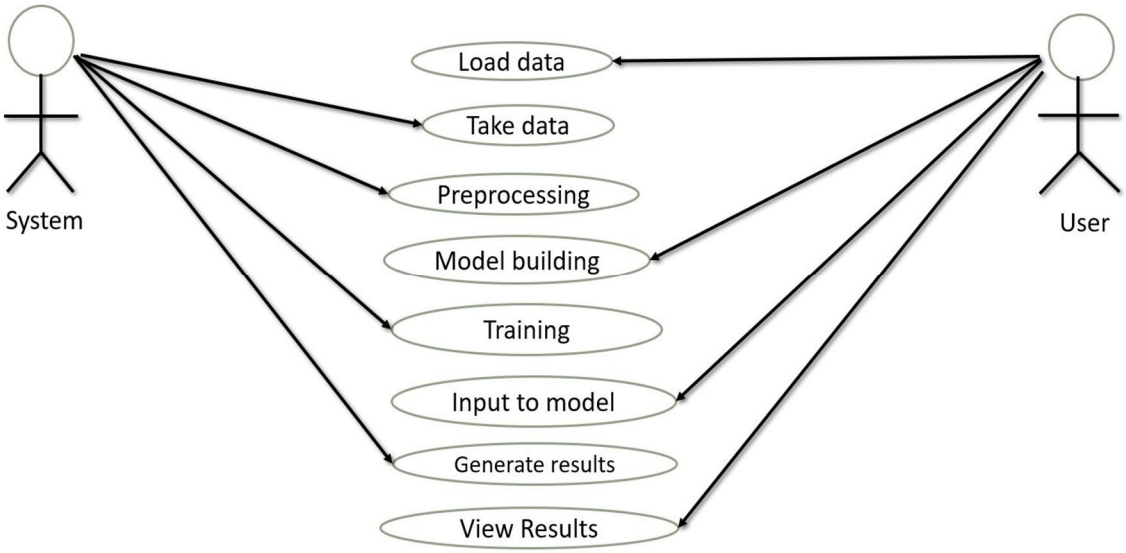


Figure 6.2 Use Case diagram

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In the above figure 6.2, The client is the actor. The actor gets the input information from the environment details of the clients to view the decisions through the given database, database stores all decisions that meet the environmental conditions. The database shortlist all decisions through DSS. Data can be shorted by the country. Fire is predicted and then client exits the system.

D. Class Diagram

A class diagram in the Unified Modelling Language is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations, and the relationships among objects.



Figure 6.3 Class Diagram

In the above figure 6.3, we have two different classes: User, System which are differentiated based on their operations, the class attributes are partitioned from the methods of the classes.

VII. SYSTEM IMPLEMENTATION

A. Data Collection

When the quality of weather conditions data is incomplete the exactness of study is reduced.In this project, it bid a Machine learning Decision tree map, Random Forest algorithm by using structured and unstructured data from weather. It also uses Machine learning algorithm for partitioning the data. To the highest of gen, none of the current work attentive on together data types in the zone of remedial big data analytics. Compared to several typical calculating algorithms, the scheming accuracy of our proposed algorithm reaches 96.3% with a regular speed which is quicker than that of the existing algorithm.

B. Dataset

Dataset is collected from Kaggle, it contains two files one is for training dataset and one is testing data set. A data set is a collection of data. In the case of tabular data, a data set corresponds to one or more database tables, where every column of a table represents a particular variable, and each row corresponds to a given record of the data set in question. The data set lists values for each of the variables, such as for example height and weight of an object, for each member of the data set. Data sets can also consist of a collection of documents or files. Dataset is collected from Kaggle, it contains two files one is for training dataset and other one is testing data set.

C. Random Forest

Random forest is a supervised learning algorithm which is used for both classification as well as regression. But however, it is mainly used for classification problems. As we know that a forest is made up of trees and more trees means more robust forest. Similarly, random forest algorithm creates decision trees on data samples and then getsthe prediction from each of them and finally selects the best solution by means of voting. It is an ensemble method which is better than a single decision tree because it reduces the over-fitting by averaging the result.

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We can understand the working of Random Forest algorithm with the help of following steps

1) First, start with the selection of random samples from a given dataset.
2) Next, this algorithm will construct a decision tree for every sample. Then it will get the prediction result from every decision tree.
3) In this step, voting will be performed for every predicted result.
4) At last, select the most voted prediction result as the final prediction result.

On applying random forest we achieved accuracy 95%.

D. Decision Tree

Decision Tree algorithm belongs to the family of supervised learning algorithms. Un- like other supervised learning algorithms, decision tree algorithm can be used for solving regression and classification problems too.

The general motive of using Decision Tree is to create a training model which can use to predict class or value of target variables by learning decision rules inferred from prior data (training data).

The understanding level of Decision Trees algorithm is so easy compared with other classification algorithms. The decision tree algorithm tries to solve the problem,by using tree representation. Each internal node of the tree corresponds to an attribute,and each leaf node corresponds to a class label.

Decision Tree Algorithm Pseudocode

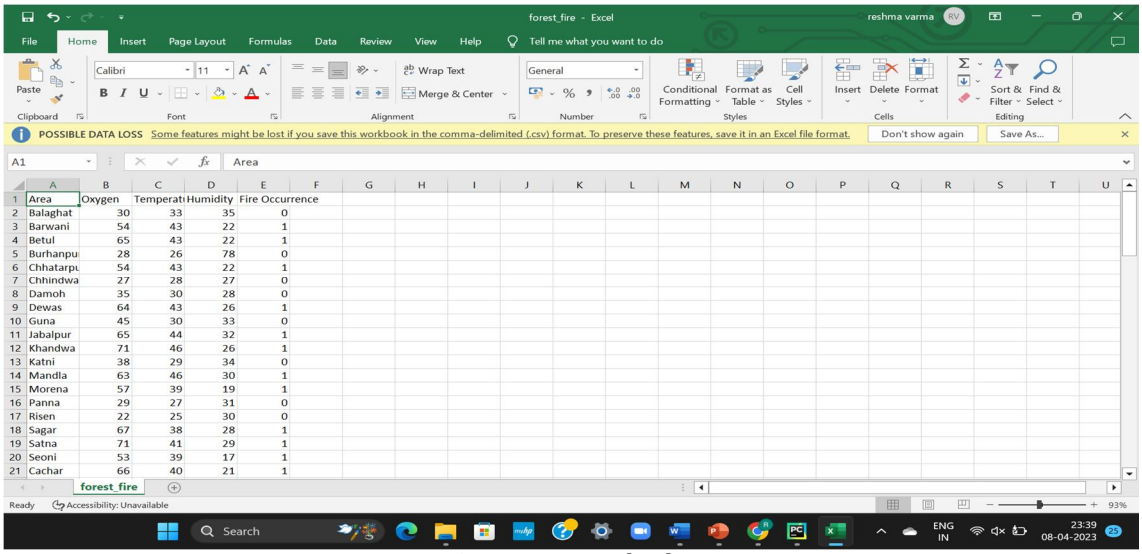
1) Place the best attribute of the dataset at the root of the tree.
2) Split the training set into subsets. Subsets should be made in such a way that Each subset contains data with the same value for an attribute.
3) Repeat step 1 and step 2 on each subset until you find leaf nodes in all the branches of the tree.
4) On applying decision tree we achieved accuracy 96%.

VIII. CODE IMPLEMENTATION

Code implementation refers to the process of translating a design or idea into a functioning software program. It involves writing code in a programming language that canbe compiled or interpreted by a computer.

A. Dataset

The dataset was taken from the Kaggle website where it contains the weather conditions like temperature ,humidity, oxygen. Here we have taken total 90 instances of data set which consists of 4 attributes. And the four attributes are oxygen, temperature, humidity and fire occurrence.



	Area	Oxygen	Temperati	Humidity	Fire Occurrence
2	Balaghat	30	33	35	0
3	Barwani	54	43	22	1
4	Betul	65	43	22	1
5	Burhanpu	28	26	78	0
6	Chhatarpu	54	43	22	1
7	Chhindwa	27	28	27	0
8	Damoh	35	30	28	0
9	Dewas	64	43	26	1
10	Guna	45	30	33	0
11	Jabalpur	65	44	32	1
12	Khandwa	71	46	26	1
13	Katni	38	29	34	0
14	Mandla	63	46	30	1
15	Morena	57	39	19	1
16	Panna	29	27	31	0
17	Risen	22	25	30	0
18	Sagar	67	38	28	1
19	Satna	71	41	29	1
20	Seoni	53	39	17	1
21	Cachar	66	40	21	1

Figure 8.1 Features in the dataset

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B. Creating the Model for the Dataset

Firstly, we have imported the required modules in the python file like below:

```
from sklearn.preprocessing import MinMaxScaler
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
import pickle
import pandas as pd

def get_score(data:pd.DataFrame,model_name:str):
        scaling_list = ['Oxygen','Temperature','Humidity']
        scalar = MinMaxScaler()
        for i in scaling_list:
            data[i] = scalar.fit_transform(data[[i]])
        y = data['Fire Occurrence']
        x = data.drop(['Fire Occurrence','Area'],axis=1)

        x_train, x_test, y_train, y_test = train_test_split(x, y,
test_size=0.3,random_state=100)
        global model
        if model_name == '1':
            model =
RandomForestClassifier(min_samples_leaf=2,random_state=0,ccp_alpha=0.48)
        elif model_name == '2':
            model =
DecisionTreeClassifier(min_samples_leaf=2,random_state=0,ccp_alpha=0.21)
        else:
            model = LogisticRegression()

        model.fit(x_train,y_train)
        pickle.dump(model,open('model.sv','wb'))
        return accuracy_score(y_test,model.predict(x_test))* 100
```

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C. Creating Templates

Index Templates

```
<html lang="en">

<head>
    <meta charset="UTF-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-
scale=1.0">
    <!-- {{url_for('static',filename='css/home.css')}} -->
    <link rel="stylesheet"
href="{{url_for('static',filename='css/home.css')}}">
    <title>Forest Fire Prediction</title>
</head>

<body>

    <div class="nav-bar">
        <div class="buttonsholder">
            <div class="buttonhome">
                <a href="/home"><input id="input" type="button"
value="Home" name="home"></a>
                <a href="/uploaddata"><input id="input" type="button"
value="UploadData" name="home"></a>
                <a href="/viewdata"><input id="input" type="button"
value="ViewData" name="home"></a>
                <a href="/trainmodel"><input id="input" type="button"
value="TrainModel" name="home"></a>
                <a href="/predict"><input id="input" type="button"
value="Prediction" name="home"></a>
            </div>
        </div>
    </div>
    <center style="margin-top: 25%; margin-left: 10%;">
        <h1 style="font-family: 'Segoe UI', Tahoma, Geneva, Verdana,
sans-serif; font-size:xx-large;">Welcome to forest
            fire prediction</h1>
    </center>

</body>

</html>
```

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Train Model Template

```
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <!-- {{url_for('static',filename='css/home.css')}} -->
    <link rel="stylesheet"
href="{{url_for('static',filename='css/home.css')}}">
    <title>Forest Fire Prediction</title>
</head>
<body>
    <div class="nav-bar">
        <div class="buttonsholder">
            <div class="buttonhome">
                <a href="/home"><input id="input" type="button" value="Home"
name="home"></a>
                <a href="/uploaddata"><input id="input" type="button"
value="UploadData" name="home"></a>
                <a href="/viewdata"><input id="input" type="button"
value="ViewData" name="home"></a>
                <a href="/trainmodel"><input id="input" type="button"
value="TrainModel" name="home"></a>
                <a href="/predict"><input id="input" type="button"
value="Prediction" name="home"></a>
            </div>
        </div>
    </div>
    <center>
        <tr>
            <center><b>
                    <h2 style="padding-top: 175px; color:#000;">Select
Model/Algorithm </center>
            </h2></b><br>
            <center>
                <form action="/selectmodel" method="post">
                    <td><select name="algo" id="algo">
                            <option value="0">Select</option>
                            <option value="1">DecisionTreeClassifier</option>
                            <option value="2">RandomForestClassifier</option>
                        </select><br>
                        <input type="submit" value="Submit" style="margin-top:
10px;">
                </form>
                </td>
                <div style="font-weight: bold; font-size: 70px; margin-left:
40px;">
                    {{score}}
                </div>
            </center>
        </tr><br>
    </center>
</body>

</html>
```

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Prediction Template

```
<html lang="en">

<head>
    <meta charset="UTF-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <!-- {{url_for('static',filename='css/home.css')}} -->
    <link rel="stylesheet" href="../static/css/home.css">
    <title>Forest Fire Prediction</title>
</head>

<body>

    <div class="nav-bar">
        <div class="buttonsholder">
            <div class="buttonhome">
                <a href="/home"><input id="input" type="button" value="Home"
name="home"></a>
                <a href="/uploaddata"><input id="input" type="button"
value="UploadData" name="home"></a>
                <a href="/viewdata"><input id="input" type="button"
value="ViewData" name="home"></a>
                <a href="/trainmodel"><input id="input" type="button"
value="TrainModel" name="home"></a>
                <a href="/predict"><input id="input" type="button"
value="Prediction" name="home"></a>
            </div>
        </div>
    </div>

    <center>
        <h1 style="margin-top: 10%;">{{msg}}</h1>
        <div style="margin-top: 10%;">
            <form action="/getdata" method="post">
                <input type="number" name="oxygen"
placeholder="Oxygen"><br><br>
                <input type="number" name="temp"
placeholder="Temperature"><br><br>
                <input type="number" name="humid"
placeholder="Humidity"><br><br>
                <input type="submit" name="Submit" style="margin-top:
2%;"><br><br>
            </form>
        </div>
    </center>

</body>

</html>
```

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View Data Template

```
<html lang="en">

<head>
    <meta charset="UTF-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <!-- {{url_for('static',filename='css/home.css')}} -->
    <link rel="stylesheet"
href="{{url_for('static',filename='css/home.css')}}">
    <title>Forest Fire Prediction</title>
</head>

<body>

    <div class="nav-bar">
        <div class="buttonsholder">
            <div class="buttonhome">
                <a href="/home"><input id="input" type="button" value="Home"
name="home"></a>
                <a href="/uploaddata"><input id="input" type="button"
value="UploadData" name="home"></a>
                <a href="/viewdata"><input id="input" type="button"
value="ViewData" name="home"></a>
                <a href="/trainmodel"><input id="input" type="button"
value="TrainModel" name="home"></a>
                <a href="/predict"><input id="input" type="button"
value="Prediction" name="home"></a>
            </div>
        </div>
    </div>
    <center style="margin-top: 100px; overflow: scroll;">
        <table>
            <tr>
                {%for c in cols%}
                <td><b>{{c}}</b></td>
                {%endfor%}

            </tr>

            {%for j in rows%}
            <tr>
                {%for i in j%}
                <td><b>{{i}}</b></td>
                {%endfor%}

            </tr>
            {%endfor%}
        </table>

    </center>
</body>

</html>
```

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Volume 11 Issue IV Apr 2023- Available at www.ijraset.com

Uploading Data Template

```
<html lang="en">

<head>
    <meta charset="UTF-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <!-- {{url_for('static',filename='css/home.css')}} -->
    <link rel="stylesheet" href="{{url_for('static',filename='css/home.css')}}">
    <title>Forest Fire Prediction</title>
</head>

<body>

    <div class="nav-bar">
        <div class="buttonsholder">
            <div class="buttonhome">
                <a href="/home"><input id="input" type="button" value="Home"
name="home"></a>
                <a href="/uploaddata"><input id="input" type="button"
value="UploadData" name="home"></a>
                <a href="/viewdata"><input id="input" type="button"
value="ViewData" name="home"></a>
                <a href="/trainmodel"><input id="input" type="button"
value="TrainModel" name="home"></a>
                <a href="/predict"><input id="input" type="button"
value="Prediction" name="home"></a>
            </div>
        </div>
    </div>
    <center>
        <form action="/getfile" method="post" enctype="multipart/form-data">
            <h2 style="padding-top: 10%; position: relative;">{{msg}}</h2>
            <input type="file" name="datafile" style="margin-top: 15%;"><br>
            <input type="submit" value="Upload" style="margin-right: 5%; margin-
top: 3%;">
        </form>
    </center>
</body>

</html>
```

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Application Code

```
from flask import Flask
from flask import render_template,url_for,request,redirect
import numpy as np
import pandas as pd
from preprocess import *
app = Flask(__name__)
app.config['UPLOAD_FOLDER'] = '../upload'
home_page = 'index.html'
upload_page = 'upload_data.html'
view_data_page = 'view_data.html'
model_page = 'model_train.html'
predict_page = 'predict.html'

@app.route('/')
def index():
    return render_template(home_page)

@app.route('/home')
def home():
    return render_template(home_page)


@app.route('/uploaddata')
def upload_data():
    return render_template(upload_page)



@app.route('/viewdata')
def view_data():
    number = 30
    return
render_template(view_data_page,cols=data.columns.values,rows=data.values.tolist()
[:number])



@app.route('/trainmodel')
def model_data():
    return render_template(model_page)


@app.route('/predict')
def predict():
    return render_template(predict_page)
```

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```
@app.route('/getfile',methods=['POST','GET'])
def get_df_file():
    if request.method == 'POST':
        try:
            data_file = request.files.get('datafile')
            if data_file:
                global data
                data = pd.read_csv(data_file)
                if data_file is not None:
                    return render_template(upload_page,msg='File uploaded
successfully')
        except:
            raise FileNotFoundError("Please select the file type")
    return render_template(upload_page,msg='Please select a file')



@app.route('/selectmodel',methods=['POST','GET'])
def return_score():
    if request.method == 'POST':
        form = request.form
        algo = form['algo']
        score = get_score(data,algo)
        return render_template(model_page,score=f'Accuracy is :
{round(score,2)}%')
    return render_template(model_page,score=f'Please try again')


@app.route('/getdata',methods=['POST','GET'])
def predict_binary():
    if request.method == 'POST':
        form = request.form
        oxygen = form['oxygen']
        temp = form['temp']
        humid = form['humid']

        oxygen = np.float64(oxygen) / 100
        temp = np.float64(temp) / 100
        humid = np.float64(humid) / 100

        model = pickle.load(open('model.sv','rb'))

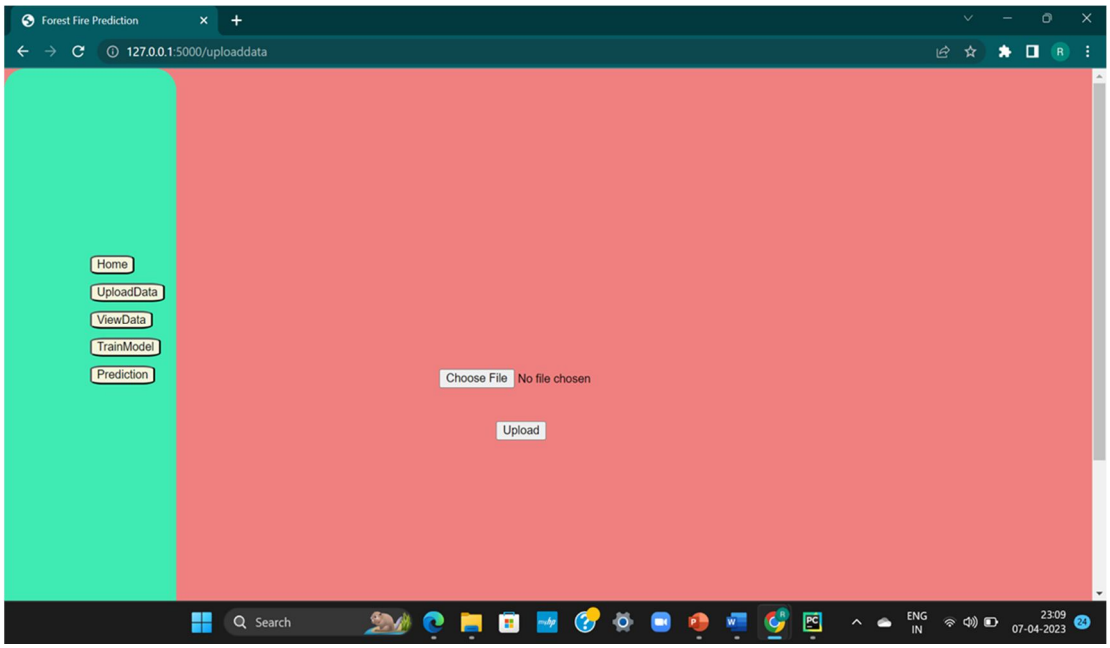
        prediction = model.predict(np.array([[oxygen,temp,humid]]))[0]
        print(str(prediction) + '\n')
        print(model.predict_proba(np.array([[oxygen,temp,humid]]))[0])
        if prediction > 0:
            return render_template(predict_page,msg='The given area will have
fire occurence')
        else:
            return render_template(predict_page,msg='The given area will not
have fire occurence')

if __name__ == '__main__':
    app.run(debug=True)
```

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IX. OUTPUT

UPLOAD DATA PAGE : Here we can upload Dataset.



In the above Figure 9.1 we could see that the output showing that we should upload the data.

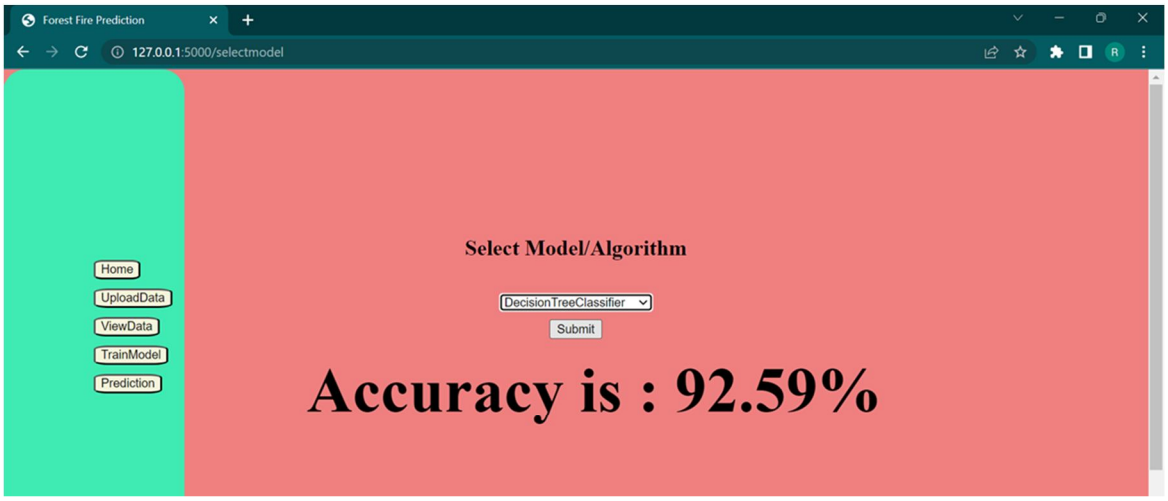


Area	Oxygen	Temperature	Humidity	Fire Occurrence
Balaghat	30	33	35	0
Barwani	54	43	22	1
Betul	65	43	22	1
Burhanpur	28	26	78	0
Chhatarpur	54	43	22	1
Chhindwara	27	28	27	0
Damoh	35	30	28	0
Dewas	64	43	26	1
Guna	45	30	33	0
Jabalpur	65	44	32	1
Khandwa	71	46	26	1
Katni	38	29	34	0
Mandla	63	46	30	1
Morena	57	39	19	1
Panna	29	27	31	0
Risen	22	25	30	0
Sagar	67	38	28	1
Satna	71	41	29	1
Seoni	53	39	17	1
Cachar	66	40	21	1
DimaHasao	62	33	47	0
Karbianglong	28	27	33	0

Figure 9.2 VIEW

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SELECT MODEL: Selecting Model For the dataset to apply.



In the above Figures 9.3 and 9.4 we could see the output showing the accuracy of the decision tree and random forest algorithms.

FIGURE 9.3

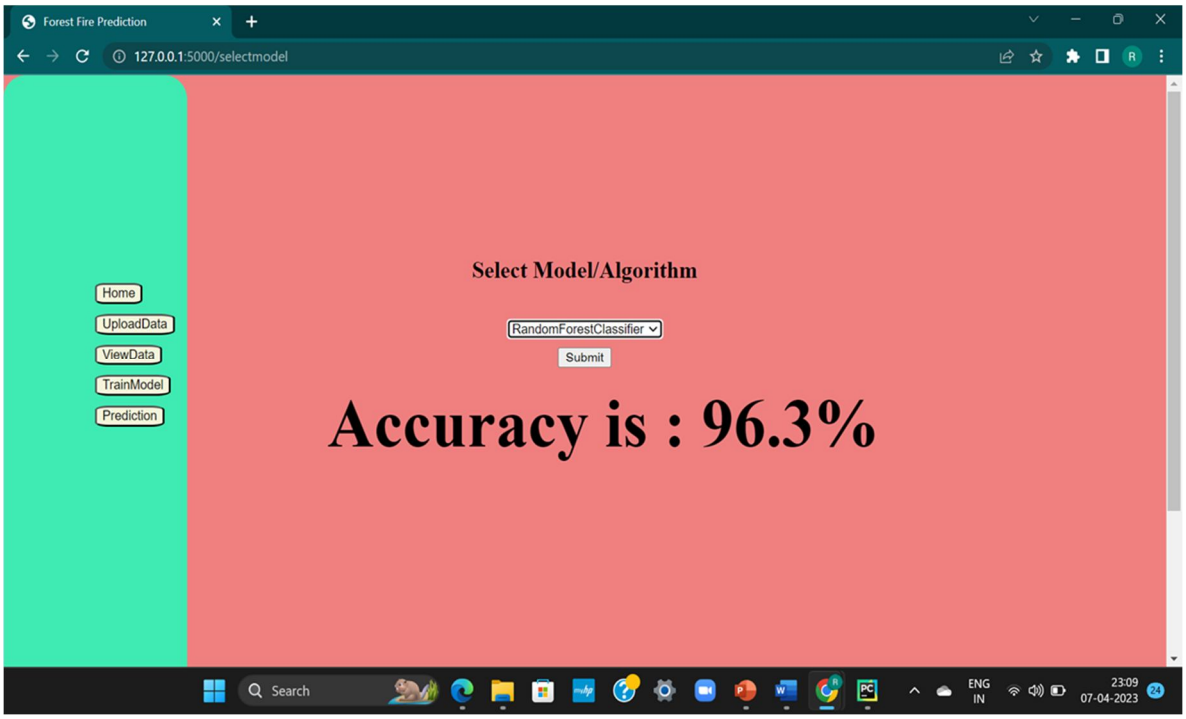
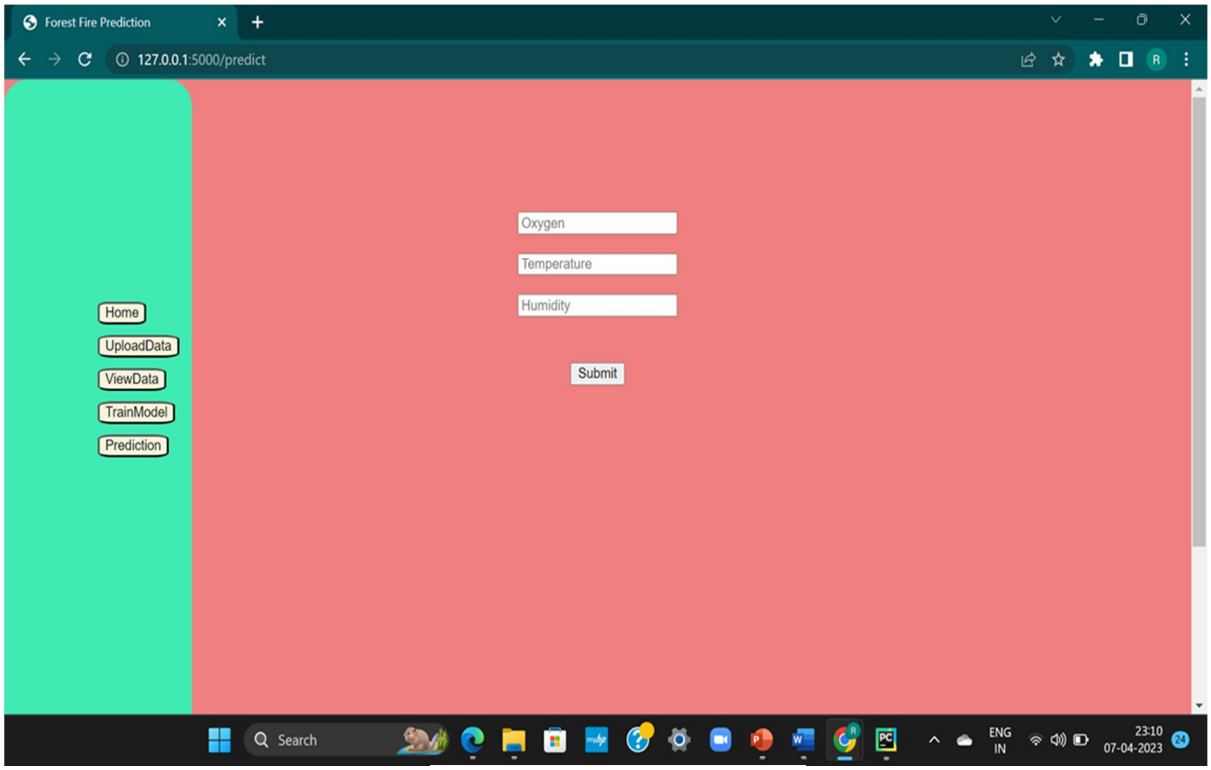


FIGURE 9.4

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View Result: Here we can see the result



In the above Figure 9.5 we could see that the prediction page where we have to enter the values of oxygen, humidity, temperature and we can predict whether fire will occur or not in that given area.

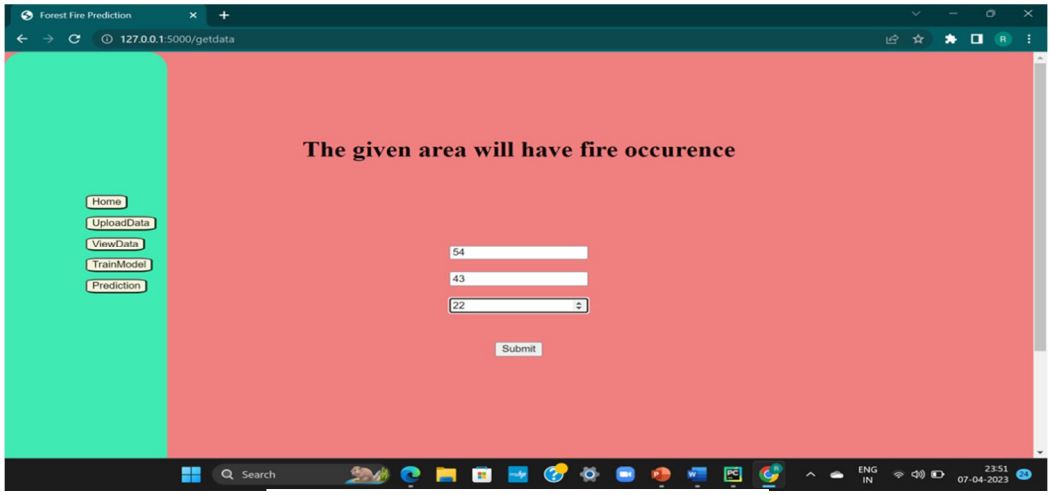


Figure 9.6

In the above Figure 9.6 we could see the output that we have entered the given values and predicted that fire will occur in that particular area.

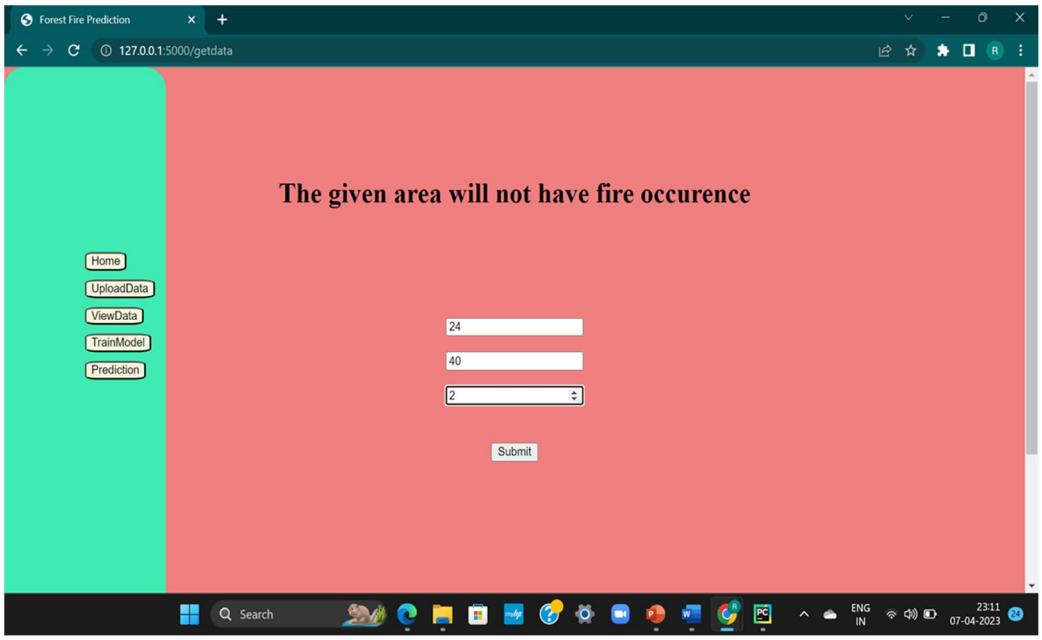


Figure 9.7

In the above Figure 9.7 we can see that the output that we have enter the given values and predicted that fire will not occur in that particular area.

X. TESTING

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub-assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

A. Unit Testing

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

B. Integration Testing

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

C. Functional Testing

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:

Valid Input : identified classes of valid input must be accepted.
Invalid Input : identified classes of invalid input must be rejected.
Functions : identified functions must be exercised.
Output : identified classes of application outputs must be exercised.

D. System Test

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration-oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

1) White Box Testing

White Box Testing is a testing in which in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level.

2) Black Box Testing

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box. you cannot “see” into it. The test provides inputs and responds to outputs without considering how the software works.

3) Unit Testing

Unit testing is usually conducted as part of a combined code and unit test phase of the software lifecycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases. Field testing will be performed manually and functional tests will be written in detail.

Test objectives

- All field entries must work properly.
- Pages must be activated from the identified link.
- The entry screen, messages and responses must not be delayed.
- Features to be tested.
- Verify that the entries are of the correct format.
- No duplicate entries should be allowed.
- All links should take the user to the correct page.

4) Integration Testing

Software integration testing is the incremental integration testing of two or more integrated software components on a single platform to produce failures caused by interface defects. The task of the integration test is to check that components or software applications, components in a software system or – one step up – software applications at the company level interact without error.

5) Acceptance Testing

User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements.

Test Results: All the test cases mentioned above passed successfully. No defects encountered.

Software Testing is a process of executing the application with an intent to find any software bugs. It is used to check whether the application met its expectations and all the functionalities of the application are working. The final goal of testing is to check whether the application is behaving in the way it is supposed to under specified conditions. All aspects of the code are examined to check the quality of application. The primary purpose of testing is to detect software failures so that defects may be uncovered and corrected. The test cases are designed in such way that scope of finding the bugs is maximum.

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6) System Test Cases

Input	Output	Result
Input features	Tested for different features given by user on the different model.	Success
Fire classification	Tested for different input features given by the user on different features from the models are created using the different algorithms and data.	Success
Forest Fire Prediction	Fire prediction will be performed using the different models build from the algorithms.	Success

Table 10.1 Test cases

XI. RESULT

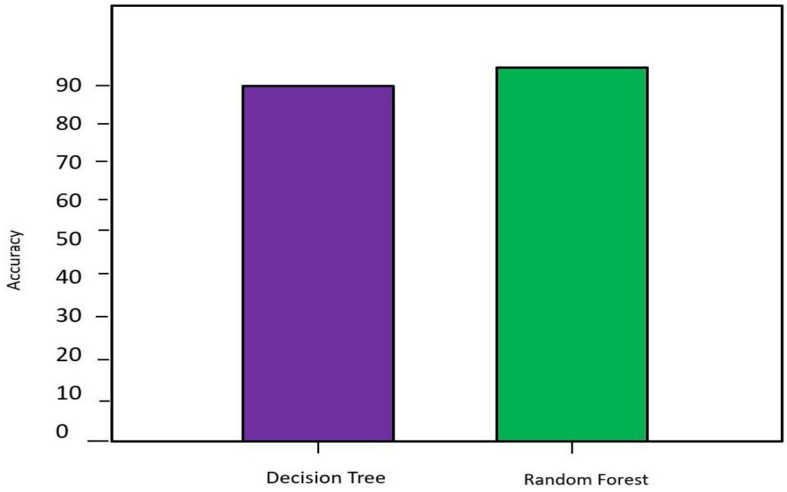


Figure 11.1 Graphical Representation Of Accuracy Of Decision Tree & Random Forest Algorithms

The proposed ensemble model secures higher accuracy of 0.96 when compared to existing models. In the above Figure 11.1 we have observed that in our proposed model we have taken the two algorithms and they have are Decision Tree Classifier and Random Forest Classifier. When comparing this two algorithms we could see that the accuracy of Random Forest is more compare to Decision Tree Classifier.

XII. CONCLUSION

With the proposed system, higher accuracy can be achieved. We have used structured data of weather conditions based on the proposed Decision Tree algorithm, Random Forest algorithm. To find that out, we have taken two algorithms and the accuracy rate can be reached up to 96%. None of the existing system and work is focused on using both algorithms. We proposed Decision Tree algorithm, Random Forest algorithm for data and we have seen increase in accuracy level compared to existing method. By using different types of algorithms to get high accuracy and accurate result. Experiments are concluded in order to have a different number of training instances set and evaluation instances set for forest fire prediction. The factors causing the frequency of fire are investigated in this project. Meteorological factors (Temperature, Relative Humidity and Wind Speed) are taken into account. Extreme temperatures, moderate humidity, high wind speeds, significantly raise the chance of burning. It is also found that the number of fires in forests is higher than in other surface areas. As the risk of forest fire increases significantly in the forest, data mining techniques are to be used for fire prediction purposes.

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XIII. FUTURE SCOPE

This project can be further expanded to do better so that the models are better equipped and the effects are better. We may also have a UI built for the application to provide some real-time performance. The workflow of the UI model could be, the user may enter the local and the zip code. Using the zip code, we will get latitude and longitude using any APIs and consume the coordinates as parameters, get the weather conditions like peak temperature, minimum temperature, humidity, wind speed for a given day.

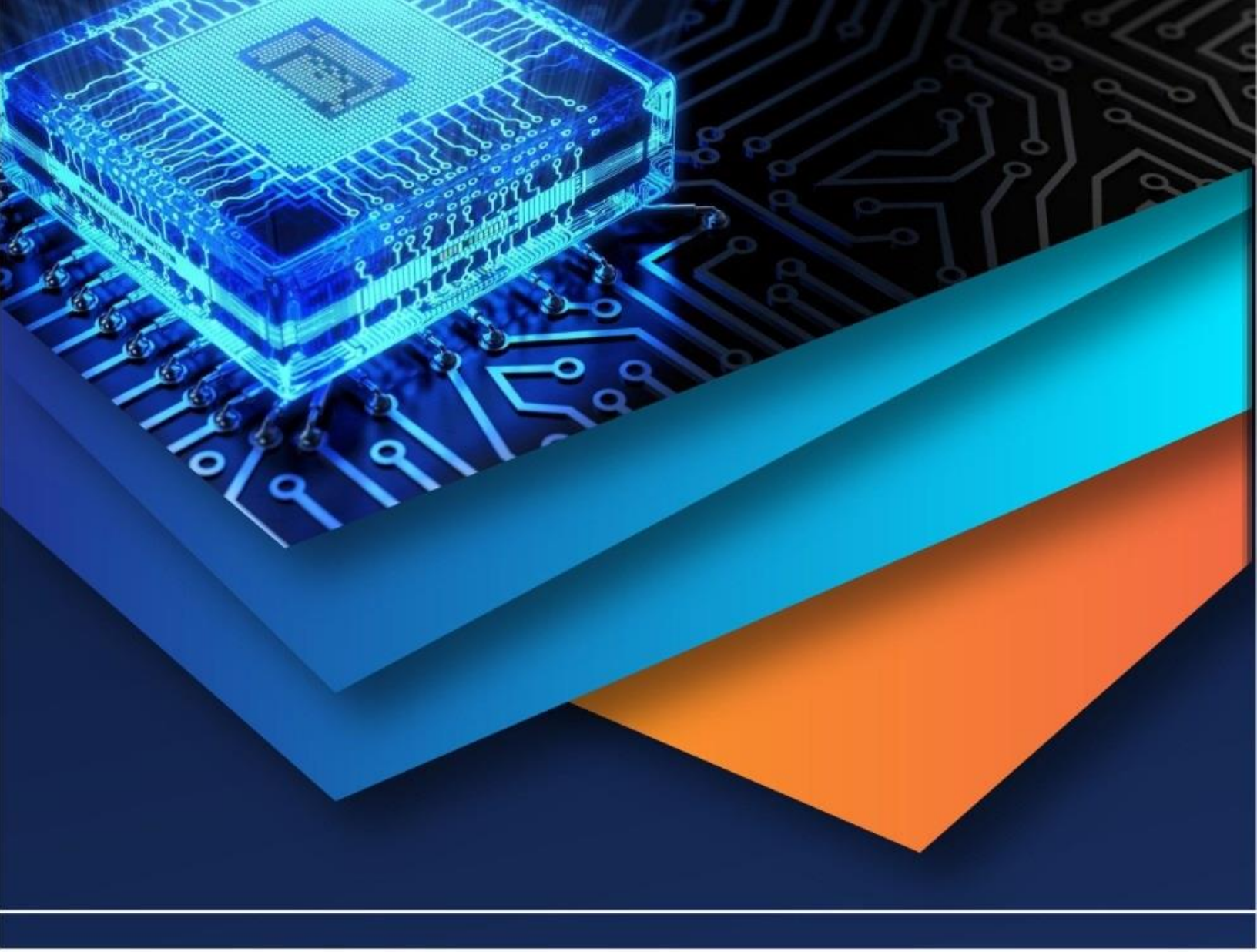
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