CROP PREDICTION USING MACHINE LEARNING

Prepared By:

TEAM - 641

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ABSTRACT

The goal of this project is to predict optimum crops to be cultivated by farmers based on several parameters and help them make an informed decision before cultivation.

INDEX

INTRODUCTION

1.1 Overview

Farming has been the backbone of human civilization since the beginning of time. Farmers are responsible for feeding the world's population, and their efforts are critical in ensuring food security. However, selecting the best crop for a farm can be a daunting task, and farmers face several challenges in this regard. selecting crops is soil suitability. These challenges include different soil requirements based on Nitrogen, Phosphorus, Potassium content in the soil, different PH value of soil, variability in climate of a region based on humidity, rainfall, temperature of a particular region. Therefore, selecting the best crop for a farm is a tedious job for farmers nowadays and it requires careful consideration of several factors.

This model can be used by farmers for predicting the best crop for their farm in order to maximize their farm yield and also their profits through farming. This model does not ask for personalized data such as name, age, gender, religion, address, etc. You can use this web application anytime and the model will give the best crop based on the soil content and climate-oriented factors.

1.2 Purpose

Crop prediction plays a crucial role in agricultural planning and decision-making. Accurate predictions of crop yields can help farmers optimize resource allocation, plan for potential risks, and maximize their agricultural productivity. In this project, we aim to develop a crop prediction system using machine learning techniques. The system will utilize historical data on weather conditions, soil attributes, and crop yields to predict the expected crop yield for a given set of input features.

The purpose of developing the crop prediction system using machine learning is to:

- Improve crop selection and optimize agricultural practices.
- Enhance yield estimation and mitigate risks in farming.
- Increase profitability and support sustainable agriculture.
- Empower farmers with data-driven insights and decision support tools.
- Contribute to global food security.

LITERATURE SURVEY

2.1 Existing Problem

The agricultural sector faces several challenges that necessitate the development of a crop prediction system using machine learning. Some of the existing problems include:

- Unpredictable crop yields, inefficient crop selection, suboptimal agricultural practices, lack of yield estimation accuracy, uncertain weather patterns due to climate change, limited access to information, and the need for sustainable agriculture.
- Addressing these problems through a crop prediction system can greatly benefit farmers, optimize practices, mitigate risks, and contribute to sustainable and profitable farming.

2.2 Proposed Solution

Crop prediction involves analyzing required fertilizers like Nitrogen(N), Phosphorus (P) and potassium(K) in Kg per hectare and by considering rainfall, humidity contents and weather parameters and display the required seed for a cultivation in Kg per acre for recommended crop.

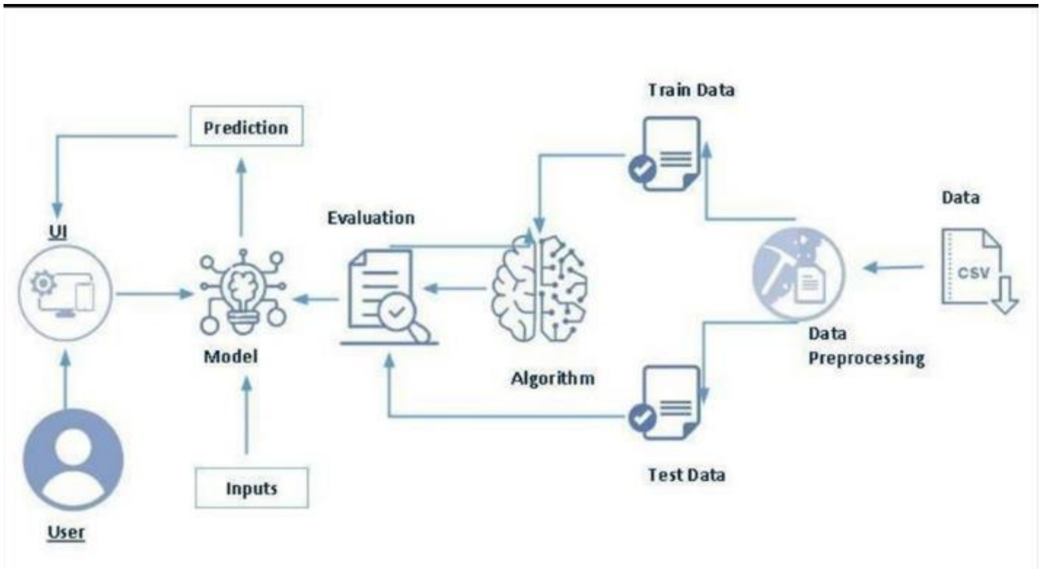
The proposed solution is to develop a crop prediction system using machine learning. The system will collect comprehensive data on crop yield, weather, soil composition, and other relevant factors. Machine learning algorithms will be employed to build predictive models for crop yield estimation.

- The models will be trained and optimized, and their performance will be evaluated using established metrics.
- The system will be implemented with a user-friendly interface, allowing farmers to input data and receive real-time predictions for crop selection and yield estimation.
- The integration of machine learning models will enable personalized recommendations based on user input.

The system aims to empower farmers with data-driven insights, optimize agricultural practices, and maximize crop yields. The results and findings will be presented, and future research directions will be outlined. Overall, the crop prediction system using machine learning will revolutionize agricultural decision-making and enhance productivity in a sustainable manner.

3.1 Block Diagram

Technical architecture of our project is as follows:



3.2 Hardware / Software Designing

Hardware Design:

- High-performance Computer or Server
- A multi-core processor (e.g., Intel Core i5 or higher) for efficient data processing and analysis.
- Memory (RAM): A minimum of 8 GB RAM is recommended for handling large datasets.
- Storage: Adequate storage space to store the datasets, software, and project files. SSD (Solid State Drive) is preferred for faster read/write speeds.

Software Design:

- Web Development Framework: A web development framework like Flask for building the user interface and handling user input.
- Data Analysis and Preprocessing Tools: Libraries like pandas and NumPy for data manipulation, cleaning, and preprocessing tasks.
- Database Management System (DBMS): MySQL
- Machine Learning Libraries: Python libraries like scikit-learn, TensorFlow, or PyTorch for implementing and training the machine learning models.
- Data Visualization Tools: Libraries such as Matplotlib for visualizing the collected data, model performance, and prediction results.

Dataset:

The dataset was provided by SmartBridge. The link for the dataset is provided below:
https://www.kaggle.com/datasets/atharvaingle/crop-recommendation-dataset

EXPERIMENTAL INVESTIGATIONS

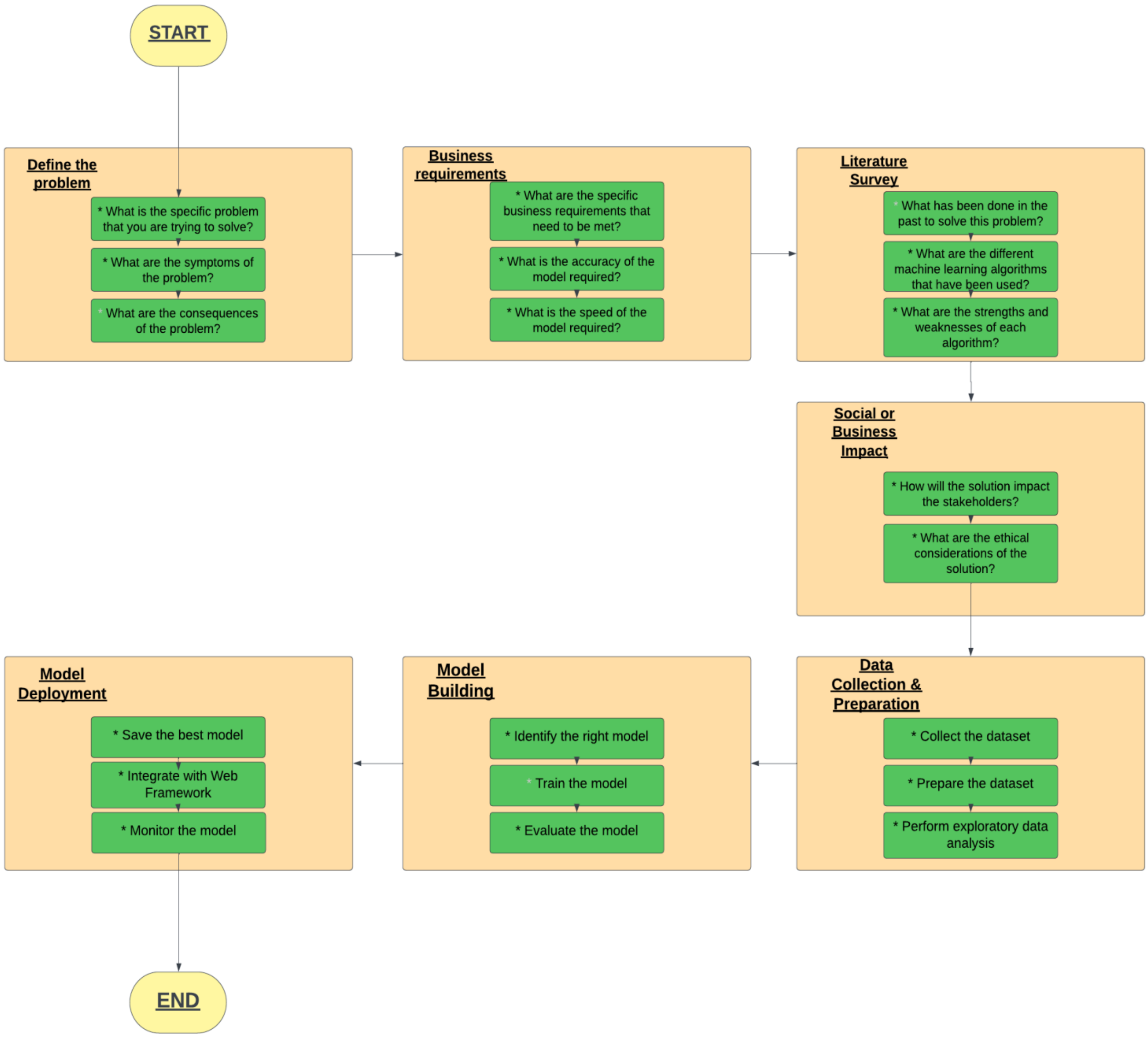
The experimental findings revealed the significance of nutrient ratios (N, P, K), environmental factors (temperature, humidity, pH, rainfall), and their interactions in determining suitable crops for a given set of conditions.

- **Feature Importance:** The analysis revealed that the ratios of Nitrogen (N), Phosphorous (P), and Potassium (K) in the soil are the most influential features for crop recommendation. These nutrients play a crucial role in determining crop growth and yield.
- **Optimal Conditions**: The investigation identified optimal ranges for temperature, humidity, pH, and rainfall that are conducive to specific crop growth. These ranges varied depending on the crop type and helped in determining the suitability of environmental conditions for different crops.
- **Crop-Specific Requirements:** The experimental findings indicated that different crops have specific nutrient and environmental requirements. For example, certain crops may thrive in acidic soil conditions (low pH), while others may prefer alkaline soil (high pH). Similarly, specific crops may require higher levels of certain nutrients, such as Nitrogen or Phosphorous, for optimal growth.
- **Correlations:** The analysis unveiled correlations between the input features. For instance, crops with higher Nitrogen requirements may exhibit increased yield when combined with appropriate levels of Phosphorous and Potassium. Similarly, certain crops may have higher yield potential under specific temperature and rainfall conditions.
- **Prediction Accuracy:** The crop recommendation model demonstrated promising prediction accuracy. The predictions were evaluated using appropriate metrics, such as precision, recall, or accuracy, to assess the model's performance in suggesting the appropriate crop based on the input soil and environmental conditions.

The crop recommendation model showcased promising prediction accuracy, empowering farmers with informed decisions regarding crop selection based on soil and environmental characteristics.

FLOWCHART

The below flowchart represents the flow of our crop prediction model using machine learning.



RESULT

We created a heatmap to visualize the correlation between different input features and the target variable (crop label).

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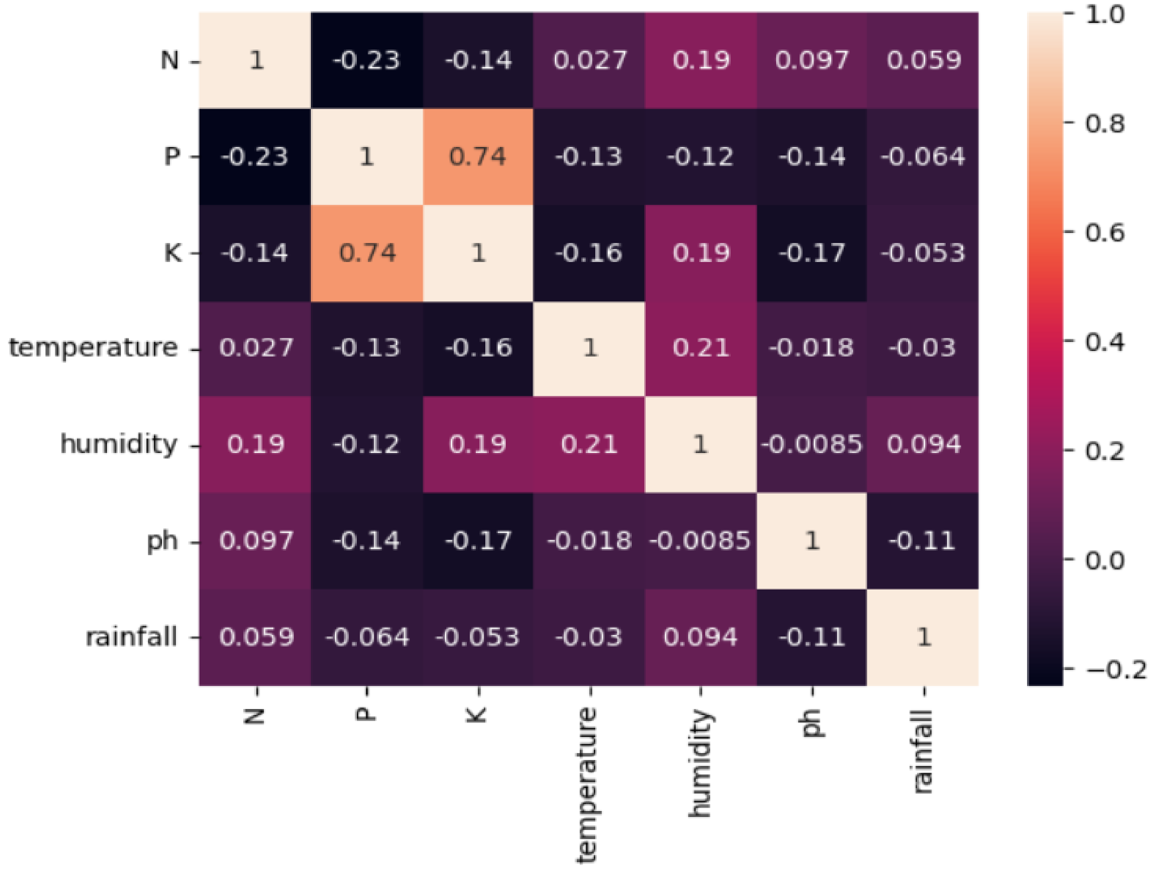
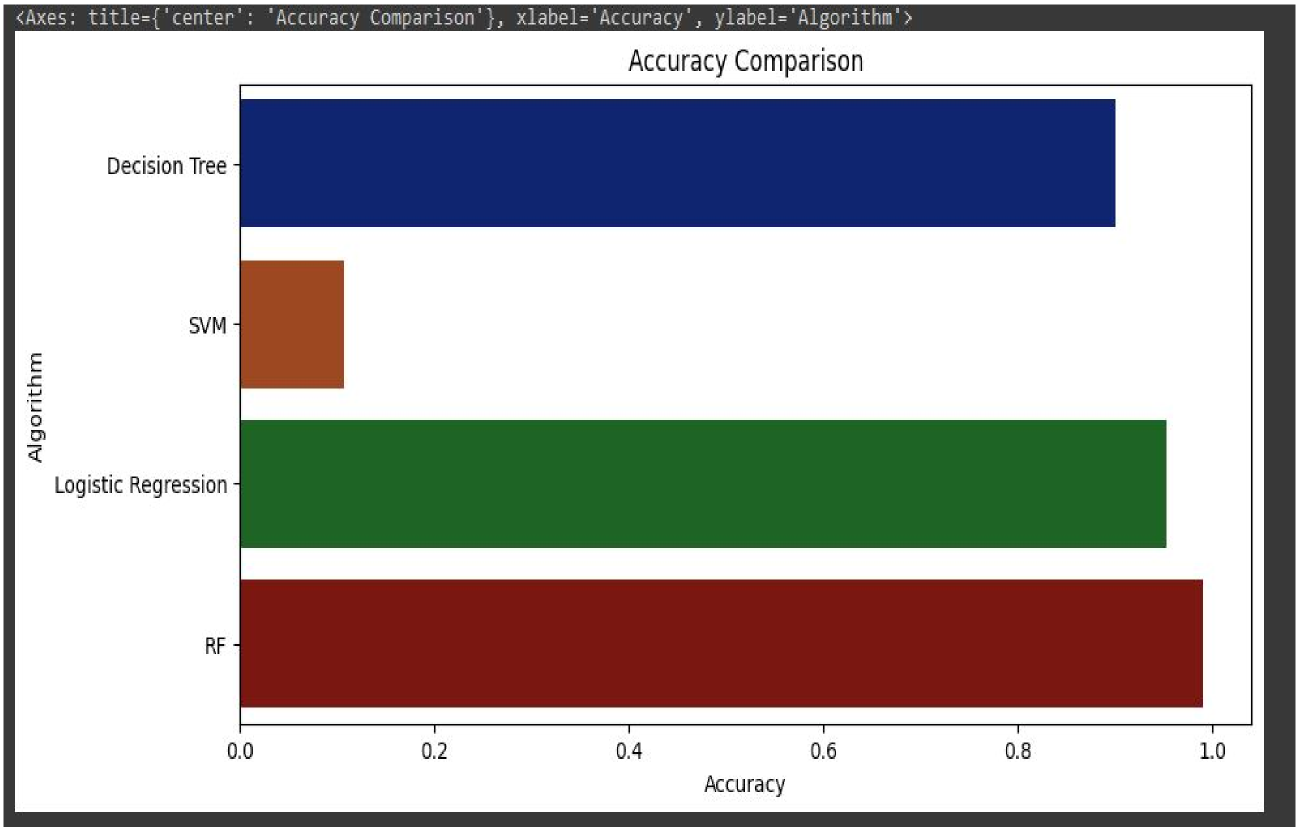


- A heatmap uses color gradients to indicate the strength and direction of the correlations, with darker colors representing stronger correlations.

We also trained our data on different algorithms I.e.

- Decision Tree Classifier
- Support Vectors Classifier
- Random Forest Classifier &
- Logistic Regression.

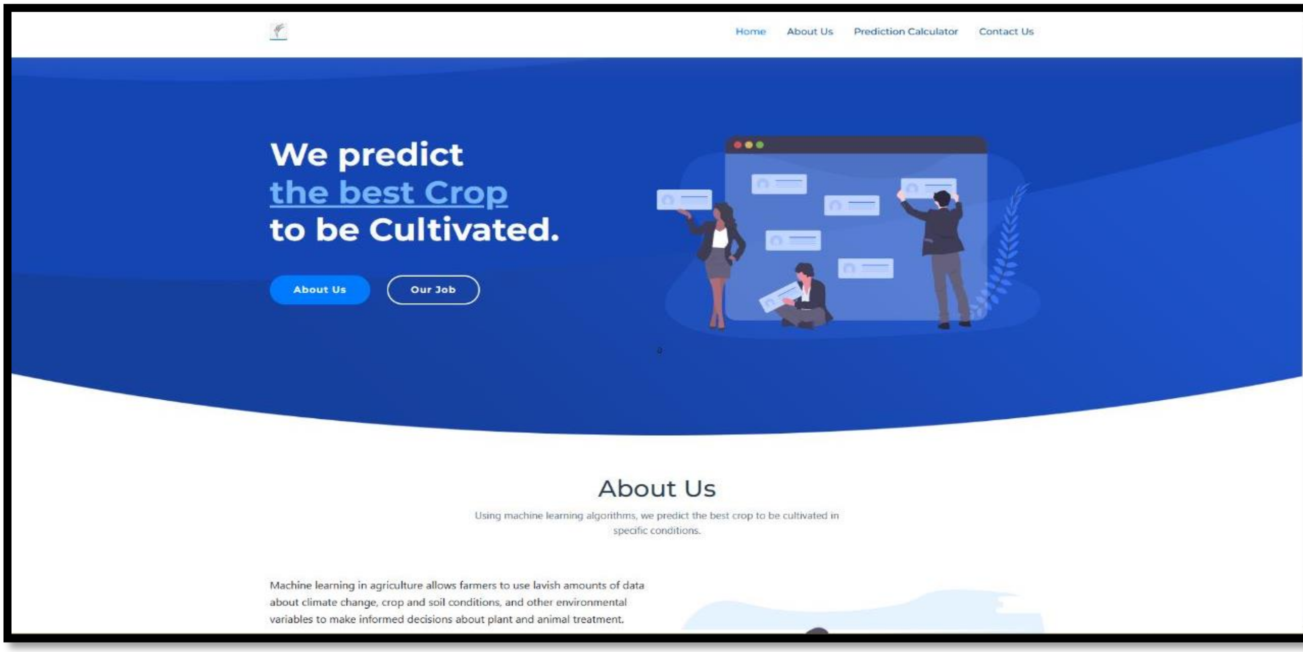


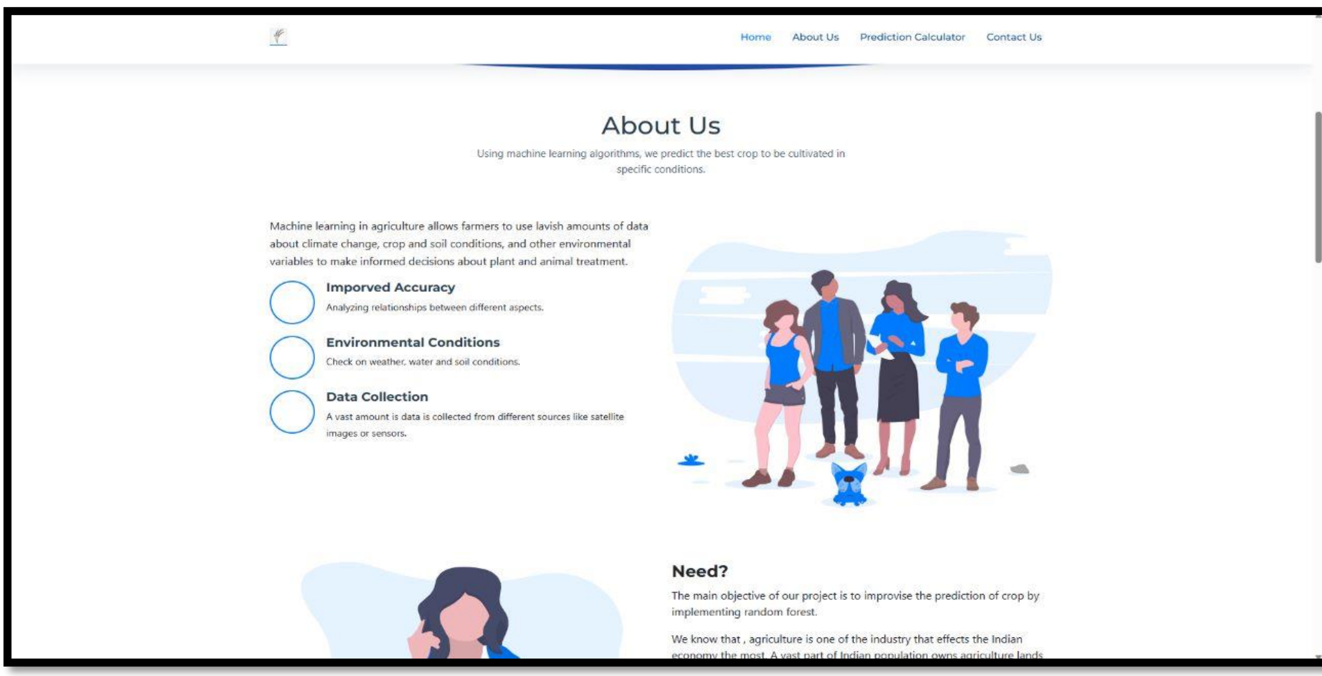

```
Decision Tree --> 90.0
SVM --> 10.681818181818182
Logistic Regression --> 95.22727272727273
RF --> 99.0909090909091
```

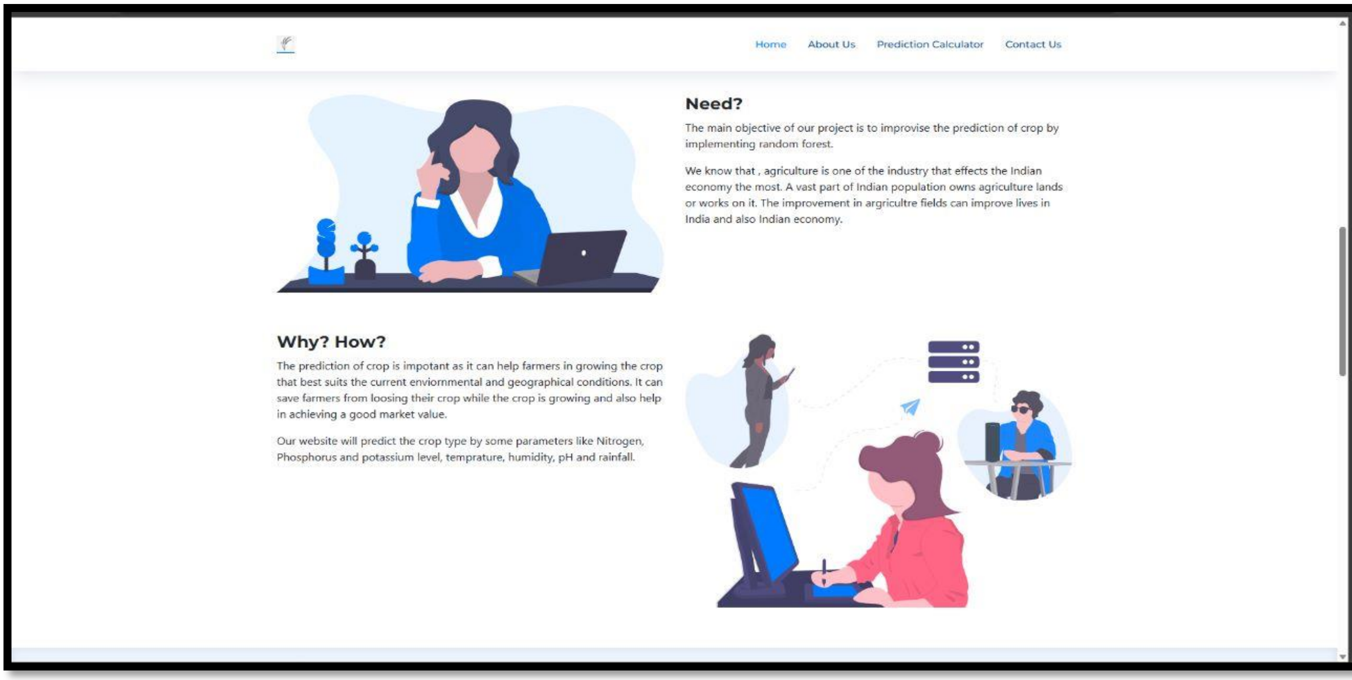
The model achieved it's highest accuracy of approx. 99.1% with the help of Random Forest classifier, therefore Random Forest model is saved based on it's performance.

Flask implementation:

HOME PAGE:






Home
About Us
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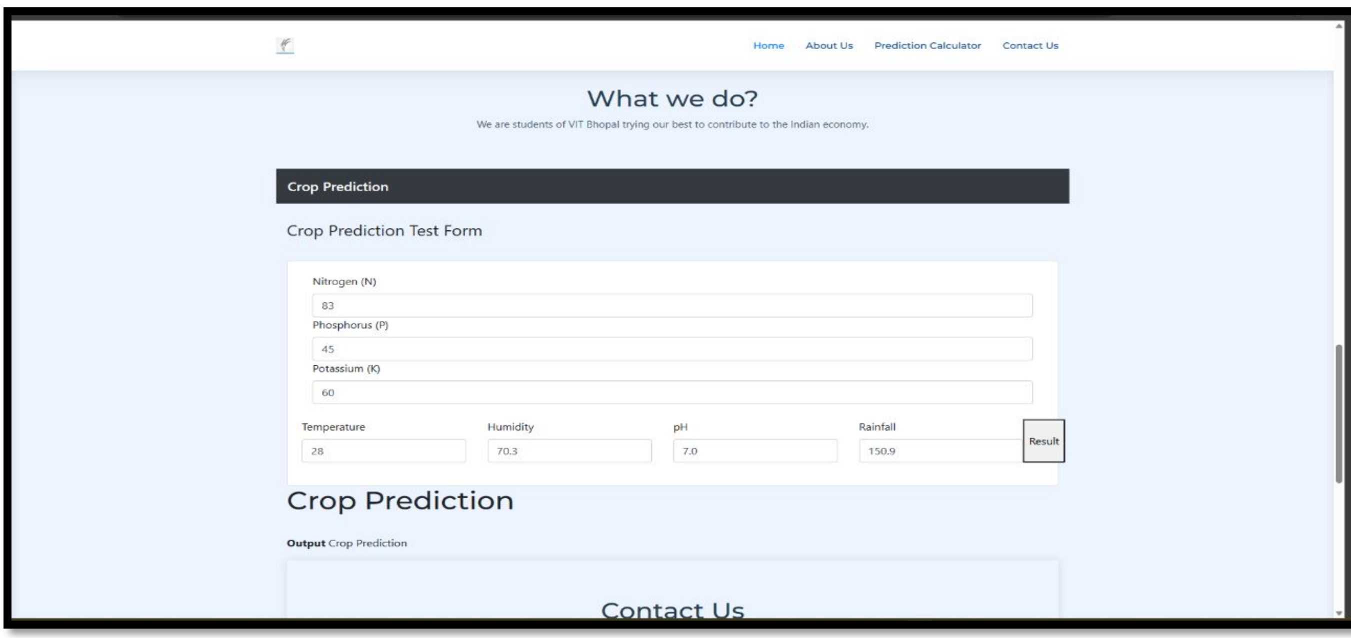
Need?
The main objective of our project is to improvise the prediction of crop by implementing random forest.
We know that , agriculture is one of the industry that effects the Indian economy the most. A vast part of Indian population owns agriculture lands or works on it. The improvement in argricultre fields can improve lives in India and also Indian economy.
Why? How?
The prediction of crop is impotant as it can help farmers in growing the crop that best suits the current enviornmental and geographical conditions. It can save farmers from loosing their crop while the crop is growing and also help in achieving a good market value.
Our website will predict the crop type by some parameters like Nitrogen, Phosphorus and potassium level, temprature, humidity, pH and rainfall.


Home
About Us
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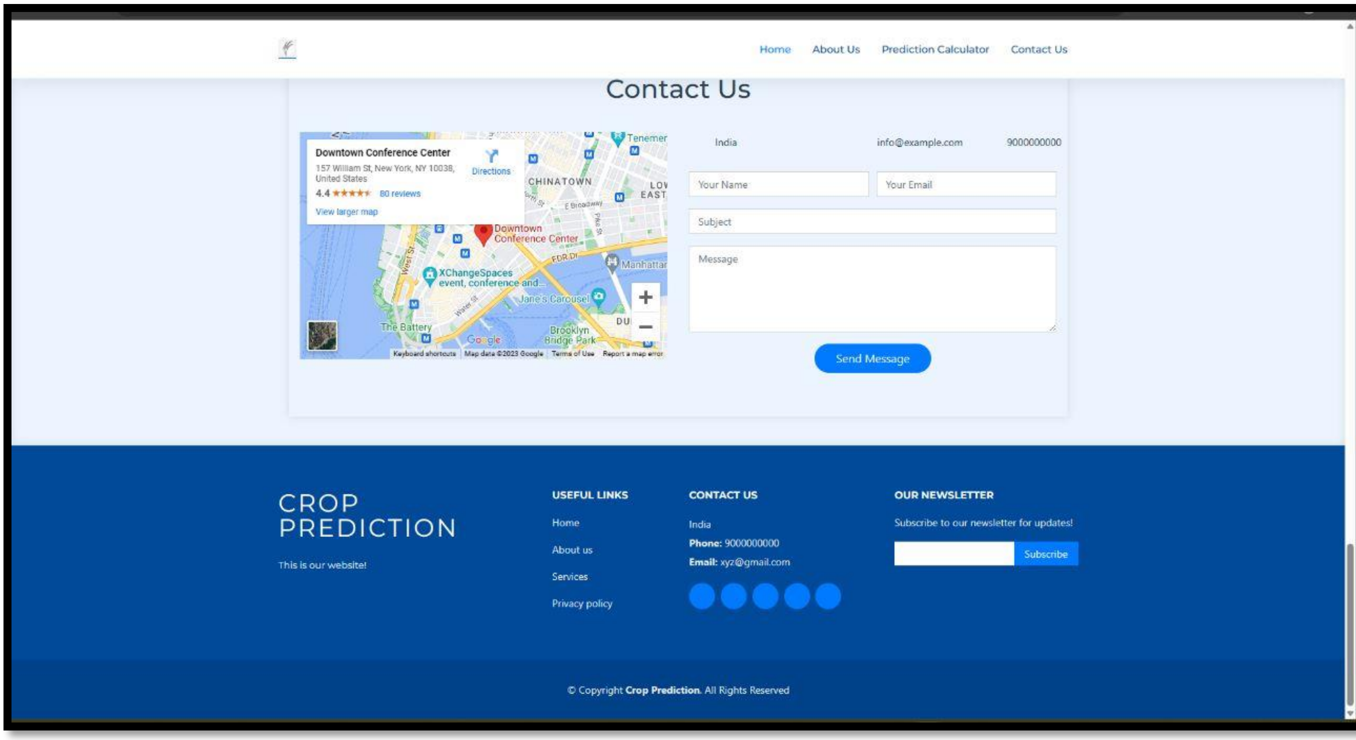
Contact Us
What we do?
We are students of VIT Bhopal trying our best to contribute to the Indian economy.
Crop Prediction
Crop Prediction Test Form
Nitrogen (N)
83
Phosphorus (P)
45
Potassium (K)
60
Temperature
28
Humidity
70.3
pH
7.0
Rainfall
150.9
Result
Crop Prediction
Output Crop Prediction
Contact Us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Downtown Conference Center
157 William St, New York, NY 10038, United States
4.4
80 reviews
View larger map
Directions
CHINATOWN
Downtown Conference Center
XChangeSpaces event, conference and...
Jane's Carousel
The Battery
Brooklyn Bridge Park
India
info@example.com
9000000000
Your Name
Your Email
Subject
Message
Send Message
CROP PREDICTION
This is our website!
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Services
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CONTACT US
India
Phone: 9000000000
Email: xyz@gmail.com
OUR NEWSLETTER
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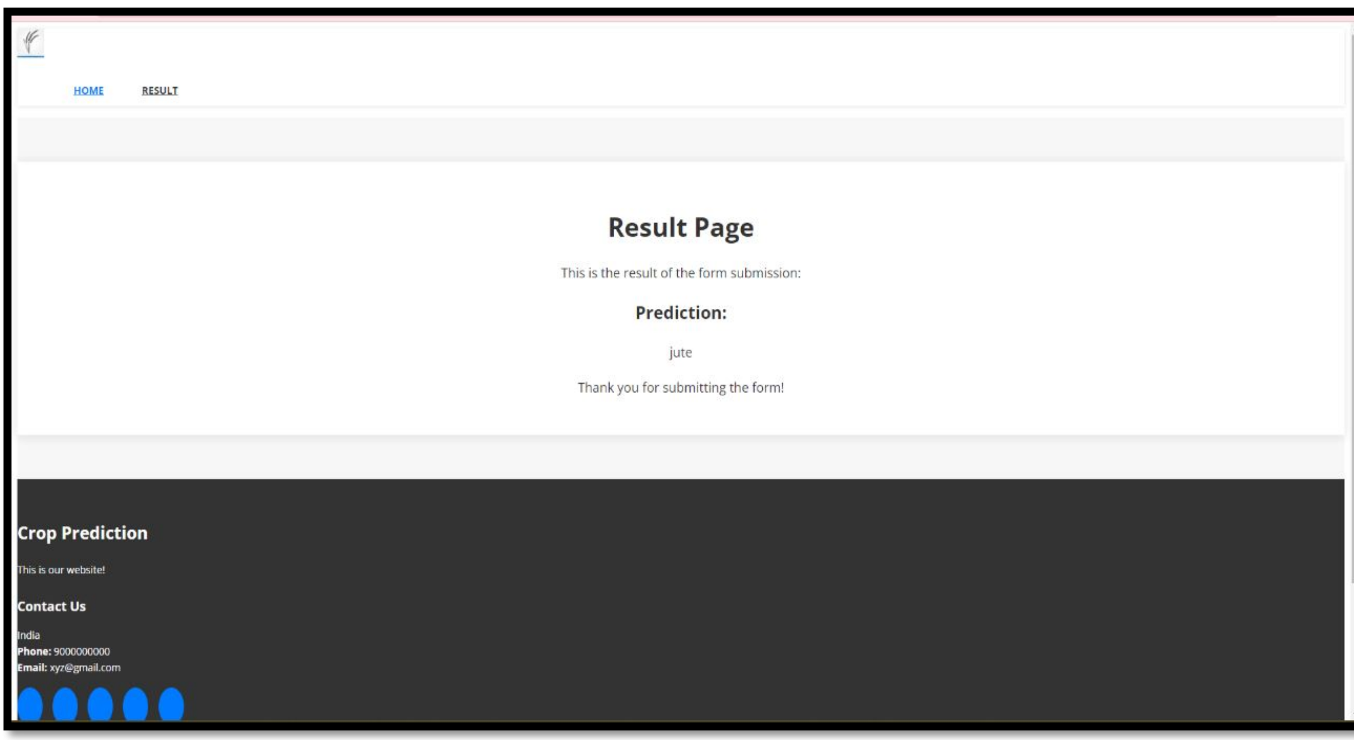
RESULT PAGE:


HOME
RESULT
Result Page
This is the result of the form submission:
Prediction:
jute
Thank you for submitting the form!
Crop Prediction
This is our website!
Contact Us
India
Phone: 9000000000
Email: xyz@gmail.com

ADVANTAGES & DISADVANTAGES

Advantages:

The crop prediction model has the following advantages:

- Improved crop selection based on soil and environmental conditions.
- Optimal resource utilization, promoting sustainable farming practices and reducing unnecessary resource wastage.
- Increased yield potential by matching crops with their specific nutrient requirements.
- Adaptability to local conditions through customization and regional data integration.
- Data-driven decision making, reducing reliance on traditional methods.
- Time and cost savings by automating the recommendation process.
- Scalability and accessibility for widespread farmer adoption.

The crop recommendation model offers the advantage of data-driven decision making, increased crop yield potential, optimal resource utilization, and adaptability to local conditions. It empowers farmers with valuable insights and recommendations to make informed choices and improve their agricultural practices.

Disadvantages:

The crop prediction model has the following disadvantages:

- Dependency on accurate input data.
- Limited scope and inability to account for all influencing factors.
- Lack of real-time updates and adaptability to sudden changes.
- Uncertainty in predictions due to complex crop performance factors.
- Requirement for technical expertise for implementation and maintenance.
- Cost implications for data collection, computational resources, and maintenance.
- Limited incorporation of human expertise and intuition.
- Generalization limitations across different regions and farming conditions.

APPLICATIONS

The Crop Prediction Model holds significant applications in various domains. Some potential applications of this project include:

- Farm Management: The model can assist farmers in making informed decisions regarding crop selection and management practices. It helps optimize resource allocation, such as fertilizers, water, and pesticides, based on the specific needs of recommended crops, leading to improved efficiency and cost savings.
- Precision Agriculture: By integrating the model with sensor technologies and satellite data, farmers can implement precision agriculture techniques. The model's recommendations can guide targeted interventions at a fine-grained level, optimizing inputs and treatments for specific areas of the farm based on crop suitability and requirements.
- Crop Diversification: The model enables farmers to explore and adopt crop diversification strategies. By suggesting alternative crops suitable for their specific conditions, farmers can reduce reliance on single crops, mitigate risks associated with climate variability, and potentially enhance their resilience against market fluctuations.
- Sustainable Agriculture: The model promotes sustainable agricultural practices by optimizing nutrient utilization and reducing environmental impacts. By recommending crops that are well-suited to the existing soil conditions, the model helps minimize nutrient runoff and reduces the need for excessive chemical inputs.
- Research and Development: The model can be used as a tool for research and development in the agricultural domain. The model's predictions can be compared with field observations and experimental results to validate and refine agronomic theories and practices.
- Educational Tool: The crop recommendation model can serve as an educational tool to raise awareness and enhance knowledge among farmers and agricultural stakeholders. It can be incorporated into training programs, workshops, and extension services, enabling farmers to learn about the interactions between soil, environment, and crop selection.

The application of the crop recommendation model in these areas can contribute to improved agricultural productivity, resource efficiency, sustainability, and informed decision making in the agricultural sector.

CONCLUSION

In conclusion, the development of the crop recommendation model using machine learning techniques offers significant potential for enhancing agricultural practices. By considering soil nutrient ratios, temperature, humidity, pH, and rainfall, the model provides valuable insights and recommendations for crop selection based on specific soil and environmental conditions. The model's advantages include improved crop selection, optimal resource utilization, increased yield potential, adaptability to local conditions, data-driven decision making, time and cost savings, scalability, and accessibility.

However, it is important to acknowledge the limitations and potential disadvantages of the model, such as the dependency on accurate input data, limited scope, lack of real-time updates, uncertainty in predictions, requirement for technical expertise, cost implications, limited incorporation of human expertise, and generalization limitations. These factors should be considered and addressed to ensure effective implementation and utilization of the model.

Despite these limitations, the crop recommendation model holds immense value in various applications, including farm management, precision agriculture, crop diversification, sustainable agriculture, planning and decision support, research and development, and as an educational tool. By leveraging the model's recommendations, farmers, policymakers, extension services, researchers, and other stakeholders can make informed decisions, optimize resource allocation, promote sustainable practices, and enhance agricultural productivity.

Moving forward, continued research, refinement, and collaboration between machine learning algorithms and human expertise are essential for improving the accuracy, robustness, and applicability of crop recommendation models. The integration of advanced technologies, such as remote sensing, Internet of Things (IoT), and big data analytics, can further enhance the model's capabilities and make it more adaptable to evolving agricultural landscapes.

Overall, the crop recommendation model offers a promising solution for addressing the challenges of crop selection and resource management in agriculture. By harnessing the power of machine learning and data-driven insights, the model has the potential to revolutionize farming practices, increase efficiency, and contribute to sustainable agricultural systems for a more food-secure future.

FUTURE SCOPE

The crop recommendation model developed using machine learning techniques presents several avenues for future exploration and improvement. The following future scope areas can be considered:

- Integration of Advanced Technologies: The model can benefit from the integration of advanced technologies such as remote sensing, drones, and IoT devices. These technologies can provide real-time data on soil moisture, nutrient levels, and crop health, enabling more accurate and dynamic recommendations.
- Incorporation of Crop Rotation and Succession Planning: Future iterations of the model can consider incorporating crop rotation and succession planning recommendations. By analyzing the long-term impact of crop choices on soil health and pest management, the model can assist in designing more sustainable cropping systems.
- Integration with Weather Forecasting: By integrating real-time weather forecasting data, the model can provide more accurate and timely recommendations based on upcoming weather events. This integration can help farmers adapt their crop selection and management strategies to mitigate risks associated with extreme weather conditions.
- Fine-tuning for Localized Conditions: Further customization of the model for specific regions and microclimates can enhance its accuracy and applicability. Localized data collection, including soil samples and historical crop performance, can be integrated to tailor the model's recommendations to specific local conditions.
- Incorporation of Social and Economic Factors: Future iterations of the model can consider incorporating social and economic factors that impact crop selection. Variables such as market demand, crop prices, and consumer preferences can be integrated to provide more comprehensive recommendations that align with both agronomic and economic objectives.
- Collaboration with Agricultural Experts: Engaging agricultural experts, agronomists, and farmers in the model development process can help validate and refine the recommendations. Their expertise and feedback can improve the model's performance and ensure its practical relevance in real-world farming scenarios.

These future directions have the potential to enhance the model's accuracy, applicability, and overall impact in supporting sustainable and efficient agricultural practices.

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APPENDIX

Code for the project is available at:

Source-Code-Link