جـامـعـة الـشـرق الأوسـط
MIDDLE EAST UNIVERSITY
Amman - Jordan

MEU AssistBot: Enhancing Student Support with AI

Graduation Project (1/2) Report

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Group No.: AI-23-1-1-[serial]

Declaration

Hereby, we declare that the project report entitled “MEU AssistBot” is our own work. We have not copied it from another student’s work or any other source.

Supervisor Approval

This project report titled "MEU AssistBot" is approved by Dr. Mohammad Hawarat as a partial fulfillment of the requirements for the undergraduate degree.

Acknowledgement

We would like to express our gratitude to our supervisor, Dr. Mohammad Hawarat, for his continuous support and guidance throughout this project. We also thank Middle East University for providing us with the resources needed to complete this project.

Abstract

In this project, we developed a chatbot to assist students at Middle East University (MEU) with obtaining accurate, quick, and secure information. By reducing wait times and enhancing the overall student experience, we aim to improve how students receive academic support. The system is capable of handling numerous users simultaneously. This report discusses the technology, system setup, and best practices for creating and maintaining the system, which utilizes a Flask backend and a React frontend.

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Chapter 1

Introduction

1.1 Problem Statement and Purpose

At Middle East University (MEU), students often face delays and inefficiencies when seeking academic support due to the limited availability of human staff. This project aims to address this challenge by developing an AI-based chatbot, MEU AssistBot, designed to provide timely, accurate, and secure academic support to students.

1.2 Project and Design Objectives

The primary objectives of this project include:

- **User-Friendly Interface:** Design an intuitive and accessible chatbot interface.
- **Accuracy and Security:** Ensure the chatbot provides reliable information while safeguarding user data.
- **Scalability:** Develop a system capable of handling a large number of concurrent users.
- **Timely Deployment:** Implement and deploy the chatbot within the project timeline.
- **Continuous Improvement:** Establish a framework for ongoing updates and enhancements based on user feedback and technological advancements.

1.3 Intended Outcomes and Deliverables

The expected outcomes of this project include:

- A fully functional chatbot capable of answering student queries related to academic and administrative matters.
- Integration with MEU's existing systems to provide seamless access to information.
- Documentation detailing the development process, system architecture, and user guidelines.
- A user feedback mechanism to gather insights for future improvements.

1.4 Motivations

The motivation for developing MEU AssistBot stems from the need to improve the efficiency and accessibility of academic support services at MEU. By leveraging AI technology, we aim to reduce wait times, enhance user satisfaction, and allow human staff to focus on more complex tasks.

1.5 Report Outline

This report covers the problem statement, objectives, background information, methodology, results, discussion, and conclusions of the MEU AssistBot project. Each chapter provides detailed insights into different aspects of the project, ensuring a comprehensive understanding of the development process and its outcomes.

Chapter 2

Background

2.1 Introduction to AI Co-workers

AI co-workers are AI machines that work alongside humans and assist in performing organizational duties. In this project, the assistant is an AI co-worker in the form of a chatbot that will meet students' academic informational needs. It can address most of the common questions students ask their colleagues or supervisors and can communicate with many people simultaneously.

2.2 Traditional Methods

Traditional student support is offered by human staff through face-to-face contact, mail, and phone calls. These methods have limitations:

- **Scalability:** Compared to human staff, fewer users can be handled at a given time, leading to long wait times during peak hours.
- **Availability:** Assistance is often tied to business hours, making support unavailable in the evenings, at night, during weekends, or on holidays.
- **Efficiency:** Handling repetitive questions consumes time that could be spent on resolving more complex issues.

2.3 Introduction to Machine Learning and Deep Learning

Machine Learning (ML) and Deep Learning (DL) are two techniques under Artificial Intelligence where programs are fed with large amounts of data to make predictions. These technologies are essential for creating sophisticated intelligent chatbots that can process natural language queries and questions posed by students [1].

2.3.1 Machine Learning

Machine learning involves using algorithms to test different data sets, learning from the training data, and predicting outcomes for new data. Widely used ML techniques include Support Vector Machines (SVM), Decision Trees, and others.

2.3.2 Deep Learning

Deep learning, a subset of machine learning, uses neural networks with multiple layers to understand data. It is well suited for tasks such as image recognition and natural language processing (NLP) [2].

2.4 Recurrent Neural Networks (RNNs)

Recurrent Neural Networks (RNNs) are designed for sequential data and are useful in tasks requiring context and order, such as language modeling and speech recognition [2].

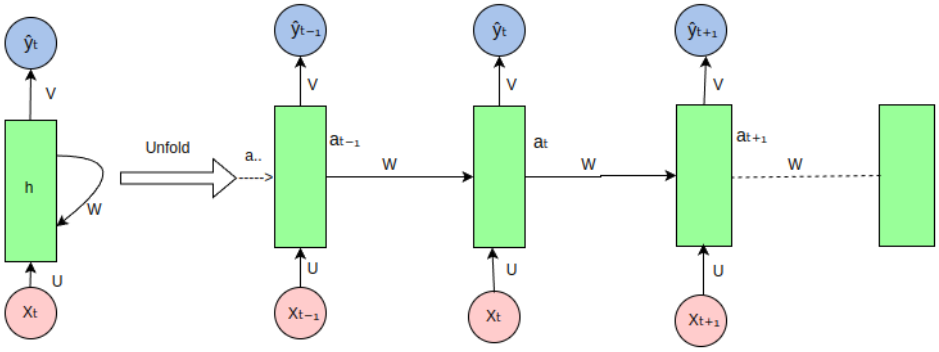

Figure 2.1: Architecture of a Recurrent Neural Network (RNN) [8]

RNNs have a hidden state that stores previous inputs, allowing them to answer student queries appropriately.

2.5 Transformer Models

Transformer-based models, such as BERT and GPT, have become state-of-the-art architectures. They use self-attention mechanisms to process information in parallel, improving the effectiveness of large-scale text processing.

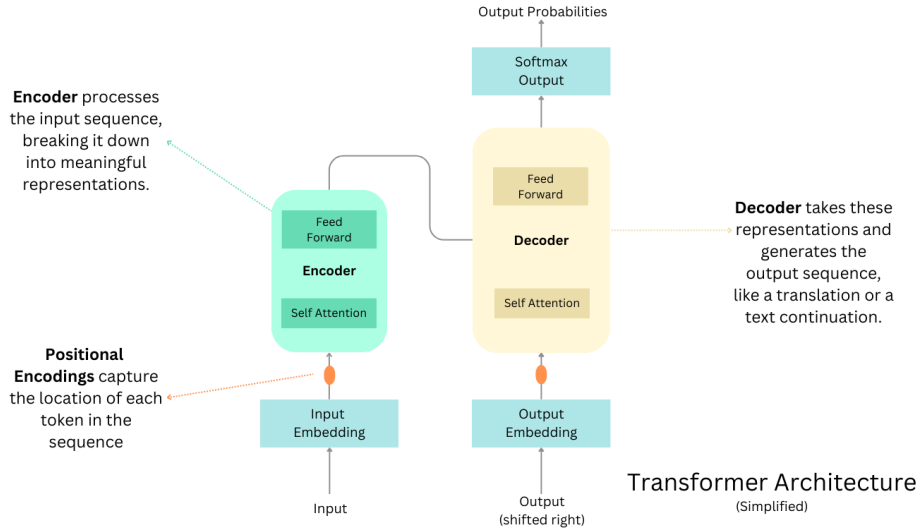

Figure 2.2: Architecture of a Transformer Model [9]

Transformers are highly effective in understanding and generating human language, making them ideal for developing chatbots.

2.5.1 Transfer Learning and Fine-Tuning

Transfer learning involves adapting a pre-trained model to a specific task, leveraging previously learned features to reduce data and computational requirements. Fine-tuning adjusts the pre-trained model's weights to improve performance on the specific task dataset.

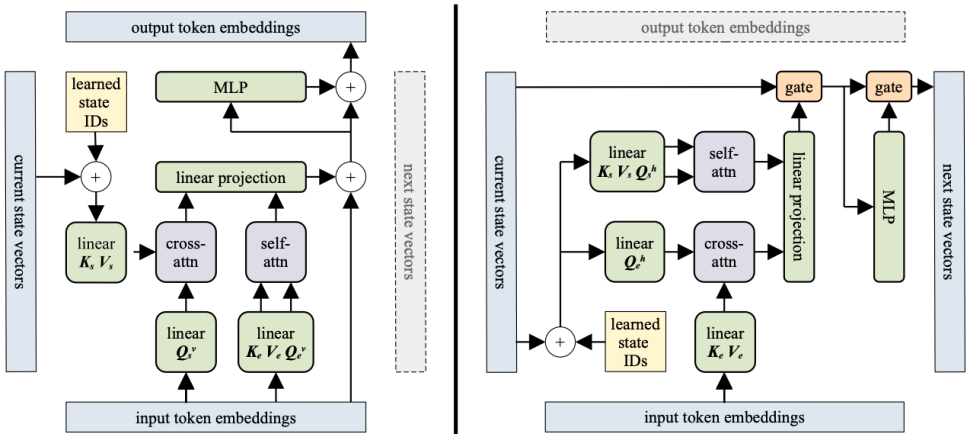

Figure 2.3: Transfer Learning and Fine-Tuning Process [10]

2.5.2 Open-Source LLMs Supporting Arabic Language

In this project, we will use open-source large language models (LLMs) that support Arabic, such as AraBERT and GPT-3-based variants, designed for understanding and generating Arabic text.

2.6 Hybrid Models

Hybrid models combine different types of neural networks to leverage their strengths. For example, combining RNNs with transformers results in a model that captures both sequential and contextual text data dependencies.

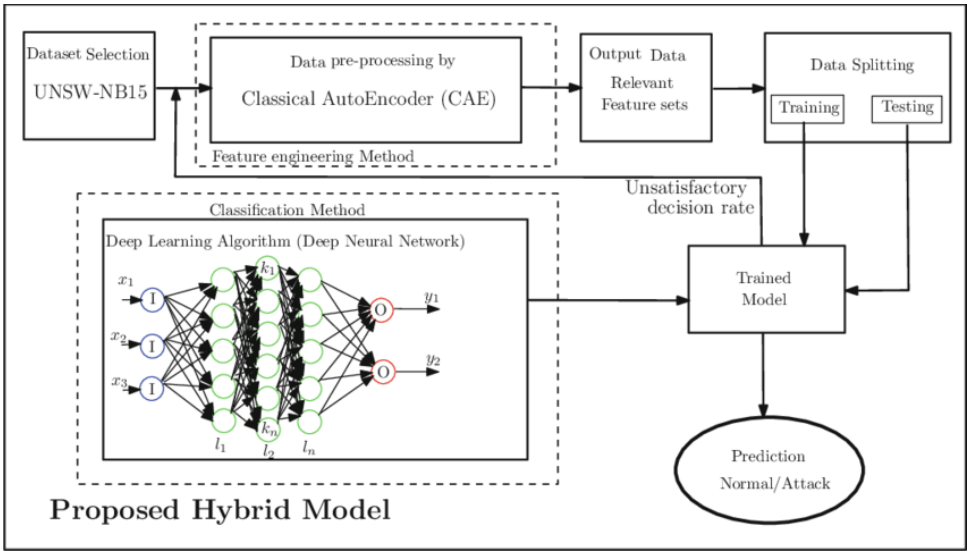

Figure 2.4: Architecture of a Hybrid Model Combining RNNs and Transformers [11]

Hybrid models enhance NLP tasks, making them efficient in developing more effective chatbots.

2.7 Previous Research

Past research shows that AI performs well in academic support roles. AI-driven chatbots significantly reduce response times, increase user satisfaction, and free up human resources for more complex tasks [3], [4].

Institutions like Arizona State University and Georgia Tech have introduced chatbots that offer 24/7 support, manage routine inquiries, and integrate with existing systems to provide personalized assistance [3], [4].

2.8 Motivation for Using AI in Academic Support

The motivation for using AI in academic support includes:

- **Timely Support:** AI chatbots provide instant responses, reducing wait times and improving the student experience.
- **Scalability:** AI systems can handle large volumes of queries simultaneously, offering great scalability.
- **Cost Efficiency:** Automating routine tasks with AI chatbots reduces the need for extensive human resources, saving costs.
- **Availability:** AI chatbots are available 24/7, providing support outside working hours.
- **Personalization:** AI chatbots deliver personalized responses using data from student profiles, making interactions more relevant and effective.

2.9 Conclusion

This background section provides an overview of the technologies and techniques used in this project. With AI technologies such as RNNs, Transformers, transfer learning, fine-tuning, and hybrid models, the chatbot is expected to deliver scalable, timely, and personalized academic support to MEU students.

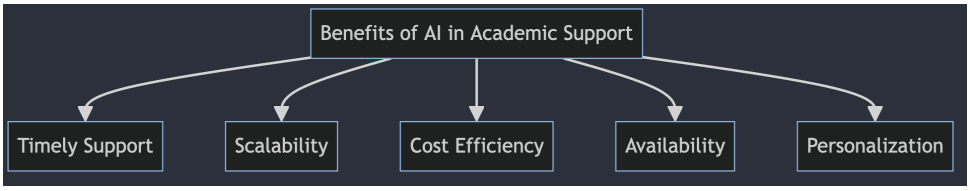

Figure 2.5: Benefits of AI in Academic Support [12]

This figure summarizes the benefits of using AI in academic support, including improved accessibility, efficiency, personalization, and scalability.

Chapter 3

Literature Review

3.1 Introduction

This chapter summarizes existing literature on the use of AI in academic support, past methods, and advanced machine learning and deep learning approaches.

3.2 Arizona State University

ASU is planning to launch a new website for their chatbot. This initiative aims to use technology to improve student support services. The chatbot's main goal is to provide easy access to information, allowing students to receive help anytime they need it. With this website, ASU aims to run efficiently and give students an exceptional learning experience. The site has many benefits, including effectiveness and cost savings. However, to ensure no student is left behind, the support system must be comprehensive [3].

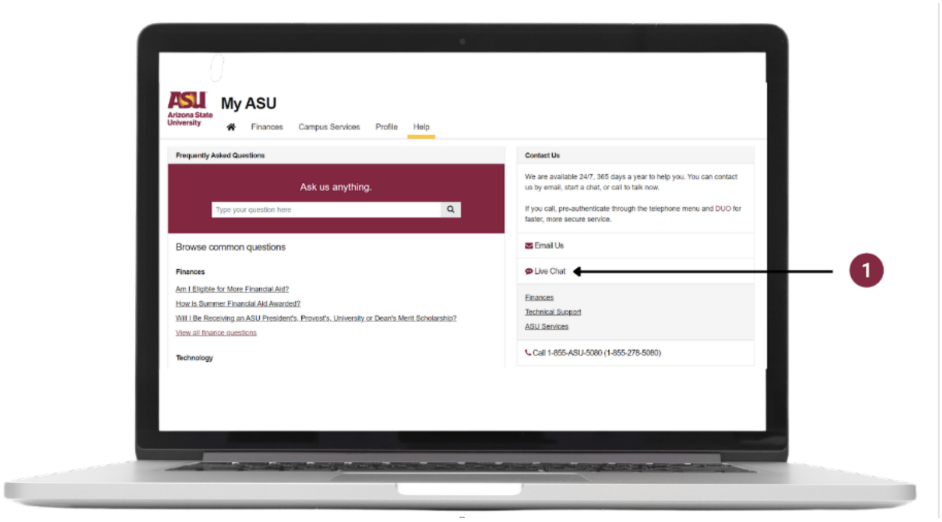

Figure 3.1: Arizona State University Chatbot Interface [3]

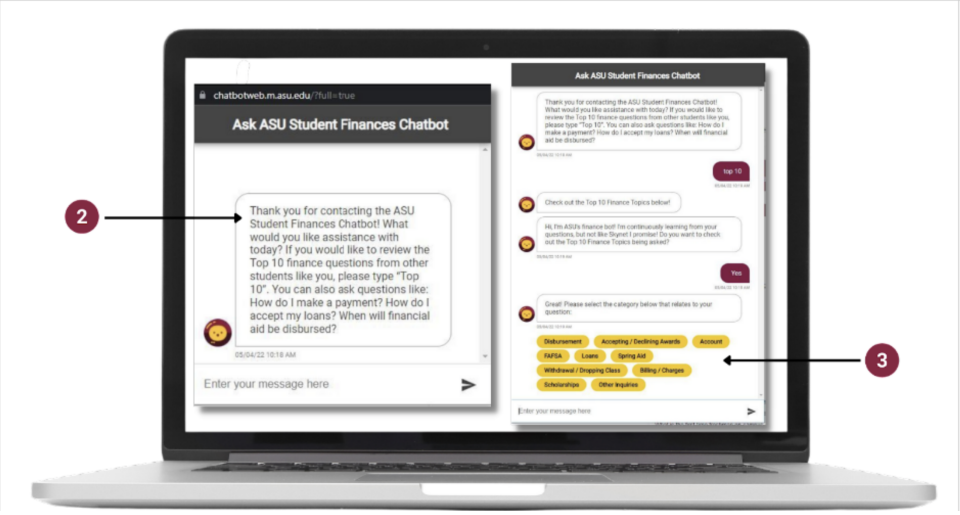

Figure 3.2: Arizona State University Student Finances Chatbot [3]

3.3 Georgia Tech

Georgia Tech's chatbot aims to help students interact more and make it easier for them to utilize school facilities. It assists in various aspects of a student's life, including academic, administrative, and social.

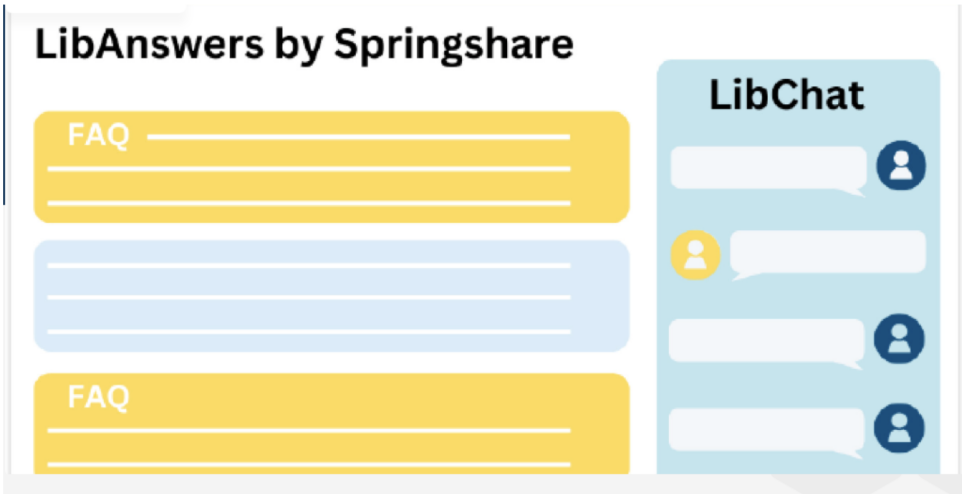

Figure 3.3: Georgia Tech Chatbot Interface [4]

3.4 Carnegie Mellon University (CMU)

Carnegie Mellon University (CMU) has developed an advanced chatbot to enhance student services and streamline access to information. Here's an in-depth look at its features, advantages, and potential drawbacks:

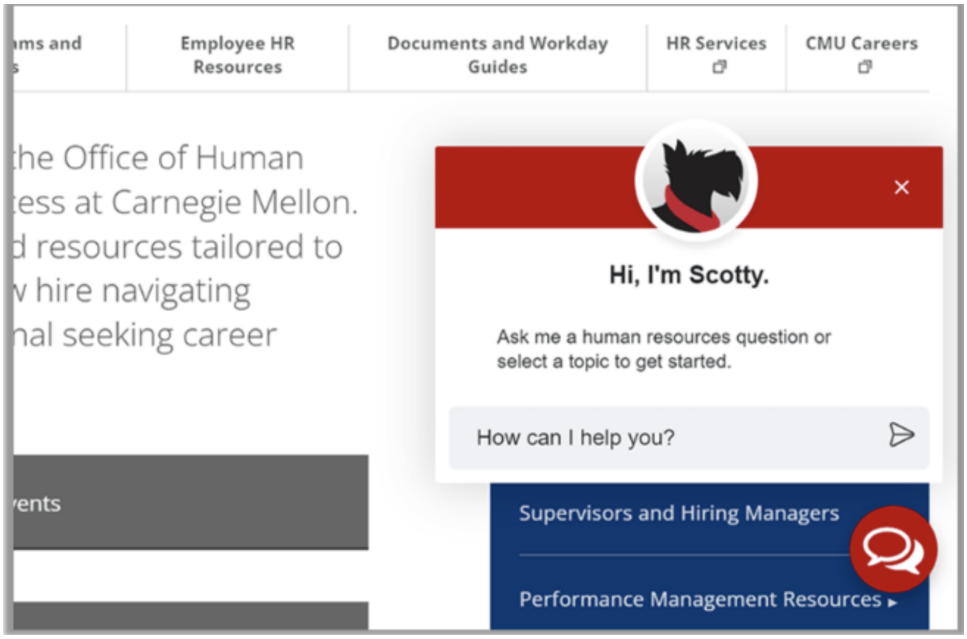

Figure 3.4: Carnegie Mellon University Chatbot Interface [5]

3.5 Duke University

Duke University has created a chatbot for students to improve their engagement and support by offering an easy-to-use and engaging tool for obtaining information and assistance.

Figure 3.5: Duke University Chatbot Interface [6]

Chapter 4

Dataset

4.1 Dataset

The dataset is a key element in the chatbot project. It consists of questions and responses that train and evaluate the chatbot's performance.

4.2 Data Selection

To create a comprehensive dataset, data was gathered from multiple sources.

4.3 Description

The dataset includes past information from the university's helpdesk, frequently asked questions from student surveys, and manually created sample questions to represent common student inquiries.

4.4 Collection

Data collection involved compiling information from the university's technical support desk, administering questionnaires, and conducting example searches.

4.5 Pre-processing

Data pre-processing involves cleaning the data, tokenization, lemmatization, and creating a bag-of-words model.

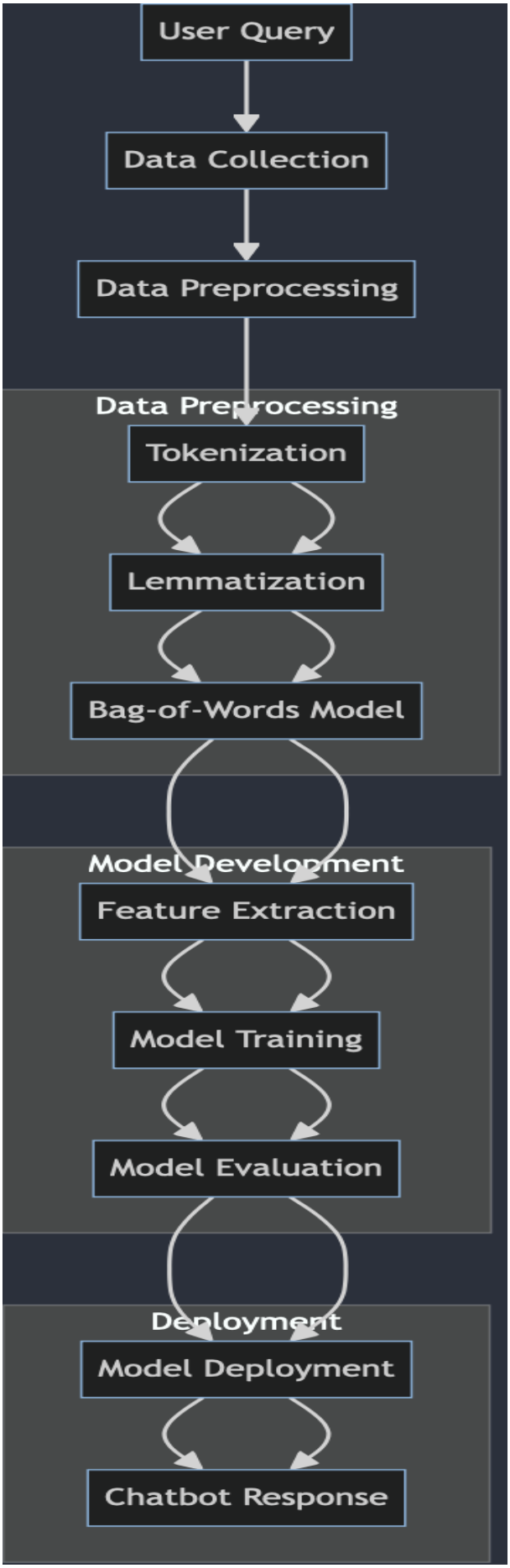

Figure 4.1: Data Preprocessing Steps

4.6 Data Processing for Model Understanding

To ensure the chatbot can understand and respond accurately to user queries, the following steps are taken:

4.6.1 Cleaning

Simplifying queries by eliminating unrelated data, fixing spelling errors, and ensuring a uniform structure for consistent understanding.

4.6.2 Tokenization

Breaking down text into its component words (tokens) for easier analysis and manipulation.

4.6.3 Lemmatization

Performing stemming to simplify words to their fundamental form, ensuring consistency in the data.

4.6.4 Vectorization

Transforming text into numbers for analysis, using methods like Bag-of-Words, TF-IDF, or word embeddings like Word2Vec or GloVe.

4.6.5 Feature Extraction

Identifying important characteristics within text data to enhance the performance of machine learning models during their training phase.

4.6.6 Model Training

Leveraging processed data to develop machine learning algorithms, specifically RNNs (Recurrent Neural Networks), Transformers, and combinations thereof, to generate appropriate answers to user inquiries.

Chapter 5

Methodology

5.1 Research Design

The research plan includes identifying project specifications, exploring current solutions, creating the system's structural framework, and building a preliminary version of the system.

5.2 Data Collection and Analysis

The chatbot will learn from student questions and improve its responses. Before using the data to train the chatbot, it will be cleaned and checked for accuracy.

5.3 Materials Used

The project will use a combination of advanced computational techniques, such as machine learning algorithms, natural language processing capabilities, and software development platforms.

5.4 Procedures

The process involves conceiving and outlining the chatbot, creating an initial version, evaluating the chatbot's functionality, and collecting student feedback.

5.5 AI Models and Techniques

We will utilize transfer learning and fine-tuning with open-source large language models (LLMs) that support the Arabic language. These models include AraBERT and GPT-3-based variants, specifically designed for understanding and generating Arabic text. The steps involved are:

- **Transfer Learning:** Leveraging pre-trained models to benefit from previously learned features.
- **Fine-Tuning:** Adjusting the pre-trained models using our specific dataset to enhance performance on our task.

5.6 Identifying Market Dynamics

We'll study market dynamics to ensure the chatbot meets students' needs and can handle varying usage patterns.

5.7 Limitations and Assumptions

- **Limitations:** High up-front investment and technical challenges in creating the AI model.
- **Assumptions:** Access to reliable data for training the AI model is essential.

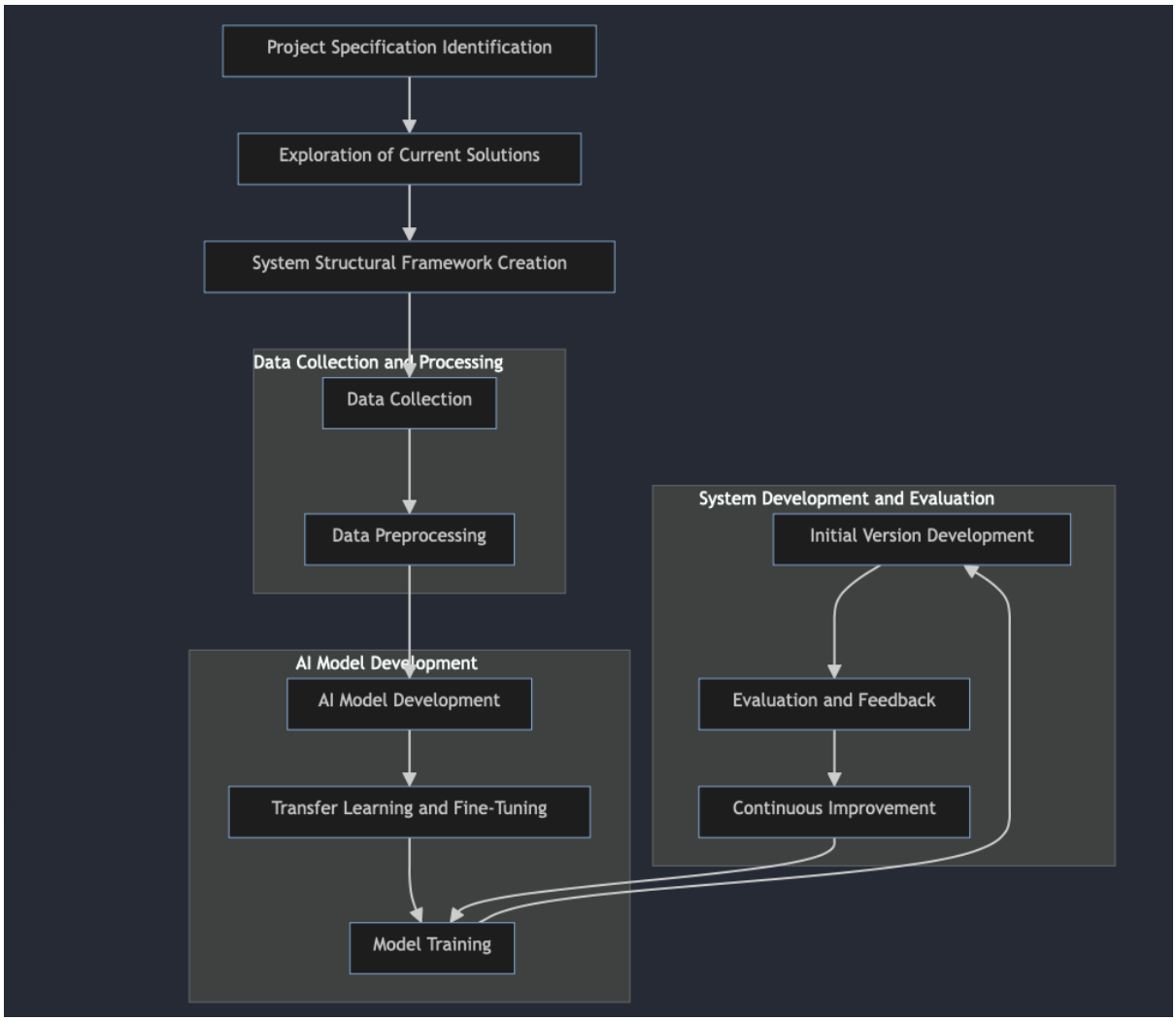

Figure 5.1: Methodology Flow Diagram

Chapter 6

Results

6.1 Introduction

This chapter highlights the findings of the project, particularly the survey results. These results provide valuable information about the needs and satisfaction levels of the students.

6.2 Survey Results

The survey data reveals valuable information about what students need and how well those needs are being met.

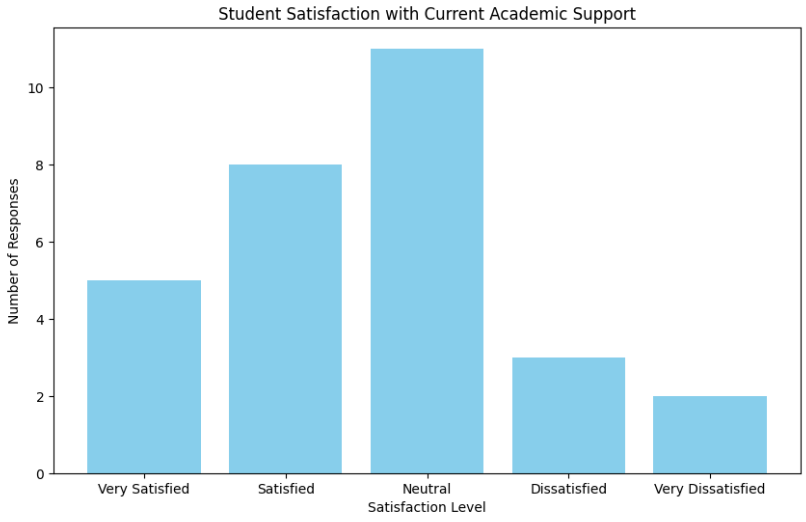

Figure 6.1: Student Satisfaction with Current Academic Support

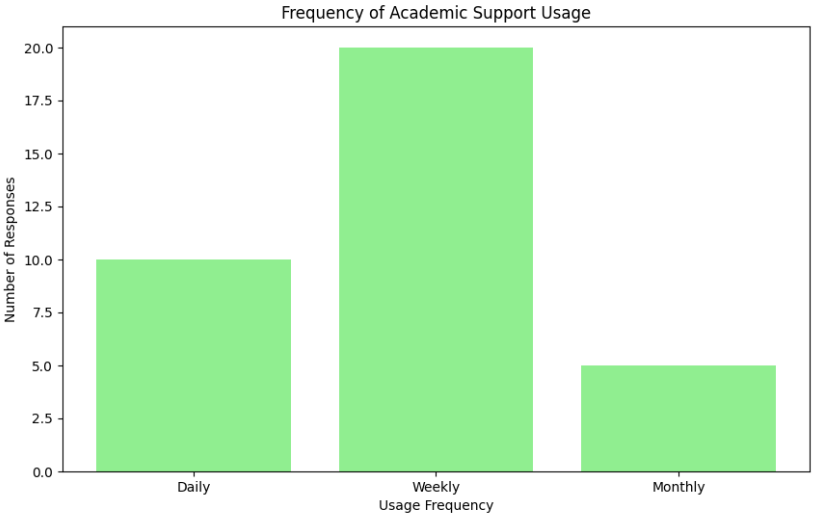

Figure 6.2: Frequency of Academic Support Usage

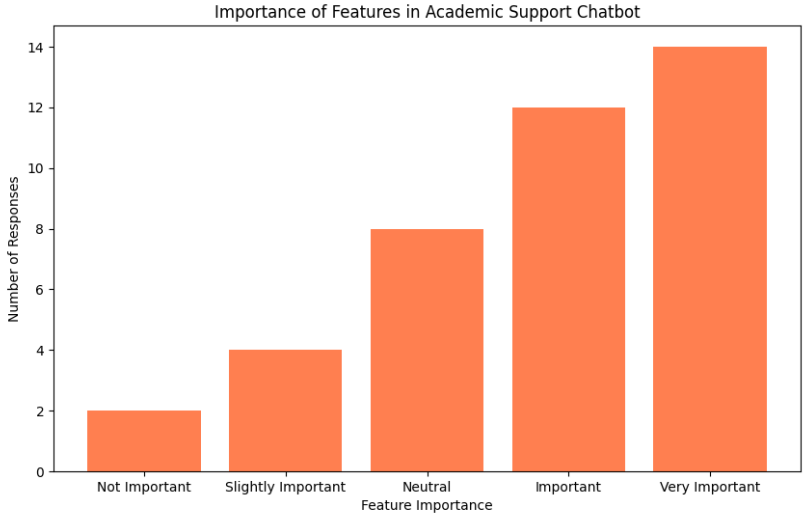

Figure 6.3: Importance of Features in Academic Support Chatbot

6.3 System Architecture

6.3.1 Overview

The MEU AssistBot system is composed of various components that work together to provide a seamless experience for users. These components include the frontend interface, backend server, AI models, and admin page.

6.3.2 Frontend Interface

The frontend interface, built using React, allows users to interact with the chatbot. It includes features such as a chat window for real-time interactions, access to academic resources, and notifications for important updates.

6.3.3 Backend Server

Developed using Flask, the backend server processes requests from the frontend, interacts with the AI models, and returns appropriate responses. It manages user sessions, handles chat interactions, stores and retrieves data from the database, and integrates with external university systems.

6.3.4 AI Models

The AI models process student queries and generate responses. These models include RNNs, Transformers, and hybrid models to ensure accurate and contextually appropriate responses. They are trained on a comprehensive dataset of student queries and responses.

6.3.5 Admin Page

The admin page allows university staff to manage the chatbot's knowledge base and monitor its performance. Features include adding and updating information in the knowledge base, monitoring chat interactions, managing user accounts and permissions, and handling notifications and announcements.

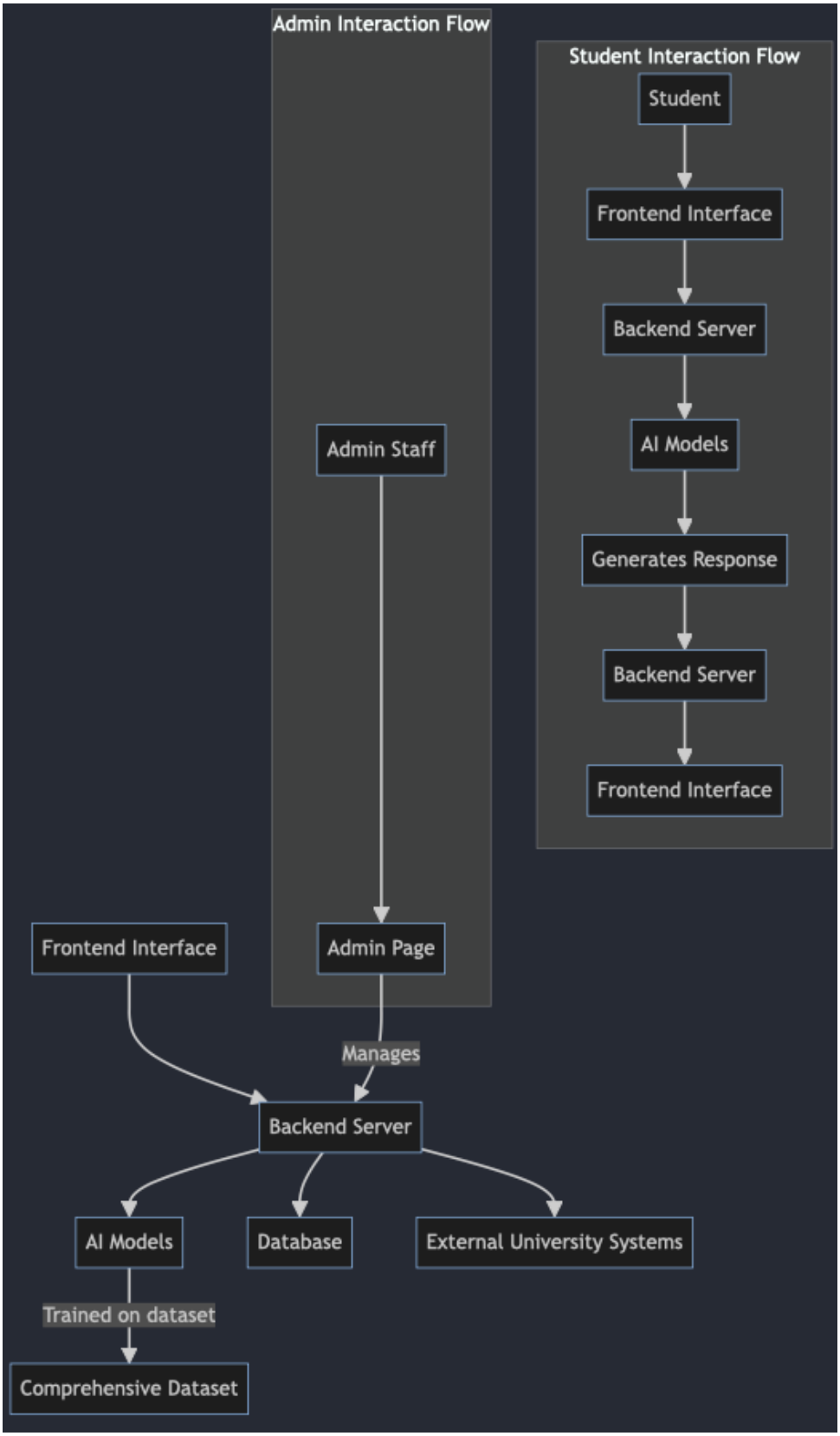

Figure 6.4: System Architecture of the MEU AssistBot Project

6.3.6 Interaction Flow

The interaction flow between the frontend, backend, AI models, and admin page is as follows:

1. A student interacts with the chatbot through the frontend interface.
2. The frontend sends the query to the backend server.
3. The backend processes the query and routes it to the appropriate AI model.
4. The AI model generates a response based on the trained data and sends it back to the backend.
5. The backend forwards the response to the frontend, which displays it to the student.
6. The admin page allows staff to update the knowledge base and monitor the chatbot's performance in real-time.

6.4 Conclusion

The results section demonstrates the insights gained from the survey, which will guide the development and improvement of the chatbot. The system architecture section provides a detailed overview of the MEU AssistBot system, highlighting the components and their interaction flow to ensure an effective and user-friendly experience.

Chapter 7

Discussion

7.1 Interpretation of Results

The study in the documentation phase shows that using a chatbot for academic support at MEU has both potential advantages and possible difficulties. The thorough design and preparation serve as a sound basis for the development process that will follow.

7.2 Implications for Academic Support

The research conducted during information gathering shows that a chatbot can assist students at MEU but may also present challenges. The detailed planning and preparation that went into the design will help with the upcoming development phase.

7.3 Strengths and Weaknesses

The documentation identifies several strengths and potential weaknesses in the planned chatbot system:

7.3.1 Strengths

- **Scalability:** The system can process a large volume of inquiries concurrently, ensuring its ability to handle large-scale operations.
- **24/7 Availability:** Students will have access to continuous assistance as the chatbot operates 24/7.
- **Personalized Responses:** The chatbot leverages advanced machine learning to deliver tailored responses aligned with each student's unique characteristics and past interactions.

7.3.2 Weaknesses

- **Handling Complex Queries:** While the chatbot efficiently handles routine inquiries, complex or nuanced queries may still require human intervention.

- **Initial Adaptation Challenges:** There might be initial challenges in adapting to the new system for both students and staff. Training and familiarization sessions will be essential to mitigate this.

The documentation phase has successfully identified these areas, allowing for targeted strategies to address them during the implementation phase.

Chapter 8

Conclusion

8.1 Summary

This document outlines a plan for creating a chatbot to assist MEU students. The chatbot aims to reduce delays and improve the overall student experience. It will be developed using a combination of machine learning models, such as RNNs and Transformers, with Flask and React for the backend and frontend, respectively.

8.2 Limitations

Implementing a chatbot may involve a high upfront investment. To maintain its accuracy and effectiveness, ongoing updates and maintenance are necessary, which can add to its long-term cost.

8.3 Future Work

Future work involves the actual implementation of the chatbot as detailed in this documentation. Specific steps for future work include:

- Developing and integrating with the university's course management system to provide more detailed academic support.
- Implementing natural language processing (NLP) improvements to enhance the chatbot's understanding and response capabilities.
- Developing mobile applications for easier access to the chatbot.
- Adding more features to the admin page for detailed management of staff and student interactions.

Bibliography

[1] Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.

[2] LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep Learning. Nature, 521(7553), 436-444.

[3] Arizona State University. (n.d.). *Chatbot for Student Support*. Retrieved from `https://www.asu.edu/chatbot`

[4] Georgia Institute of Technology. (n.d.). *Chatbot for Student Services*. Retrieved from `https://www.gatech.edu/chatbot`

[5] Carnegie Mellon University. (n.d.). *AI Chatbot for Student Engagement*. Retrieved from `https://www.cmu.edu/chatbot`

[6] Duke University. (n.d.). *Chatbot for Student Interaction*. Retrieved from `https://www.duke.edu/chatbot`

[7] Virginia Commonwealth University. (n.d.). *BOTaina - AI Chatbot*. Retrieved from `https://www.qatar.vcu.edu/chatbot`

[8] Poudel, S. (n.d.). *Recurrent Neural Network (RNN) Architecture Explained*. Retrieved from `https://medium.com/@poudelsushmita878/recurrent-neural-network-rnn-architecture-explained-1d69560541ef`

[9] Tech-Gumptions. (n.d.). *Transformer Architecture Simplified*. Retrieved from `https://medium.com/@tech-gumptions/transformer-architecture-simplified-3fb501d461c8`

[10] VitalFlux. (n.d.). *Transfer Learning vs Fine-Tuning Differences*. Retrieved from `https://vitalflux.com/transfer-learning-vs-fine-tuning-differences/`

[11] Towards Data Science. (n.d.). *Block-Recurrent Transformer: LSTM and Transformer Combined*. Retrieved from `https://towardsdatascience.com/block-recurrent-transformer-lstm-and-transformer-combined-ec3e64af971a`

[12] LeewayHertz. (n.d.). *AI Use Cases in Education*. Retrieved from `https://www.leewayhertz.com/ai-use-cases-in-education/`

Appendices

Survey Questions

The following are the survey questions used to gather requirements from students:

- What is your major?
- How often do you require academic support?
- What types of academic support do you need most frequently?
- How satisfied are you with the current academic support system?
- What improvements would you like to see in the academic support system?
- `https://forms.gle/G2HzYUdQPXvXXwMz6`

Mermaid Code for Figures

System Architecture Diagram

```
graph TD;
    subgraph Admin Interaction Flow
        AdminStaff[Admin Staff] --> AdminPage[Admin Page]
    end
    subgraph Student Interaction Flow
        Student[Student] --> FrontendInterface1[Frontend Interface]
        FrontendInterface1 --> BackendServer1[Backend Server]
        BackendServer1 --> AIModels1[AI Models]
        AIModels1 --> GeneratesResponse[Generates Response]
        GeneratesResponse --> BackendServer2[Backend Server]
        BackendServer2 --> FrontendInterface2[Frontend Interface]
    end
    AdminPage -.-> BackendServer[Backend Server]
    BackendServer -.-> FrontendInterface[Frontend Interface]
    BackendServer -.-> AIModels[AI Models]
    BackendServer -.-> Database[Database]
    BackendServer -.-> ExternalUniversitySystems[External University Systems]
    AIModels -.-> TrainedDataset[Trained on dataset] -.-> ComprehensiveDataset[Compre
```

Methodology Diagram

```
graph TD;
    ProjectSpec[Project Specification Identification] --> Exploration[Exploration of
    Exploration --> SystemStructure[System Structural Framework Creation]
    subgraph Data Collection and Processing
        DataCollection[Data Collection] --> DataPreprocessing[Data Preprocessing]
    end
    SystemStructure --> DataCollection
    subgraph AI Model Development
```

```
        AIModelDevelopment[AI Model Development] --> TransferLearning[Transfer Learni
        TransferLearning --> ModelTraining[Model Training]
    end
    DataPreprocessing --> AIModelDevelopment
    subgraph System Development and Evaluation
        InitialVersion[Initial Version Development] --> Evaluation[Evaluation and Fee
        Evaluation --> ContinuousImprovement[Continuous Improvement]
        ContinuousImprovement -.-> InitialVersion
    end
    ModelTraining -.-> InitialVersion
```

Data Preprocessing Diagram

```
graph TD;
    UserQuery[User Query] --> DataCollection[Data Collection]
    DataCollection --> DataPreprocessing[Data Preprocessing]
    subgraph Data Preprocessing
        Tokenization[Tokenization] --> Lemmatization[Lemmatization]
        Lemmatization --> BagOfWords[Bag-of-Words Model]
    end
    DataPreprocessing --> ModelDevelopment[Model Development]
    subgraph Model Development
        FeatureExtraction[Feature Extraction] --> ModelTraining[Model Training]
        ModelTraining --> ModelEvaluation[Model Evaluation]
    end
    ModelEvaluation --> ModelDeployment[Model Deployment]
    ModelDeployment --> ChatbotResponse[Chatbot Response]
```