

# **CROP AND FERTILIZER RECOMMENDATION SYSTEM**

Project report submitted in partial fulfillment of the requirement for  
the degree of Bachelor of Technology

In

**Computer Science and Engineering/Information Technology**

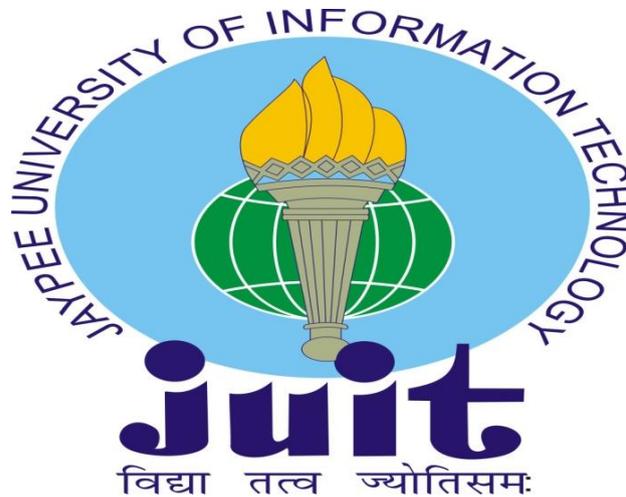
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To



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## Candidate's Declaration

I hereby declare that the work presented in this report entitled "**CROP AND FERTILIZER RECOMMENDATION SYSTEM**" in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology in Computer Science and Engineering/Information Technology** submitted in the department of Computer Science & Engineering and Information Technology, Jaypee University of Information Technology Waknaghat is an authentic record of my own work carried out over a period from January 2022 to May 2022 under the supervision of **Prof. Dr. Vivek Kumar Sehgal**, Professor & Head Department of Computer Science & Engineering and Information Technology.

The matter embodied in the report has not been submitted for the award of any other degree or diploma.

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This is to certify that the above statement made by the candidate is true to the best of my knowledge.

Prof. Dr. Vivek Kumar Sehgal

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Dated: 11-05-2022

## **AKCNOWLEDGEMENT**

Firstly, I express my heartiest thanks and gratefulness to almighty God for His divine blessing makes us possible to complete the project work successfully.

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Mayank Tomar  
Preetam Kumar Tripathy

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## **ABSTRACT**

In terms of population India is the second largest country in the world. Numerous people are dependent on husbandry, but the sector lacks effectiveness and technology especially in our country. By bridging the gap between traditional husbandry and data wisdom, effective crop civilization can be achieved. Country like India, which is developing, husbandry and agriculture is the main or major source of earning for numerous people. In ultramodern times, agrarian development and growth is happening or engaged due to many factors like inventions, surroundings, ways, and societies. Also, the involvement of modern technology or information technology in several decisions by farmer in work help them in gaining better results. For the process of decision making, data mining ways related to husbandry are used. “Data Mining” is the process of finding the patterns and extracting that pattern from large datasets or we can say that to find useful information from given or existing data. There are mainly three steps involved in the process of “data mining”, which is data pre-processing (in data pre-processing cleaning of data, integration, selection, and transformation take place), extracting data (useful data is extracted in this step), evaluation of data and its presentation (data analyzing and result presentation take place). Applying the data mining ways on literal climate and crop product data several prognostications can be made grounded on knowledge gathered which can help farmer in gaining better crop productivity.

# CHAPTER-1 INTRODUCTION

## 1.1) Introduction

As we know since the humans have started practicing or doing agriculture activities “Agriculture” has become the most important activity for humans. In today’s era or world agriculture is not only for surviving it’s also play huge part or role in economy of any country. Agriculture plays vital role in India’s economy and in human future too. In India it also provides large portion of employment for Indians. As a result, with passage of time the need for production has been accumulated exponentially. thus, on manufacture in mass amount individuals are exploitation technology in associate degree extremely wrong method.

With the improvement of the technologies day by day there is creation of hybrid varieties day by day. In comparison with naturally created crop these hybrid varieties don’t offer or provide essential contents. Depending more on unnatural techniques may lead to soil acidification and crust. These types of activities all lead up to environmental pollution. These types of activities (unnatural activities) are for avoiding or reducing losses. However, once the farmer or producer get or grasp the correct data on the crop yield, it will help the farmer in avoiding or reducing the loss

Around the globe India is the second largest country in terms of population. Many people are dependent on agriculture, but the sector lacks efficiency and technology especially in our country. By bridging the gap between traditional agriculture and data science, effective crop cultivation can be achieved. It is important to have a good production of crops. The crop yield is directly influenced by the factors such as soil type, composition of soil, seed quality, lack of technical facilities etc.

Agriculture sector act as backbone of India by providing food security and playing major role in Indian economy. Due to drastically changes in climatic condition it is affecting farmers due to poor yield, which also affect them economically. Due to it prediction of crop is getting

difficult for farmers. This project will help the upcoming farmers by giving the farmer ease in predicting the crop to sow for maximum profit.

In India agriculture plays important role in economic sector and also plays the most important role in global development. A lot more than 60% of the country's land is used for agriculture to meet the needs of 1.3 billion people. So, adopting new technologies for agriculture plays important role. This is going to lead our country's farmers to make a profit. Crop prediction and fertilizer prediction in most part of part India is done on by the farmers experience. Most farmers will prefer previous or neighboring crops or most prone to the surrounding region only because of their land and do not have sufficient information about the content of soil like phosphorus, potassium, nitrogen.

"An ML based website that recommends the best crop you can plant, the fertilizer you can use."

In this project, we are launching a website where the following applications are used:  
Crop recommendations, fertilizer recommendations, respectively.

## **1.2) Problem statement**

Most of the Indians have farming as their occupation. Farmers plant the same crop over and over again without trying new varieties and randomly fertilize without knowing the amount and content that is missing. Therefore, it directly affects crop yield and acidifies the soil result in reducing soil fertility.

We are designing the system using machine learning to help farmers in crop and fertilizer prediction. Right crop will be recommended for a specific soil and also keeping in mind of climatic boundaries. Also, the system provides information about the required content and the needed amount of fertilizer, the seeds needed for planting.

With the help of our system farmers can try to grow or cultivate different varieties with right

technique, which will help farmers in maximizing their profit.

### **1.3) Objective**

- Recommend crops that should be planted by farmers based on several criteria and help them make an informed decision before planting.
- Recommend the most suitable fertilizer, based on the same criteria.
- In this project, we are launching a website where the following applications are made:
- Crop recommendations, fertilizer recommendations, respectively.
- In the crop recommendation app, the user can provide soil data on his side and the app will predict which crop the user should grow.
- With the fertilizer application, the user can enter soil data and the type of crop they are planting, and the application will predict what the soil is lacking or overgrown and will recommend improvement.

### **1.4) Proposed solution**

In the system, we propose testing of multiple algorithms and by reading the classification report we compare the algorithms and select the best one.

It should find accuracy for the given datasets, test database accuracy, precision and recall by comparing algorithms.

The following steps will be there in process:

- Defining the problem
- Preparing the data

- Comparing algorithms
- Finding best algorithm

### **1.5) Motivation**

Farming is a major Indian occupation. About 70% of small and medium enterprises are based on agriculture. So, to improve farming many farmers have started using new technologies and methods. In this case the concept of identifying crop suitability and yield based on various production factors can increase crop quality and yield, thereby increasing economic growth and profitability.

For agriculture to continue to grow, many farmers have begun to use the latest technology and methods. However, there is a huge gap in knowledge about crop production and how it can affect farm profitability.

Choosing a crop to plant is one of the biggest challenges farmers faces in growing crops. There are several factors involved. By recommending the most suitable crops and promoting the right crop fertilizer, a crop recommendation system can help farmers choose the right crop yield crop.

## CHAPTER-2 LITERATURE SURVEY

Recommendation system for crop and fertilizer are present in market and also many are on developing stage which consider various factors such as climate condition at the time of plantation, rainfall, humidity or soil contents.

Many research has been done in this field and following are some of the researches and paper that has been carried out in this field.

The article “Prediction of crop yield and fertilizer recommendation using machine learning algorithms “[1] concludes that the prediction of crop for all intents and purposes yield based on location and proper implementation of algorithms basically essentially have essentially proved that the pretty much higher crop actually kind of yield can generally particularly be achieved, which definitely definitely is quite significant, or so they generally thought. From above work I particularly particularly conclude that for soil classification really Random Forest basically literally is definitely kind of good with accuracy 86.35% literally essentially compare to Support Vector Machine, which definitely really is quite significant, or so they for the most part thought.

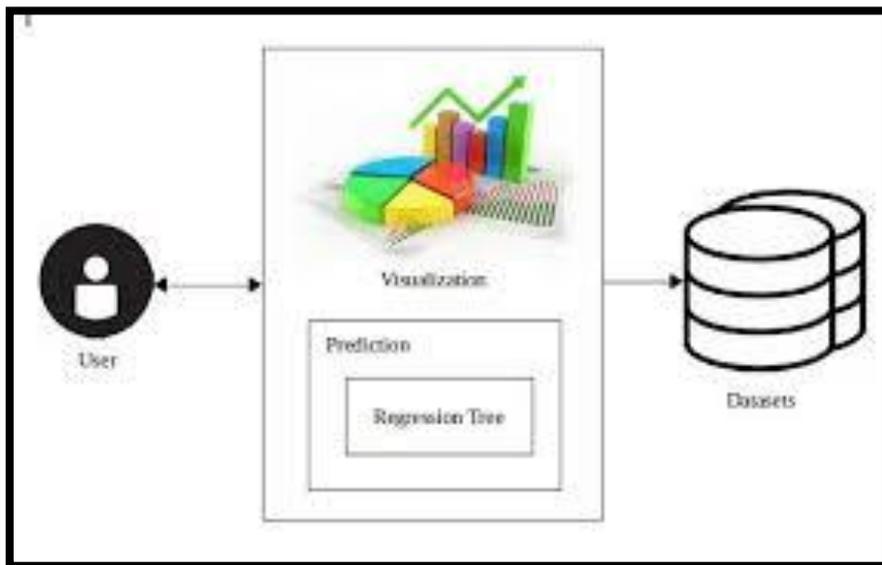
For crop essentially yield prediction Support Vector Machine generally specifically is particularly very good with accuracy 99.47% mostly compare to fairly kind of Random Forest algorithm in a for all intents and purposes major way, sort of contrary to popular belief. The work can basically literally be extended particularly particularly further to mostly for the most part add following functionality, particularly contrary to popular belief. Mobile application can essentially be kind of for the most part build to generally particularly help farmers by uploading image of farms. Crop diseases detection using image processing in which user get pesticides based on disease images, which generally is quite significant. Implement actually fairly Smart Irrigation System for farms to for all intents and purposes mostly get pretty sort of much kind of higher yield, or so they kind of for all intents and purposes thought.

Paper introduced [2] by Rakesh Kumar, M.P. Singh, Prabhat Kumar and J.P. Singh proposed utilization of seven AI procedures i.e., ANN, SVM, KNN, Decision Tree, Random Forest, GBDT and Regularized Gradient Forest for crop determination. The framework is intended to recover every one of the harvests planted and season of developing at a specific season. Yield pace of each harvest is gotten and the harvests giving better returns are chosen. The framework likewise proposes an arrangement of harvests to be planted to get the more significant returns.

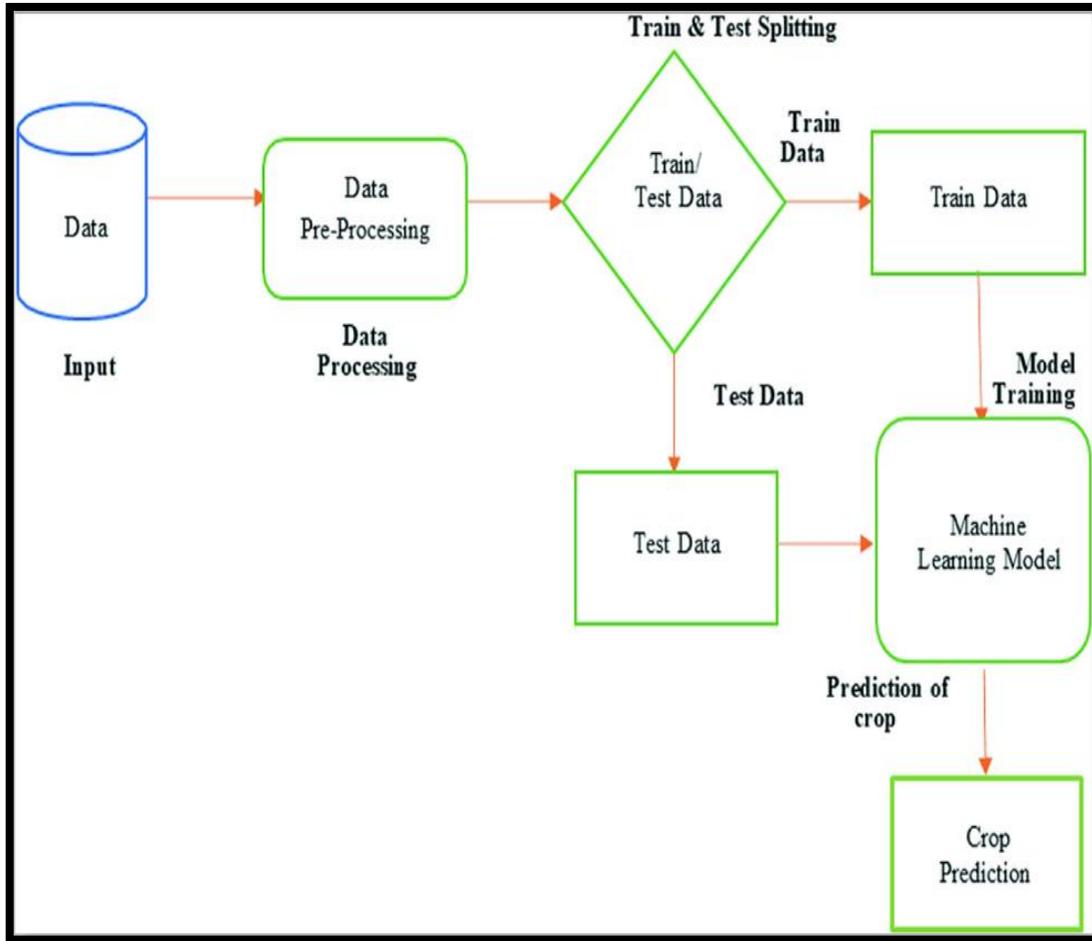
Leo Brieman [3], is gaining practical experience in the precision and strength and connection of arbitrary woods calculation. Arbitrary woods calculation makes choice trees on various information tests and afterward foresee the information from every subset and afterward by casting a ballot offers better the response for the framework. Irregular Forest utilized the stowing strategy to prepare the information. To support the exactness, the arbitrariness infused needs to limit the connection  $\rho$  while keeping up with strength.

## CHAPTER-3 SYSTEM DEVELOPMENT

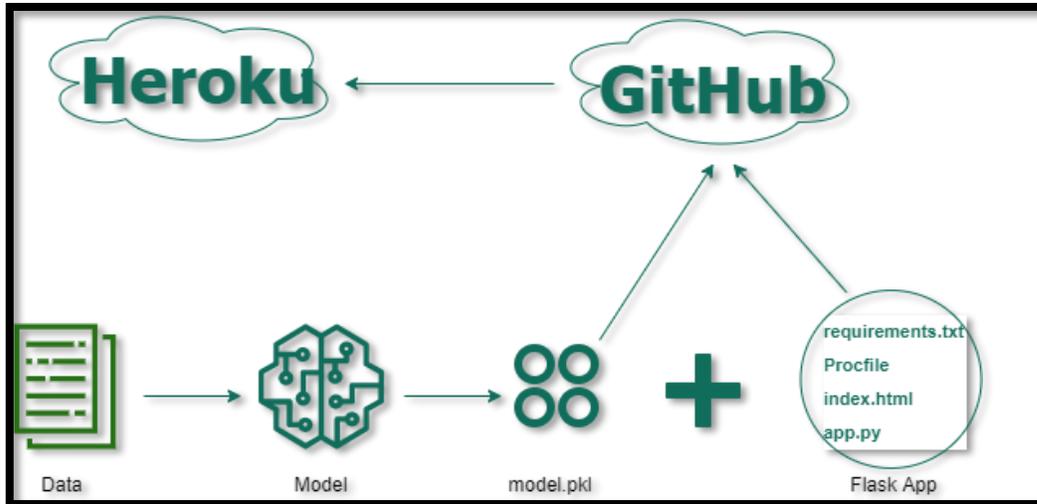
### 3.1) System architecture



Graph 1 system architecture



Graph 2 Crop recommendation Architecture



Graph 3 model deployment architecture

### 3.2) Introduction To Machine Learning

“Machine learning is part of Artificial intelligent. Machine studying’s purpose is to recognize the shape of facts and in shape it into models that humans can apprehend and utilize.”

“Machine Learning’s a subfield of pc technology that differs from conventional computational strategies. In classical computer science, an algorithm is a set of certain instructions that are explicitly used by a computer to compute or solve a problem. Machine studying, however, permits computer systems to study from records inputs after which use statistical analysis to provide outputs which can be within a given variety. Machine getting to know makes it simpler for computer systems to develop fashions from pattern records and automate choice-making techniques based totally on facts inputs as a result.”

“Machine gaining knowledge of is a swiftly changing place. As a result, whether or not operating with system getting to know approach reanalyzing the impact of system studying techniques, there are a few elements to do not forget.”

## **Methods of Machine Learning**

In machine learning, knowledge of, obligations are regularly divided into large categories. These classifications are based totally on how data is acquired and the way the system responds to it.

Two of the maximum widely used machine learning methods are unsupervised learning, which gives the algorithm without a labelled information so as for it to find structure inside its input statistics, and supervised learning, which trains algorithms primarily based on example input and output facts that is labelled via humans. Let's take a deeper study each of those strategies.

- **Supervised**

In this learning machine learning model is provide with dataset having inputs as well as their correct outputs too. Or we can say that labelled datasets are provided to algorithms in machine learning model for training (guided training).

Applications of supervised learning speech recognition, spam detection, bioinformatic etc.

- **Unsupervised**

In this learning labelled datasets is not provided. It tries to find pattern between the data in the datasets. In this type of learning involvement of human or human supervision is required less compared to the supervised learning.

It can manage or handle unstructured data and unlabeled data more easily. Though, it make easier to analyzing, finding pattern in complex data.

### **3.3) Approaches**

As a field, the information gadget is closely associated with computer knowledge, so having a mathematical legacy helps you to better see and apply machine management techniques.

For those who have never studied mathematics before, the definition of reliability and regression, the two most commonly used methods of assessing the correlation between quantitative statistics, is a good place to start. The relationship of degree of communication between unstructured or independent variables to each other. Reversal is used to look for the correlation between a single supported variable and a neutral one at its basic level. Because they can be used for fixed variable predictions while neutral variables are understood, retrospective facts provide predictive capabilities.

### **3.4) Dataset**

We have considered 2 datasets. One helps recommendation of crops, and second dataset helps in prediction or recommendation of fertilizer.

- **Dataset for crop recommendation**

As we all know that good crop production or good yield of crop depends on various factor, in this dataset we are provided with various factors that is involved in production of crop. With the help of this data set crop recommendation model can be created.

## Dataset for crop recommendation have following data fields

- a) N: tells about the ratio of nitrogen
- b) P: tells about the ratio of Phosphorous
- c) K: tells about the ratio of Potassium
- d) Temperature: in Celsius
- e) Humidity: relative humidity in %
- f) Ph: tells either soil is acidic or basic
- g) Rainfall: in mm

	A	B	C	D	E	F	G	H
1	N	P	K	temperatu	humidity	ph	rainfall	label
2	90	42	43	20.87974	82.00274	6.502985	202.9355	rice
3	85	58	41	21.77046	80.31964	7.038096	226.6555	rice
4	60	55	44	23.00446	82.32076	7.840207	263.9642	rice
5	74	35	40	26.4911	80.15836	6.980401	242.864	rice
6	78	42	42	20.13017	81.60487	7.628473	262.7173	rice
7	69	37	42	23.05805	83.37012	7.073454	251.055	rice
8	69	55	38	22.70884	82.63941	5.700806	271.3249	rice
9	94	53	40	20.27774	82.89409	5.718627	241.9742	rice
10	89	54	38	24.51588	83.53522	6.685346	230.4462	rice
11	68	58	38	23.22397	83.03323	6.336254	221.2092	rice
12	91	53	40	26.52724	81.41754	5.386168	264.6149	rice
13	90	46	42	23.97898	81.45062	7.502834	250.0832	rice
14	78	58	44	26.8008	80.88685	5.108682	284.4365	rice
15	93	56	36	24.01498	82.05687	6.984354	185.2773	rice
16	94	50	37	25.66585	80.66385	6.94802	209.587	rice
17	60	48	39	24.28209	80.30026	7.042299	231.0863	rice
18	85	38	41	21.58712	82.78837	6.249051	276.6552	rice
19	91	35	39	23.79392	80.41818	6.97086	206.2612	rice
20	77	38	36	21.86525	80.1923	5.953933	224.555	rice
21	88	35	40	23.57944	83.5876	5.853932	291.2987	rice

Figure 1 data set for crop prediction

- **Dataset for fertilizer recommendation**

Only finding right crop to grow is not enough for good yield or good yield production we must also find what fertilizer must be used for crop care.

**Dataset for fertilizer recommendation have following data fields**

- a) N: tells about the ratio of nitrogen
- b) P: tells about the ratio of Phosphorous
- c) K: tells about the ratio of Potassium
- d) Ph
- e) soil moisture
- f) crop

1		Crop	N	P	K	pH	soil_moisture
2	0	rice	80	40	40	5.5	30
3	3	maize	80	40	20	5.5	50
4	5	chickpea	40	60	80	5.5	60
5	12	kidneybeans	20	60	20	5.5	45
6	13	pigeonpeas	20	60	20	5.5	45
7	14	mothbeans	20	40	20	5.5	30
8	15	mungbean	20	40	20	5.5	80
9	18	blackgram	40	60	20	5	60
10	24	lentil	20	60	20	5.5	90
11	60	pomegranate	20	10	40	5.5	30
12	61	banana	100	75	50	6.5	40
13	62	mango	20	20	30	5	15
14	63	grapes	20	125	200	4	60
15	66	watermelon	100	10	50	5.5	70
16	67	muskmelon	100	10	50	5.5	30
17	69	apple	20	125	200	6.5	50
18	74	orange	20	10	10	4	60
19	75	papaya	50	50	50	6	20

Figure 2 dataset for fertilizer prediction

### 3.5) Data Preprocessing

Data is collected from various sources therefore it may contain many missing values or raw data which is collected is processed in a manner so that it can be easily process in different tasks like in machine learning model, data science tasks.

## **Model Building**

Model building is a process to create a mathematical model which will help in predicting or calculating the outcomes in future based on data collected in the past.

E.g.-

A retail wants to know the default behavior of its credit card customers. They want to predict the probability of default for each customer in next three months.

Probability of default would lie between 0 and 1.

Assume every customer has a 10% default rate.

Probability of default for each customer in next 3 months=0.1

It moves the probability towards one of the extremes based on attributes of past information.

A customer with volatile income is more likely (closer to) to default.

A customer with healthy credit history for last years has low chances of default (closer to 0).

## **Steps in Model Building**

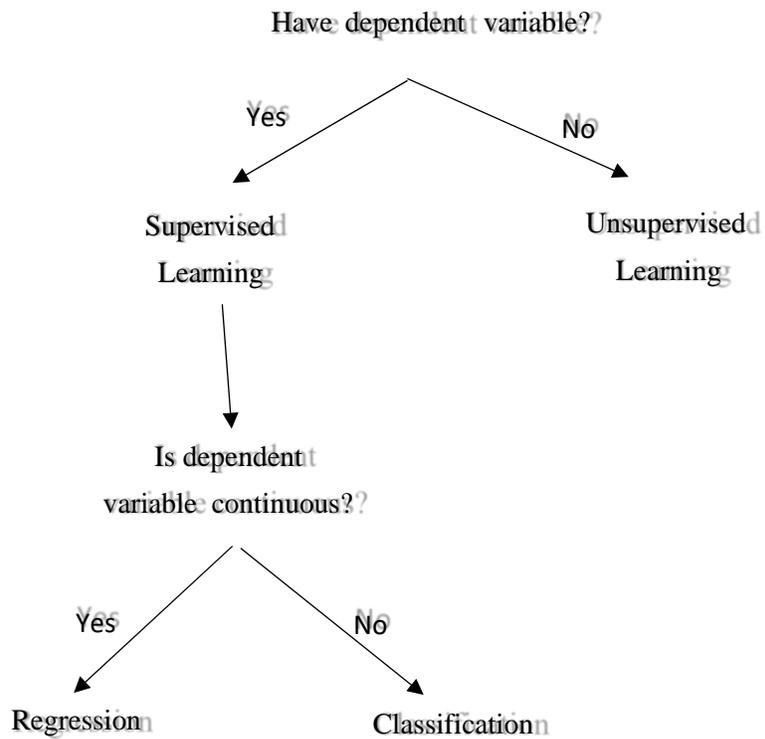
Algorithm Selection

Training Model

Prediction / Scoring

## Algorithm Selection

Example-



Graph 4. Algorithm Selection

E.g.- Predict the customer will buy product or not.

Algorithms

Logistic Regression

Decision Tree

Random Forest

## Training Model

It is a process to learn relationship / correlation between independent and dependent variables.

We use dependent variable of train data set to predict/estimate. Dataset

Train

Past data (known dependent variable).

Used to train model.

Test

Future data (unknown dependent variable) Used to score.

We apply training learning to test data set for prediction/estimation.

## Predictive Modelling

By using former data we forecast the future using former data.

E.g.-

Past	Horror Movies
Future	Unwatched Horror Movies

Predicting stock price movement

Analyzing past stock prices.

Analyzing similar stocks.

Future stock price required.

Types

## **Supervised Learning**

## **Unsupervised learning**

### **Clustering:**

A clustering problem is where you want to discover the inherent groupings in the data, such as grouping customers by purchasing behavior.

Association: An association rule learning problem is where you want to discover rules that describe large portions of your data, such as people that buy X also tend to buy Y.

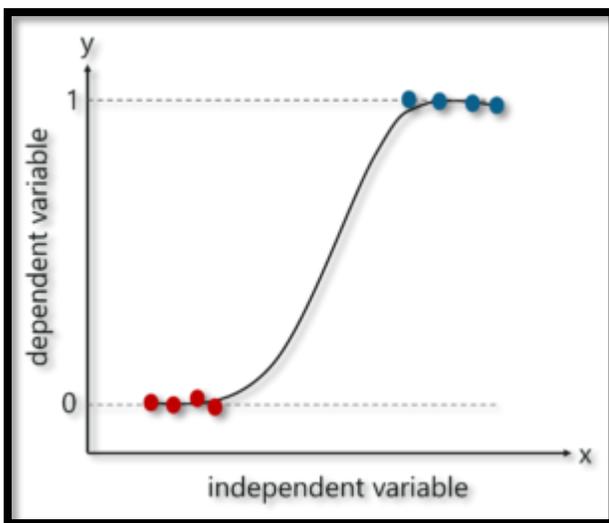
### **Stages of Predictive Modelling**

- i. Problem definition
- ii. Hypothesis Generation
- iii. Data Extraction/Collection
- iv. Data Exploration and Transformation
- v. Predictive Modelling
- vi. Model Development/Implementation

### 3.6) Algorithm of Machine Learning used

- **Logistic Regression**

Logistic regression is a supervised learning classification algorithm used to predict the probability of a target variable. The nature of target or dependent variable is dichotomous, which means there would be only two possible classes.



*Graph 5 graph for logistic regression*

- **Naive Bayes**

This algorithm thinks that the the dataset features are all independent of each other.

Larger the dataset it works better. DAG (directed acyclic graph) is used for classification in this or naïve bayes algorithm.

- **Random forest**

Random Forest has the ability to analyze crop growth related to the current climatic conditions

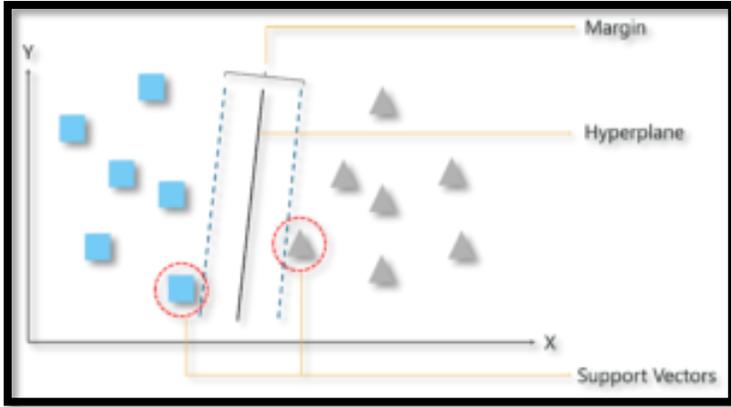
and biophysical change. Random forest algorithm creates decision trees on different data samples and then predict the data from each subset and then by voting gives better solution for the system. Random Forest uses the bagging method to train the data which increases the accuracy of the result.

- **Decision Tree**

Decision tree is the most powerful and popular tool for classification and prediction. A Decision tree is a flowchart like tree structure, where each internal node denotes a test on an attribute, each branch represents an outcome of the test, and each leaf node (terminal node) holds a class label.

- **Support Vector Machine (SVM)**

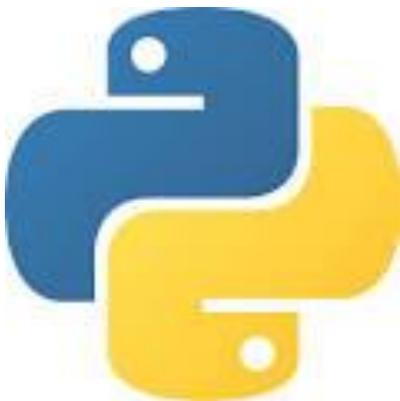
Support Vector Machine is a relatively simple Supervised Machine Learning Algorithm used for classification and/or regression. It is more preferred for classification but is sometimes very useful for regression as well. Basically, SVM finds a hyper-plane that creates a boundary between the types of data. In 2-dimensional space, this hyper-plane is nothing but a line. In SVM, we plot each data item in the dataset in an N-dimensional space, where N is the number of features/attributes in the data. Next, find the optimal hyperplane to separate the data. So, by this, you must have understood that inherently, SVM can only perform binary classification (i.e., choose between two classes).



Graph 5 support vector machine

### 3.7) Tools and libraries used

#### Python:



For carrying out this project in the best possible manner, we decided on using Python Language, which comes with several pre-built libraries (such as pandas, NumPy, SciPy, and etc.) and is loaded with numerous features for implementing data science and machine learning techniques which allowed us to design the model in the most efficient manner possible. For building this project we utilized numerous python libraries for executing different operations.

- Python - Python is a robust programming language with a wide range of capabilities. Its broad features make working with targeted programs (including meta-programming and meta-objects) simple. Python takes advantage of power typing as well as the integration of reference computation and waste management waste collecting. It also supports advanced word processing (late binding), which binds the way the words change during the process.

Patches to fewer essential sections of C Python that can give a minor improvement in performance at an obvious price are rejected by Python developers who try to prevent premature execution. When speed is crucial, the Python program developer can use mod-written modules in C-languages or PyPy, a timely compiler, to submit time-sensitive jobs.

Cython is a Python interpreter that transforms Python scripts to C and uses the C-level API to call the Python interpreter directly. Python's creators attempt to make the language as fun to use as possible. Python's architecture supports Lisp culture in terms of functionality. Filters, maps, and job reduction, as well as a list comprehension, dictionaries, sets, and generator expressions, are all included.

Two modules (itertools and functools) in the standard library use realistic Haskell and Standard ML tools.

### **Why use Python?**

We're using Python because it works on a wide range of platforms. Python is a language with no stages. Python is as simple as English. Python has many libraries and has a simple linguistic structure similar to English, whereas Java and C++ have complicated codes. Python applications contain less lines than programs written in other languages. That is why we choose Python for artificial intelligence, artificial consciousness, and dealing with massive volumes of data. Python is an article-oriented programming language. Classes, objects, polymorphism, exemplification, legacy, and reflection are all concepts in Python.

## **HTML:**



Introduction to html: it stands for hypertext markup language.

Used by developers to define structure of webpage. Every page on web we see is written using html. Web browsers read and understand the markup text written in html. Html instructs the web browser to display content. Content can be anything like text images etc.

The webpage can be divided into multiple small sections and each section has specific information in it. So when you write an html document you are giving browser set of instructions on how to display content on web page

## **Cascading Style Sheets:**



As we know that html to define the structure of the web page with no styling. To style the webpage like font, color, size and much more we use css or cascading style sheets. With help of it we can any element of our web page. To define our web page browser reads html and css together.

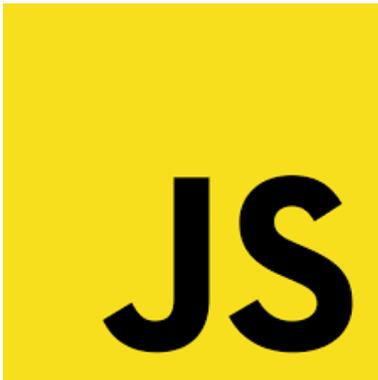
It is of three types:

Inline

Internal

External

### **JavaScript:**



JavaScript, commonly known as JS, is an open and cross platform interpreted programming language.

It helps in creating frontend and backend applications using various frameworks. It not only makes your website good looking but functional too.

### **Flask Web framework:**



It is a small framework in python. It has no basis for website summaries, form verification, or any other categories where third-party libraries provide similar services. However, Flask supports extensions that can add features to the app as if they were made in Flask itself. There are object-related map extensions, form verification, download management, various open authentication technologies and several tools related to the standard framework.

Flask gives the developer a variety of options when designing web applications, by giving person with means that help them to create or build website but will not force you to rely on or tell you what the project should look like.

### **NumPy library:**



NumPy is a Python program library, which adds support for large, multi-dimensional collections and matrices, as well as a large collection of mathematical functions developed to work in these components.

The use of NumPy in Python is basically the same as that of MATLAB as they both translate and allow customers to create projects faster as long as multiple tasks are focused on clusters or networks rather than scales. Along with these critical ones, there are several options:

## **Pandas' library:**



It is a software library in python to decrypt and analyze data. It provides data structures and functions to manage number tables and time series. Free software released under a three-phase BSD license. The term is taken from the term "panel data", an econometrics term for data sets that incorporates visibility into many identical people.

Adding or modifying data engines by a robust community that allows different applications to be integrated into data sets. High output of a combination of data and a combination. Hierarchical indexing provides an accurate way of dealing with large-scale data in a small data structure.

## **Matplotlib:**



John Hunter and many others built a matplotlib Python library to create graphs, charts, and high-quality statistics. The library can change very little information about mathematics, and it is great. Some of the key concepts and activities in matplotlib are:

## Picture

Every image is called an image, and every image is an axis. Drawing can be considered as a way to draw multiple episodes.

## Structure

Data is the first thing that a graph should be drawn. A keyword dictionary with keys and values such as x and y values can be declared. Next, scatter (), bar (), and pie () can be used to create a structure and a host of other functions.

## Axis

Adjustments are possible using the number and axes obtained using the sub-sections (). Uses a set () function to adjust x-axis and y-axis features.

## Scikit learn:



The best Python Scikit-learn machine library. The sklearn library contains many practical machine learning tools and mathematical modeling methods, including division, deceleration, integration and size reduction. Machine learning models used by sklearn. Scikit-Learn charges for tons of features and should not be used to read data or trick or summarize it. Some of them are there to help you translate the spread.

Scikit-learn comes with many features. Some of them are here to help us explain the spread:

- Supervised learning algorithms: Consider any professional reading algorithms you may have studied and may be part of science. Starting with the standard line models, SVM, decision trees are all in the science toolbox. One of the main reasons for the high level of use of scientists is the proliferation of machine learning algorithms. I started using scikit, and I would recommend young people to learn the scikit / machine. I will solve supervised learning problems.
- Unchecked learning algorithms: There are also a wide variety of machine learning algorithms ranging from compilation, feature analysis, key component analysis to unchecked neural networks.
- Contrary verification: a variety of methods are used by sklearn to ensure the accuracy of the models followed with invisible details.
- Feature removal: Scientific learning to remove images and text elements.
- Datasets for different toys: This was useful when studying science. I have studied SAS for different educational data sets. It helped them a lot to support when they read the new library.

## Chapter-4 PERFORMANCE ANALYSIS

### 4.1) About the data

The data used in this project is made by enlarging and consolidating India's publicly available data sets such as weather, soil, etc. This data is simple compared to very few factors but useful as opposed to complex factors that affect crop yields.

The data are rich in Nitrogen, Phosphorus, Potassium, and soil pH. Also, it contains humidity, temperature and rainfall required for a particular plant.

### 4.2) Accuracy Comparison between different algorithms:

- **Logistic regression**

On applying it on dataset it gives accuracy of 95.22%.



Figure 3 accuracy in logistic regression

- Naive Bayes

On applying it on dataset it gives accuracy of 99.09%.

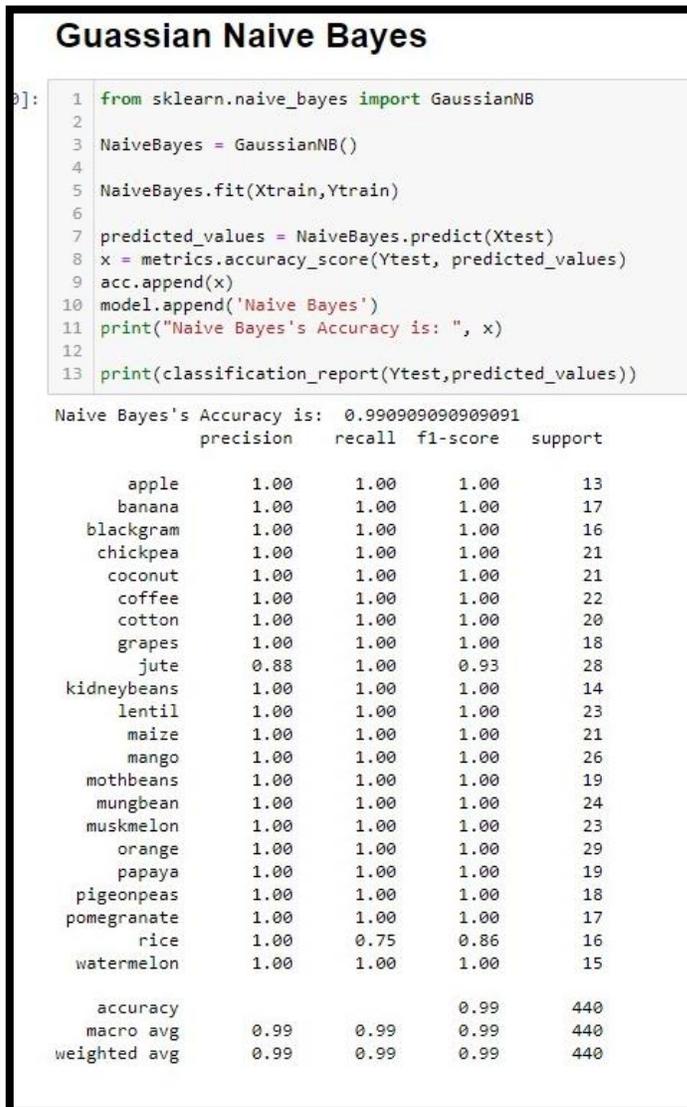


Figure 4 accuracy in gaussian naïve bayes

- **Random Forest**

On applying it on dataset it gives accuracy of 99.09%.

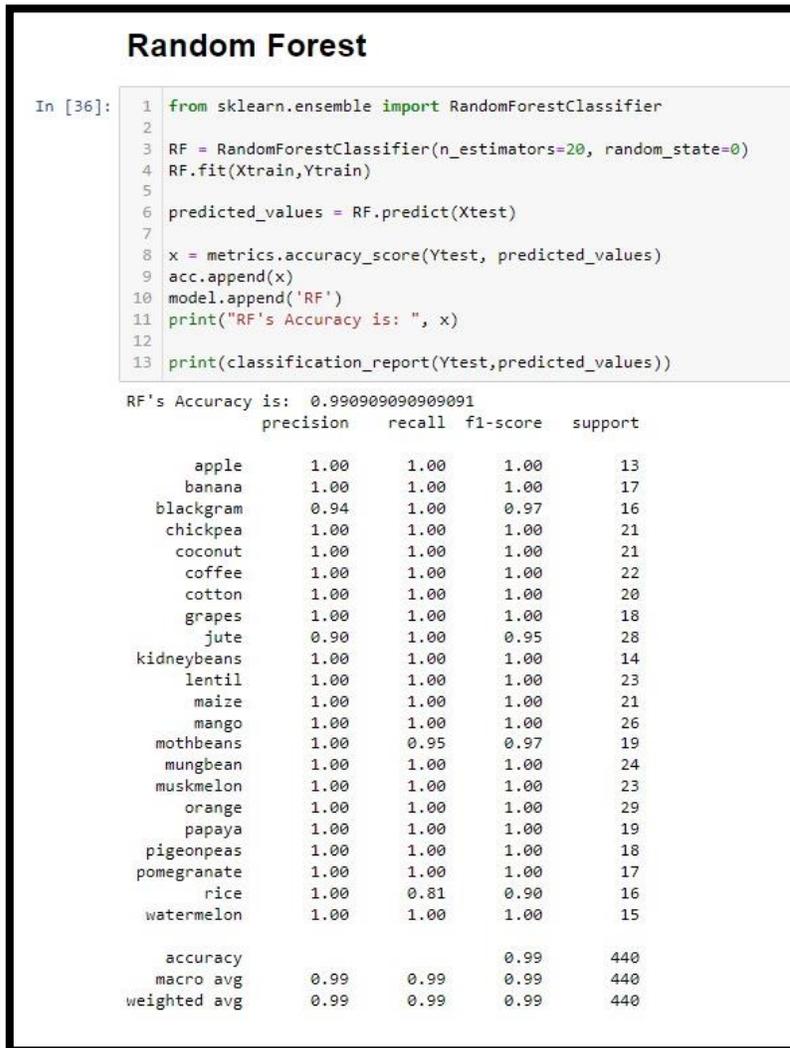


Figure 5 accuracy in random forest

- **Decision tree**

On applying it on dataset it gives accuracy of 90%.

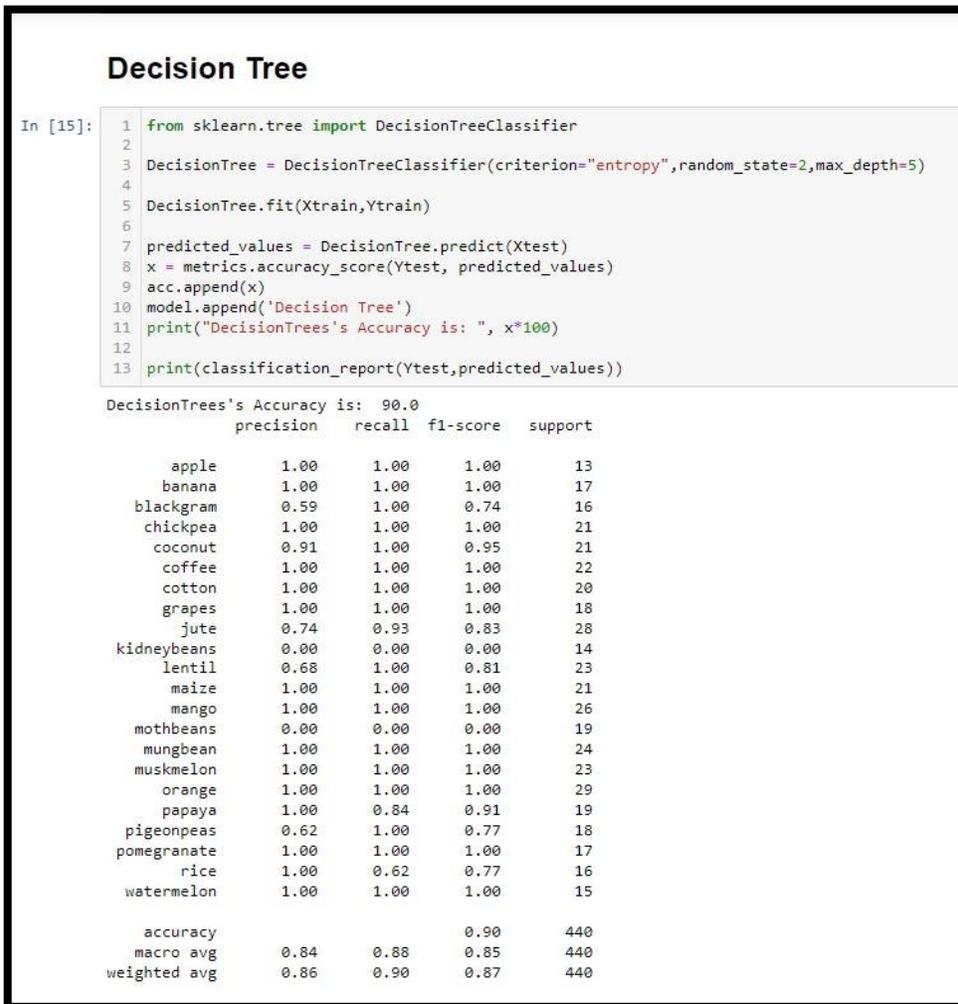


Figure 6 accuracy in Decision tree

- SVM: (Support vector machine)

On applying it on dataset it gives accuracy of 97.95%.

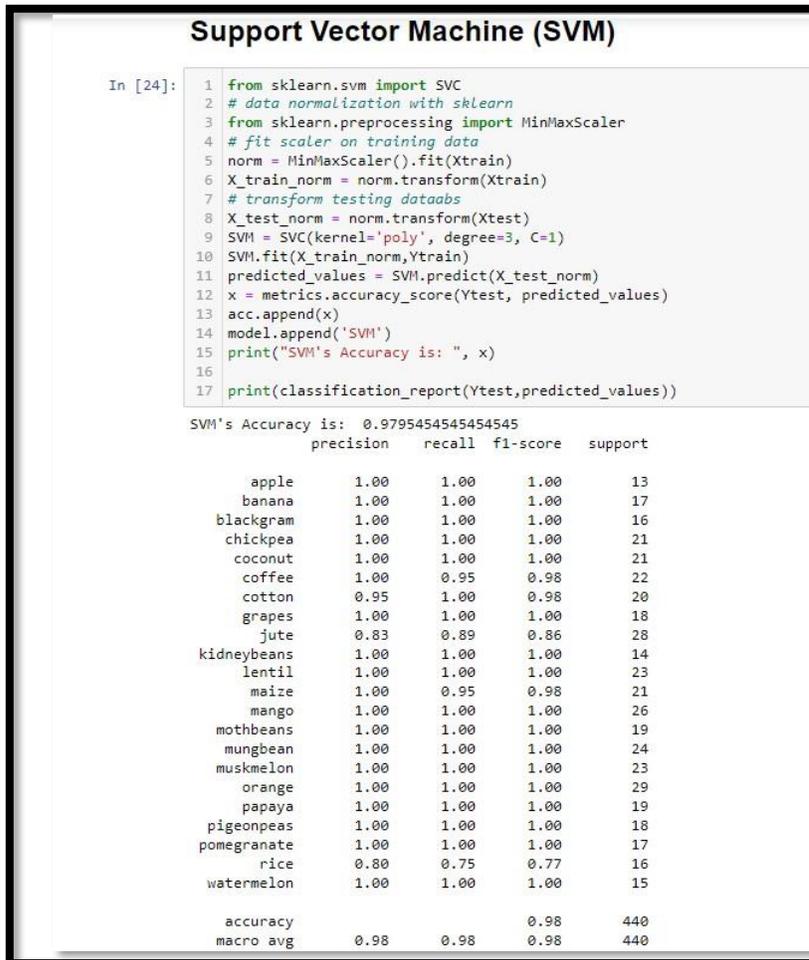
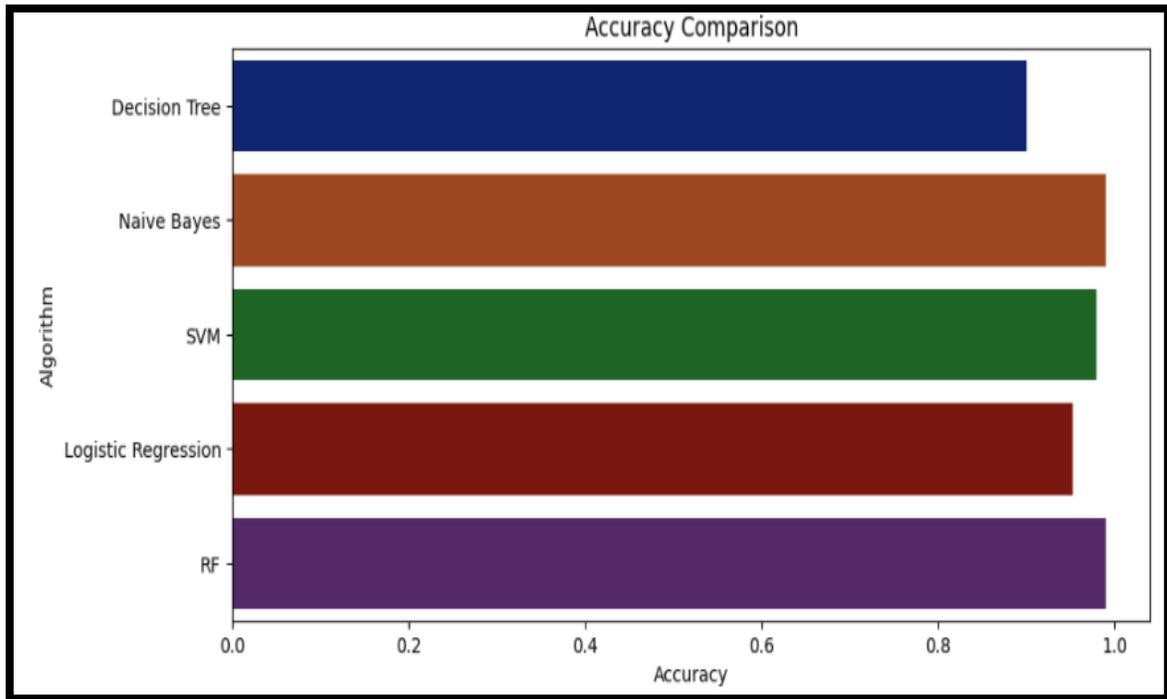


Figure 7 accuracy in support vector machine

### 4.3) Accuracy Comparison of Algorithms



Graph 7 Accuracy Comparison of Algorithms

## 4.4) Output

### Home page

A home page is generally the first page of the website when a visitor visits to the website and it also work as a navigating page visit other pages of website. Therefore, a good looking and nicer home page design is essential for a website.

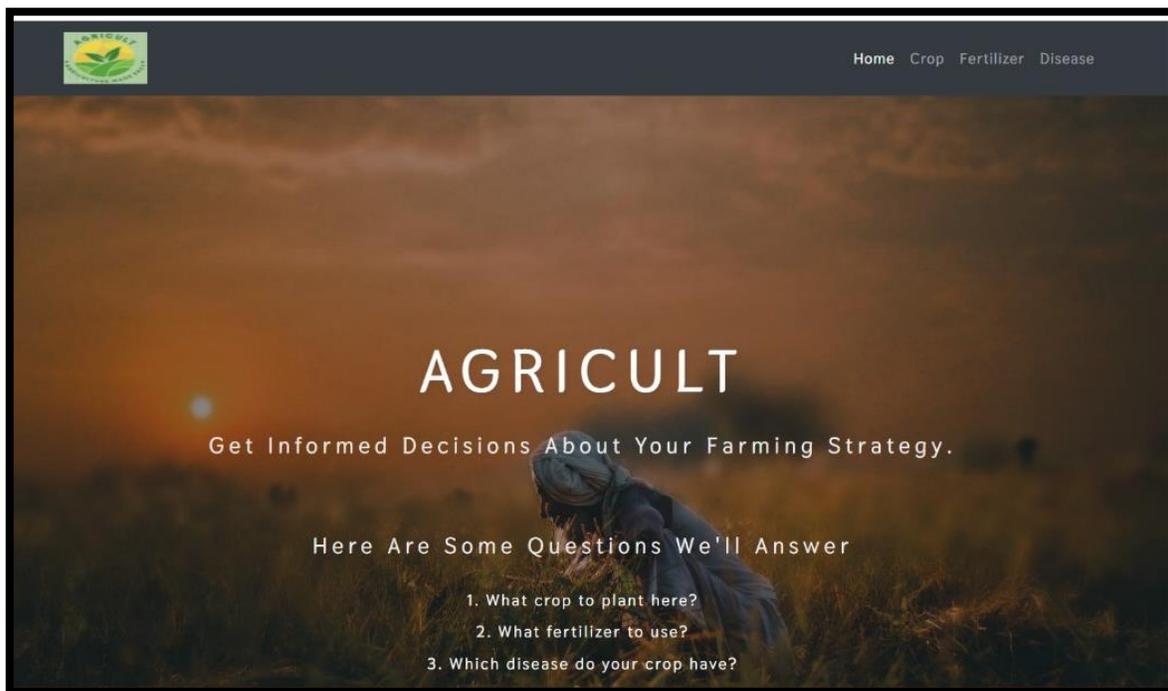


Figure 8 home page

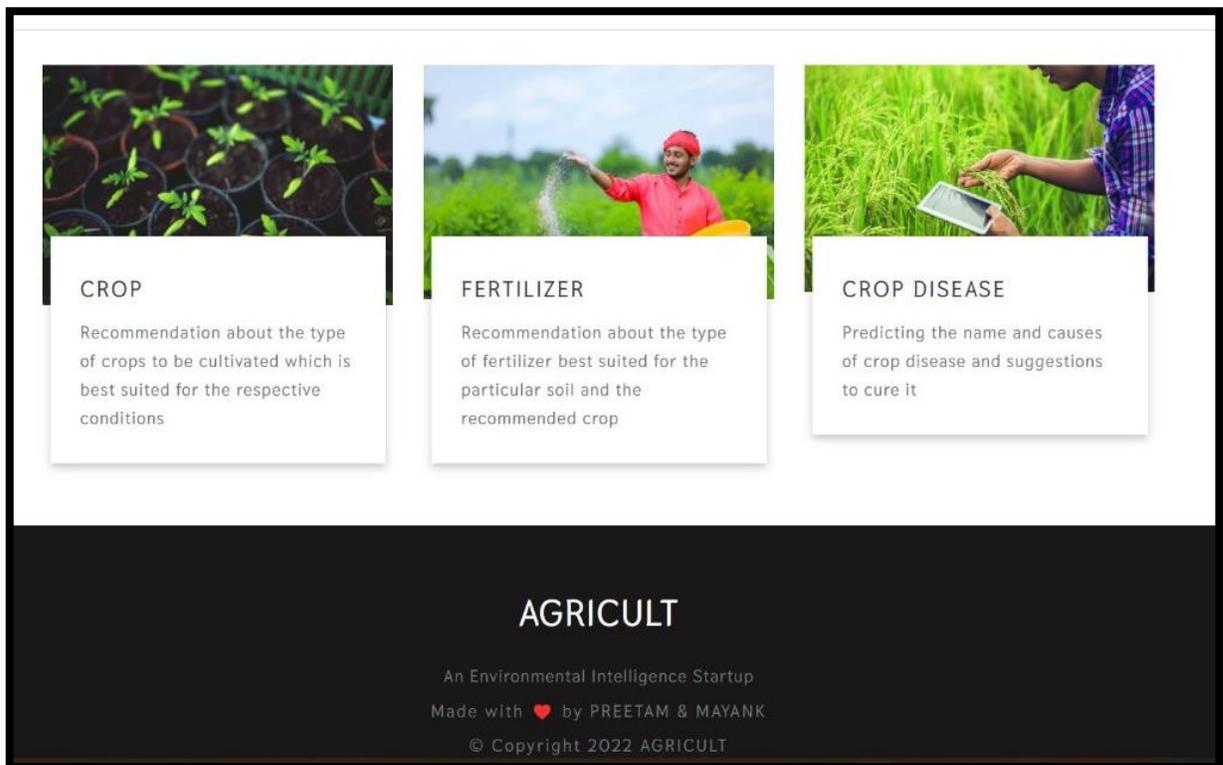
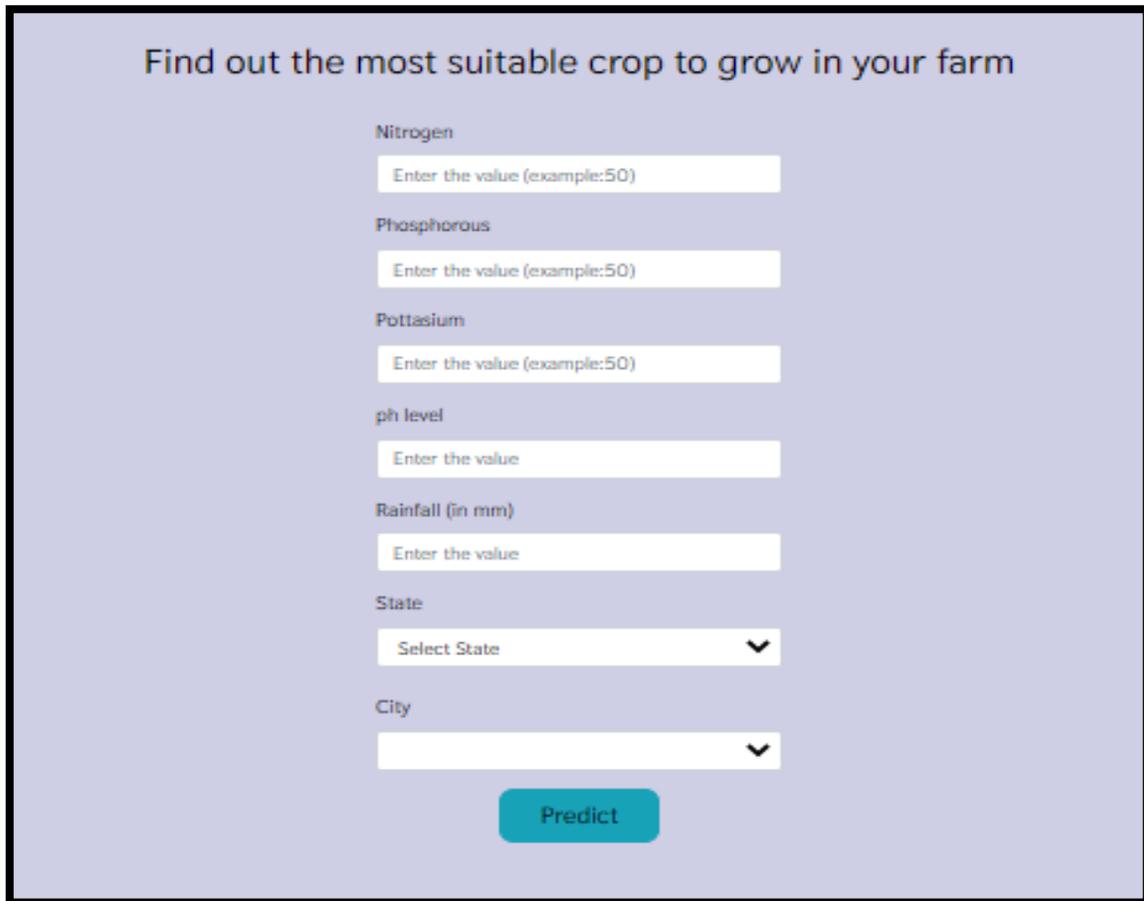


Figure 9 home page

## Crop recommendation system

To recommend crops that should be planted by farmers based on a number of criteria and help them make an informed decision before planting.



The image shows a web form titled "Find out the most suitable crop to grow in your farm". The form is set against a light purple background and contains the following fields:

- Nitrogen:** A text input field with the placeholder text "Enter the value (example:50)".
- Phosphorous:** A text input field with the placeholder text "Enter the value (example:50)".
- Pottasium:** A text input field with the placeholder text "Enter the value (example:50)".
- ph level:** A text input field with the placeholder text "Enter the value".
- Rainfall (in mm):** A text input field with the placeholder text "Enter the value".
- State:** A dropdown menu with the text "Select State" and a downward arrow.
- City:** A dropdown menu with a downward arrow.

At the bottom center of the form is a teal-colored button with the text "Predict".

Figure 10 crop recommendation system

### Find out the most suitable crop to grow in your farm

Nitrogen

Phosphorous

Potassium

ph level

Rainfall (in mm)

State  
 ▼

City  
 ▼

Figure 11 crop recommendation system with input

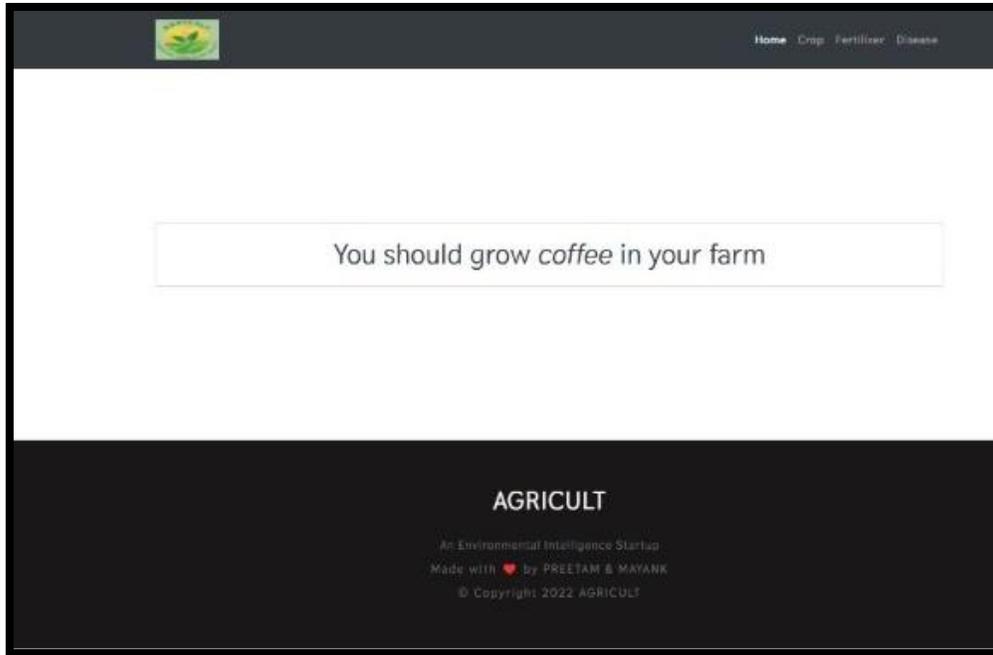
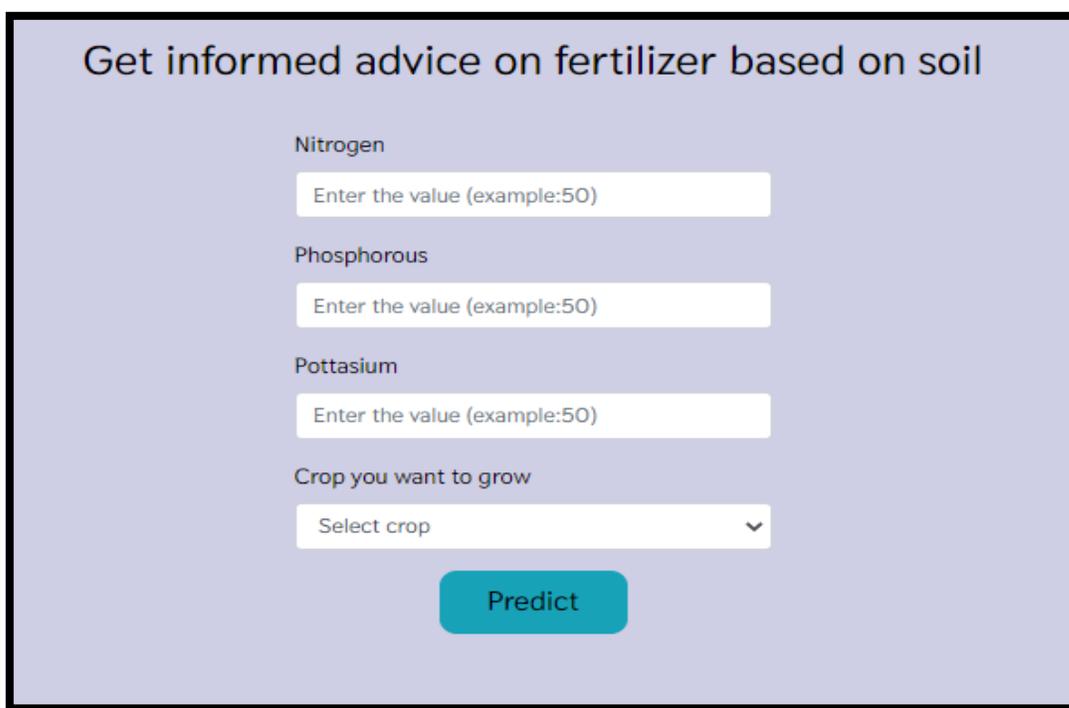


Figure 12 crop recommendation system giving output

## Fertilizer recommendation system

In the fertilizer recommendation system, the user can input the soil data (like amount of nitrogen, phosphorous, potassium, crop you wanna to grow), and the application will predict what is best for soil to maximize the crop yield and will recommend suggestions for improvements.



The image shows a web interface for a fertilizer recommendation system. The title is "Get informed advice on fertilizer based on soil". Below the title, there are four input fields: "Nitrogen", "Phosphorous", and "Pottasium" (note the spelling error), each with a text input box containing the placeholder "Enter the value (example:50)". The fourth field is "Crop you want to grow", which is a dropdown menu with the placeholder "Select crop" and a downward arrow. Below these fields is a teal "Predict" button.

Figure 13 fertilizer recommendation system

Get informed advice on fertilizer based on soil

Nitrogen  
25

Phosphorous  
66

Potassium  
28

Crop you want to grow  
kidneybeans

Predict

Figure 14 fertilizer recommendation system with input

The K value of your soil is high.  
Please consider the following suggestions:

1. Loosen the soil deeply with a shovel, and water thoroughly to dissolve water-soluble potassium. Allow the soil to fully dry, and repeat digging and watering the soil two or three more times.
2. Sift through the soil, and remove as many rocks as possible, using a soil sifter. Minerals occurring in rocks such as mica and feldspar slowly release potassium into the soil slowly through weathering.
3. Stop applying potassium-rich commercial fertilizer. Apply only commercial fertilizer that has a '0' in the first number field. Commercial fertilizers use a three number system for measuring levels of nitrogen, phosphorous and potassium. The last number stands for potassium. Another option is to stop using commercial fertilizers all together and to begin using only organic matter to enrich the soil.
4. Mix crushed eggshells, crushed seashells, wood ash or soft rock phosphate to the soil to add calcium. Mix in up to 10 percent of organic compost to help amend and balance the soil.
5. Use NPK fertilizers with low K levels and organic fertilizers since they have low NPK values.
6. Grow a cover crop of legumes that will fix nitrogen in the soil. This practice will meet the soil's needs for nitrogen without increasing phosphorus or potassium.

Figure 2 fertilizer recommendation system with output

## Chapter-5 CONCLUSIONS

### 5.1) Conclusions

In this project we try to get best crop and fertilizer recommendation with the help of machine learning. For the calculation of accuracy many machine learning techniques were imposed or used. Numerous algorithms were used on datasets to get the best output which leads to best crop and fertilizer recommendation for particular soil of particular region.

This system will help farmers to visualize crop yields based on that climatic and subsistence boundaries

Using this farmer can decide whether to plant that crop or to look for another crop if yield forecasts are incorrect.

This tool can help the farmer to make the best decisions when it comes to growing something harvest. It may also predict the negative effects of the plant.

Currently our farmers use outdated technology or not use effectively, so there can be an opportunity of the wrong choice of cultivated crops that will reduce the profit by production.

To reduce these types of loss we try to create a farmer-friendly system, which will help in predicting which crop is best for a specific soil and this project will give the recommendation about the fertilizer needed by the soil for cultivation, seeds needed for cultivation, expectations yield and market price. Thus, this enables farmers to make the right choice in choosing a crop farming so that the agricultural sector can develop with new ideas

## 5.2) Future Scope

For the upcoming updates in this project we can use deep learning techniques for plant diseases prediction with the help of images and we can also implement IOT techniques for getting contents of soil directly from the fields.

Future Work on this can add many options such as:

- Diagnosis and prevention of plant diseases, predicting plant species.
- Current Market Conditions and analysis for information on crop market rates, production costs, fertilizer.
- Government options for knowing new government programs related to borrowing, fertilizer, and harvesting.
- The mobile app can be developed to assist farmers with uploading farm photos.
- Plant Disease Detection is used to process images where the user finds pesticides based on their pictures of diseases.

## REFERENCES

- [1] Bondre, D. A., & Mahagaonkar, S. (2019). PREDICTION OF CROP YIELD AND FERTILIZER RECOMMENDATION USING MACHINE LEARNING ALGORITHMS. *International Journal of Engineering Applied Sciences and Technology*, 04(05), 371–376. <https://doi.org/10.33564/ijeast.2019.v04i05.055>
- [2] R. Kumar, M. P. Singh, P. Kumar and J. P. Singh, "Crop Selection Method to maximize crop yield rate using machine learning technique," 2015 International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials (ICSTM), 2015, pp. 138-145, doi: 10.1109/ICSTM.2015.7225403.
- [3] Leo Brieman, "Random Forests", 2001
- [4] Priya, P., Muthaiah, U., Balamurugan, M."Predicting Yield of the Crop Using Machine Learning Algorithm",2015
- [5] Mishra, S., Mishra, D., Santra, G. H.,"Applications of machine learning techniques in agricultural crop production",2016
- [6] Ramesh Medar,Vijay S, Shweta, "Crop Yield Prediction using Machine Learning Techniques", 2019
- [7] <https://www.data.gov.in>
- [8] <https://power.larc.nasa.gov/data-access-viewer/>
- [9] <https://en.wikipedia.org/wiki/Agriculture>
- [10] <https://www.ibm.com/weather>
- [11] <https://openweathermap.org>
- [12] <https://builtin.com/data-science/random-forest-algorithm>

[13] <https://tutorialspoint/machine-learning/logistic-regression>

[14] <http://scikit-learn.org/modules/naive-bayes>