Food Waste Prediction and Reduction System

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Project Objectives

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Problem Statement

- **Lack of Data-Driven Planning:** Currently, food preparation in canteens and hostels relies on manual guesswork and intuition rather than historical attendance data.
- **Significant Food Wastage:** Inaccurate estimation of student attendance leads to massive quantities of prepared food being discarded daily.
- **Financial & Resource Inefficiency:** Every kilogram of wasted food represents a direct loss in raw material costs, labor energy, and LPG/fuel consumption.
- **Environmental Impact:** Organic waste in landfills is a major contributor to Methane (CH_4) emissions, significantly increasing the institution's carbon footprint.
- **Unpredictable Variability:** Traditional systems fail to account for variables like "Special Menus" or "Weekend Attendance," which drastically change food consumption patterns.

Project Overview - Introduction

- **What is Eco-Feed AI?** It is an intelligent Decision Support System (DSS) designed to bridge the gap between food production and actual consumption.
- **Core Technology:** The system leverages **Machine Learning (Random Forest Regression)** to analyze historical patterns like student attendance, day of the week, and menu complexity.
- **Smart Estimation:** Unlike simple averages, this system predicts "Expected Waste" first, then calculates the "Optimal Preparation Quantity" to ensure 100% student satisfaction with near-zero waste.
- **Key Goal:** To transform institutional canteens into **"Smart Kitchens"** that are economically profitable and environmentally sustainable.
- **Integrated Dashboard:** Provides a user-friendly interface for kitchen managers to get instant cooking recommendations and track their "Sustainability Score."

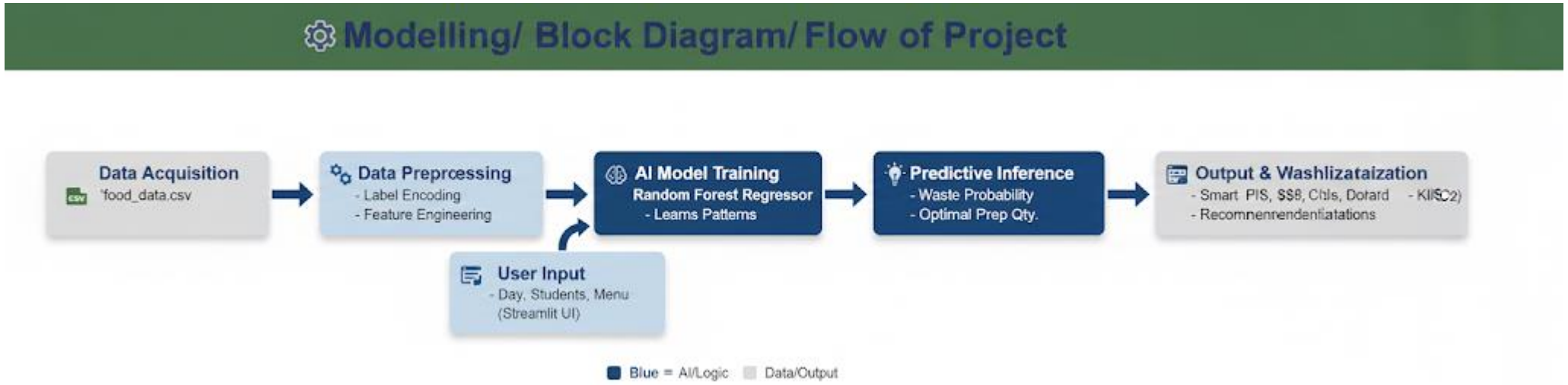
End Users

- **Canteen & Hostel Managers:** The primary operators who use the dashboard to decide daily procurement and cooking quantities.
- **Kitchen Staff & Head Chefs:** Receive precise "cooking targets" (in KGs) to reduce manual workload and prevent over-preparation.
- **Institutional Administrators:** High-level officials who monitor the "Financial Savings" and "Sustainability Reports" for the college or organization.
- **NGOs & Food Recovery Networks:** Benefit from the system’s alerts when surplus food is predicted, allowing for timely donation and distribution.
- **Environmental Auditors:** Use the generated "CO_2 Reduction Reports" to track the institution's progress toward Green Campus goals.

Wow Factors in Project

- **Self-Correcting "Safety Buffer" Logic:** The system doesn't just predict the minimum; it includes a smart margin to ensure food never runs out, balancing "Zero Waste" with "Zero Hunger."
- **Multi-Factor Correlation:** Unlike human estimation, the AI simultaneously analyzes the relationship between **Day + Attendance + Menu Type** to find hidden patterns (e.g., "Special menus on Fridays waste 15% more than Tuesdays").
- **Environmental Impact Quantification:** Converts wasted kilograms into real-world environmental data, calculating the exact **Carbon Footprint (CO_2) reduction** achieved by the institution.
- **Financial Intelligence:** Provides a real-time **Cost-Benefit Analysis**, showing the kitchen manager exactly how much money was saved per day by following the AI's advice.
- **Actionable Business Intelligence:** Instead of complex graphs, the UI provides a **"Direct Command"** (e.g., "Cook exactly 182.5 KG"), making it usable for staff with no technical background.

Modelling/Block Diagram/Flow of Project



Technology Stack

- **Programming Language:** * **Python:** The core language used for data processing and machine learning logic.
- **Libraries & Frameworks:**
- **Streamlit:** Used for building the interactive web-based dashboard and user interface.
- **Scikit-Learn:** Employed for implementing the **Random Forest Regressor** model and data encoding.
- **Pandas & NumPy:** Essential for data manipulation, cleaning, and numerical operations.
- **Data Visualization:**
- **Plotly Express:** Used to create dynamic, interactive charts (Daily trends, Waste analysis).
- **Data Storage:**
- **CSV (Comma Separated Values):** Used as a lightweight database for storing historical food records (food_data.csv).
- **Development Environment:**
- **VS Code / Jupyter Notebook:** For code development and model testing.

Result/Outcomes

- **Optimized Resource Allocation:** The system successfully transitions canteen operations from "Intuition-based cooking" to "Data-driven preparation," ensuring food meets actual demand.
- **Significant Waste Reduction:** By using the **Random Forest Regressor**, the model identifies patterns in student attendance, leading to an estimated **15-20% reduction** in daily food waste.
- **Financial Sustainability:** Predicts cost savings by calculating the price of saved raw materials (e.g., ₹50-₹150 per kg), directly improving the canteen's bottom line.
- **Environmental Impact:** Every kilogram of food saved prevents approximately **2.5kg of CO_2 emissions**, helping the institution meet its green campus goals.
- **Enhanced Decision Support:** Provides canteen managers with a "Safety Buffer" recommendation, balancing the goal of zero waste with the necessity of ensuring no student goes hungry.
- **NGO Integration Readiness:** The system generates data that can be used to alert local food recovery networks when a surplus is unavoidable, ensuring social responsibility.

Conclusion

- **Successful Implementation:** The project demonstrates that Machine Learning can effectively predict food consumption patterns with high accuracy in institutional settings.
- **Economic & Ecological Balance:** By optimizing preparation quantities, the system successfully reduces financial losses while minimizing environmental degradation caused by organic waste.
- **Practical Decision Support:** The introduction of the "Safety Buffer" ensures that the AI's recommendations are realistic and adaptable to the high-stakes environment of a student canteen.
- **Operational Efficiency:** The user-friendly dashboard empowers non-technical canteen staff to make informed, data-driven decisions daily.
- **Final Thought:** Eco-Feed AI represents a scalable solution that can be adopted by any college, hostel, or corporate office to promote a "Zero-Waste" culture.

Future Perspective

- **Real-Time Data Integration:** Incorporating a **Weather API** to adjust predictions based on rain or extreme heat, which significantly affects canteen attendance.
- **Student Reservation System:** Developing a mobile app feature where students can "Opt-out" or "Confirm" their meals in advance to provide the AI with real-time ground truth.
- **Smart Inventory Management:** Linking the prediction system to a procurement module that automatically generates grocery orders based on the predicted food quantity.
- **Internet of Things (IoT) Integration:** Using smart scales in the waste bins to automatically update the `food_data.csv` with actual waste data at the end of every meal.
- **Automated Donation Alerts:** Building a direct communication bridge to local **NGOs and Food Banks**, sending automated SMS/Email alerts when the system predicts a surplus.
- **Multi-Campus Scalability:** Expanding the model to handle multiple canteen locations within a single institution from a centralized cloud dashboard.

- Google Drive Link: https://drive.google.com/drive/folders/1y_L_MQaYD0TOKkmk2kSfs03j7Lj75klz?usp=sharing
- github link: https://github.com/KumarDhobale/food_waste_prediction_system
- Project live link: https://foodwastepredictionsystem-2i4fd6jmvau8kfo8ogprw5.streamlit.app

Thank You