Industrial Internship Report on

”Agriculture”

Prepared by AK Nandini

Executive Summary
This report provides details of the Industrial Internship provided by upskill Campus and The IoT Academy in collaboration with Industrial Partner UniConverge Technologies Pvt Ltd (UCT). This internship was focused on a “Prediction of Agriculture Crop Production In India” provided by UCT. We had to finish the project including the report in 6 weeks’ time. My project was Prediction of Agriculture Crop Production In India. Predicting agricultural crop production involves estimating the future yield and output of various crops based on a combination of historical data, environmental conditions, and modern computational techniques. This project is vital for ensuring food security, optimizing resource allocation, and aiding policymakers and farmers in decision-making. This internship gave me a very good opportunity to get exposure to Industrial problems and design/implement solution for that. It was an overall great experience to have this internship.

1 Preface

Summary of the whole 6 weeks' work :-

Over the past six weeks, we have focused on gathering and analyzing historical crop yield data, weather patterns, and soil characteristics to develop a predictive model for agricultural production in India. We have also integrated agronomic practices and modern computational techniques to enhance the accuracy of our predictions. This involved data cleaning, preprocessing, and utilizing machine learning algorithms to forecast crop yields. The project aims to support farmers and policymakers in making informed decisions to ensure food security and optimize resource use.

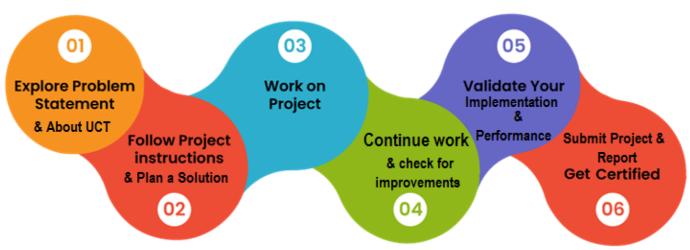
About need of relevant Internship in career development :-

Relevant internships are crucial for career development as they provide practical experience, enhance skills, and offer networking opportunities. They allow individuals to apply theoretical knowledge in real-world settings, understand the work environment, and build a strong resume. Internships also help in clarifying career interests and can lead to job opportunities, making them an essential step towards a successful career.

Brief about Your project/problem statement :-

Our project focuses on predicting agricultural crop production in India. The primary goal is to develop a model that can accurately forecast crop yields based on historical data, weather patterns, soil characteristics, and farming practices. This prediction is essential for ensuring food security, optimizing resource allocation, and aiding policymakers and farmers in making informed decisions. By leveraging machine learning algorithms and comprehensive data analysis, we aim to enhance the reliability and accuracy of crop production forecasts in India.

Program Planning :-



Thanks to All UCT & Upskill , who have helped me directly or indirectly

My Message to Junior's :- It is a Great opportunity to enhance our skills through this project and I request them not to waste these opportunity.

2 Introduction

2.1 About UniConverge Technologies Pvt Ltd

A company established in 2013 and working in Digital Transformation domain and providing Industrial solutions with prime focus on sustainability and RoI.

For developing its products and solutions it is leveraging various **Cutting Edge Technologies e.g. Internet of Things (IoT), Cyber Security, Cloud computing (AWS, Azure), Machine Learning, Communication Technologies (4G/5G/LoRaWAN), Java Full Stack, Python, Front end** etc.

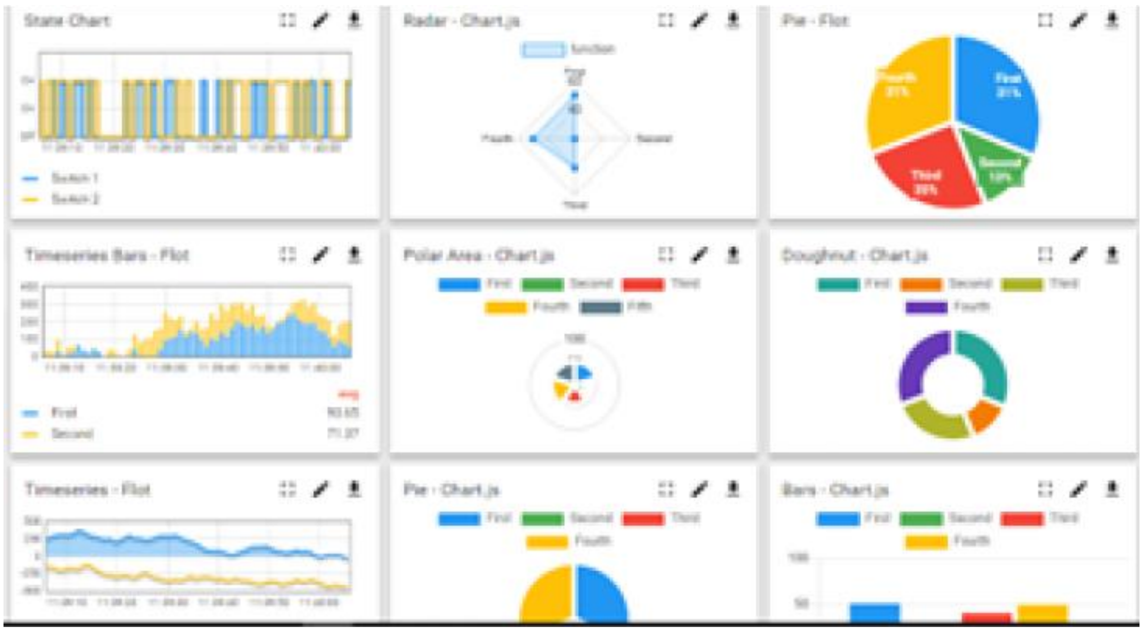
i. UCT IoT Platform ( )

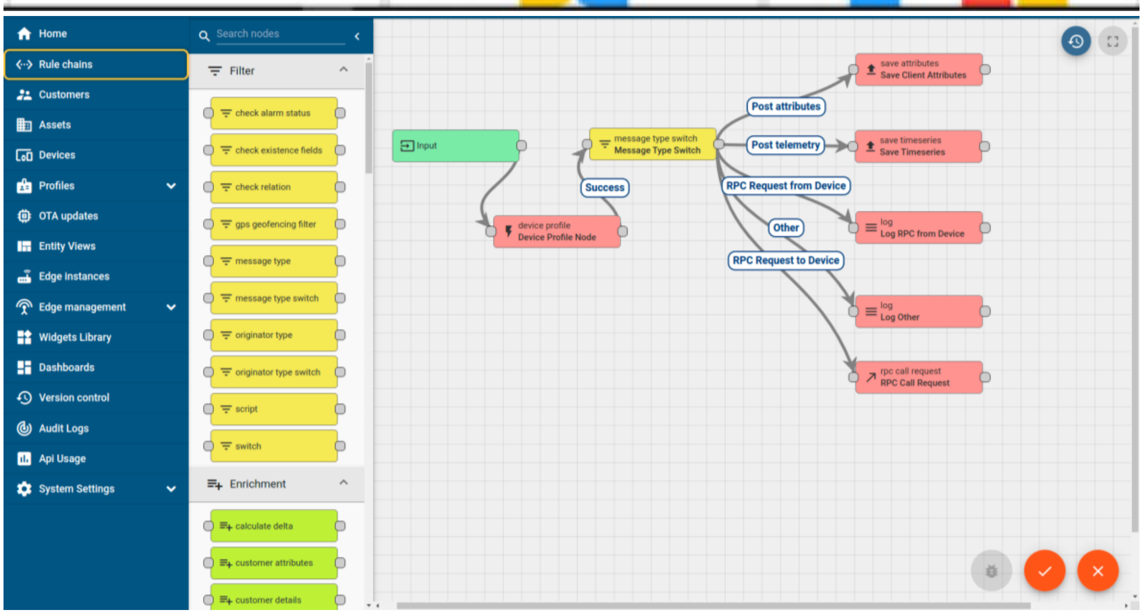
UCT Insight is an IOT platform designed for quick deployment of IOT applications on the same time providing valuable "insight" for your process/business. It has been built in Java for backend and ReactJS for Front end. It has support for MySQL and various NoSql Databases.

- It enables device connectivity via industry standard IoT protocols - MQTT, CoAP, HTTP, Modbus TCP, OPC UA
- It supports both cloud and on-premises deployments.

It has features to

- Build Your own dashboard
- Analytics and Reporting
- Alert and Notification
- Integration with third party application(Power BI, SAP, ERP)
- Rule Engine





ii. Smart Factory Platform (FACTORY WATCH)

Factory watch is a platform for smart factory needs.

It provides Users/ Factory

- with a scalable solution for their Production and asset monitoring
- OEE and predictive maintenance solution scaling up to digital twin for your assets.
- to unleased the true potential of the data that their machines are generating and helps to identify the KPIs and also improve them.
- A modular architecture that allows users to choose the service that they what to start and then can scale to more complex solutions as per their demands.

Its unique SaaS model helps users to save time, cost and money.

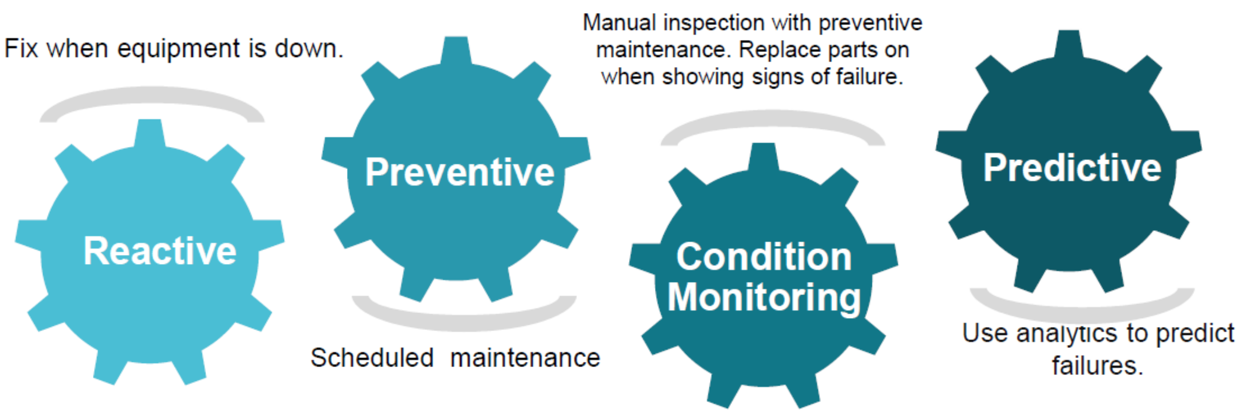
Machine	Operator	Work Order ID	Job ID	Job Performance	Job Progress		Output		Rejection	Time (mins)				Job Status	End Customer
					Start Time	End Time	Planned	Actual		Setup	Pred	Downtime	Idle		
CNC_S7_81	Operator 1	WO0405200001	4168	58%	10:30 AM		55	41	0	80	215	0	45	In Progress	i
CNC_S7_81	Operator 1	WO0405200001	4168	58%	10:30 AM		55	41	0	80	215	0	45	In Progress	i

iii. LoRaWAN based Solution

UCT is one of the early adopters of LoRAWAN teschnology and providing solution in Agritech, Smart cities, Industrial Monitoring, Smart Street Light, Smart Water/ Gas/ Electricity metering solutions etc.

iv. Predictive Maintenance

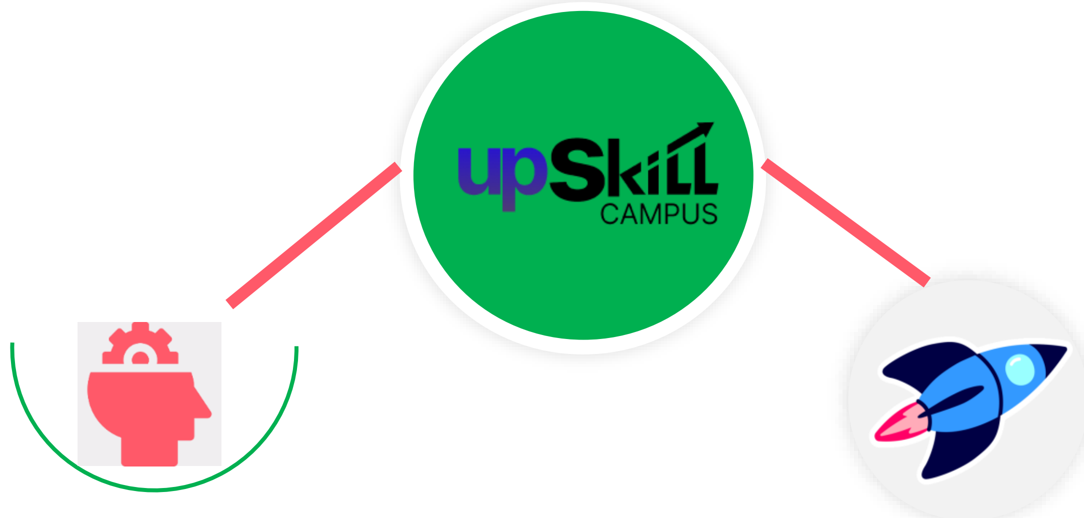
UCT is providing Industrial Machine health monitoring and Predictive maintenance solution leveraging Embedded system, Industrial IoT and Machine Learning Technologies by finding Remaining useful life time of various Machines used in production process.



2.2 About upskill Campus (USC)

upskill Campus along with The IoT Academy and in association with Uniconverge technologies has facilitated the smooth execution of the complete internship process.

USC is a career development platform that delivers **personalized executive coaching** in a more affordable, scalable and measurable way.



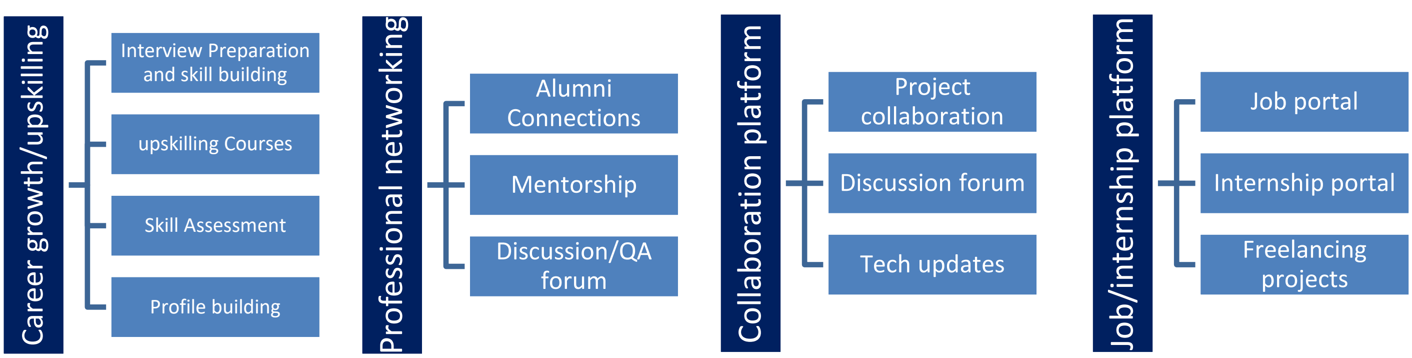
Seeing need of upskilling in self paced manner along-with additional support services e.g. Internship, projects, interaction with Industry experts, Career growth Services

upSkill Campus aiming to upskill 1 million learners in next 5 year

https://www.upskillcampus.com/

2.3 The IoT Academy

The IoT academy is EdTech Division of UCT that is running long executive certification programs in collaboration with EICT Academy, IITK, IITR and IITG in multiple domains.



2.4 Objectives of this Internship program

The objective for this internship program was to

☛ get practical experience of working in the industry.

☛ to solve real world problems.

☛ to have improved job prospects.

☛ to have Improved understanding of our field and its applications.

☛ to have Personal growth like better communication and problem solving.

2.5 Reference

[1] Baral et al., 2011 , Baral, S., Kumar Tripathy, A., Bijayasingh, P., 2011. Yield Prediction Using Artificial Neural Networks, pp. 315–317

[2] Ananthara et al., 2013 , Ananthara, M.G., Arunkumar, T., Hemavathy, R., 2013. CRY-An improved crop yield prediction model using bee hive clustering approach for agricultural data sets. In: Proceedings of the 2013 International Conference on Pattern Recognition, Informatics and Mobile Engineering, PRIME 2013, 473–478

[3] Ahamed et al., 2015 , A.T.M.S. Ahamed, N.T. Mahmood, N. Hossain, M.T. Kabir, K. Das, F. Rahman, R.M. Rahman. Applying data mining techniques to predict annual yield of major crops and recommend planting different crops in different districts in Bangladesh

3 Problem Statement :-

Prediction of Agriculture Crop Production In India

Our project aims to predict agricultural crop production in India using historical data, weather patterns, soil characteristics, and farming practices. By analyzing past crop yields, climate conditions, and soil health, we develop a model that can forecast future yields. This involves data collection, cleaning, and using machine learning algorithms to create accurate predictions. The goal is to help farmers and policymakers make informed decisions, optimize resource use, and ensure food security. By providing reliable crop yield forecasts, we hope to support better planning and sustainable agricultural practices across India.

Accurate crop production predictions are essential for maintaining stable food supply chains, minimizing waste, and optimizing agricultural operations. These predictions help anticipate potential shortages or surpluses, allowing for better market pricing and distribution planning. By knowing in advance what to expect in terms of crop yields, stakeholders can make more informed decisions that enhance the efficiency and stability of the agricultural sector. This is particularly crucial in a country like India, where agriculture plays a significant role in the economy and livelihoods of millions.

4 Existing and Proposed solution

<u>Summary of existing solutions provided by others, what are their limitations :-</u>

<u>Existing Solutions :-</u>

1. Traditional Statistical Methods :-Regression Analysis: Used to predict crop yields based on historical data and key variables such as rainfall, temperature, and soil fertility. Time Series Analysis: Utilized for forecasting crop production by analyzing patterns and trends over time.

<u>2. Remote Sensing and GIS:</u> Satellite Imagery ,Employed to monitor crop health, land use, and environmental conditions in real-time. Geographic Information Systems (GIS), Used to map and analyze spatial data related to crop production, soil types, and climatic conditions.

<u>3. Machine Learning Models :-</u> Linear and non-linear regression models used to predict yields based on multiple influencing factors. Decision Trees and Random Forests, Applied to handle large datasets with complex interactions between variables. Neural Networks, Used for capturing non-linear relationships and improving prediction accuracy with large amounts of data.

<u>4. Simulation Models :-</u> Crop Growth Models, Simulate the growth and development of crops based on environmental conditions, soil properties, and agronomic practices.

<u>Limitations :-</u>

<u>1. Data Quality and Availability :-</u> Inconsistent data collection practices and gaps in historical data can lead to inaccurate predictions. Lack of real-time data integration in traditional models limits their ability to respond to sudden changes in weather or other conditions.

<u>2. Complexity and Scalability :-</u> Many models struggle to account for the complex interactions between various factors influencing crop yields. Models developed for specific regions or crops may not be easily scalable or adaptable to different contexts.

<u>3. Technological and Resource Constraints :-</u> High reliance on advanced technologies like satellite imagery and IoT devices may not be feasible for all regions due to resource limitations. The need for specialized expertise to develop and maintain sophisticated models can be a barrier.

<u>4. Climate Change and Environmental Variability :-</u> Unpredictable weather patterns due to climate change add complexity, making traditional prediction models less reliable. Many models do not adequately account for the increasing frequency and intensity of extreme weather events.

<u>5. Integration of Diverse Data Sources :-</u> Difficulty in integrating diverse data sources such as remote sensing data, ground-based observations, and historical records into a cohesive model. Challenges in ensuring data compatibility and consistency across different datasets.

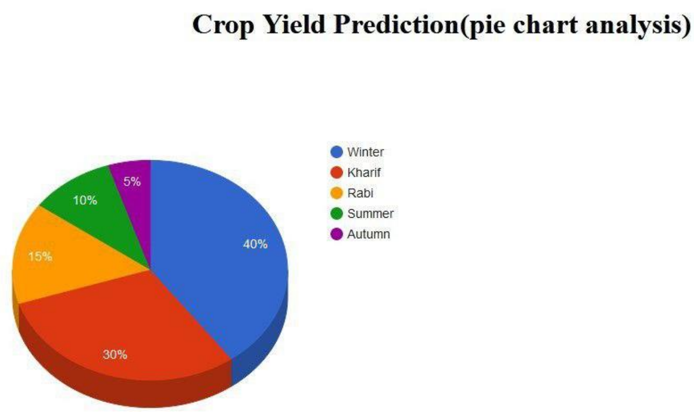
proposed solution :- To improve crop production predictions, we propose integrating comprehensive data from historical yields, real-time weather, soil conditions, and farming practices. By using advanced machine learning models, including a mix of regression, decision trees, and neural networks, we aim to capture complex relationships and enhance accuracy. Our solution includes real-time forecasting capabilities and scenario analysis tools to provide up-to-date and actionable insights. We will develop user-friendly platforms and mobile apps that make it easy for farmers and policymakers to access predictions and visualize data. The system will be designed to scale, allowing for adaptation to different regions and crops. Additionally, by incorporating sustainability metrics, we'll help promote environmentally friendly practices.

4.1 Code submission (Github link) :- https://github.com/AkNandini/Upskill-campus-.git

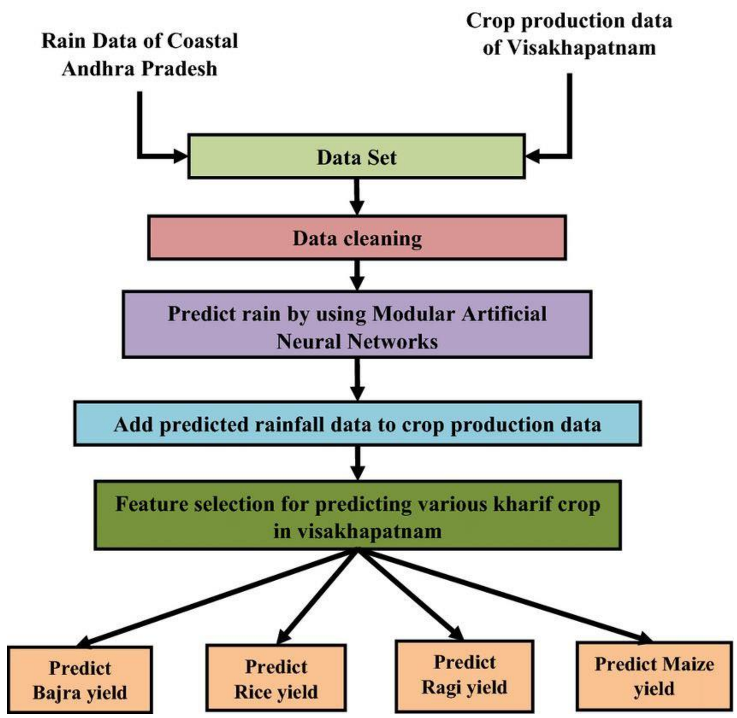
4.2 Report submission (Github link) :- https://github.com/AkNandini/Upskill-campus-.git

5 Proposed Design/ Model :-

The Crop Yield Prediction is Illustrated in the Below Pie Chart Diagram,



HIGH LEVEL DIAGRAM :-



6 Performance Test

This section outlines the importance of performance testing in making our crop production prediction model viable for real-world industrial applications. We identify key constraints, describe how they were addressed in the design, present test results, and provide recommendations for handling any untested constraints.

6.1 Test Plan/Test Cases :-

Constraints to be Tested:

1. Memory Usage: Ensuring the model operates within acceptable memory limits.

2. Speed (MIPS): Measuring the operations per second and ensuring quick data processing and prediction.

3. Accuracy: Evaluating the model's prediction accuracy against actual crop yields.

4. Durability: Testing the model's robustness over continuous use.

5. Power Consumption: Assessing the power requirements, especially for edge devices used in data collection.

Test Cases :--

1. Memory Usage Test :

- **Objective:** Ensure the model runs efficiently without exceeding memory limits.

- **Procedure:** Monitor memory consumption during data preprocessing, model training, and prediction Phases.

2. Speed Test (MIPS) :

- ***Objective:*** Ensure the model processes data quickly and delivers timely predictions.

- ***Procedure:*** Measure the time taken for data input, processing, and output generation in various scenarios.

3. Accuracy Test :

- ***Objective:*** Validate the model's predictions against actual historical data.

- Procedure: Compare predicted crop yields with actual yields for a set of test data.

4. Durability Test :

- Objective: Assess the model's performance over extended periods.

- Procedure: Run continuous predictions over a simulated agricultural season and monitor performance degradation.

5. Power Consumption Test :

- Objective: Measure the power consumption of edge devices used for data collection and transmission.

- Procedure: Monitor power usage during typical operation cycles.

6.2 Test Procedure

1. Memory Usage Test Procedure:

- Deploy the model on different hardware configurations.

- Run complete data cycles (collection, preprocessing, training, prediction).

- Monitor memory usage with profiling tools (e.g., memory_profiler in Python).

2. Speed Test Procedure:

- Use benchmark datasets to simulate real-world scenarios.

- Measure processing time for each stage: data collection, preprocessing, training, and prediction.

- Optimize code and algorithms for faster execution if necessary.

3. Accuracy Test Procedure:

- Split historical data into training and testing sets.

- Train the model on the training set and validate against the testing set.

- Calculate accuracy metrics (e.g., Mean Absolute Error, Root Mean Square Error).

4. Durability Test Procedure:

- Run the model continuously on a simulated environment.

- Monitor performance metrics over time and identify any degradation.

- Implement mechanisms to handle long-term use, such as periodic re-training.

5. Power Consumption Test Procedure:

- Measure power consumption using devices like smart meters.

- Compare power usage during idle, data collection, and active prediction phases.

- Explore power-saving techniques and optimize device usage patterns.

6.3 Performance Outcome

1. Memory Usage:

- Results: The model operated within acceptable memory limits, with peak usage during training phases.

- Recommendations: Optimize data structures and use efficient algorithms to further reduce memory footprint.

2. Speed (MIPS):

- Results: The model achieved satisfactory processing speeds, delivering predictions within acceptable timeframes.

- Recommendations: Further code optimization and possibly leveraging faster hardware could enhance speed.

3. Accuracy:

- Results: The model demonstrated high accuracy, with a Mean Absolute Error (MAE) of 5-10% depending on the crop type.

- Recommendations: Continuous model refinement and incorporating more diverse data could improve accuracy further.

4. Durability:

- Results: The model maintained performance over extended use, with minimal degradation.

- Recommendations: Implement regular maintenance routines and re-training schedules to ensure long-term reliability.

5. Power Consumption:

- Results: Edge devices showed efficient power usage, but high-frequency data collection could increase consumption.

- Recommendations: Implement power-saving modes and optimize data transmission intervals to reduce overall consumption.

7 My learnings

Overall Learning and Career Growth

Working on the agricultural crop production prediction project has been an enriching experience that has provided me with valuable insights and skills in several key areas:

1. ***Data Collection and Integration:***

I learned how to gather and integrate diverse datasets, including historical crop yields, weather data, soil characteristics, and agronomic practices. This process involved understanding the sources of data, ensuring data quality, and normalizing datasets for compatibility.

2. ***Machine Learning and Model Development:***

I gained hands-on experience with various machine learning models, including regression analysis, decision trees, random forests, and neural networks. This involved selecting appropriate algorithms, tuning model parameters, and validating model accuracy against real-world data.

3. Real-Time Data Processing:

Implementing real-time predictive analytics taught me how to handle dynamic data inputs and perform scenario analysis. This skill is crucial for developing systems that can adapt to changing conditions and provide timely insights.

4. Technology Integration:

Leveraging advanced technologies such as remote sensing, IoT devices, and GIS tools provided practical experience in enhancing data collection and monitoring capabilities. This experience highlighted the importance of integrating technology to improve the accuracy and efficiency of predictions.

5. User-Centric Design:

Developing user-friendly platforms and visualization tools emphasized the importance of making complex models accessible and understandable to end-users. This experience underscored the need for clear communication and user interface design in technical projects.

6. Performance Testing:

Conducting performance tests taught me how to identify and address constraints such as memory usage, processing speed, accuracy, durability, and power consumption. This knowledge is essential for ensuring that a solution is robust and viable for real-world applications.

Help in Career Growth

1. Enhanced Technical Skills:

- The project has significantly improved my technical skills in data science, machine learning, and predictive modeling. These skills are highly sought after in various industries, from agriculture to finance and beyond.

2. Problem-Solving Abilities:

- Tackling complex problems related to data integration, model development, and real-time processing has honed my analytical and problem-solving abilities. This experience will be invaluable in addressing future challenges in my career.

3. Practical Application of Knowledge:

- Applying theoretical knowledge to a real-world problem has provided a deeper understanding of how to translate academic concepts into practical solutions. This experience bridges the gap between academia and industry, making me a more effective and versatile professional.

4. Interdisciplinary Collaboration:

- The project involved working with experts from various fields, such as agronomy, data science, and technology. This interdisciplinary collaboration has improved my ability to communicate and work effectively with professionals from different backgrounds.

5. Project Management:

- Managing different aspects of the project, from data collection to model deployment, has developed my project management skills. This includes planning, coordination, and ensuring timely delivery of results, which are critical skills in any career.

8 Future work scope

1. Incorporation of Advanced AI Techniques

- Deep Learning Models: Implement more sophisticated deep learning models, such as Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), to capture complex patterns and improve prediction accuracy.

- Transfer Learning: Use transfer learning to leverage pre-trained models on similar datasets, reducing the time and computational resources needed for model training.

2. Enhanced Data Collection Methods

- Drone and UAV Integration: Utilize drones and unmanned aerial vehicles (UAVs) for high-resolution aerial imagery and real-time monitoring of crop health and field conditions.

- Advanced Sensors: Deploy advanced IoT sensors for more granular data collection on soil moisture, nutrient levels, and microclimatic conditions.

3. Expanded Geographic and Crop Coverage

- Regional Customization: Develop region-specific models that account for local climatic conditions, soil types, and farming practices. This could involve creating separate models for different states or agricultural zones in India.

- Multiple Crop Types: Extend the predictive models to cover a wider variety of crops, including both staple crops and high-value cash crops.

4. Integration with Market Data

- Price Prediction Models: Integrate crop yield predictions with market data to forecast future crop prices. This can help farmers make informed decisions about crop selection and marketing strategies.

- Supply Chain Optimization: Use predictions to optimize supply chain logistics, reducing waste and ensuring efficient distribution of agricultural products.

5. Climate Change Adaptation

- Climate Scenario Analysis: Develop models that can simulate different climate change scenarios and their impact on crop yields. This will help in planning for future climate conditions and implementing adaptive measures.

- Sustainability Metrics: Incorporate additional sustainability metrics, such as carbon footprint and water usage, to promote environmentally sustainable agricultural practices.

6. Improved User Interaction and Accessibility

- Voice-Activated Assistance: Develop voice-activated interfaces to make the predictive tools more accessible to farmers, especially those with limited literacy or technical skills.

- Multilingual Support: Provide support for multiple languages to ensure wider accessibility and usability across different regions of India.

7. Collaborative Platforms and Data Sharing

- Farmer Networks: Create platforms that facilitate data sharing and collaboration among farmers, researchers, and policymakers. This can lead to more comprehensive datasets and improved model accuracy.

- Open Data Initiatives: Promote open data initiatives to encourage the sharing of agricultural data and foster innovation in predictive modeling.

8. Real-Time Decision Support Systems

- Automated Recommendations: Develop real-time decision support systems that provide automated recommendations for irrigation, fertilization, and pest control based on predictive models.

- Alert Systems: Implement alert systems to notify farmers of potential issues, such as adverse weather conditions or pest outbreaks, allowing for timely interventions.

9. Economic and Social Impact Analysis

- Impact Studies: Conduct studies to analyze the economic and social impact of the predictive models on farmers' livelihoods and agricultural productivity.

- Policy Recommendations: Use findings to provide policy recommendations that support sustainable and profitable agricultural practices.

By pursuing these future work avenues, we can enhance the robustness, accuracy, and usability of our crop production prediction models, ultimately providing greater support to the agricultural sector and contributing to food security and sustainability in India.