CROP RECOMMENDATION SYSTEM USING MACHINE LEARNING

A PROJECT REPORT

Submitted by

MANO S (312418205046)

KARTHIKEYAN S (312418205037)

in partial fulfillment for the award of the degree

of

BACHELOR OF TECHNOLOGY

in

INFORMATION TECHNOLOGY

ST. JOSEPH’S INSTITTUE OF TECHNOLOGY

ANNA UNIVERSITY, CHENNAI 600 025

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BONAFIDE CERTIFICATE

Certified that this project report **“CROP RECOMMENDATION SYSTEM USING MACHINE LEARNING”** is the bonafide work of **MANO SRITHAR (312417205046) and KARTHIKEYAN S (312418205037)** who carried out the project work under my supervision, for the partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Information Technology. Submitted for the Viva-Voce held on ____.

SIGNATURE	**SIGNATURE**
Dr. S.KALARANI M.E.,Ph.D.,	Dr.M.K.KIRUBAKARAN M.E.,Ph.d.,
HEAD OF THE DEPARTMENT	**ASSOCIATE PROFESSOR**
Department of Information Technology	Department of Information Technology
St. Joseph’s Institute of Technology	St. Joseph’s Institute of Technology
Old Mamallapuram Road	Old Mamallapuram Road
Chennai- 600119	Chennai- 600119

(INTERNAL EXAMINER)	**(EXTERNAL EXAMINER)**

CERTIFICATE OF EVALUATION

College Name **:** St. Joseph's Institute of Technology

Branch & Semester **:** Information Technology (VIII)

S.NO	NAME OF STUDENT	TITLE OF THE PROJECT	NAME OF THE SUPERVISOR WITH DESIGNATION
1	**Karthikeyan S** **(312418205037)**	Crop Recommendation System using Machine Learning	Dr.M.K.Kirubakaran M.E.,Ph.D., Associate Professor
2	**Mano S** **(312418205046)**		

The report of the project work submitted by the above students in partial fulfilment for the award of Bachelor of Technology degree in Information Technology of Anna University were evaluated and confirmed to be reports of the work done by the above students and then evaluated.

(INTERNAL EXAMINER) **(EXTERNAL EXAMINER)**

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Last but not the least, we thank our family members and friends who have been the greatest source of support to me.

ABSTRACT

Agriculture and its allied sectors are undoubtedly the largest providers of livelihoods providers of livelihoods in rural India. Agriculture plays a vital role in the socioeconomic fabric of India. The agriculture sector is also a significant contributor factor to the country's Gross Domestic Product (GDP). Blessing to the country is the overwhelming size of the agricultural sector. However, regrettable is the yield per hectare of crops in comparison to international standards. This is one of the possible causes for a higher suicide rate among marginal farmers in India.

Failure of farmers to decide on the most-suited crop for the land using traditional and non-scientific methods is a serious issue for a country where approximately 58 percent of the population is involved in farming. Sometimes farmers were failed to choose the right crops based on the soil conditions, and season. This results in suicide, quitting the agriculture field, moving towards urban areas for livelihood. To overcome this issue, this research work has proposed a considering all the factors like N, P, K, and rainfall.

Furthermore, precision agriculture is being implemented with a modern agricultural technology and it is evolving in developing countries that concentrates on site-specific crop management. The proposed system provides a connectivity to farmers via a web application. The user provides the ph, rainfall, N, P, and K. Machine Learning algorithms allow choosing the most profitable crop for user provided input. To recommend the crop for cultivation system uses machine learning algorithms like random forest, decision tree, support vector classifier.

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ABBREVIATIONS	EXPANSION
N	Nitrogen
P	Phosphorus
K	Potassium
ML	Machine Learning
EDA	Exploratory Data Analysis
CDA	Confirmatory Data Analysis
IOT	Internet of Things
MLP	Multi-Layer Perceptron
KNN	K-Nearest Neighbors
RF	Random Forest
SVM	Support Vector Machine
SVC	Support Vector Classifier
CFS	Correlation Feature Selection
IG	Information Gain
GR	Gain Ratio
RMSE	Root Mean Squared Error
CMR	Conventional Multiple Regression
GRNN	Generalized Regression Neural Network
PLSR	Partial Least Square Regression
MLR	Multivariate Linear Regression
ENSVM	Ensemble Classification and Pattern Recognition for Crop Monitoring System
ECPRC	Ensemble Nonlinear Support Vector Machine

TABLE OF CONTENT

CHAPTER 1

INTRODUCTION

1.1 SYSTEM OVERVIEW

1.1.1 DATA ANALYSIS

Data analysis is a process of inspecting, cleansing, transforming, and modelling data, with the goal of discovering useful information, informing conclusions, and supporting decision-making. Data analysis has multiple facets and approaches, encompassing divers' techniques under a variety of names, and is used in different business, science, and social science domains. In today's business world, data analysis plays a role in making decisions more scientific and helping businesses operate more effectively. Data mining is a particular data analysis technique that focuses on statistical modelling and knowledge discovery for predictive rather than purely descriptive purposes, while business intelligence covers data analysis that relies heavily on aggregation, focusing mainly on businesses information. In statistical applications, data analysis can be divided into descriptive statistics, exploratory data analysis, and confirmatory data analysis. EDA (Exploratory Data Analysis) focuses on discovering new features in the data while CDA (Confirmatory Data Analysis) focuses on confirming or falsifying existing hypotheses. Predictive analytics focuses on the application of statisticalmodels for predictive forecasting or classification, while text analytics applies statistical, linguistic, and structural techniques to extract and classify information from textual sources, a species of unstructured data. All above are varieties of data analysis. Data analysis is a process for obtaining raw data, and subsequently converting it into information useful for decision-making by users.

1.1.2 SCIKIT-LEARN

Scikit-learn is a free software machine learning library for the python programming language. It features various classification regression and clustering algorithms including support-vector machines; random forests, gradient boosting, k-vector machines, random forests, gradient boosting, k-means and clustering algorithms including support-vector machines, random forests, gradient boosting, k-means and is designed to interoperate with the python numerical and scientific libraries Numpy and Scipy.

1.1.3 CLASSIFICATION ANALYSIS

Classification analysis is a data analysis task within data mining that identifies and assigns categories to a collection of data to allow for more accurate analysis. The classification method makes use of mathematical techniques such as decision trees, linear programming, neural network, and statistics. Classification is the process of predicting the class of given data pints. Classes are sometimes calledas targets/labels or categories. Classification predictive modeling is the task of approximating a mapping function from input variables to discrete output variables.

Classification analysis can be used to question, decide, or predict behavior using an algorithm. It works by developing a set of training data which contains a certain set of attributes as well as the likely outcome. The jobof the classification algorithm is to discover how that set of attributes reaches its conclusion. There are two steps in the construction of a classification model. Learning Step and Classification Step. Learning step is where different algorithms are used to build a classifier by making the model learn using the training set available. The model has to be trained for the prediction of accurate results.

Classification Step is where the model used to predict class labels, tests the constructed model on test data. Which in turn estimates the accuracy of the classification rules. Some scenarios where classification is used includespredicting the weather and analyzing health conditions.

1.1.4 SUPPORT VECTOR MACHINE

Support Vector Machine is one of the most popular Supervised Learning algorithms, which is used for Classification as well as Regression problems. However, primarily, it is used for classification problems in Machine Learning. The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. The best decision boundary is called a hyperplane. SVM chooses the extreme points/vectors that help in creating the hyperplane. Support Vector Machine chooses the extreme points\vectors that help in creating the hyperplane. These extreme cases are called as support vectors, and hence algorithm is termed as support Vector Machine.

1.2 SCOPE OF THE PROJECT

In this project system are going to recommend the crop for cultivation based the characteristics of lands like potassium, nitrogen, and rainfall. The project as a web application which everyone can access and instantly get their recommendation for their field. As a result, farmers can get the maximum amount yield because of choosing the right crop for production. The model has been deployed as a web application, anyone needs help in the selecting the crop for cultivation can use this application and select the most suitable crop for cultivation based on the input their given and past agricultural changes that has been analyzed by the machine learning model. The web application will produce the result within few seconds. The user gives input into the application the data has been send to machine learning model via the web application framework which connect the pickle file which contain the ml model and sends back the prediction, this prediction has been converted into recommendation based on the condition that has been given in the web application. Web application will reroute to another web page which most suited for the result of the crop recommendation system.

CHAPTER 2

LITERATURE SURVEY

2.1 Crop Prediction Based on Characteristics of the Agricultural Environment Using Various Feature Selection Techniques and Classifiers (S. P. Raja; Barbara Sawicka; Zoran Stankovic; and G.Mariammal, IEEE Access, volume:10,2022)

Agriculture is a growing field of research. Crop prediction in agriculture is critical and is chiefly contingent upon soil and environment conditions, including rainfall, nitrogen, potassium. In the past, farmers were able to decide on the crop to be cultivated, monitor its growth, and determine when it could be harvested. Today, however, rapid changes in environmental conditions have made it difficult for the farming community to continue to do so. Consequently, in recent years, machine learning techniques have taken over the task of prediction, and this work has used several of these to determine crop yield. To ensure that a given machine learning (ML) model works at a high level of precision, it is imperative to employ efficient feature selection methods to preprocess the raw data into an easily computable Machine Learning friendly dataset. To reduce redundancies and make the ML model more accurate, only data features that have a significant degree of relevance in determining the final output of the model must be employed. Thus, optimal feature selection arises to ensure that only the most relevant features are accepted as a part of the model. Conglomerating every single feature from raw data without checking for their role in the process of making the model will unnecessarily complicate the model. Furthermore, additional features which contribute little to the ML model will increase its time and space complexity and affect the accuracy of the model's output. The result depict that an ensemble technique offers better prediction accuracy than the existing classification technique.

2.2 Machine Learning Application for Precision Agriculture (Abhinav Sharma; Arpit Jain; Prateek Gupta; Vinay Chowdary, IEEE Access, volume:9,2021)

Agriculture plays a vital role in the economic growth of any country. With the increase of population, frequent changes in climatic conditions and limited resources, it becomes a challenging task to fulfil the food requirement of the present population. Precision agriculture also known as smart farming have emerged as an innovative tool to address current challenges in agricultural sustainability. The mechanism that drives this cutting-edge technology is machine learning (ML). It gives the machine ability to learn without being explicitly programmed. Machine Learning together with IoT (Internet of Things) enabled farm machinery are key components of the next agriculture revolution. In this article, authors present a systematic review of Machine Learning applications in the field of agriculture. The areas that are focused are prediction of soil parameters such as organic carbon and moisture content, crop yield prediction, disease and weed detection in crops and species detection. Machine Learning with computer vision is reviewed for the classification of a different set of crop images in order to monitor the crop quality and yield assessment. This approach can be integrated for enhanced livestock production by predicting fertility patterns, diagnosing eating disorders, cattle behavior based on ML models using data collected by collar sensors, etc. Intelligent irrigation which includes drip irrigation and intelligent harvesting techniques are also reviewed that reduces human labor to a great extent. This article demonstrates how knowledge-based agriculture can improve the sustainable productivity and quality of the product.

2.3 Cascading Feature Filtering and Boosting Algorithm for Plant Type Classification Based on Image (Adel Bakshipour; IEEE Access, Volume:9,2021)

Crop and weeds identification is of important steps towards the development of efficient automotive weed control systems. The higher the accuracy of plant detection and classification, the higher the performance of the weeding machine. In this study, the capability of two popular boosting methods including Adaboost. LogitBoost algorithms was evaluated to enhance the plant classification performance of four classifiers, namely Multi-Layer Perceptron (MLP), k-Nearest Neighbors (kNN), Random Forest (RF), and Support Vector Machine (SVM). Four feature filtering techniques including Correlation-based Feature Selection (CFS), Information Gain (IG), Gain Ratio (GR), and OneR were applied to the image-extracted features and 10 of the most significant features were selected and fed into single and boosted classifiers. The model trained by IG selected features was the most appropriate classifier among the evaluated models whether in single or boosted modes. It was also found that boosting by using Adaboost.M1 and LogitBoost algorithms improved the classification accuracy. Regarding the performance values, the LogitBoost structure, which provided a classification accuracy of 99.58%, a kappa of 0.9948, and a Root Mean Squared Error (RMSE) of 0.0688 on training dataset, was selected as the most appropriate classifier for plant discrimination in peanut fields. The accuracy, k, and Root Mean Squared Error (RMSE) criteria of this combination on test dataset were 95.00%, 0.9375, and 0.1591, respectively. It was concluded that combination of boosting algorithms and feature selection methods can promote plant type discrimination accuracy, which is a crucial factor in the development of precision weed control systems.

2.4 Soil Sensors-Based Prediction System for Plant Diseases Using Exploratory Data Analysis and Machine Learning (Manish Kumar; Ahlad Kumar; Vin S.Palaparthy, IEEE Sensors Journal, volume 21, Issue:16,2021)

In this paper various prediction approaches, based on Conventional Multiple Regression (CMR), Generalized Regression Neural Network (GRNN), Support Vector Machine (SVM) has been used in building prediction models for plant diseases. Plant disease identification, based on GRNNs and probabilistic neural networks have been used as the classifiers to identify wheat and grape diseases. Based on high-resolution multispectral stereo images, K-Nearest Neighbor(KNN) classifiers have been employed for pixel-wise classification for automatic classification of leaf diseases. Models, like a Multi-Layered Perceptron model (MLP), are also used in plant disease recognition using various techniques involve Multivariate Liner Regression (MLR) and Partial Least Square Regression (PLSR), which use hyperspectral data to estimate the severity of plant disease.

2.5 Ensemble Classification and IoT-Based Pattern Recognition for Crop Disease Monitoring System (Gayathri Nagasubramanian; Rakesh Kumar Sakthivel; Rizwan Patan; Muthuramalingam Sankaya; Mahnoud Daneshmand; Amir H.Gandomi, IEEE Internet of Things Journal, Volume:8, Issue:16,2021)

Internet of Things in the agriculture field provides crops-oriented data sharing and automatic farming solutions under single network coverage. The components of IoT collect the observable data from different plants at different points. The data gathered through IoT components such as sensors and cameras can be used to be manipulated for a better farming oriented decision-making process. This work proposes a system that observes the crops growth and leaf diseases continuously for advising farmers in need. To provide analytical statistical on plan growth and disease patterns, the proposed framework uses machine learning techniques such as support vector machine and convolutional neural network. This framework produces efficient crop condition notifications to terminal IoT components which are assisting in irrigation, nutrition planning and environmental compliance related to the farming lands, in this regard this work proposes Ensemble Classification and Pattern Recognition for Crop Monitoring System (ECPRC) to identify plant diseases at the early stages. The Proposed Ensemble Classification and Pattern Recognition for Crop Monitoring System (ECPRC) uses Ensemble Nonlinear Support Vector Machine (ENSVM) for detecting leaf and crop diseases.

2.6 Weather Based Crop Prediction in India using Big Data Analytics (Rishi Gupta, Akhilesh Kumar Sharma, Krishna mode, Shareen Kasim, Zirawani Baharum, IEEE Access, Volume 9,2021)

This paper aims at collecting and analyzing temperature, rainfall, soil, seed, crop production, humidity, and wind speed data (in a few regions), which will help the farmers improve the produce of their crops. Firstly, data pre-process the data in a Python environment and then apply the MapReduce framework, which further analyses and processes the large volume of data. Secondly, k-means clustering is employed on results gained from MapReduce and provides a mean result on the data in terms of accuracy. After that, the use bar graphs and scatter plots to study the relationship between the crop, rainfall, temperature, soil, and seed type of two regions (Ahmednagar, Maharashtra and, Andaman and Nicobar Islands). Further, a self-designed recommender system has been used to predict the crops and display them on a Graphic User Interface designed in a Flask environment. The system design is scalable and can be used to find the recommended crops of other states in a similar manner in the future.

CHAPTER 3

SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

The existing system has uses different machine learning algorithms for the factor they used to get the recommendation, for productivity-based recommendation they are using ensemble technique, they use k-means algorithm and clustering analysis in productivity and season-based recommendation. They only use certain parameters to make a recommendation. In their system they only use parameters to get recommendation. They use decision tree, support vector machine, logistic regression algorithms based on the input dataset. This machine learning algorithms are hyper tuned to the dataset they use for recommendation of crop; this leads to improper hyperparameter turning.

3.1.1 DISADVANTAGES

- Unable to fulfill the factors that provide high yield of crop
- It provides lower accuracy in real time scenario
- This system provides the biased results of the parameters they use
- In larger perspective it also led to rise in food prices, starvation, crippling of economy

3.2 PROPOSED SYSTEM

The proposed system is implemented using machine learning. In the proposed system the environmental parameters such as, temperature, and geographical location in terms of the state along with characteristics such as soil type, pH value, and nutrients concentration all the factors are being considered to recommend a suitable crop to the user. In this system all the agricultural factors are cumulative considered for recommendation, in this system use support vector classifier algorithm. In support vector classifier hyperparameter tunning has been done for algorithms which considers all factors to make recommendation.

3.2.1 ADVANTAGES

- Recommendation of most suitable crop
- Eliminates the biased result for certain factors
- More accurate result

3.3 SYSTEM REQUIREMENTS

3.3.1 SOFTWARE REQUIREMENTS

REQUIREMENT	SPECIFICATION
Operating System	Linux/Mac OS/ Windows7+
System Type	64 Bit OS
Tool	Jupyter, Anaconda, Spyder
Coding Language	Python

TABLE 3.1- SOFTWARE REQUIREMENTS

3.3.2 HARDWARE REQUIREMENTS

REQUIREMENT	SPECIFICATION
Processor	Intel® Core™ i3 or AMD
Clock Speed	3.40 GHz
RAM	4 GB

TABLE 3.2- HARDWARE REQUIREMENT

3.4 LANGUAGE SPECIFICATION

3.4.1 PYTHON

Python is a general-purpose interpreted, interactive, object-oriented scripting and high-level programming language. Python is designed to be highly readable. It uses English keywords frequently whereas other languages use punctuation, and it has fewer syntactical constructions than other languages. Its design philosophy emphasizes code readability, and its syntax allows programmers to express concepts in fewer lines of code than would be possible in languages such as c++ or java. The language provides constructs intended to enable clear programs on both a small and large scale.

Python supports multiple programming paradigms, including object-oriented, imperative and functional programming or procedural styles. It features a dynamic type system and automatic memory management and has a large and comprehensive standard library. Python interpreters are available for installations on many operating systems, allowing python code execution on a wide variety of systems.

Python is Interpreted − Python is processed at runtime by the interpreter. Do not need to compile the program before executing it. This is like PERL and PHP.

Python is Interactive − Actually set at a Python prompt and interact with the interpreter directly to write programs.

Python is Object-Oriented − Python supports Object-Oriented style or technique of programming that encapsulates code within objects.

Python is a Beginner's Language − Python is a great language for the beginnerlevel programmers and supports the development of a wide range of applications from simple text processing to WWW browsers to games.

3.4.2 HISTORY OF PYTHON

Python was created by Guido van Rossum who is a Dutch programmer. He was also known as the "Benevolent dictator for life" (BDFL) for python, until he stepped down from the position in July 2018. He Worked at the Centrum Wiskunde & Informatica (CWI) and contributed a globe () routine to BSD Unix during 1986 and helped develop the ABC programming language. But later during December 1989, he was looking for a hobby project around the time in Christmas and started working on a new interpreter for a new language. He later named this language as Python after choosing the word form a TV serial named Monty Python's Flying Circus. He admits that ABC language is the predecessor of Python language. The first release of the language was done in 1991.

3.4.3 FEATURES OF PYTHON

Python is one of the most widely used language over the web. Some of the features are

- **Easy-to-learn** − Python has few keywords, simple structure, and a clearly defined syntax. This allows the student to pick up the language quickly.
- **Easy-to-read** − Python code is more clearly defined and visible to the eyes.
- **Easy-to-maintain** − Python's source code is fairly easy-to-maintained.
- **A broad standard library** − Python's bulk of the library is very portable and cross-platform compatible on UNIX, Windows, and Macintosh.
- **Interactive Mode** − Python has support for an interactive mode which allows interactive testing and debugging of snippets of code.
- **Portable** − Python can run on a wide variety of hardware platforms and has the same interface on all platforms.
- **Extendable** – It can add low-level modules to the Python interpreter. These modules enable programmers to add to or customize their tools to be more efficient.
- **Databases** − Python provides interfaces to all major commercial databases.

- **GUI Programming** − Python supports GUI applications that can be created and ported to many system calls, libraries and windows systems, such as Windows MFC, Macintosh, and the X Window system of Unix.
- **Scalable** − Python provides a better structure and support for large programs than shell scripting.

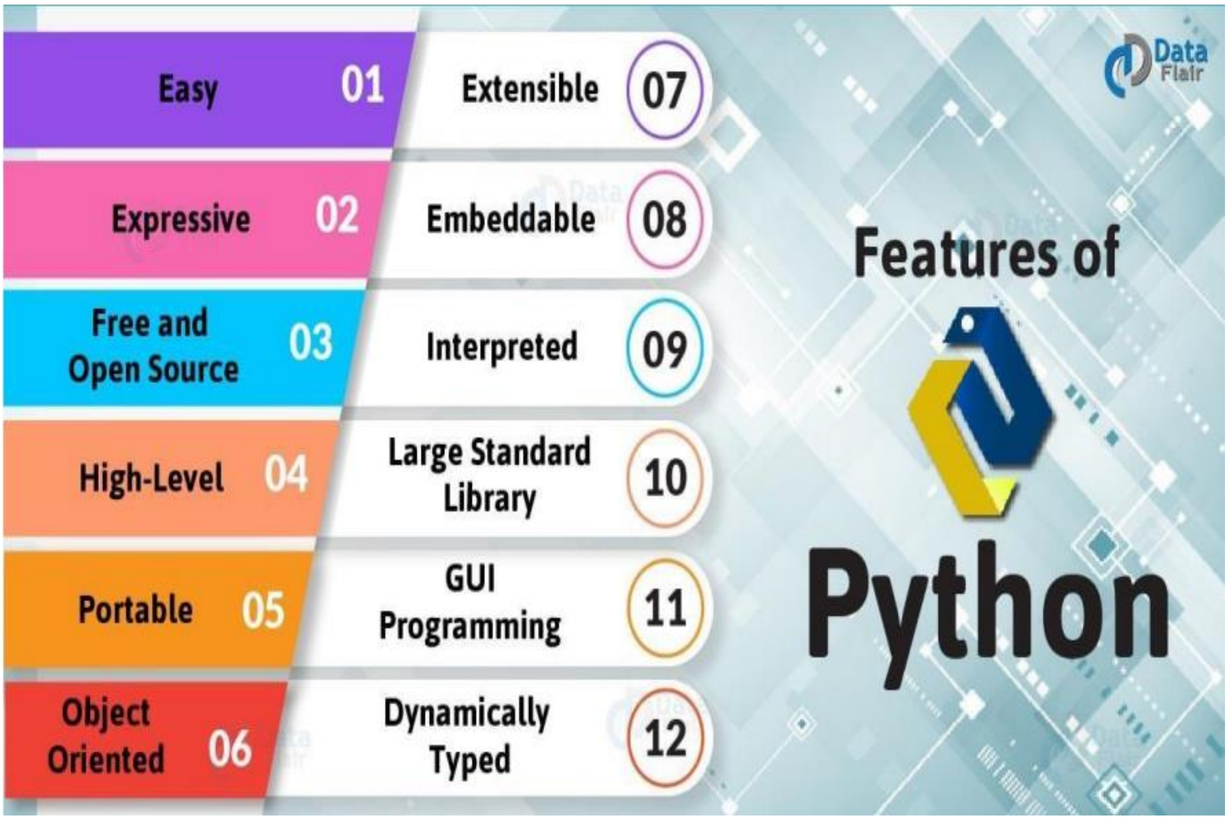


FIGURE 3.1 FEATURES OF PYTHON

3.4.4 LIBRARIES USED

- Numpy
- Pandas
- Scikit-learn

Numpy

Numpy is a Python library used for working with arrays. Numpy y stands for Numerical Python. It also has functions for working in domain of linear algebra, fourier transform, and matrices. In Python we have lists that serve the purpose of arrays, but they are slow to process. NumPy aims to provide an array object that is up to 50x faster than traditional Python lists.

Installation command: $ pip install numpy

Pandas

Pandas is a software library written for the python programming language for data manipulation and analysis. In particular, it offers data structures and operations for manipulating numerical tables and time series. It is free software released under the three-clause BSD license.

Installation command: $ pip install pandas

Scikit-learn

Scikit-learn is a free software machine learning library for the python programming language. It features various classification, regression and clustering algorithms including support vector, random forests, gradient boosting, k-means and DBSCAN, and is designed to interoperate with the python numerical and scientific libraries Numpy and Scipy.

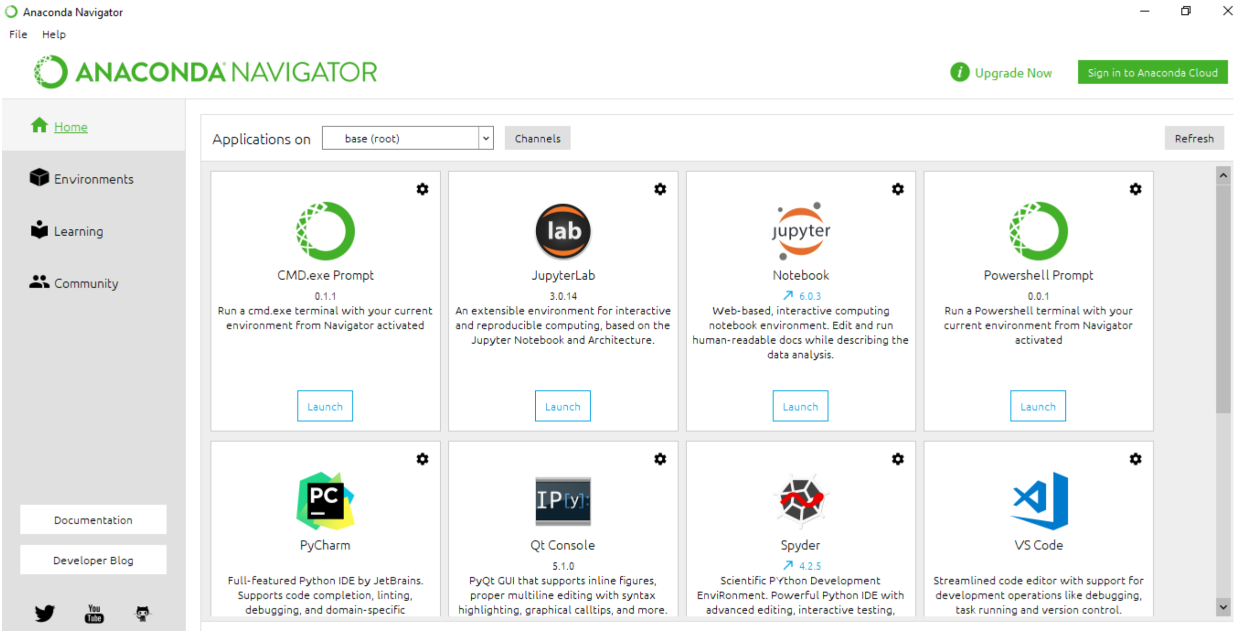
Installation command: $ pip install Scikit-learn

3.5 SOFTWARE SPECIFICATION

3.5.1 ANACONDA NAVIGATOR

Conda is an open source, cross-platform, language-agnostic package manager and environment management system that installs, runs, and updates packages and their dependencies. It was created for Python programs, but it can package and distribute software for any language including multi-language projects. The conda package and environment manager is included in all versions of Anaconda, Miniconda, and Anaconda

Repository. Anaconda Navigator is a desktop graphical user interface included in Anaconda distribution that allows to launch applications and easily manage conda packages, environments, and channels without using command-line commands. Navigator can search for packages on Anaconda.org or in a local Anaconda Repository. Now, if this is a primarily doing data science work, Anaconda is also a great option. Anaconda is created by Continuum Analytics, and it is a Python distribution that comes preinstalled with lots of useful python libraries for data science. Anaconda is a distribution of the Python and R programming languages for scientific computing (data science, machine learning applications, large-scale data processing, predictive analytics,), that aims to simplify package management and deployment. In order to run, many scientific packages depend on specific versions of other packages. Data scientists often use multiple versions of many packages and use multiple environments to separate these different versions. The command-line program conda is both a package manager and an environment manager.



CMD.exe Prompt
0.1.1
Run a cmd.exe terminal with your current environment from Navigator activated

JupyterLab
3.0.14
An extensible environment for interactive and reproducible computing, based on the Jupyter Notebook and Architecture.

Notebook
6.0.3
Web-based, interactive computing notebook environment. Edit and run human-readable docs while describing the data analysis.

Powershell Prompt
0.0.1
Run a Powershell terminal with your current environment from Navigator activated

PyCharm
Full-featured Python IDE by JetBrains. Supports code completion, linting, debugging, and domain-specific

Qt Console
5.1.0
PyQt GUI that supports inline figures, proper multiline editing with syntax highlighting, graphical calltips, and more.

Spyder
4.2.5
Scientific PYthon Development EnviRonment. Powerful Python IDE with advanced editing, interactive testing,

VS Code
Streamlined code editor with support for development operations like debugging, task running and version control.

FIGURE 3.2 ANACONDA NAVIGATOR

This helps data scientists ensure that each version of each package has all the dependencies it requires and works correctly. Navigator is an easy, point-and-click way to work with packages and environments without needing to type conda commands in a terminal window. They can use it to find the packages want, install them in an environment, run the packages, and update them – all inside Navigator.

3.5.2 JUPYTER NOTEBOOK

The Jupyter Notebook App is a server-client application that allows editing and running notebook documents via a web browser. The Jupyter Notebook App can be executed on a local desktop requiring no internet access or can be installed on a remote server and accessed through the internet.

In addition to displaying/editing/running notebook documents, the Jupyter Notebook App has a Dashboard, a control panel showing local file and allowing to open notebook documents or shutting down their kernels.

Kernel: A notebook kernel is a computational engine that executes the code contained in a Notebook document. The ipython kernel, referenced in this guide, executes python code. Kernels for many other languages exits. While open a Notebook document, the associated kernel is automatically launched. When the notebook is executed, the kernel performs the computation and produces the results. Depending on the type of computations, the kernel may consume significant cup and random access memory.

3.5 Git

Git is a distributed version-control system for tracking changes in source code during software development. It is designed for coordinating work among programmers, but it can be used to track changes in any set of files. Its goals include speed, data integrity, and support for distributed, non-linear workflows.

Git was created by Linus Torvalds in 2005 for development of the Linux kernel, with other kernel developers contributing to its initial development. Its current maintainer since 2005 is Junio Hamano.

As with most other distributed version-control systems, and unlike most client–server systems, every Git directory on every computer is a full-fledged repository with complete history and full version-tracking abilities, independent of network access or a central server. Git is free and open-source software distributed under the terms of the GNU General Public License version 2

Git will be integrated with deploying platforms to make the deployment easier to deploy updates in Application can done by updating the git version, updated git version will automatically be updated in deployment platform, and also reflected in the Application.

3.6 STREAMLIT

Streamlit is an open-source python library for creating and sharing web apps for data science and machine learning projects. The library can help to create and deploy machine learning solution in a few minutes with a few lines of code.

Streamlit can seamlessly integrate with other popular python libraries used in data science such as NumPy, Pandas, Matplotlib, Scikit-learn and many more

Installation command: $ pip install Streamlit

CHAPTER 4

SYSTEM DESIGN

4.1 SYSTEM ARCHITECTURE

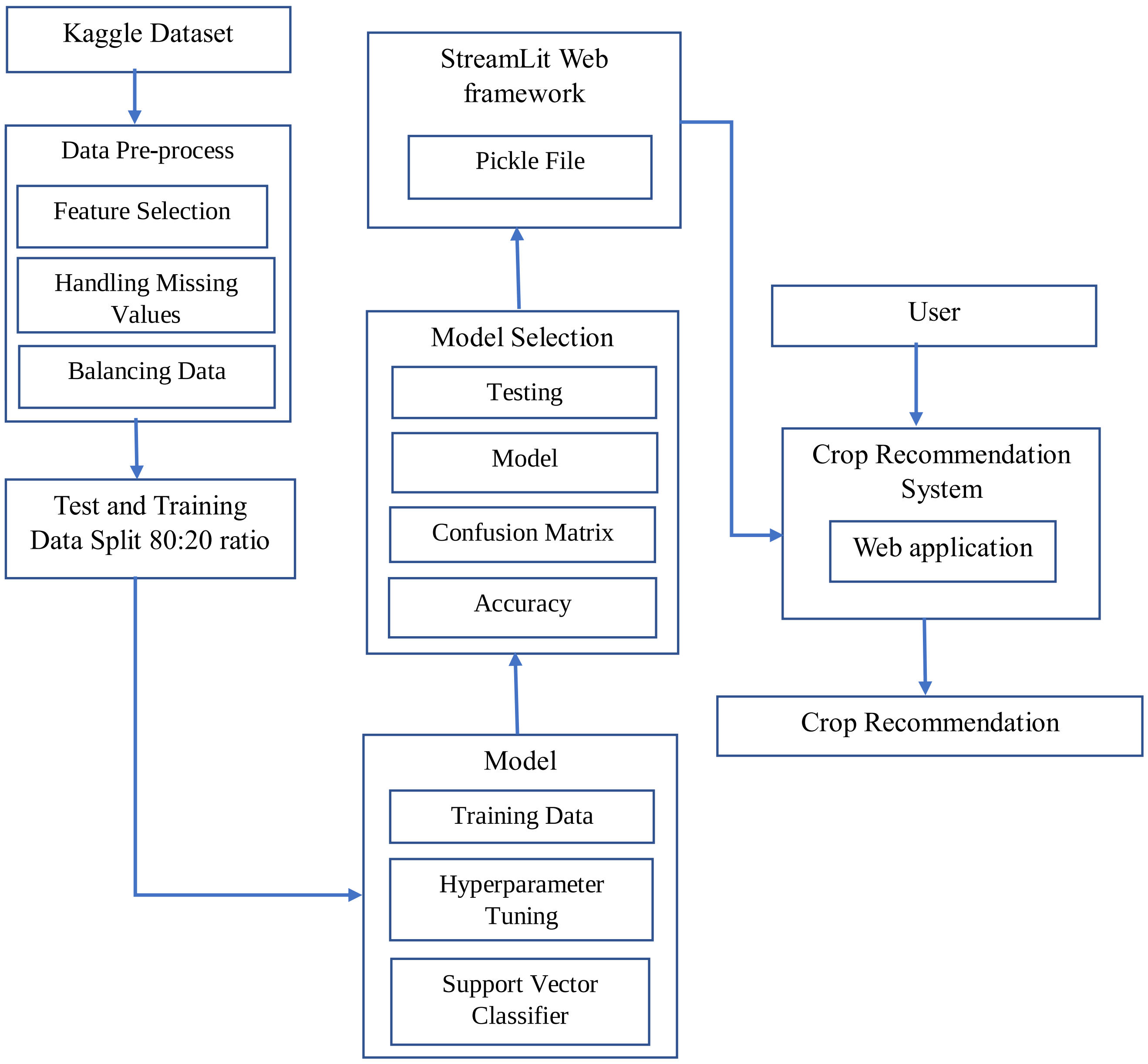


FIG 4.1 ARCHITECTURE DIAGRAM

4.1.1 ARCHITECTURE DESCRIPTION

In Fig 4.1 Consider a crop recommendation system data has been collected from the agricultural website and used kaggle data. The dataset contains wide range of inputs for recommending the crop for cultivation, that contains crop duration, temperature required for a crop potassium, nitrogen, ph, rainfall amount of water need, water source that most suits for this kind of crop. Collected data has preprocessing before analyzing, it can refer to manipulation or dropping of data before it is used in order to ensure or enhance performance. Exploratory Data Analysis is a next step of data preprocessing, exploratory data analysis is animportant machine learning step that involves learning about the data without spending too much time or getting lost in it. Exploratory Data Analysis consist of renaming the columns, finding data types of columns, missing values treatment, dropping the duplicate rows, variable transformation, dropping the missing or null values. It also uses visualizations techniques like heat map to find relevance of independent fields and dependent fields, in missing value treatment used is mean, mode for different fields. System encodes the categorical values using one hot encodingmethod for using data in system, it also includes checking whether the data is balanced or not, the unbalanced data reduces accuracy of a system. Algorithm selection the dataset has been split into a particular ratio as training and testing data. Training data has been used to train the machine learning model, after training the model using machine learning algorithm has testing using the test data to validate the model using the accuracy score of confusion matrix, if the accuracy of model is low different algorithms is used based on the EDA, different machine algorithms examined to get best accuracy. In state of getting most accuracy there also a possibility of model getting overfitted. The most suitable algorithm has been built into model and that model has been stored into a pickle file for system to be used when recommendation of crop needs. The web application has been created using a web framework streamlit, web application contains code for getting user input and sending it to the model and getting result from model by using a pickle file. The web application has been deployed in an online platform for user.

CHAPTER 5

SYSTEM IMPLEMENTATION

5.1 LIST OF MODULES

5.1.1 Data collection

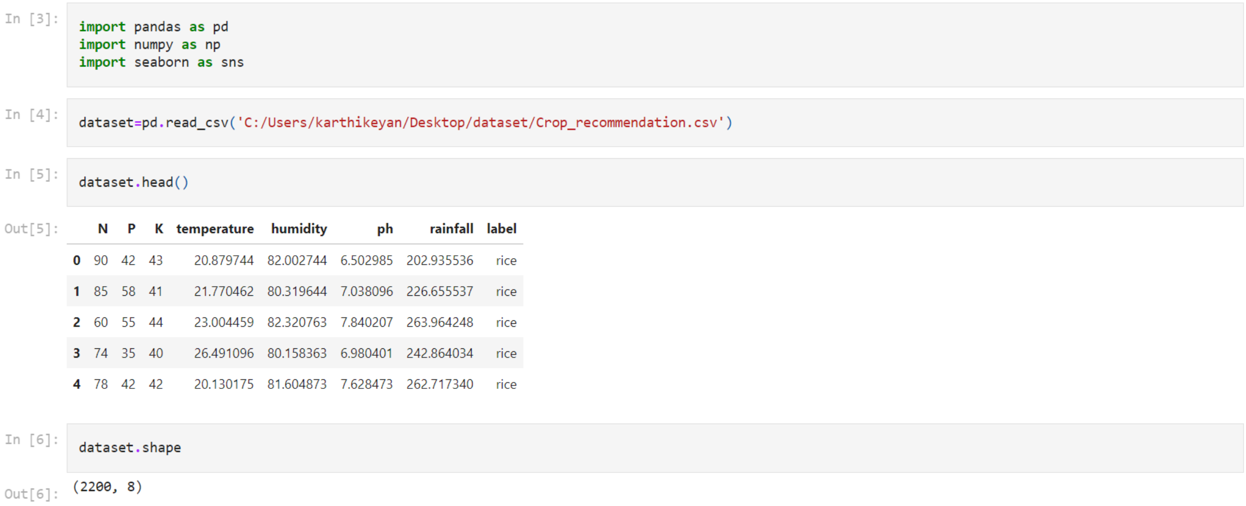
5.1.2 Exploratory data analysis

5.1.3 Data modeling

5.1.4 Deployment

5.1.1 DATA COLLECTION

Data is important part of this project; all the recommendations are made by the model that uses dataset for the training. Dataset must be more accurate to make a good recommendation, as data base part of recommendation dataset most not biased. Dataset must not be an old because every decade the climate conditions has been changing and agriculture cycle also change, data must be in a current to get best result for user. Dataset from Kaggle is used in the model building.

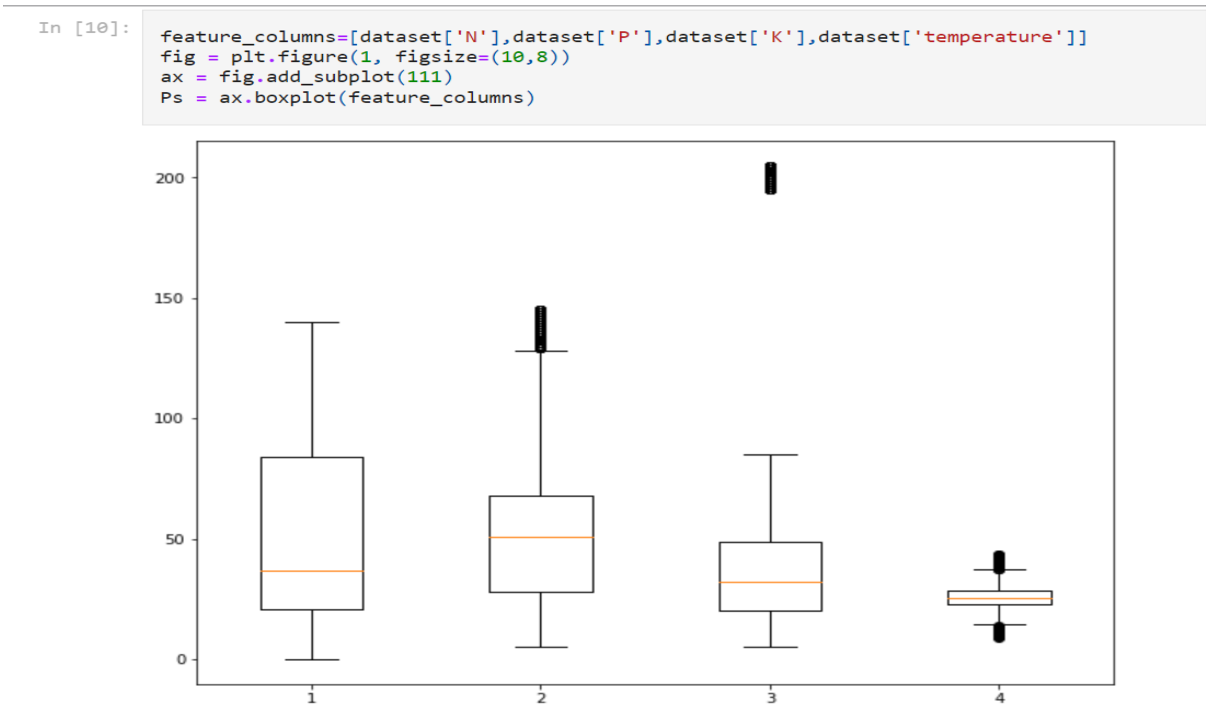


```
In [3]:  import pandas as pd
         import numpy as np
         import seaborn as sns

In [4]:  dataset=pd.read_csv('C:/Users/karthikeyan/Desktop/dataset/Crop_recommendation.csv')

In [5]:  dataset.head()

Out[5]:
     N   P   K  temperature   humidity        ph    rainfall  label
 0  90  42  43    20.879744  82.002744  6.502985  202.935536   rice
 1  85  58  41    21.770462  80.319644  7.038096  226.655537   rice
 2  60  55  44    23.004459  82.320763  7.840207  263.964248   rice
 3  74  35  40    26.491096  80.158363  6.980401  242.864034   rice
 4  78  42  42    20.130175  81.604873  7.628473  262.717340   rice

In [6]:  dataset.shape

Out[6]:  (2200, 8)
```

FIGURE 5.1 SAMPLE DATASET

5.1.2 EXPLORATORY DATA ANALYSIS

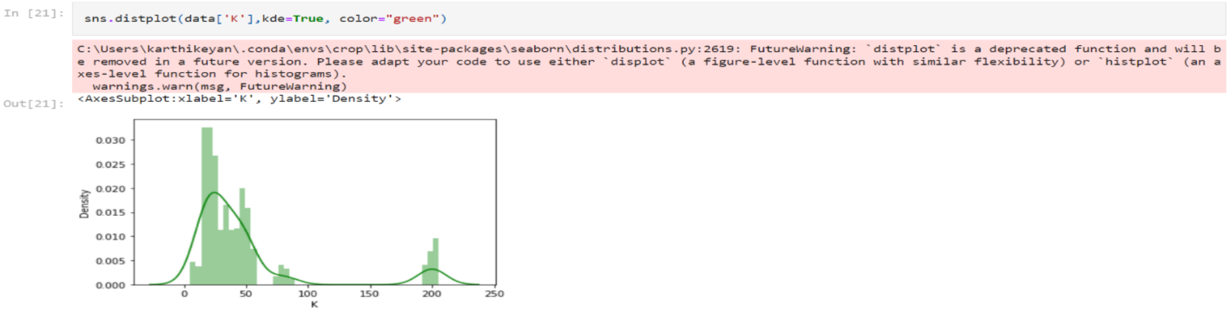
This step includes getting some concept about the answer and elements affecting it, earlier than constructing the real model. Distribution of data inside distinctive variables of a character are explored graphically the usage of bar-graphs, Relations between distinct aspects are captured via graphical representations like scatter plots and warmth maps. Many data visualization strategies are considerably used to discover each characteristic individually and by means of combining them with different features. Exploratory data analysis is an approach toanalyze the data using visual techniques. Heat maps, Distribution graphs are used in visualization. It is used to discover trends, patterns, orto check assumptions with the help of statistical summary and graphical representations.



```
In [10]:  feature_columns=[dataset['N'],dataset['P'],dataset['K'],dataset['temperature']]
          fig = plt.figure(1, figsize=(10,8))
          ax = fig.add_subplot(111)
          Ps = ax.boxplot(feature_columns)
```

FIGURE 5.2 OUTLIERS IN DATASET

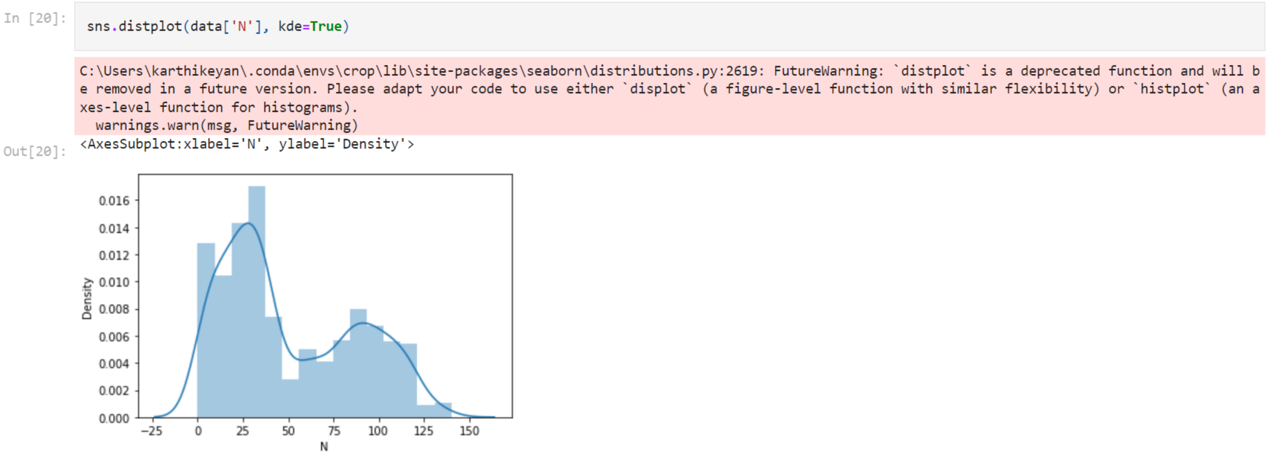
In this process handling all the data manipulation, which contains treatment of missing values, handling imbalanced dataset by drop the rows, if dataset contains huge number of rows or adding extra row for low amount of data. Missing values has been treated by dropping the records, replacing the null values with minimum, maximum or median values. It finds pattern in the data. Visualizations like heat maps, bar charts, scatter plots, heat maps are used to find the significance between the fields, and bar charts are used to find distribution of data. It helps choosing the right machine learning algorithm. Data that has been split into training and testing data after performing exploratory data analysis. Data has been split into a particular ratio as testing and training data as 75:25 respectively.



```
In [21]: sns.distplot(data['K'],kde=True, color="green")
```

```
C:\Users\karthikeyan\.conda\envs\crop\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `distplot` is a deprecated function and will b
e removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an a
xes-level function for histograms).
  warnings.warn(msg, FutureWarning)
Out[21]: <AxesSubplot:xlabel='K', ylabel='Density'>
```

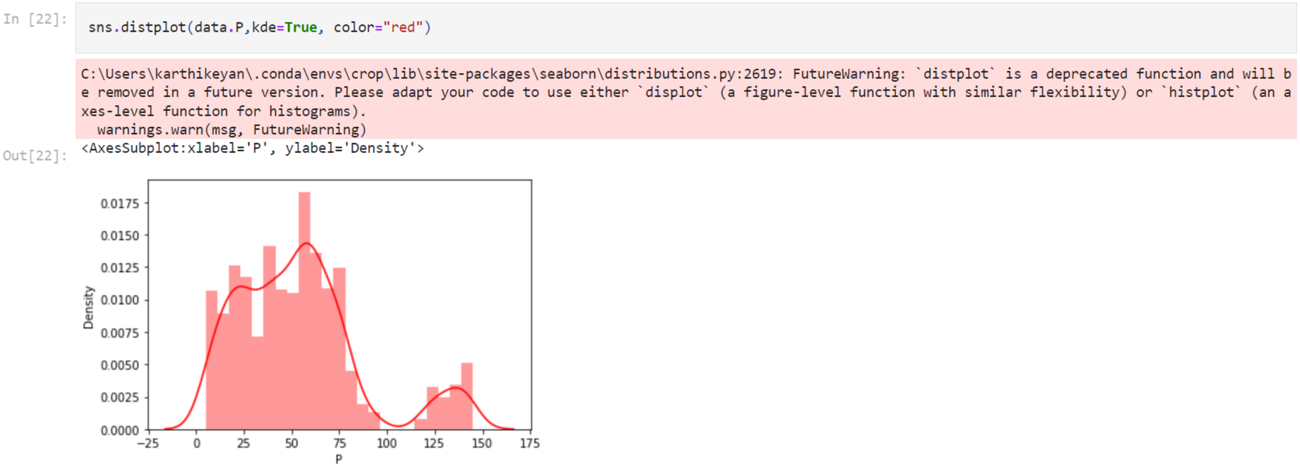
FIGURE 5.3 POTASSIUM DISTRIBUTION



```
In [20]: sns.distplot(data['N'], kde=True)
```

```
C:\Users\karthikeyan\.conda\envs\crop\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `distplot` is a deprecated function and will b
e removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an a
xes-level function for histograms).
  warnings.warn(msg, FutureWarning)
Out[20]: <AxesSubplot:xlabel='N', ylabel='Density'>
```

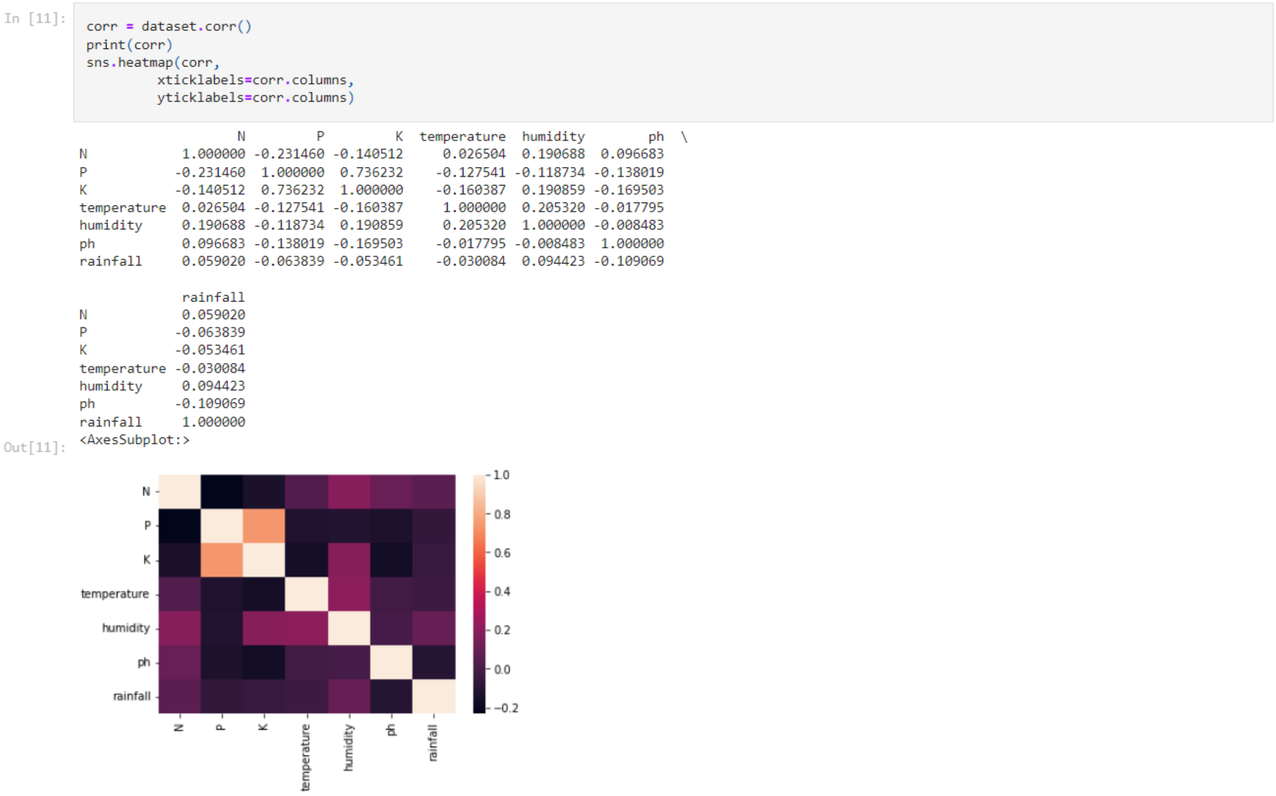
FIGURE 5.4 NITROGEN DISTRIBUTION



```
In [22]: sns.distplot(data.P,kde=True, color="red")

C:\Users\karthikeyan\.conda\envs\crop\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `distplot` is a deprecated function and will b
e removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an a
xes-level function for histograms).
  warnings.warn(msg, FutureWarning)
Out[22]: <AxesSubplot:xlabel='P', ylabel='Density'>
```

FIGURE 5.5 PHOSPHORUS DISTRIBUTION VISUALIZATION

Nitrogen, Phosphorus, and Potassium which are the essential nutrient for any plant growth. Figure 5.2, Figure 5.3, Figure 5.4 show the distribution of the values in Nitrogen (N), Phosphorus (P), Potassium (K).

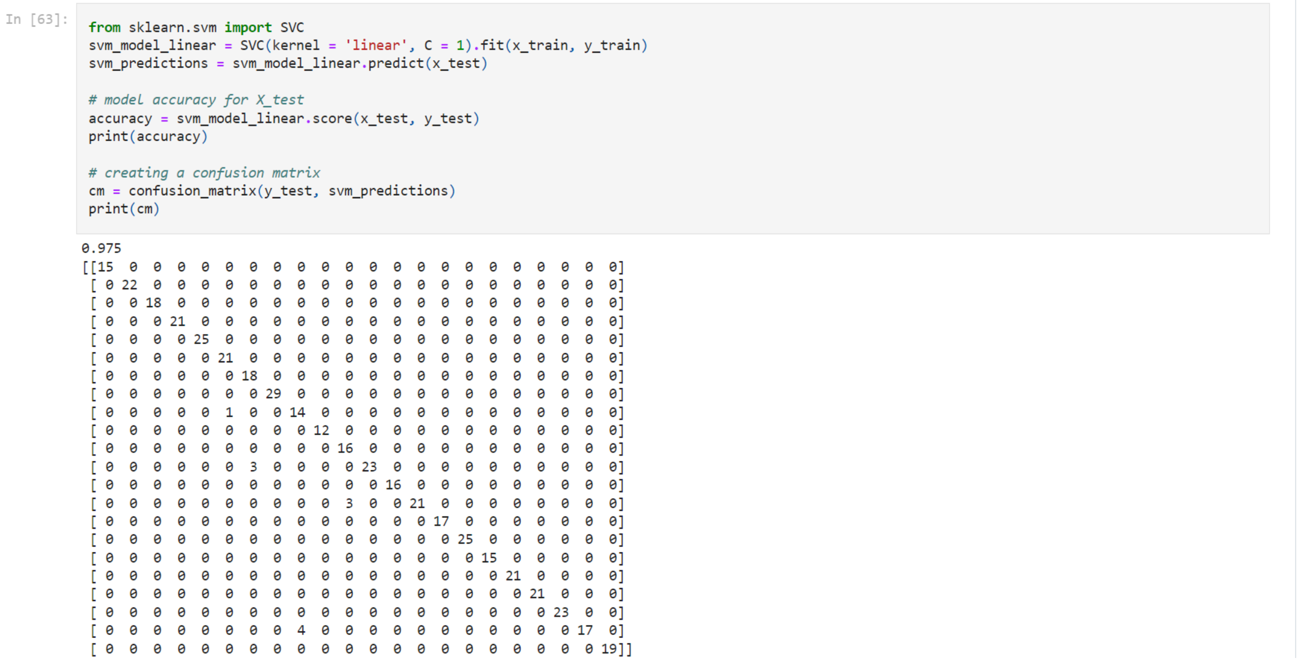


```
In [11]: corr = dataset.corr()
         print(corr)
         sns.heatmap(corr,
                  xticklabels=corr.columns,
                  yticklabels=corr.columns)

                    N         P         K  temperature  humidity        ph  \
N            1.000000 -0.231460 -0.140512     0.026504  0.190688  0.096683
P           -0.231460  1.000000  0.736232    -0.127541 -0.118734 -0.138019
K           -0.140512  0.736232  1.000000    -0.160387  0.190859 -0.169503
temperature  0.026504 -0.127541 -0.160387     1.000000  0.205320 -0.017795
humidity     0.190688 -0.118734  0.190859     0.205320  1.000000 -0.008483
ph           0.096683 -0.138019 -0.169503    -0.017795 -0.008483  1.000000
rainfall     0.059020 -0.063839 -0.053461    -0.030084  0.094423 -0.109069

             rainfall
N            0.059020
P           -0.063839
K           -0.053461
temperature -0.030084
humidity     0.094423
ph          -0.109069
rainfall     1.000000
Out[11]: <AxesSubplot:>
```

FIGURE 5.6 HEATMAP

5.1.3 DATA MODELING

Data modeling is the coronary heart of data analysis. A model takes the organized data as input and gives the preferred output. This step consists of selecting the suitable kind of model whether the problem is a classification problem or a regression problem or a clustering problem. After deciding on the model family, amongst the number of algorithms amongst that family need to cautiously pick out the algorithms to put into effect and enforce them. System used Random Forest. Algorithm for recommendation System. System needs to tune the hyper parameters of every model to obtain the preferred performance. System additionally need to make positive there is the right stability between overallperformance and generalizability. Confusion matrix has been used to find the accuracy of model, if the accuracy of the model is low hyper parameter tuning has been done to get maximum result, if the accuracy remains low the machine learning algorithm changed based on the exploratory data analysis.



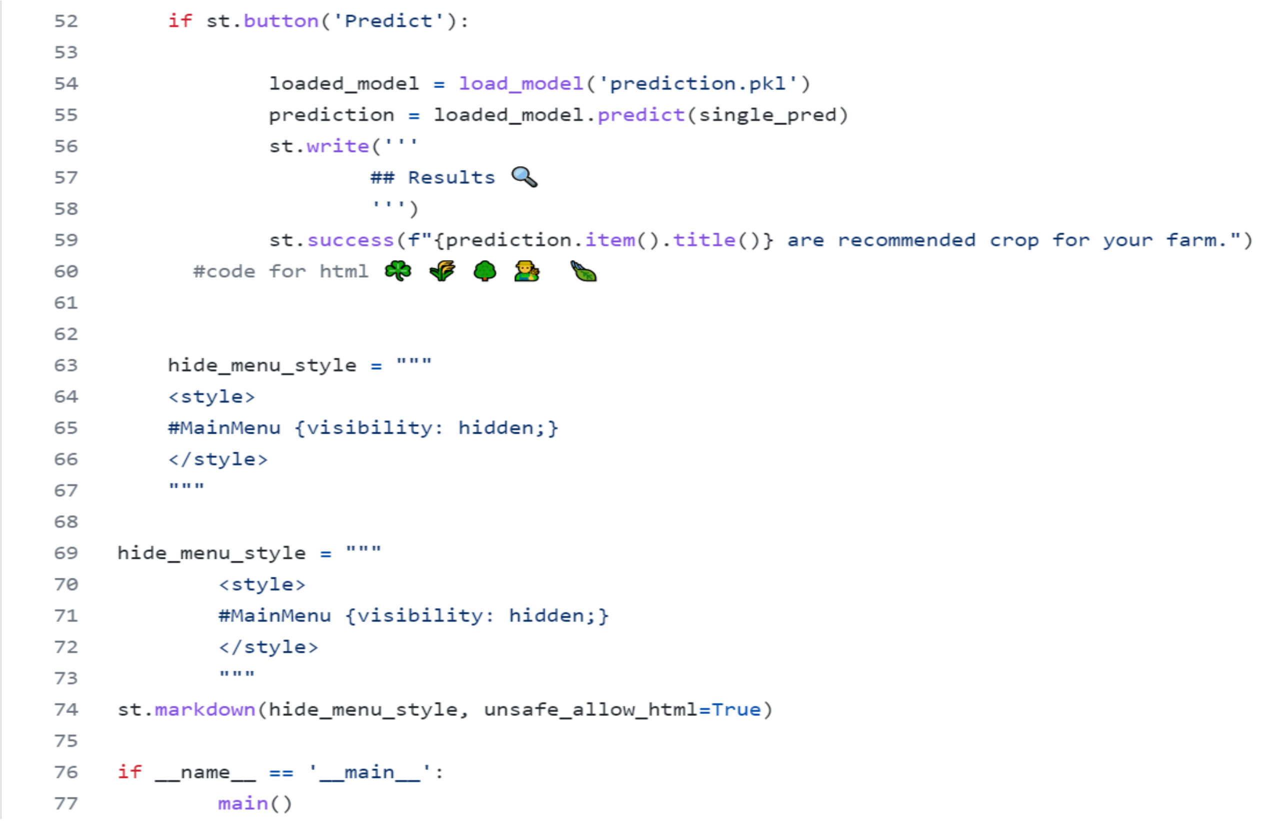
```
In [63]:
from sklearn.svm import SVC
svm_model_linear = SVC(kernel = 'linear', C = 1).fit(x_train, y_train)
svm_predictions = svm_model_linear.predict(x_test)

# model accuracy for X_test
accuracy = svm_model_linear.score(x_test, y_test)
print(accuracy)

# creating a confusion matrix
cm = confusion_matrix(y_test, svm_predictions)
print(cm)
```

```
0.975
[[15  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0]
 [ 0 22  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0]
 [ 0  0 18  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0]
 [ 0  0  0 21  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0]
 [ 0  0  0  0 25  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0]
 [ 0  0  0  0  0 21  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0]
 [ 0  0  0  0  0  0 18  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0]
 [ 0  0  0  0  0  0  0 29  0  0  0  0  0  0  0  0  0  0  0  0  0  0]
 [ 0  0  0  0  0  1  0  0 14  0  0  0  0  0  0  0  0  0  0  0  0  0]
 [ 0  0  0  0  0  0  0  0  0 12  0  0  0  0  0  0  0  0  0  0  0  0]
 [ 0  0  0  0  0  0  0  0  0  0 16  0  0  0  0  0  0  0  0  0  0  0]
 [ 0  0  0  0  0  0  3  0  0  0  0 23  0  0  0  0  0  0  0  0  0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  0 16  0  0  0  0  0  0  0  0  0]
 [ 0  0  0  0  0  0  0  0  0  0  3  0  0 21  0  0  0  0  0  0  0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 17  0  0  0  0  0  0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 25  0  0  0  0  0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 15  0  0  0  0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 21  0  0  0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 21  0  0  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 23  0  0]
 [ 0  0  0  0  0  0  0  0  4  0  0  0  0  0  0  0  0  0  0  0 17  0]
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 19]]
```

FIGURE 5.7 SUPPORT VECTOR CLASSIFIER ALGORITHM ACCURACY

5.1.4 DEPLOYMENT

The user accesses the crop recommendation system using the web application. Recommendation system webpage has been created using Streamlit web framework of webpage. Webpage for crop recommendation has fields for potassium, nitrogen, rainfall, and other factors for prediction. The inputs given by the user has been sent to model through the webapi contains the file that has pickle file contain model for recommendation. The web application has been deployed in the streamlit platform. The deployment of web application consists of pickle file, webpage, and streamLit web application framework for the web application development. Deployment plays a vital role in a project any user from anywhere can get the benefit of the web application for crop recommendation system. As the webapplication is deployed it will be very useful to user to get recommendation in any place.



```
    if st.button('Predict'):

            loaded_model = load_model('prediction.pkl')
            prediction = loaded_model.predict(single_pred)
            st.write('''
                    ## Results 🔍
                    ''')
            st.success(f"{prediction.item().title()} are recommended crop for your farm.")
      #code for html ☘️ 🌾 🌳 👨‍🌾  🍃


    hide_menu_style = """
    <style>
    #MainMenu {visibility: hidden;}
    </style>
    """

hide_menu_style = """
        <style>
        #MainMenu {visibility: hidden;}
        </style>
        """
st.markdown(hide_menu_style, unsafe_allow_html=True)

if __name__ == '__main__':
        main()
```

FIGURE 5.8 APP DEPLOYMENT

CHAPTER 6

CONCLUSION AND FUTURE ENHANCEMENT

The emerging trends and the availability of intelligent technologies makes us to develop new models that help to satisfy the needs of emerging world. So, we have developed a crop recommendation system which can possibly contribute to public agriculture. The model proposes an efficient application based on machine learning algorithm to recommend the crop for farming or cultivated the suitable crop for their land. Major characteristics for crop recommendation have been considered build a model for recommendation. The project also contains a web application which is deployed and available to all at any instance. It can recommend suitable crop for land within few seconds of processing. The model uses support vector classifier for recommendation of crop. The recommendation system works very effectively and efficiently in identifying the most suitable crop for cultivation according to the inputs given by the user. In future the application will be extended with many crops and data about many geographical locations. It contains the fertilizers, information about each crop, application will provide monsoon details and add the economic situations, based on the economic situation which type of crop is will produce more profit. The extended version of this applications will provide one point information guide for all the details, forecast for weather and all the factors for cultivation of crops.

CHAPTER 7

APPENDIX I

SAMPLE CODING

```
import pandas as pd

import numpy as np

import seaborn as sns

dataset=pd.read_csv('C:/Users/karthikeyan/Desktop/dataset/Crop_recommendation.csv
')

dataset.head()

print("Number of Instances and Attributes:", df.shape)

print('Dataset columns:',df.columns)

print('Data types of each columns: ', df.info())dataset.count()

dataset.isnull().sum()

count_dups = df.duplicated().sum()

print("Number of Duplicates: ", count_dups)

  if count_dups >= 1:

    df.drop_duplicates(inplace=True)

    print('Duplicate values removed!')

  else:

    print('No Duplicate values')

Q1=df.quantile(0.25)

Q3=df.quantile(0.75)

IQR=Q3-Q1

df_out = df[~((Df < (Q1 -1.5*IQR)) | (df > (Q3+1.5 * IQR))).any(axis=1)]
```

```
import matplotlib.pyplot as plt

feature_columns=[dataset['N'],dataset['P'],dataset['K'],dataset['temperature']]

fig = plt.figure(1, figsize=(10,8))

ax = fig.add_subplot(111)

Ps = ax.boxplot(feature_columns)

corr = dataset.corr()

print(corr)

sns.heatmap(corr,

        xticklabels=corr.columns,

        yticklabels=corr.columns)

"Age Distribution barchart(figure_3)"

bins = [100,150,200,250]

plt.hist(dataset['rainfall'], bins, histtype='bar', rwidth=0.5)

plt.title('Age Distribution')

plt.xlabel('Age')

plt.ylabel('No of Persons')

plt.show()

dataset.tail()

dataset.reindex()

shuffled_dataset = dataset.sample(frac=1, random_state=1).reset_index()

shuffled_dataset.head()

data=shuffled_dataset.drop(['index'], axis = 1)
```

```
data.head()

shuffled_dataset.head()

sns.distplot(data['N'], kde=True)

sns.distplot(data['K'],kde=True, color="green")

sns.distplot(data.P,kde=True, color="red")

data.head()

from sklearn.model_selection import train_test_split

features_columns=['N', 'P', 'K', 'temperature', 'humidity', 'ph', 'rainfall']

predicted_class=['label']

x=data[features_columns].values

y=data[predicted_class].values

x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.20,random_state=0)

print(x_train.shape,y_test.shape)

from sklearn.linear_model import LogisticRegression

model=LogisticRegression(max_iter=500)

model.fit(x_train,y_train)

y_pred=model.predict(x_test)

from sklearn.metrics import accuracy_score

print(accuracy_score(y_test,y_pred))

from sklearn.metrics import confusion_matrix

confusion_matrix(y_test, y_pred)

print(cm)
```

```
from sklearn.neighbors import KNeighborsClassifier
knn = KNeighborsClassifier(n_neighbors = 7).fit(x_train, y_train)
# accuracy on X_test
accuracy = knn.score(x_test, y_test)
print (accuracy)
# creating a confusion matrix
knn_predictions = knn.predict(x_test)
cm = confusion_matrix(y_test, knn_predictions)
print(cm)
from sklearn.naive_bayes import GaussianNB
gnb = GaussianNB().fit(x_train, y_train)
gnb_predictions = gnb.predict(x_test)
# accuracy on X_test
accuracy = gnb.score(x_test, y_test)
print(accuracy)
# creating a confusion matrix
cm = confusion_matrix(y_test, gnb_predictions)
print(cm)
from sklearn.svm import SVC
svm_model_linear = SVC(kernel = 'linear', C = 1).fit(x_train, y_train)
svm_predictions = svm_model_linear.predict(x_test)
```

```
# model accuracy for X_test
accuracy = svm_model_linear.score(x_test, y_test)
print(accuracy)
# creating a confusion matrix
cm = confusion_matrix(y_test, svm_predictions)
print(cm)
from sklearn.neighbors import KNeighborsClassifier
knn = KNeighborsClassifier(n_neighbors = 7).fit(x_train, y_train)
# accuracy on X_test
accuracy = knn.score(x_test, y_test)
print(accuracy)
# creating a confusion matrix
knn_predictions = knn.predict(x_test)
cm = confusion_matrix(y_test, knn_predictions)
print(cm)
from sklearn.ensemble import RandomForestClassifier
classifier = RandomForestClassifier(n_estimators = 10, criterion = 'entropy', random_state = 0)
classifier.fit(x_train, y_train.ravel())
y_pred=classifier.predict(x_test)
print("RandomForest:{0}".format(accuracy_score(y_test,y_pred)))
```

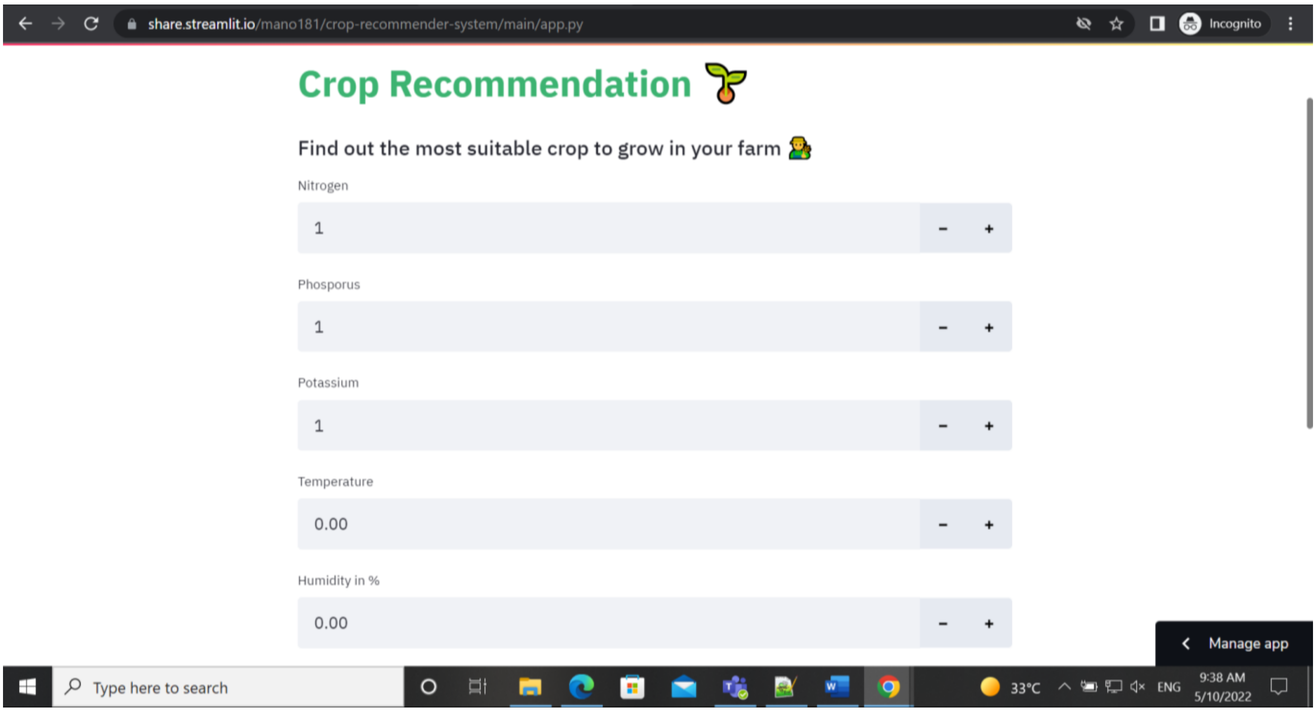
```
from sklearn.model_selection import cross_val_score
accuracies = cross_val_score(estimator = classifier, X = x_train, y = y_train, cv = 10)
print("Accuracy: {:.2f} %".format(accuracies.mean()*100))
print("Standard Deviation: {:.2f} %".format(accuracies.std()*100))
n_estimators=[100,200,300,400,500]
min_samples_split=[2,4,6,8,10]
criterion=['gini','entropy']
max_features=['auto', 'sqrt', 'log2']
"Gridsearch CV"
gridsearch={'n_estimators':n_estimators,
            'criterion':criterion,
            'min_samples_split':min_samples_split,
            'max_features':max_features}
print(gridsearch)
from sklearn.model_selection import GridSearchCV
grid_search=GridSearchCV(SVC(),
                         ‘C’:[0.1,1,10,100]
                         ‘gamma’:[1, 0.1, 0.01, 0.001]
                         ‘kernel’: [‘rbf’]
grid_search.fit(x_train, y_train)
best_accuracy = grid_search.best_score_
best_parameters = grid_search.best_params_
print("Best Accuracy: {:.2f} %".format(best_accuracy*100))
print("Best Parameters:", best_parameters)

grid_search.best_params_
best_grid_search=grid_search.best_estimator_
y_pred=best_grid_search.predict(x_test)
print(confusion_matrix(y_test,y_pred))
print("Accuracy Score{}".format((accuracy_score(y_test,y_pred))))
print("Classification report:{}".format(classification_report(y_test,y_pred)))
#pickle is used to pack the machine learning model as file for future use.

import pickle

"saving model as a disk"

pickle.dump(svm_model_linear,open('prediction.pkl','wb'))

"loding model to compare the results"

prediction =pickle.load(open('prediction.pkl','rb'))

print(svm_model_linear.predict([[25,129,195,17,81,5,72]]))

#streamlit is an webframework for deploying the application

import streamlit as st

import pandas as pd

import numpy as np

import os

import pickle

#warnings are imported for neglecting the warnings during the running of the
application

import warnings

st.beta_set_page_config(page_title=”Crop Recommender”, page_icon=” ”,
layout=’centered’, initial_sidebar_state=”collapsed”)

def load_model(modelfile):

        loaded_model=pickle.load(open(modelfile, ‘rb’))

        return loaded_model
```

```
def main():
        html_temp= “””
        <div>
        <h1 styple=”color:MEDIUMSEAGREEN; text-align:left;”>Crop
        Recommendation <h1>
        </div>
        “””
        St.markdown(html_temp, unsafe_allow_html=True)
        st.subheader(" Find out the most suitable crop to grow in your farm ")
        #fields for giving inputs of  application
        N = st.number_input("Nitrogen", 1,10000)
        P = st.number_input("Phosporus", 1,10000)
        K = st.number_input("Potassium", 1,10000)
        temp = st.number_input("Temperature",0.0,100000.0)
        humidity = st.number_input("Humidity in %", 0.0,100000.0)
        ph = st.number_input("Ph", 0.0,100000.0)
        rainfall = st.number_input("Rainfall in mm",0.0,100000.0)
        feature_list = [N, P, K, temp, humidity, ph, rainfall]
        single_pred = np.array(feature_list).reshape(1,-1)
        #if the user press the predict button the function will jump to this point
        if st.button('Predict'):
                loaded_model = load_model('prediction.pkl')
```

```
            prediction = loaded_model.predict(single_pred)
            col1.write('''
             ## Results 🔍
             ''')
        col1.success(f"{prediction.item().title()} are recommended crop for your farm.")
    hide_menu_style = """
    <style>
    #MainMenu {visibility: hidden;}
    </style>
    """
hide_menu_style = """
        <style>
        #MainMenu {visibility: hidden;}
        </style>
        """
st.markdown(hide_menu_style, unsafe_allow_html=True)
if __name__ == '__main__':
    main()
```

APPENDIX II

SCREENSHOTS


share.streamlit.io/mano181/crop-recommender-system/main/app.py
Incognito
Manage app
Type here to search
33°C
ENG
9:38 AM
5/10/2022

Crop Recommendation

Find out the most suitable crop to grow in your farm

Nitrogen

1

Phosporus

1

Potassium

1

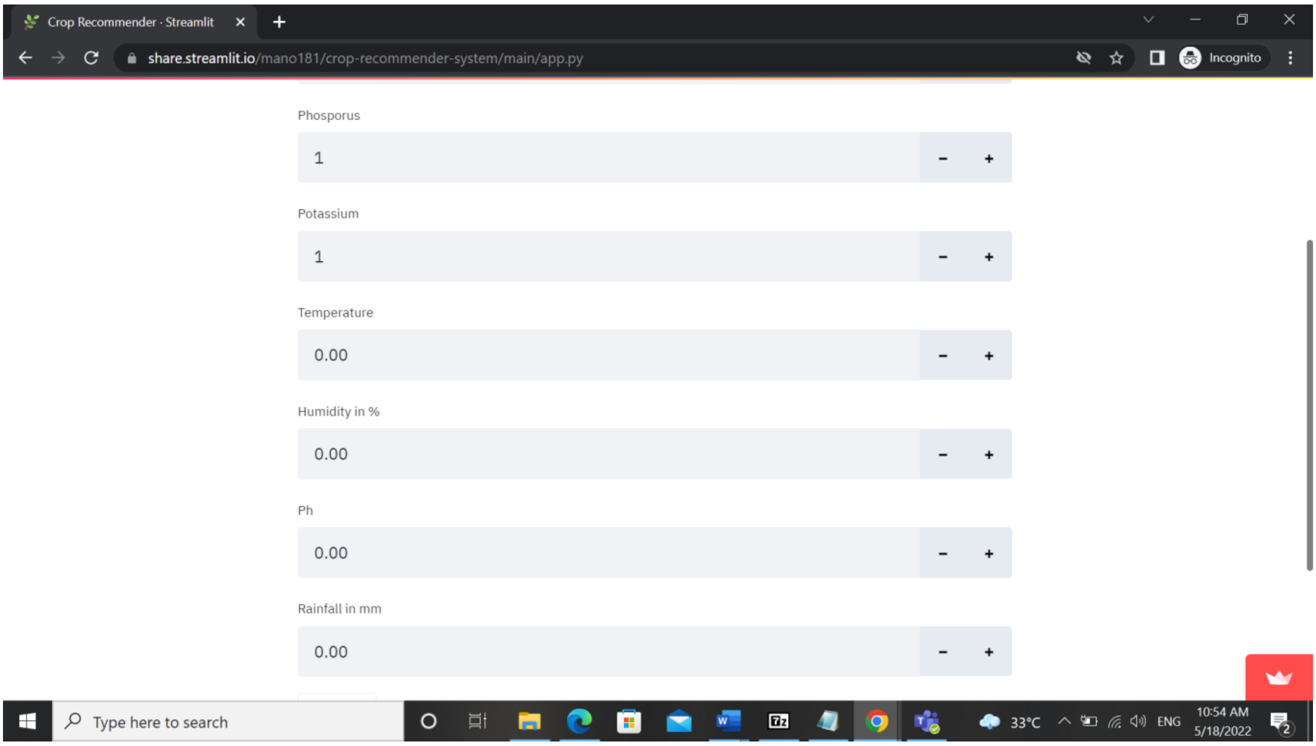
Temperature

0.00

Humidity in %

0.00

FIGURE 7.1 N, P, K INPUT


Crop Recommender · Streamlit
share.streamlit.io/mano181/crop-recommender-system/main/app.py
Incognito
Type here to search
33°C
ENG
10:54 AM
5/18/2022

Phosporus

1

Potassium

1

Temperature

0.00

Humidity in %

0.00

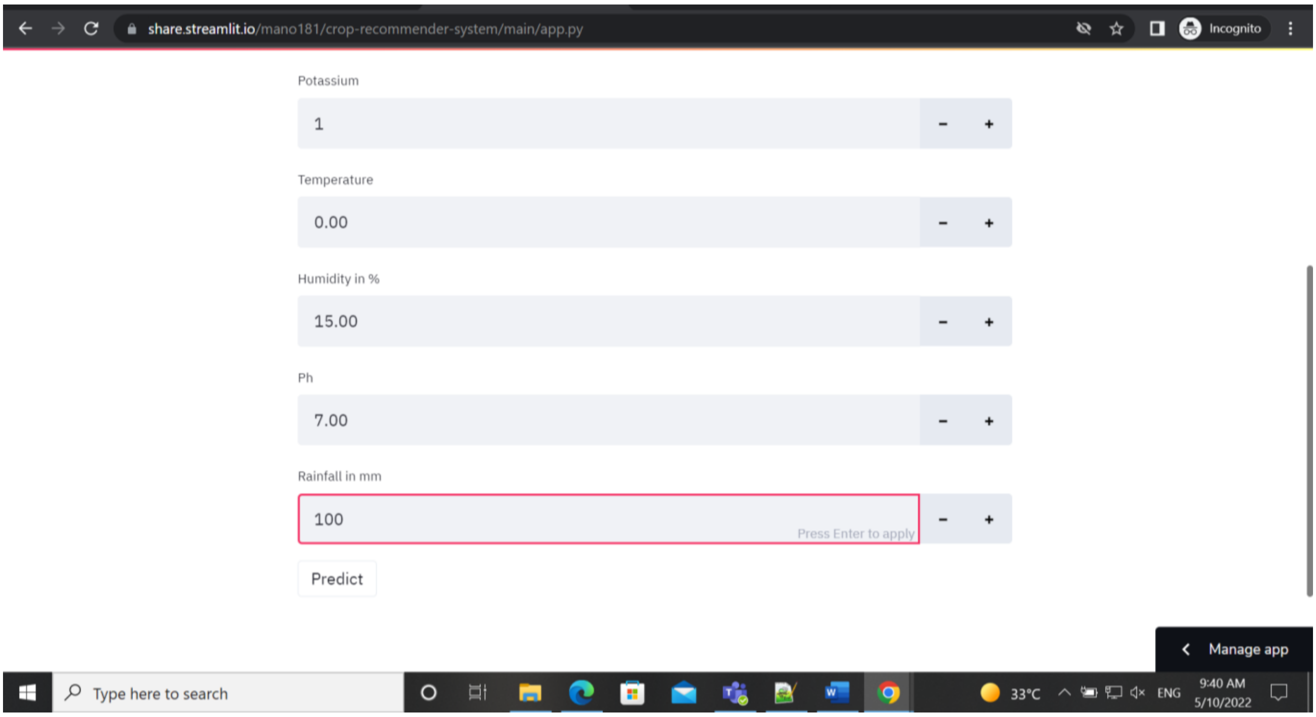
Ph

0.00

Rainfall in mm

0.00

FIGURE 7.2 TEMPERATURE, HUMIDITY INPUT



Potassium: 1

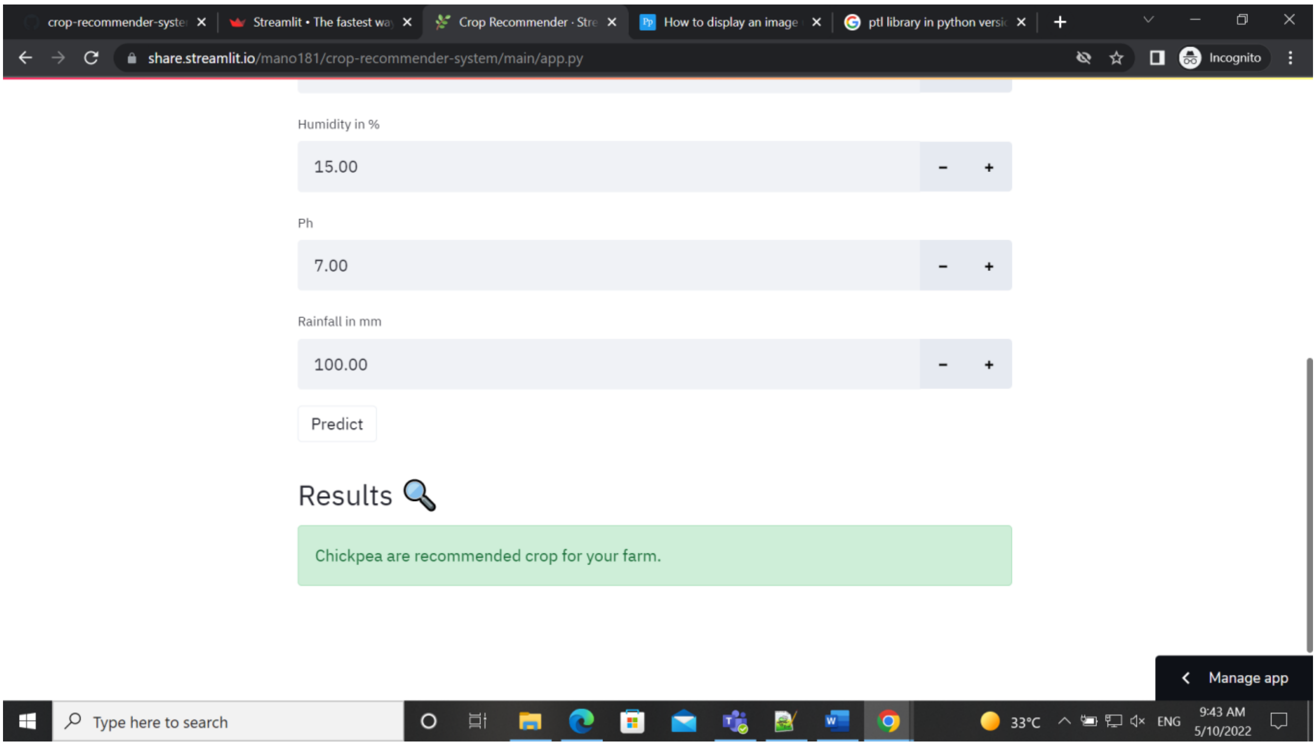
Temperature: 0.00

Humidity in %: 15.00

Ph: 7.00

Rainfall in mm: 100

FIGURE 7.3 PH, RAINFALL INPUT



Humidity in %: 15.00

Ph: 7.00

Rainfall in mm: 100.00

Results 🔍

Chickpea are recommended crop for your farm.

FIGURE 7.4 RECOMMENDATION RESULT

CHAPTER 8
REFERENCES

[1] S.P. Raja, Barbara Sawicka, Zoran Stankovic, and G.Mariammal "Crop Prediction Based on Characteristics of the Agricultural Environment Using Various Feature Selection Techniques and Classifiers", IEEE Access Journal, Volume:10, 2022.

[2] Abhinav Sharma, Arpit Jain, Prateek Gupta, Vinay Chowdary "Machine Learning Application for Precision Agriculture", IEEE Access Journal, Volume:9, 2021.

[3] Adel Bakshipour "Cascading Feature Filtering and Boosting Algorithm for Plant Type Classification", IEEE Access Journal, Volume:9, 2021.

[4] Andrii Shelestov, Mykola Lavreniuk, Vladimir Vasiliev, Leonid Shumilo, Andrii kolotii "Cloud Approach to Automated Crop Classification Using Sentinel-1 Imagery", International Journal of Computers Technology, Volume:6, Issue:3, 2020.

[5] Waleej Haider, Aqeel-Ur Rehman, Nouman M. Durrani, Sadiq Ur Rehman "International Journal of Artificial Intelligence", IEEE Access Journal, Volume:9, 2021.

[6] Manish Kumar, Ahlad kumar, Vinay S.Palaparthy "Soil Sensors-Based Prediction System for Plant Diseases Using Exploratory Data Analysis and Machine Learning", 2021, IEEE Sensors Journal, Volume:21,Issue:16, 2021.

[7] Gayathri Nagasubramanian, Rakesh Kumar Sakthivel, Rizwan Patan, Muthuramalingam Sankayya, Mahnoud Daneshmand, Amir H.Gandomi " Ensemble Classification and IoT-Based Pattern Recognition for Crop Disease Monitoring System", IEEE Internet of Things Journal, Volume:8, Issue:16, 2021.

[8] Rishi Gupta, Akhilesh Kumar Sharma, Krishna mode, Shahreen Kasim, Zirawani Baharum "Weather Based Crop Prediction in India using Big Data",International Journal of Big data Analytics", Volume:9, 2021.

[9] Muhammad Tufail, Javaid Iqbal, Mohsin Islam Tiwana, Muhammad Shahab Alam "Identification of Tobacco Crop Based on Machine Learning for a Precision Agricultural Sprayer", International Journal of Computer Vision, Volume:9, 2021.

[10] Waleej Haider, Aqeel-Ur Rehman, Nouman M. Durrani, Sadiq Ur Rehman “A Generic Approach for Wheat Disease classification and Verification Using Expert Opinion for Knowledge-Based Decisions”, IEEE Access Journal, Volume:9, 2021.

[11] Bo cheng, Wanyin Wu, Dapeng Tao, Shibo Mei, Ting Mao, Jun Cheng “ Random Cropping Ensemble Neural Network for Image Classification in a Robotic Arm Grasping System”, IEEE Transactions on Instrumentation and Measurement, Volume:69, Issue:9, 2020.

[12] Rayner Alfred, Joe Henry Obit, Christie Pei- Yee Chin, Haviluddin Haviluddin, Yuto Lim “Towards Paddy Rice Smart Farming: A Review on Big Data, Machine Learning, and Rice Production Tasks”, Journal of Artificial Intelligence Research, Volume:9, 2021.

[13] Alsulaiman, Mohammed Arafah, Mohamed Amine Mekhitiche “Intelligent Harvesting Decision System for Date Fruit Based on Maturity Stage Using Deep Learning and Computer Vision”, International Journal of Computer Technology, Volume:8, 2020.

[14] Zengwei Tang, Hong Wang, Xiaobing Li, Xiaohui Li “An Object-Based Approach for Mapping Crop Coverage Using Multiscale Weighted and Machine Learning Methods”, IEEE Access Journal, Volume;13, 2020.

[15] Shantam Shorewala, Armaan Ashfaque, R.Sidharth, Ujjwal Verma “Weed Density and Distribution Estimation for Precision Agriculture Using Semi-Supervised Learning”, Association for Computing Machinery journal ,volume:1, 2021.