Visvesvaraya Technological University
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First Year
A Mini-Project
ReportOn

"GreenBot: A ChatBot for Home Gardeners"

Submitted in the partial fulfilment of the requirements for the award of the Degree of
BACHELOR OF ENGINEERING
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COMPUTER SCIENCE AND ENGINEERINGDATA SCIENCE

Submitted by

Aiden Tomas George (1DS23CD004)Ashlesh (1DS23CD012)
Kushagra Shukla (1DS23CD027)
Madhuri VS (1DS23CD029)

Under the Guidance of
Dr. Rashmi
HOD, Dept. of CSE (Data Science), DSCE

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DEPARTMENT OF CSE (DATA SCIENCE)
DAYANANDA SAGAR COLLEGE OF ENGINEERING
SHAVIGE MALLESHWARA HILLS, KUMARASWAMY LAYOUT, BANGALORE-78

DAYANANDA SAGAR COLLEGE OF ENGINEERING

Shavige Malleshwara Hills, Kumaraswamy Layout
Bangalore-560078

Department of CSE (DATA SCIENCE)

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Certificate

This is to certify that the Mini Project Work entitled **"GreenBot: A ChatBot for Home Gardeners"** is a bonafide work carried out by **Aiden Tomas George (1DS23CD004), Ashlesh (1DS23CD012), Kushagra Shukla (1DS23CD027) andMadhuri (1DS23CD029)**, in partial fulfilment for the II semester of Bachelor of Engineering in CSE (Data Science) of the Visvesvaraya Technological University, Belgaum during the year 2023-2024. The Project report has been approved as it satisfies the academics prescribed for the Bachelor of Engineering degree.

Signature of Guide [Dr. Rashmi S]	Signature of HOD [Dr. Rashmi S]

Name of the Examiners	Signature with Date
1.	
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Chapter 1
Introduction

1.1. Introduction

Home gardening has seen a surge in popularity, attracting millions of new enthusiasts. But for beginners, the vast amount of information can & navigating the world of plant care can be overwhelming. Finding reliable and specific information on a vast array of plant varieties can be a time-consuming challenge. GreenBot, a chatbot designed to assist home gardeners, tackles this issue by providing real-time access to essential plant care knowledge. Leveraging advanced technologies like artificial neural networks (ANNs) and natural language processing (NLP), GreenBot can answer questions about planting basics like sowing depth, spacing, ideal temperature, and harvesting time required. a comprehensive knowledge base of gardening practices. This empowers new gardeners with the information they need to get started and nurture their plants successfully.

1.2. Problem statement

The rise in popularity of home gardening has created a surge of new enthusiasts, but many of them struggle to find reliable and specific information tailored to their needs. This lack of readily available, interactive guidance hinders their ability to successfully navigate the world of plant care.

The current gardening information landscape presents several challenges for beginners:

1. **Information Overload:** The vast amount of online resources and books can be overwhelming, making it difficult to identify reliable sources and pinpoint specific advice.
2. **Generic Advice:** Existing resources often provide broad, generic recommendations that may not be applicable to individual plant varieties, local climates, or unique gardening goals.
3. **Misinformation and Inconsistencies:** Navigating through a sea of information can lead to confusion and conflicting advice. This inconsistency can cause frustration and hinder effective gardening practices, as beginners struggle to determine the best course of action.
4. **Lack of Interactivity:** Traditional resources lack the interactivity needed for users to receive real-time answers to their specific questions. This limits their ability to address immediate gardening concerns effectively.

1.3 Objectives and Scope of Project

Objectives:

1. **Provide Personalized Plant Care Guidance:** To offer users accurate and reliable gardening advice tailored to specific plant needs, including sowing instructions, spacing requirements, harvest times, and other relevant information based on user queries.
2. **Interactive Communication Through a Website:** Enable interactive communication with real-time responses to user queries, enhancing user engagement and satisfaction from a Website.
3. **Scalable Architecture:** Design the system architecture to be scalable and robust, capable of handling many user interactions without performance degradation.
4. **Future Expansion:** Plan for the addition of more data to further enhance the gardening assistance provided.

Scope:

1. **Target Audience:** GreenBot is designed primarily for new and beginner home gardeners, and anyone seeking accessible and reliable plant-specific advice.
2. **Web Application:** The project includes the development of a web-based application accessible through web browsers, providing a user-friendly platform for interaction.
3. **NLP and AI Integration:** Utilize Natural Language Processing (NLP) and Artificial Intelligence (AI) techniques to process user queries and generate relevant responses.
4. **Data Sources:** Rely on curated datasets from reliable gardening websites, articles, and forums to build a comprehensive knowledge base for the GreenBot.
5. **Limitations:** The scope is limited to providing information on specific plant-related queries. It does not include advice on broader topics like soil management or pest control.

1.4 Motivation of Project

The surge in home gardening has ignited a passion for plant care in millions, but navigating the world of conflicting advice can quickly extinguish that spark. New gardeners often face a multitude of challenges:

1. Difficulty finding reliable information tailored to local climates and specific plant varieties can be a daunting task.
2. Confusing and conflicting advice leads to frustration and setbacks in their gardening efforts.

GreenBot aims to empower these enthusiastic home gardeners by providing a reliable and interactive platform to address their specific plant care needs. By combining a comprehensive database of gardening knowledge with the power of Artificial Intelligence (AI) and Natural Language Processing (NLP), GreenBot seeks to make gardening more accessible, efficient, and enjoyable. This user-friendly chatbot will ensure that home gardeners have a trusted resource to solve their gardening queries efficiently, fostering a successful and rewarding gardening experience.

New gardeners struggling with these challenges often:

1. **Become discouraged:** The difficulty in finding reliable guidance can lead to frustration and a sense of being overwhelmed.
2. **Experience plant failure**: Inconsistent or incorrect information can lead to poor plant care decisions, resulting in unsuccessful growth and potential plant death.
3. **Miss out on the full enjoyment:** The struggle to navigate complex information can hinder the enjoyment of home gardening, a hobby meant to be relaxing and rewarding.

GreenBot is motivated by the desire to address these challenges, ensuring that gardening remains a productive and satisfying activity for everyone involved.

Chapter 6

Literature Survey

Otter, D. W., Medina, J. R., & Kalita, J. K. (2021). ***A Survey of the Usages of Deep Learning for Natural Language Processing*****.** This survey reviews the applications of deeplearning in NLP, covering text classification, machine translation, sentiment analysis, and conversational agents. The advancements in neural network architectures and techniques can enhance GreenBot's ability to understand and respond accurately to user queries about plant care, leveraging these deep learning methods to improve chatbot performance.

Deeplearning.ai. This resource offers comprehensive materials on NLP principles and practices, focusing on deep learning. It includes tutorials and case studies demonstrating NLP applications. These practical examples and strategies will guide the implementation of deep learning models in GreenBot, improving its processing of complex user inputs and optimizing its gardening advice.

Adamopoulou, E., & Moussiades, L. (2020). ***An Overview of Chatbot Technology (pp.373-383). Springer, Cham..*** This chapter provides an overview of chatbot technologies, discussing design principles, architectures, and evaluation metrics. It highlights the strengths and weaknesses of different chatbot types. This knowledge will help in designing a robustsystem for GreenBot and assessing its performance to iteratively enhance its plant care responses.

Farm Sector Policy Department (2018). ***Sectoral Paper on Plantation and Horticulture.*** This paper discusses the current state and challenges ofthe plantation and horticulture sectors, including crop management practices and technological interventions. The detailed information on horticultural practices and technological advancementswill be used to enhance the content and advice provided by GreenBot, ensuring practical and impactful gardening guidance.

Bhagwat, V. A. (n.d.). Deep Learning for Chatbots. This work explores the use of deep learning techniques specifically for chatbots, discussing various models and their applications in creating more intelligent conversational agents. The insights gained from this study can be applied to GreenBot to leverage deep learning models, enhancing the chatbot's ability to provide accurate and contextually relevantadvice to users seeking plant care information.

Chapter 3

Requirements

3.1 Software Requirements

- **Operating System:** Windows 10 (or later), macOS Mojave (or later)
- **Integrated Development Environment (IDE):** Visual Studio Code (or equivalent)
- **Programming Language:** Python
- **Core Framework**: Flask
- **Libraries Required**
    - ***Flask*** (Web framework for building APIs and web applications)
    - ***Flask-Cors*** (Cross-Origin Resource Sharing support for Flask applications)
    - ***scikit-learn*** (Machine learning library for classical machine learning algorithms and tools)
    - ***joblib*** (Library for serialization and deserialization of Python objects, especially for model persistence)
    - ***pandas*** (Data manipulation and analysis library for numerical tables and time series)
    - ***numpy*** (Fundamental package for scientific computing with support for large, multi-dimensional arrays)
    - ***nltk*** (Natural Language Toolkit for natural language processing tasks)
    - ***Keras*** (High-level neural networks API for deep learning experimentation)
    - ***TensorFlow*** (Open-source deep learning framework for building and training neural networks)

3.2 Hardware Requirements

- Personal Computer or Laptop
- Minimum 4GB RAM
- Processor: Intel i3 or equivalent
- Sufficient Storage for software and datasets

Chapter 4

System Design

4.1 Existing Systems:

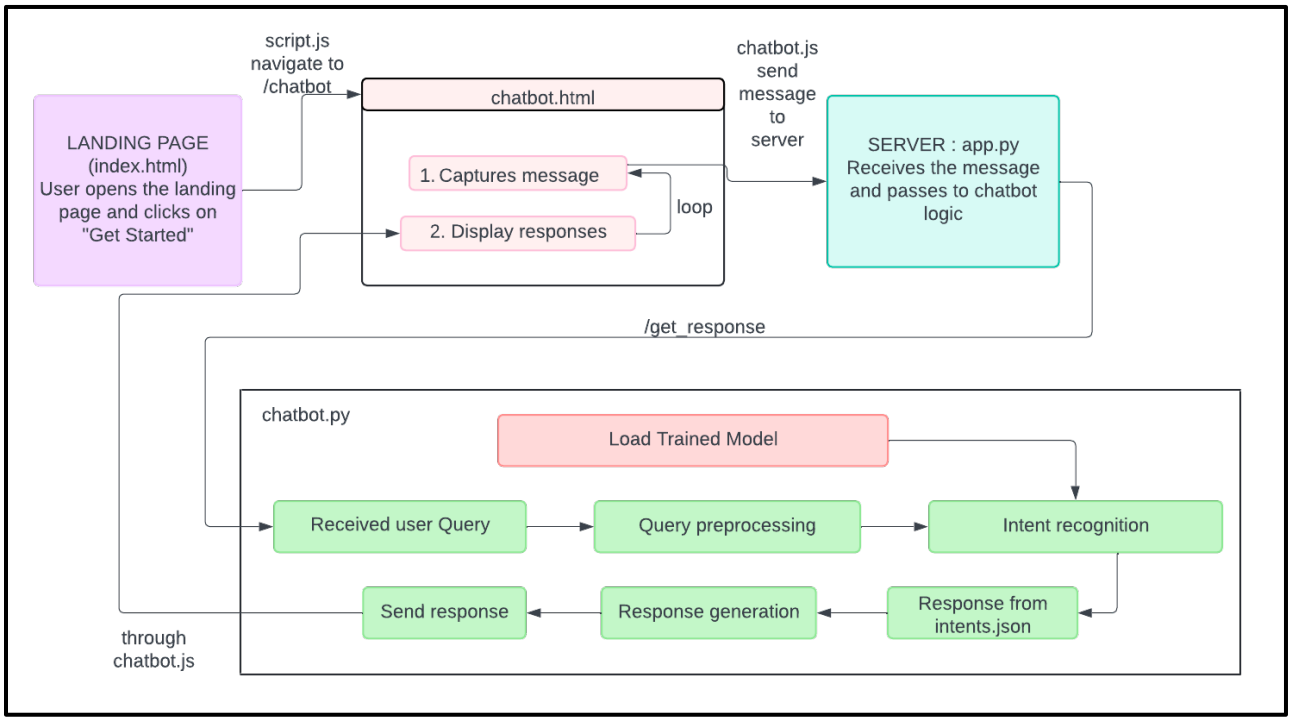
Many existing home gardening resources, such as books, websites, forums and mobile apps, provide valuable information on gardening practices. However, these systems generally offer static information and lack the ability to personalize advice for individual user needs. This can lead to several challenges for home gardeners :

Challenges and Drawbacks:

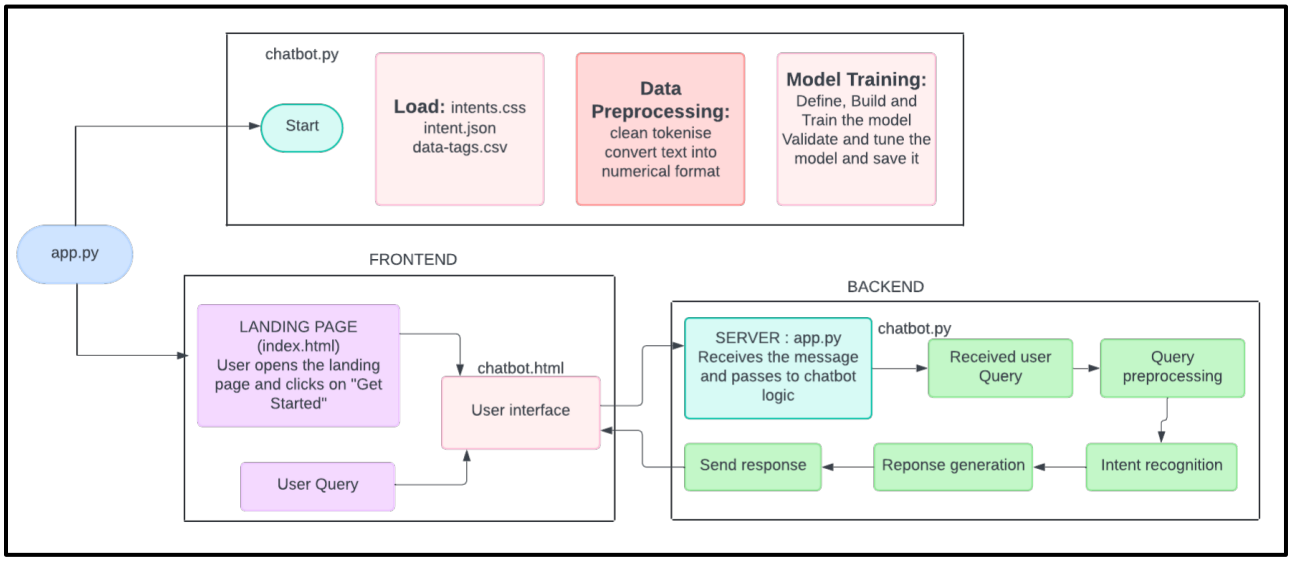
- **Lack of Personalization:** Existing systems often provide generic advice that may not be suitable for a user's specific setup, plant varieties, or local climate.
- **Inadequate Real-Time Support:** Gardeners facing urgent plant problems might not be able to find immediate solutions through traditional resources.
- **Information Overload:** The vast amount of gardening information available online can be overwhelming, making it difficult to identify reliable and relevant advice.
- **Limited Interaction:** Current systems lack interactivity, hindering users from receiving dynamic response to their ongoing gardening questions and challenges.

4.2 System Architecture of GreenBot

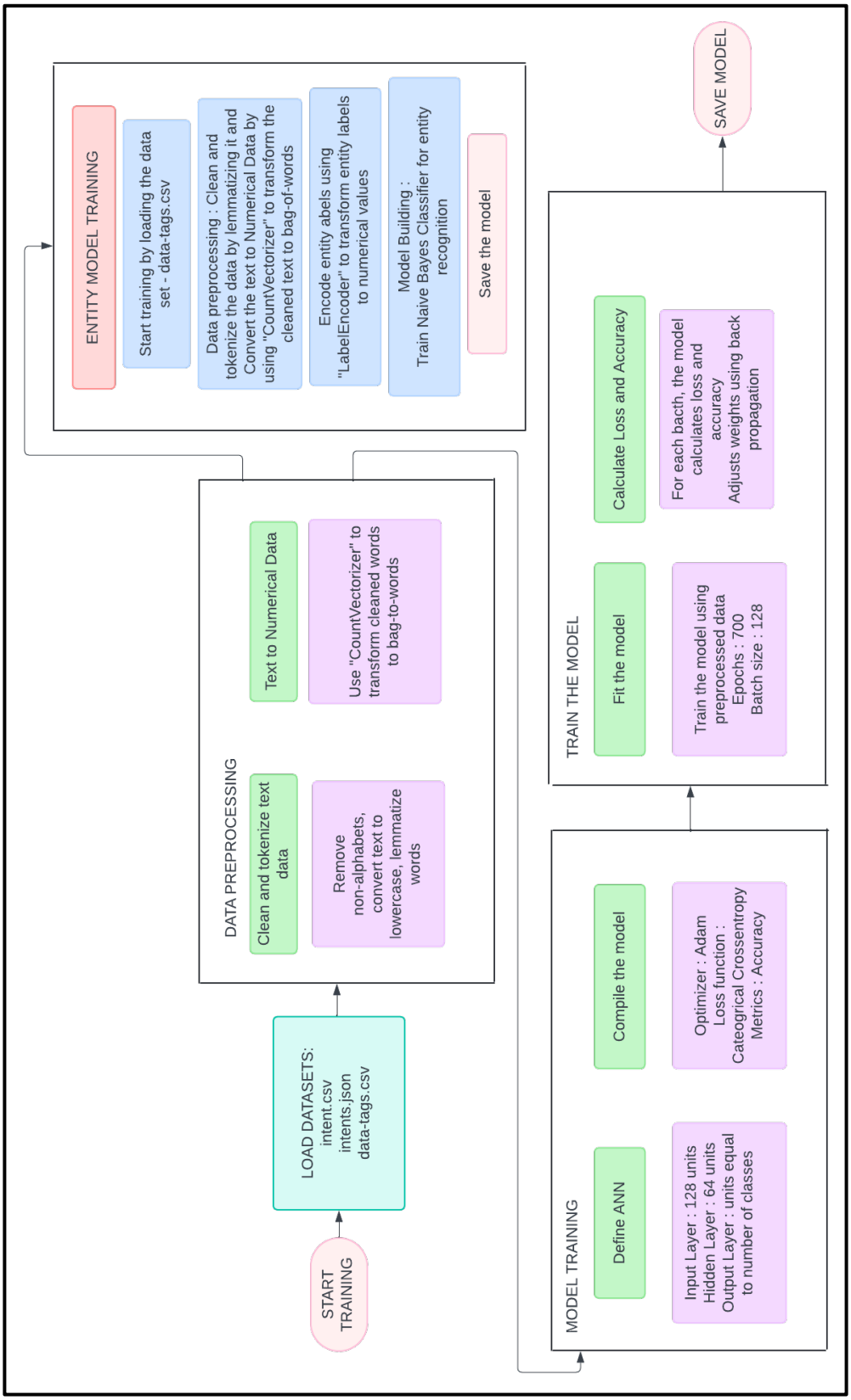
- **Flow Overview:**



- **Server Flow:**



- **ChatBot Training:**



4.3 Proposed System:

In this section, we will divide the entire chatbot system Accessible through website Locally architecture into three flowcharts to illustrate the process clearly. The three flowcharts are:

1. **Overall Flow**
2. **app.py Script**
3. **Chatbot Training Process**

Each flowchart will detail specific components and their interactions within the system.

1. Overall Flow

The overall flow diagram illustrates the end-to-end process of the chatbot system, detailing how different components interact from user input to response generation:

- **User Interface (UI):** The starting point where users interact with the chatbot. This could be a web interface, mobile app, or messaging platform.
- **Input Handling:** The user input is captured and sent to the backend for processing.
- **Preprocessing:** The input is preprocessed to clean and format the text, making it suitable for the model. This involves steps like tokenization, lowercasing, and removing stop words.
- **Intent Recognition & Entity Extraction:** The preprocessed input is fed into the trained model which performs intent recognition to understand the user's intention and entity extraction to identify specific details.

```
def process_query(user_query):
    # Clean and preprocess the user query
    query = re.sub('[^a-zA-Z]', ' ', user_query)
    query = query.split()
    lemmatizer = WordNetLemmatizer()
    tokenized_query = [lemmatizer.lemmatize(word.lower()) for word in query]
    processed_text = ' '.join(tokenized_query)
    processed_text = loaded_intent_CV.transform([processed_text]).toarray()

    # Predict the user's intent
    predicted_Intent = loadedIntentClassifier.predict(processed_text)
    result = np.argmax(predicted_Intent, axis=1)

    # Find the intent label from the predicted result
    USER_INTENT = [key for key, value in intent_label_map.items() if value == result[0]][0]

    # Print a response for the predicted intent
    response = ""
    for i in intents['intents']:
        if i['tag'] == USER_INTENT:
            response = random.choice(i['responses'])

    # Extract entities from the user query
    entities = getEntities(tokenized_query)
    return response, entities
```

- **Response Generation:** Based on the recognized intent and extracted entities, the chatbot generates a suitable response. This may involve querying a database, executing a predefined script, or generating a response using a language model.
- **Output Handling:** The generated response is sent back to the user interface, where it is displayed to the user.
- **Logging & Analytics:** User interactions and responses are logged for analytics and continuous improvement of the chatbot system.

2. app.py Script

The app.py script is the main application file that drives the chatbot. This script is essential as it defines the routes for handling user inputs and generating responses. Here's a detailed breakdown of its functionality:

- **Importing Libraries:** The script begins by importing necessary libraries such as Flask for creating web routes, and other libraries for NLP tasks like pandas, numpy, scikit-learn, keras, nltk, and regular expressions.
- **Flask App Initialization:** A Flask application instance is created, which serves as the core of the web application.
- **Route Definitions:** The script defines various routes to handle HTTP requests. For instance:
    - **Home Route:** Renders the homepage where users interact with the chatbot.
    - **Chat Route:** Receives user inputs via POST requests, processes the input through the chatbot model, and returns the generated response.
- **Chatbot Logic Integration:** The script integrates the chatbot model which processes the user query, performs intent recognition, entity extraction, and generates a response.
- **Running the App:** The script includes a condition to run the Flask application, typically at the end of the script, enabling the application to listen for incoming requests.

3. Chatbot Training Process

The chatbot training process is a crucial phase where the model learns to understand and generate appropriate responses. This image outlines the following steps:

- **Dataset Preparation:** Collecting and preprocessing a dataset consisting of user queries and corresponding responses. This includes tasks such as cleaning the text, tokenization, and formatting the data into a suitable structure for training.

In the Code:

- **Model Selection:** The chatbot utilizes two models:
    - **Intent Recognition Model:** A neural network built using Keras.
    - **Entity Recognition Model:** A Naive Bayes classifier.
- **Training:** The models are trained on prepared datasets:
    - **Intent Recognition Model Training:**
      The intent recognition model is trained using an artificial neural network (ANN). This involves the following steps:
        i. **Initialization:** The neural network is initialized using Keras' Sequential model.
        ii. **Layers Addition:**
            - An input layer with 128 units and ReLU activation function.
            - A dropout layer to prevent overfitting.
            - A hidden layer with 64 units and ReLU activation function.
            - Another dropout layer for regularization.
            - An output layer with units equal to the number of intent classes and a softmax activation function for multiclass classification.
        iii. **Compilation:** The model is compiled using the Adam optimizer and categorical cross-entropy loss function.
        iv. **Training:** The model is trained for 700 epochs with a batch size of 128.

```
# Initialize the Artificial Neural Network
classifier = Sequential()
classifier.add(Dense(units=128, activation='relu', input_shape=(corpus.shape[1],)))  # Input layer
classifier.add(Dropout(0.5))  # Dropout layer for regularization
classifier.add(Dense(units=64, activation='relu'))  # Hidden layer
classifier.add(Dropout(0.5))  # Dropout layer for regularization
classifier.add(Dense(units=y.shape[1], activation='softmax'))  # Output layer
classifier.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])  # Compile the model
classifier.fit(corpus, y, batch_size=128, epochs=700)  # Train the model
```

- **Entity Recognition Model Training:**
  The entity recognition model uses a Naive Bayes classifier, which is trained as follows:
    v. **Initialization:** The Naive Bayes model is initialized using scikit-learn's GaussianNB.
    vi. **Training:** The model is trained on the entity dataset, which consists of words and their corresponding labels.

```
# Train the Naive Bayes classifier
classifier = GaussianNB()
classifier.fit(X, y)  # Fit the model
print("Entity Model trained successfully!")
```

- **Evaluation:** After training, the models are evaluated to ensure they perform well on unseen data. Metrics like accuracy are used for performance measurement.

- **Fine-tuning:** Based on the evaluation results, the models may be fine-tuned by adjusting hyperparameters, augmenting the dataset, or making architectural changes to improve performance. In the current implementation, fine-tuning steps are implicit within the model training phase.

4.4 Technologies Used in GreenBot:

- **Artificial Neural Networks (ANN):** Employed for their ability to mimic the human brain's structure and functionality, enabling sophisticated pattern recognition and predictive capabilities.
- **Natural Language Processing (NLP):** Facilitates communication between users and GreenBot by understanding and interpreting human language, allowing for seamless interactions.

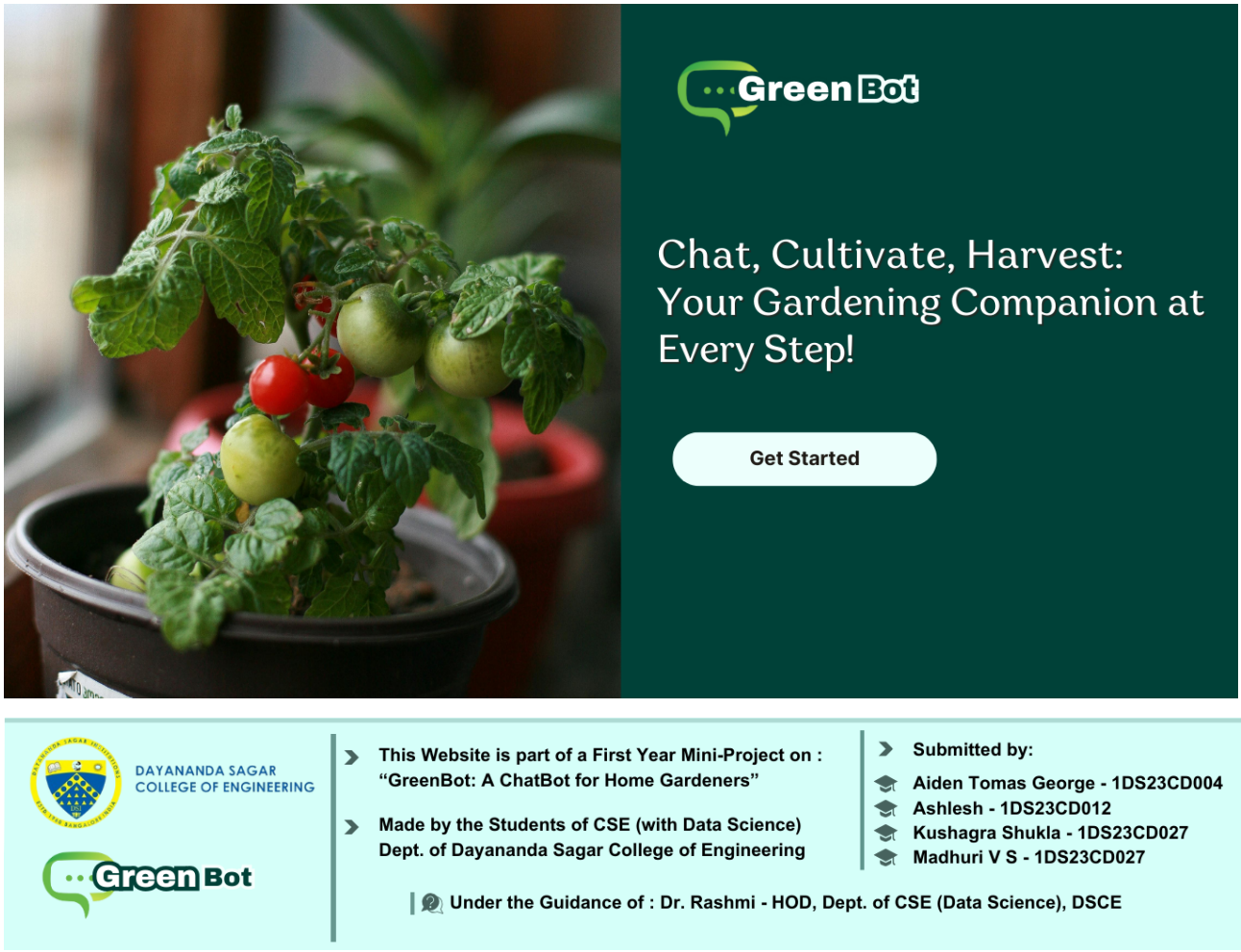
Chapter 5

Results and Discussion

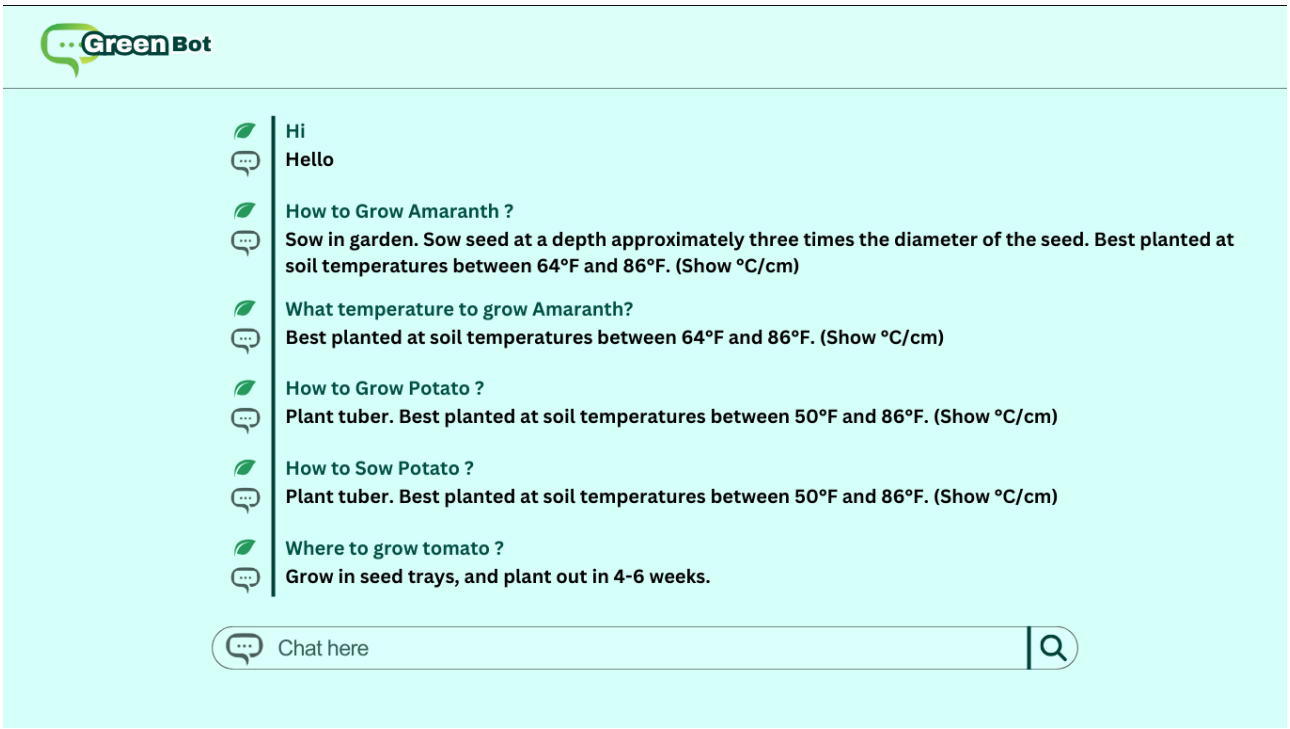
5.1 Results

This project outlines the development of a chatbot which can be accesed through web locally, specifically designed to assist culinary gardeners. The chatbot will provide users with readily accessible information on various culinary plants, empowering them to make informed decisions for their gardens.

Website




GreenBot
Let's Grow Together!
• Chat
• Cultivate
• Harvest
Chat here


GreenBot
Hi
Hello
How to Grow Amaranth ?
Sow in garden. Sow seed at a depth approximately three times the diameter of the seed. Best planted at soil temperatures between 64°F and 86°F. (Show °C/cm)
What temperature to grow Amaranth?
Best planted at soil temperatures between 64°F and 86°F. (Show °C/cm)
How to Grow Potato ?
Plant tuber. Best planted at soil temperatures between 50°F and 86°F. (Show °C/cm)
How to Sow Potato ?
Plant tuber. Best planted at soil temperatures between 50°F and 86°F. (Show °C/cm)
Where to grow tomato ?
Grow in seed trays, and plant out in 4-6 weeks.
Chat here

GreenBot's Capabilities:

- **Knowledge Base:**

The information GreenBot uses to answer your questions comes from a comprehensive knowledge base, built through a combination of manual curation by experts and automated data gathering from trusted sources. This knowledge base covers a wide range of culinary plants and offers details on planting (general recommendations), care (considering temperature preferences, watering needs etc), and harvesting.

- **Growing Environment:**

GreenBot can assist you with understanding the general preferences of your culinary crops, like :

  - **Temperature:** Does a specific plant prefer warm or cool weather?
  - **Planting Location:** Is the plant better suited for growing in a garden bed or in a container (pot or tray) that can be brought indoors if needed?

- **Harvesting**:

GreenBot can provide information on the optimal harvesting times for various culinary crops.

- **User Interface:**

User Interface a user-friendly interface that allows you to ask your questions in a conversational manner and receive relevant information. The interface is currently accessible through a text-based chat window, and future iterations might explore mobile app integration.

- **Accessibility**:

The chatbot can be designed to be accessible on various devices, including smartphones, tablets, and computers.

Impacts of GreenBot:

- **Empowering Gardeners:** By providing information on plant care tailored to their specific questions, GreenBot empowers users to make informed decisions, leading to a thriving garden. New gardeners can avoid common mistakes, while experienced gardeners can explore new plant varieties with confidence.
- **Increased Engagement:** The interactive format allows users to have a conversation with GreenBot, making learning about gardening more engaging than passively reading online

resources. Users can ask questions as they arise, fostering a more dynamic learning experience.

- **Reduced Reliance on External Resources:** Users will have readily available information at their fingertips, eliminating the need to search for online resources constantly. GreenBot provides a one-stop shop for basic gardening knowledge, saving users time and frustration.
- **Improved Sustainability:** By helping users cultivate their own food successfully, GreenBot can contribute to a more sustainable approach to food production by reducing reliance on commercially grown produce and its associated transportation footprint. This can lead to a more localized food system and potentially lower environmental impact.

5.2 Future Scope

GreenBot is a project under ongoing development, and the team is constantly exploring ways to enhance its capabilities. Here are some areas for future iterations:

- **Expanding the Knowledge Base:** Looking for opportunities to gather information from additional trusted sources to broaden the scope of plants GreenBot can answer questions about. User feedback can also be a valuable resource for identifying knowledge gaps. This can be achieved as our team of four, we've adopted a strategy of:
    - **Data Collection:** Manually searching for information online from trusted sources to populate the knowledge base.
    - **Data Integration:** Carefully selecting and integrating this information to ensure consistency and accuracy within the knowledge base.
    - **Quality Control:** Implementing quality control procedures to minimize errors during data collection and integration.
- **Refining Information:** Over time, user interactions and feedback can help identify areas where the information in the knowledge base can be improved or expanded upon.
- **Advanced Natural Language Processing:** In future iterations, GreenBot may incorporate more sophisticated natural language processing techniques. This could involve features like:
    - **Clarification Prompts:** If a query is unclear, GreenBot might ask clarifying questions to better understand your intent.
    - **Disambiguation Techniques:** GreenBot could utilize techniques like identifying synonyms or recognizing the context of a conversation to interpret your questions more accurately.
- **Personalization:** Exploring ways to personalize user experiences is another area of future development. This could involve tailoring information based on factors like:

    - **Location:** GreenBot could provide recommendations considering your specific climate zone.
    - **Garden Size:** Information could be customized based on the space available for your culinary garden.
    - **Plant Preferences:** GreenBot could personalize suggestions based on your favorite types of vegetables, herbs, or fruits.
- **Voice Recognition Integration:** One of our most exciting future endeavors is the integration of voice recognition capabilities. This would make GreenBot even more accessible and user-friendly, particularly for those with visual impairments or who simply prefer a hands-free gardening assistant. Imagine asking GreenBot questions about your plants while you're tending to your garden – a seamless and convenient way to get the information you need, right at your fingertips (or rather, voice!).

Chapter 6

Conclusion

The development of GreenBot represents an advancement in home gardening support, utilizing Artificial Neural Networks (ANNs) and Natural Language Processing (NLP) to deliver personalized, real-time guidance for plant care. By addressing common challenges such as information overload, generic advice, and the lack of interactive resources, GreenBot provides gardeners with accurate, context-specific recommendations, significantly enhancing their gardening experience and yielding better outcomes.

GreenBot's development is focused on providing tailored guidance for individual plant care needs. Its ability to interact in real-time and offer personalized advice sets it apart from traditional gardening resources, which often provide broad and static information. This interactive and user-centric approach not only makes gardening more accessible for beginners but also serves as a tool for experienced gardeners seeking specific information on new plant varieties and techniques.

Moving forward, the future development of GreenBot will focus on expanding its knowledge base, refining its NLP capabilities, and enhancing user personalization. These enhancements will ensure that GreenBot continues to meet the diverse needs of home gardeners, promoting successful and sustainable gardening practices. Through this approach, GreenBot aims to make home gardening more accessible, efficient, and enjoyable for all enthusiasts.

References:

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