AI Based Plant Advisor

Session: 2022–2026

Submitted By
Ariba Shafaqat 2022-CS-113
Wajeeha Javaid 2022-CS-136

Submitted To
Sir Samyan Qayyum Wahla

Department of Computer Science
University of Engineering and Technology
Lahore, Pakistan.

Contents

List of Tables

List of Figures

1 Executive Summary

The AI Plant Advisor is an intelligent system that utilizes machine learning techniques to help users identify plants, suggest predict growth rates,sunlight requirements,watering needs,fertilization types and soil requirements.This system is powered by an AI model trained on plant data, including sunlight, watering needs, and soil types. The system is designed to help both novice and expert gardeners optimize plant care and growth.

2 Introduction

2.1 Purpose of the AI Plant Advisor System

The purpose of the AI Plant Advisor system is to provide a smart, user-friendly tool that offers personalized plant care guidance. Using advanced machine learning models, the system helps users identify plants accurately and predict essential growth characteristics like growth rate, sunlight requirements, soil type, watering needs, and fertilization preferences.The system enhances plant management by delivering reliable, real-time insights, ensuring better care and healthier growth.

2.2 Scope of the Project

This project focuses on the development of an AI-driven system capable of fulfilling a wide range of functionalities for plant care. The scope includes the following key features:

- **Plant Identification:** Recognizing and identifying plant based on user input (either through images or names).
- **Growth Prediction:** Predicting plant growth rates based on input data.
- **Personalized Care Advice:** Offering customized care guidelines such as watering schedules, sunlight requirements, and soil preferences.
- **User Interaction:** Allowing users to interact with the system through an intuitive interface, inputting data to receive real-time advice.

2.3 Objectives and Goals

The AI Plant Advisor system is developed with the following objectives in mind:

- **Enhance Gardening Practices:** To provide gardeners with scientific and AI-backed recommendations to improve plant care and health.
- **Promote Efficient Plant Care:** To minimize plant care errors and reduce the effort needed to maintain healthy plants by offering automated insights.
- **Increase Accessibility to Gardening Knowledge:** Making expert-level plant care advice available to all users, irrespective of their gardening experience.
- **Support Sustainable Gardening:** By providing optimized care routines, the system encourages more sustainable gardening practices, resulting in healthier plants and more efficient resource use.

2.4 Significance of the System

The AI Plant Advisor stands to significantly impact both individual gardeners and the broader gardening community by providing a easy-to-use platform that brings gardening advice to everyone. The system combines traditional gardening knowledge with modern AI to provide a data-driven way of managing plant care. The system uses technology to help plants grow better, leading to healthier ecosystems and more sustainable farming.

2.5 Target Audience

The AI Plant Advisor is intended for a wide range of users, including:

- **Amateur Gardeners:** Individuals who are new to gardening and need assistance with identifying plants and understanding their care needs.
- **Experienced Gardeners:** Gardeners seeking advanced recommendations and insights based on their specific plant types and environmental conditions.
- **Agricultural Professionals:** Experts looking for a tool that can predict plant growth and optimize plant care.

2.6 Data Sources

The AI Plant Advisor system is trained on a custom-built dataset collected from many sources like National Gardening Association, Smithsonian Gardens and many more.

- **Plant Names:** A list of plants used for identification and recommendations.
- **Sunlight Requirements:** Data on sunlight preferences (e.g., full sunlight, partial sunlight,indirect sunlight), essential for personalized care.
- **Soil Types:** Information on optimal soil conditions (e.g., sandy, loamy, well-drained, acidic) for healthy growth.
- **Watering Schedules:** Guidelines on watering frequency for each plant.
- **Growth Information:** Details on growth rate i.e. fast,slow or moderate.

2.7 AI Model Development

The AI model for the Plant Advisor system consists of three primary components: plant identification, growth prediction and plant care recommendations including sunlight requirement, watering frequency, fertilization type and soil type.

- **Plant Identification:**For plant identification, the system handles plant names by using Term Frequency-Inverse Document Frequency (TF-IDF) to match names to known species. When an image is provided, a Convolutional Neural Network (CNN) is used to classify the planT. This combination allows the system to accurately identify plants from both text and images.
- **Growth Prediction and Care Recomendations:** To predict the growth rate, sunlight requirements, soil type, watering and fertilization needs, the system uses a Random Forest Classification model. Each aspect is predicted with a separate model, trained on plant name data that is vectorized using TF-IDF.

3 Model Training and Evaluation

In this system, multiple **Random Forest Classification** models and a **Convolutional Neural Network (CNN)** model are used to predict different plant care requirements, such as growth rate, sunlight needs, soil type, watering, fertilization, and to classify plant images. The process of training and evaluating these models involves several key steps:

3.1 Data Preprocessing

- The plant name data is vectorized using the **TF-IDF** (Term Frequency-Inverse Document Frequency) method to convert textual data into numerical form suitable for model training. This is done using the `TfidfVectorizer` from **scikit-learn**, with stop words removed to improve model performance.
- For plant image classification, images are resized and normalized to ensure they are suitable for training the **CNN** model. Libraries such as **tensor flow keras** are used to preprocess the images.

3.2 Model Training

Separate models are trained for each prediction task:

- **Growth Prediction Model**
- **Sunlight Requirement Model**
- **Soil Type Model**
- **Watering Model**
- **Fertilization Model**
- **Plant Image Classification Model** (using CNN)

Random Forest Classifier These models are trained using the **Random Forest Classifier** with the `class_weight='balanced'` parameter, which handles class imbalances by giving more weight to minority classes during training.

Convolutional Neural Network (CNN) To classify plant images, a CNN model is used with the following architecture:

- **Input Layer**: Accepts preprocessed plant images (e.g., 224x224 pixels).
- **Convolutional Layers**: Extracts features from the images using filters (e.g., 3x3) with **ReLU** activation.
- **Output Layer**: Connects the extracted features to produce predictions.

3.3 Data Balancing

To address class imbalances in the training data for the watering and fertilization models, techniques such as **Random Oversampling** and **TomekLinks** are applied:

- **RandomOverSampler**: Balances the class distribution by duplicating minority class samples.
- **TomekLinks**: Removes borderline examples that may introduce noise into the model.

3.4 Hyperparameter Tuning

The performance of the watering and fertilization models is optimized using **GridSearchCV**. A range of hyperparameters, including `n_estimators`, `max_depth`, and `min_samples_split`, are tuned to find the best combination that improves model performance.

For the CNN, hyperparameters such as **learning rate**, **batch size**, and the number of **convolutional layers** are tuned to improve accuracy.

3.5 Cross-Validation

To ensure that the models generalize well to unseen data, **cross-validation** is performed on the training data. This helps evaluate the model's stability and performance across multiple subsets of the training data.

3.6 Model Evaluation

After training, each model is evaluated using appropriate metrics:

- **Random Forest Models**: Evaluated using the **confusion matrix** and **classification report**, which provide metrics such as **precision**, **recall**, **F1-score**, and **accuracy**.
- **CNN Model**: Evaluated using accuracy, loss, and visualized.

3.7 Testing on Data

Finally, the models are tested on unseen data (the test set) to estimate their real-world performance. This step confirms the models' effectiveness in making predictions for new or unknown plants and images.

Table 1: Model Evaluation Metrics

Model	**Precision**	**Recall**	**F1-Score**	**Accuracy**
Growth Model	0.88	0.89	0.88	0.89
Sunlight Model	0.91	0.94	0.93	0.95
Soil Model	0.74	0.88	0.79	0.81
Watering Model	0.27	0.30	0.23	0.42
Fertilization Model	0.51	0.36	0.39	0.56
Plant Image Model (CNN)	0.85	0.87	0.86	0.84

The addition of the **CNN model** allows the system to provide accurate predictions not only based on text-based input but also for **plant images**, enhancing the overall functionality of the AI-Based Plant Advisor system.

4 Wireframes and User Interface Design

4.1 Landing Page

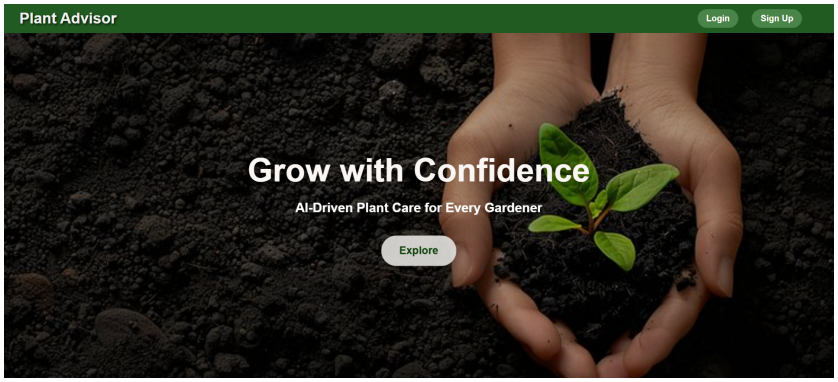

Figure 1: Landing Page

4.2 SignUp page

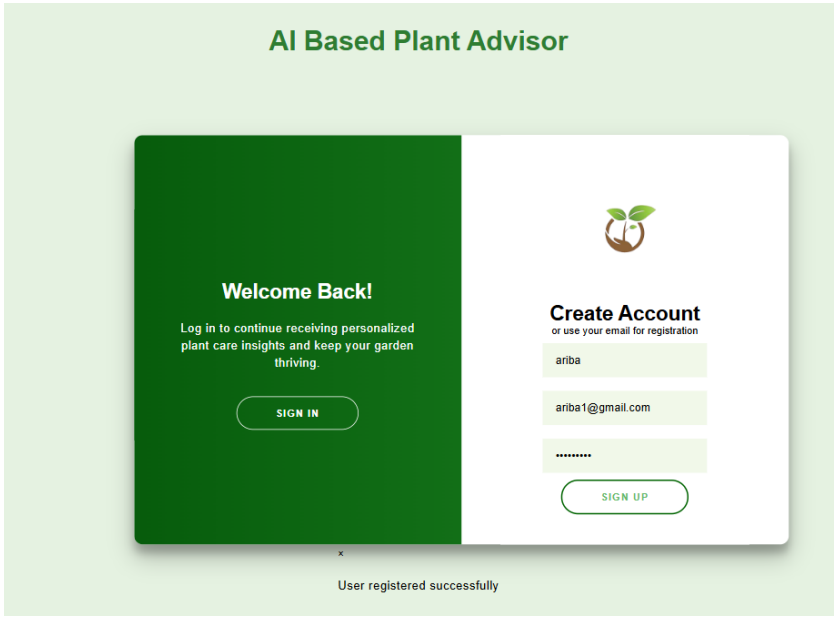

Figure 2: SignUp Page

4.3 SignIn page

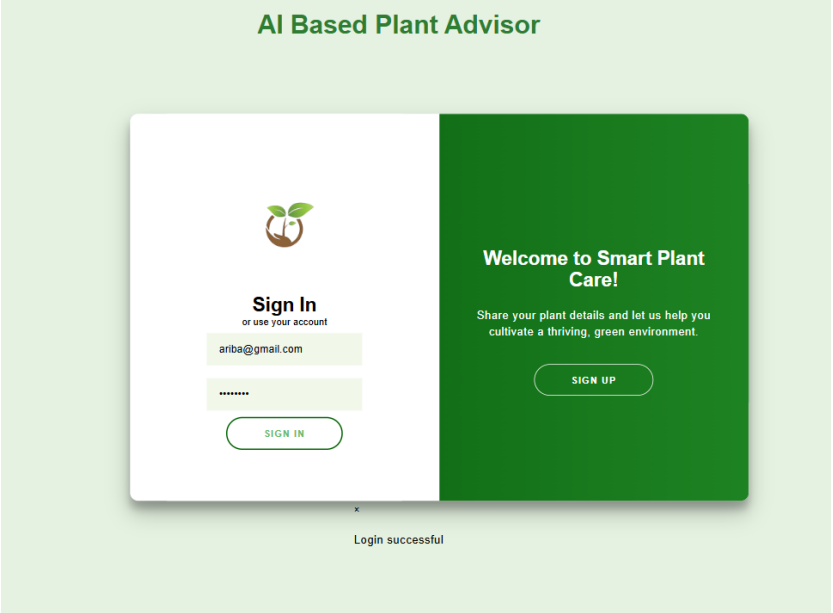

Figure 3: SignIn Page

4.4 Plant Identification Page

A page where users can input plant names or upload images to identify plants.

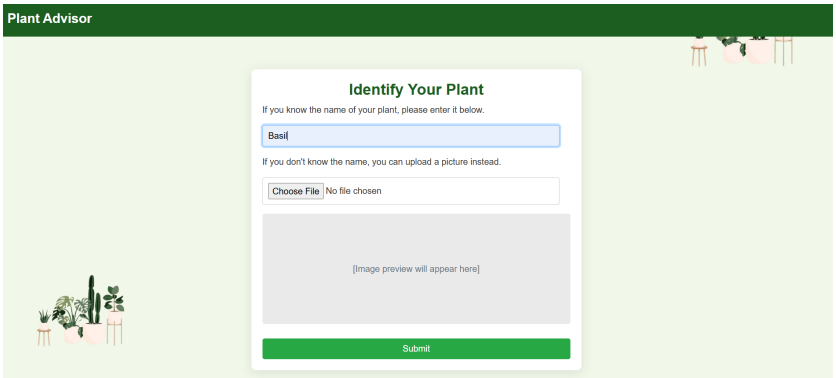

Figure 4: Plant Submission Form

4.5 Growth Prediction Page

A page where the system predicts the growth of a plant based on user input and plant data and provides personalized care advice based on plant type and user input.

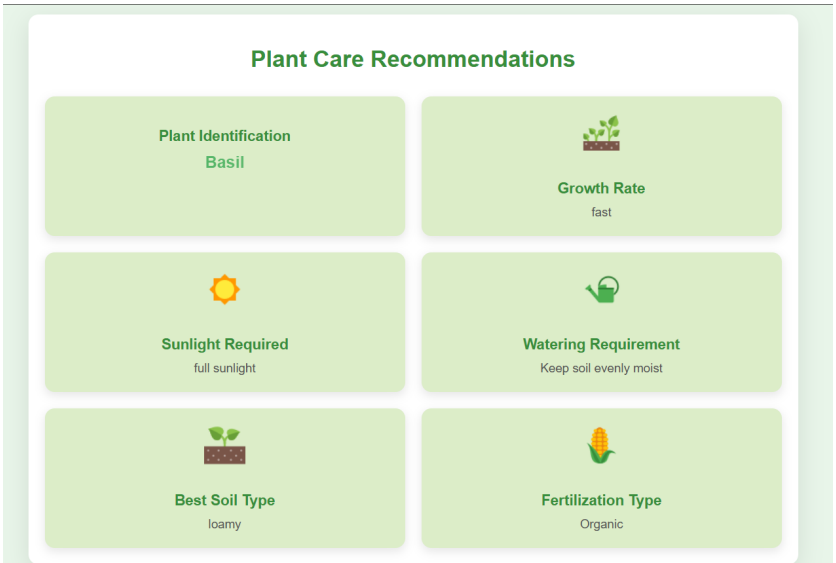

Figure 5: Growth Prediction and Care Recommendations

4.6 User Interface and Interaction

1. **User-Friendly Navigation:** The interface allows users to easily navigate between the plant identification, growth prediction, and personalized care recommendation features.

2. **Data Visualization:** The outputs are displayed in visually intuitive formats to enhance user understanding of the results.

3. **Dynamic Feedback:** The system provides feedback based on user inputs, ensuring clear communication of results and error messages when required.

4. **Error Handling:** If any feature encounters an issue due to technical problems, the system provides an error message and possible troubleshooting suggestions to the user.

5 Future Work and Improvements

Future enhancements to the AI-Based Plant Advisor include:

- **Expanded Plant Database:** Adding more plant species to cater to diverse gardening needs.
- **Model Optimization:** Refining AI models for improved accuracy in plant identification and care recommendations.
- **Mobile Application:** Developing a mobile app for greater accessibility and on-the-go gardening assistance.
- **Personalized Recommendations:** Enhancing user-specific advice based on preferences and past interactions.

These improvements will ensure the system remains accurate, user-friendly, and adaptable to future technological advancements.

6 Conclusion

The AI Plant Advisor offers a smart and user-friendly solution for improving the care of plants. The use of AI model makes it possible for gardeners to understand and manage some key plant care needs, like growth predictions, watering schedules, sunlight requirements, and soil types. The system is simple for beginners to handle, and it gives valuable insights to an experienced gardener in having healthier plants and better results. With such flexibility, ease of use, and potential for further enhancements, it is an effective tool that encourages smarter and more efficient gardening practices.