Project Plan
Product-based Capstone Project

Team ID **: C242-PR602**

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Final Selected Themes:
Sustainable Futures: Nurturing harmony between humanity and the environment

Title of the Project:
Website EcoPlan

Excecutive Summary/Abstract:

The volume of waste, increasing due to population and urbanization, has today become a serious problem, mainly in urban areas. Ineffective management of municipal wastes very often results in health problems and environmental pollution since there is no awareness of waste separation and recycling methods. This is especially prominent among students and youngsters in campus living where waste management awareness is still at a low level, based on the feedback of local communities, either reluctance or confusion over waste segregation and its benefits.

In this regard, we propose the creation of an intelligent waste detection and management application leveraging the power of machine learning. It will identify the types of waste using advanced image recognition and will provide specific suggestions on the most effective methods of managing the particular waste, such as converting organic waste to compost or specifying material-specific recycling. By integrating the relevant APIs, this application offers actionable, practical advice on recycling in a user-friendly manner and educates them.

This application will focus on university campuses to help institutions maintain a cleaner environment by instilling good waste segregation habits among students. The advantages are that it will reduce wastes in campus areas, help attain sustainability goals, and result in a healthier community. Ultimately, this solution aims at the reduction of negative health and environmental impacts, while fostering eco-conscious behavior in academic institutions.

How did your team come up with this project?
The inspiration behind this application for detecting waste developed due to being bothered by the rise in the load of waste degrading the environment and negative results on human life. Watching the adverse outcomes of wastes on soil, water pollution, and air led us to find an efficient solution for identifying various kinds of wastes. This web-based application is designed to detect various kinds of waste using image recognition technology. Therefore, it will enable users to learn how to properly recycle or dispose of various types of wastes and increase their awareness of the importance of better waste

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management. We want this app to be able to actively create a contribution toward decreasing unmanaged waste and relieve those burdens from negative influences that waste has on the environment and climate change.

Project Scope & Deliverables:

- **Develop a Waste Detection Web Application called "EcoScan" :** A web-based application designed to help users identify various types of waste and provide suggestions for proper disposal and recycling methods.
- **Project Objective:** The goal is to mitigate environmental pollution by offering a user-friendly platform for people to identify waste, understand its environmental impact, and adopt better waste management practices.
- **Features and Functionalities:**
  1. **Recycling Reminder:** The app will notify users about the correct time and method to recycle different materials.
  2. **Automatic Waste Detection from Photos:** Users can upload images, and the app will use machine learning to classify the waste and offer disposal recommendations.
  3. **Environmental Impact Analysis:** The app will educate users about the environmental consequences of improper waste disposal.
  4. **Organic Waste Management:** Guidelines on managing organic waste, including composting and recommending local composting facilities.
- **Technology Stack:**
  1. **Machine Learning:**
     Model: CNN to classify types of waste based on images uploaded by users.
     Framework: TensorFlow for building the deep learning model and training.
     Dataset: Kaggle dataset supporting classification of waste types from photos.
     Deployment: Deploying the machine learning model to make it accessible within the web application.
  2. **Cloud Storage:**
     API: Creating API functions for user login and registration.
     Hosting: Setting up hosting for the web application to be accessed online.
     Storage: Storing assets and user-uploaded images in Google Cloud Storage.

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Integration: Connecting the machine learning model to the web application via API to display waste classification results to the user.

3. **All Stack (Web Development):**
   Front-End: Designing and developing the user interface using HTML, CSS, and JavaScript to ensure the application is responsive and user-friendly.
   Back-End: Using Python (Flask) to develop the API and server-side logic to manage interactions between the web app, machine learning model, and cloud storage.

- **Team Organization**
  1. **Machine Learning Team:**
     Responsibilities: Developing and training the machine learning model using transfer learning and CNNs, and deploying the model to the application.
     Tools: TensorFlow, Kaggle, Dataset, Python
  2. **Cloud Computing Team:**
     Responsibilities: Creating and managing APIs for user login/registration, setting up cloud storage on Google Cloud, and connecting the machine learning model to the web app through API integration.
     Tools: Google Cloud, API Development
  3. **All Stack (Web Development) Team:**
     Responsibilities: Designing and developing the website's user interface using HTML, CSS, and JavaScript, and building the server-side logic with Python (Flask) to integrate all the technology stacks.
     Tools: HTML, CSS, JavaScript, Python (Flask), Figma
- **Project Timeline**
  The team will work over the next 4 weeks to deliver the project, following a weekly breakdown of tasks and milestones.

Week	Task	Tech Stack	Expected Output
1	Designing website UI with Figma and implementing on web platform	All	Figma Prototype and front-end set up
	Create resources needed from cloud platform	Cloud Computing	Activated cloud storage and database
	Researching and preparing the dataset	Machine Learning	Prepared dataset

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2	Authentication and camera access	All	Fully functional authentication and camera access
	Prepared and uploaded final dataset	Cloud Computing	Dataset uploaded to cloud
	Training model for waste detection	Machine Learning	Trained model
3	Integrating ML model with website	Machine Learning	Website able to detect waste
	Connecting to database	Cloud Computing	Database connection established
	Increasing detection accuracy of the model	Machine Learning	Improved model accuracy
4	Show recognition results in website	All	Website able to show the detection results
	Connecting to cloud database	Cloud Computing	Database connection with website established
	Deploying model to website	Machine Learning	Model deployed to website
1-4	Gathering feedback on UI/UX and features	All	User feedback collected for improvements
	Improving user interface and detection features	All	UI and feature improvements based on feedback

- **Deliverables:**
  - Project Plan
  - Progress Report
  - Prototype (in Figma)
  - Web App Deployment (accessible online)
  - Github Repository with Documentation

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- Presentation Slides & Demo Video (10 minutes)
- Final Project Report
- Go-to market strategy for future updates

Project Schedule:

	4 Nov - 10 Nov	11 Nov - 17 Nov	18 Nov - 24 Nov	25 Nov - 1 Des	2 Des - 13 Des
Designing website UI with Figma and implementing on web platform					
Creating resources needed from cloud platform					
Authentication and camera access					
Preparing and uploading final dataset					
Training model for waste detection					
Integrating ML model with website					
Connecting database and cloud services					
Deploying ML model and showing recognition results on website					
Gathering user feedback and improving UI/UX					

Project Start : 4 November 2024
Project Deadline : 13 December 2024
Working time : Four Weeks

Based on your team's knowledge, what tools/IDE/Library and resources that your team will use to solve the problem?

Tools:

1. Figma : Used for collaborative UI design, ensuring optimal user experience for the application.
2. Github : A platform for version control and collaboration, used to manage code and track changes throughout the development process.

IDE (Integrated Development Environment) :

1. Google Colab: Used for experimenting and training machine learning models, especially with large datasets, in an online environment.
2. Jupyter Notebook : Ideal for data exploration and creating interactive notebooks that document the data analysis process.
3. Visual Studio Code : Used for full-stack development, including backend (Flask) and front-end code.

Libraries :

1. TensorFlow: The primary framework for building machine learning models, especially for classifying types of waste.
2. NumPy: Used for array manipulation and mathematical operations needed for data processing.

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3. Matplotlib/Seaborn: Used for visualizing data, such as displaying statistics and environmental impact analysis.
4. Flask: A backend framework used to integrate machine learning models and provide API endpoints for the application.

Resource :

1. Dataset of Trash Images from Kaggle: The main dataset containing images of various types of trash for training the machine learning model.
2. Google Cloud Services (API): Used for hosting machine learning models, storing data, and integrating APIs into the web application.

Learning Path Categories:

1. Designing & Planning:
    - Tools: Figma, GitHub
    - Purpose: Designing the user interface and managing the project with collaboration.
2. Machine Learning Development:
    - Tools: Google Colab, Jupyter Notebook
    - Libraries: TensorFlow, NumPy, OpenCV, Scikit-learn
    - Resources: Kaggle dataset
    - Purpose: Developing the waste classification model using machine learning algorithms.
3. Backend & API Integration:
    - Tools: Visual Studio Code
    - Libraries: Flask
    - Resources: Google Cloud Services
    - Purpose: Integrating the machine learning model into the application and providing API endpoints.
4. Data Analysis & Visualization:
    - Tools: Jupyter Notebook
    - Libraries: Matplotlib, Seaborn, Pandas
    - Purpose: Displaying insights from data analysis and visualizing statistics.
5. Deployment & Hosting:
    - Resources: Google Cloud Services, GitHub
    - Purpose: Hosting the application and making it accessible to users.

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Based on your knowledge and explorations, what will your team need support for?Capstone!

In order for our waste detection and environmental management web application to be developed & functional, there are several areas where we need your support. We also ask for mentorship in improving our machine learning model to be more accurate with waste classification, and guidance on how to best utilize TensorFlow. Furthermore we need help setting up the Google Cloud for longterm scaling and reliability in regards to scalability/ data storage, server deployment / api management etc. This support will allow us to create an intuitive, responsive application that meets project needs.

Based on your knowledge and explorations, tell us the Machine Learning Part of your capstone?

EcoScan App, which revolves around identifying and classifying waste types, core to the site functionality with machine learning. We will build a Convolutional Neural Network (CNN) using TensorFlow for classifying the categories of waste: plastic, glass, metal paper and organic. For the most part, this model will be trained on a labeled waste dataset while preprocessing steps (including) data augmentation primarily to improve accuracy and robustness across other conditions. In order to further boost the performance, we are going to do a transfer learning on pre-trained models like MobileNet or ResNet and fine-tune it taking our own dataset into consideration. This model will be deployed on the website using TensorFlow after training. Being written in the form of a.js file allows it to run well on server-side as well creating minimal overheard and insuring its efficiency in browser.

Based on your knowledge and explorations, tell us the Mobile Development Part of your capstone?

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Based on your knowledge and explorations, tell us the Cloud/Web/Frontend/Backend Part of your capstone?

We are going to implement a strong login and registration mechanism in cloud-based computing using a private API call for authentication and authorization. We will create an API key for users to authenticate against when trying to access resources. Additionally, cloud storage will securely house all machine learning models and assets. Running and deploying these models on our cloud AI platform allows us to look after performance, reliability, and scale. This not only makes model management and execution easier but also provides the ability to do further model development and analysis with cloud resources.

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A web interface where users can choose an image and upload to analyze trash. The frontend will be developed in languages like HTML, CSS, and JavaScript to help us build functionalities such as image upload and real-time result display. The model was supposed to be integrated into the backend that we implemented in Python using Flask, and it would take care of processing images uploaded by users on our app as input, while detecting waste. On top of all that, the backend would speak to a database where it could store user data or detection results.

Based on your team's planning, is there any identifiable potential Risk or Issue related to your project?

Main Risks or Problems: If the model fails to detect waste accurately that can make degradation of effectiveness on system side. Incorrect waste detection could result in incorrect classifications and ultimately, cause user distrust as well as affect the performance of an application. It's also the fact that I have to make sure this model can generalize across different types of waste for all kinds of environments. Its high-performance must be constantly implemented and maintained with training, testing throughout adjustments. Successful deployment of a waste detection application requires careful model optimization and data management to manage these risks.

Any other notes/remarks we should consider on your team's application

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