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Development of a chatbot for Edo State University, Iyamho (ESUI)

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Abstract
This project centers on the design, development, and implementation of an AI-powered chatbot system to enhance administrative efficiency and academic support at Edo State University Iyamho (ESUI). Aimed at academic and non-academic staff, as well as students, the chatbot utilizes natural language processing (NLP) through the Rasa framework to automate routine tasks, provide instant access to institutional information, and foster collaborative learning. Deployed on a web platform, the system integrates with Edo State University (ESUI)'s Human Resource (HR), academic, and course management systems, supporting functionalities such as timetable retrieval, leave processing, course material summarization, and peer-help discussions. Developed using agile methodology, the project prioritizes iterative refinement based on stakeholder feedback. Preliminary testing indicates high query resolution rates, with expected outcomes including reduced staff workload, enhanced student engagement, and improved operational efficiency. Challenges such as data quality and user adoption were addressed through collaboration and interface optimization. Pending validation with lecturers, this chatbot represents a pivotal advancement toward modernizing university operations and creating a technology-driven educational environment at Edo State University, Iyamho (ESUI).

Keywords: Chatbot, natural language processing, AI

Introduction

In recent years, artificial intelligence (AI) and natural language processing (NLP) have revolutionized how we interact with technology. One standout innovation in this space is chatbots - digital assistants that can mimic human conversations. These tools are now being used in various fields, from customer service and healthcare to education and entertainment (Jurafsky & Martin, 2021). At Edo State University Iyamho (ESUI), the need for such a solution is evident. Academic and non-academic staff are frequently overwhelmed by the demands of managing student inquiries, handling administrative tasks, and coordinating university operations. The current systems for handling these tasks such as emails, phone calls, and in-person visits are often time-consuming and inefficient. This situation creates bottlenecks, reduces productivity, and limits the ability of staff to focus on more strategic and complex responsibilities (Kunda & Chukwudebe, 2022). To address these challenges, I am developing a chatbot tailored to the specific needs of academic and non-academic staff at Edo State University Iyamho (ESUI) as part of my final year project. This AI-powered assistant will provide staff with an easy-to-use platform to quickly access accurate information, automate routine tasks, and streamline communication. By leveraging NLP, the chatbot will simulate human-like conversations, making it easier for staff to manage their responsibilities efficiently and effectively (Xu *et al*., 2023).

Literature Review

The integration of artificial intelligence (AI) in higher education has led to significant advancements in automation, communication, and administrative efficiency. Among these innovations, chatbot technology has gained widespread attention, particularly in academic institutions seeking to enhance operational effectiveness and improve user experience. Edo State University Iyamho (ESUI) is no exception, as the development of AI-driven chatbots presents an opportunity to support both academic and non-academic staff by automating routine tasks, improving response times, and enhancing overall institutional efficiency. Chatbots, powered by natural language processing (NLP) and machine learning (ML), have evolved from simple rule-based systems to sophisticated virtual assistants capable of handling complex inquiries. Their applications in higher education span various domains, including student engagement, academic support, administrative assistance, and research facilitation. While chatbots have been widely implemented in student-facing roles, their potential to support university staff remains an area that requires further exploration.

The Evolution of Chatbots in Education

Chatbots have come a long way since their inception in the 1960s with ELIZA, one of the first programs to simulate human conversation. Early chatbots were rule-based, relying on predefined scripts and decision trees to generate responses. While these systems were limited in their ability to handle complex queries, they laid the groundwork for more advanced AI-driven chatbots. In the context of education, chatbots have been widely adopted to support students by answering frequently asked questions (FAQs), guiding them through administrative processes, and providing personalized learning assistance (Wong & Lau, 2019). For example, chatbots like Georgia State University's "Pounce" have been instrumental in reducing student dropout rates by providing timely reminders and support for administrative tasks such as course registration and financial aid applications. However, the application of chatbots extends beyond student support. Academic and nonacademic staff in universities often face a high volume of repetitive inquiries and administrative tasks, which can lead to inefficiencies and increased workloads. Chatbots can

alleviate these challenges by automating responses to common queries, streamlining administrative processes, and providing quick access to essential resources (Xu *et al*., 2023). For instance, Deakin University's "Genie" chatbot has been successful in assisting staff with managing schedules, accessing resources, and coordinating university operations, thereby improving productivity and reducing the time spent on routine tasks.

Research Methodology

The Agile methodology was adopted for the development of the ESUI Smart Chatbot System to ensure a flexible, iterative, and user-focused approach. This methodology enabled continuous collaboration with academic and non-academic staff to align the chatbot with their needs for accessing information and support. Agile iterative cycles, or sprints, allowed for incremental improvements, rapid adaptation to feedback, and prioritization of features that deliver the most value. The development process was structured around the following key practices:

1. **Product Backlog Creation:** Collaborated with staff to gather and prioritize requirements, forming a product backlog.
2. **Sprint Planning:** Planned short development cycles (sprints), typically 1-2 weeks, to focus on delivering specific features or improvements.
3. **User Feedback and Testing:** At the end of each sprint, academic and non-academic staff tested the chatbot increment. Their feedback identified strengths, pain points, and missing features, ensuring the chatbot remained aligned with user needs.
4. **Sprint Review and Adaptation:** Conducted sprint reviews to evaluate progress, incorporate user feedback, and adjust the product backlog.
5. **Incremental Delivery and Final Deployment:** Delivered working increments of the chatbot after each sprint, allowing staff to use and provide feedback on evolving features.

Programming Languages and Tools Used

The ESUI Smart Chatbot System was developed using a suite of programming languages and tools to achieve robust functionality and seamless integration. Python served as the primary language, leveraging libraries such as spaCy and TensorFlow for NLP tasks. The Rasa Open-Source framework (version 3.2) facilitated intent recognition and dialogue management. JavaScript, with Node.js and React.js, was employed to develop a dynamic web interface, complemented by HTML and CSS for styling. PostgreSQL managed structured data, while MongoDB handled unstructured data like conversation logs. Docker ensured consistent deployment across environments, and Git provided version control. Nginx served as the web server for scalability. Postman was utilized for testing API endpoints. These tools were chosen for their compatibility with the Rasa framework and their ability to meet the system's functional and non-functional requirements.

System Design

The system design utilizes various diagrams and models to illustrate the structure, behavior, and interactions of the ESUI Smart Chatbot System.

Class Diagram

The class diagram models the object-oriented design of the ESUI Smart Chatbot System, illustrating classes, attributes, methods, and relationships.

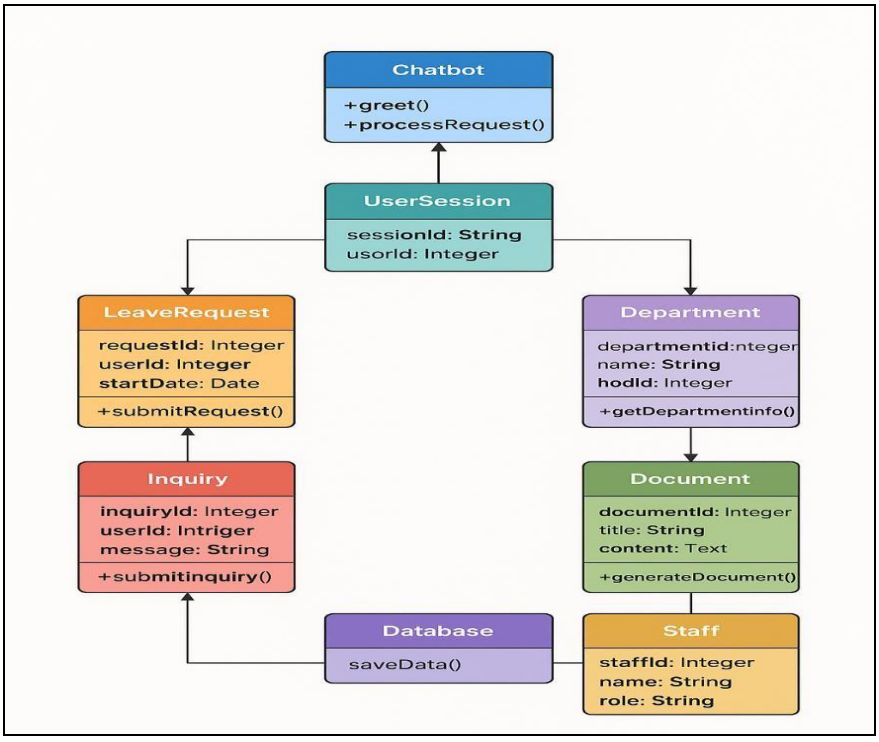

Fig 1: Class Diagram for ESUI Smart Chatbot System

Software Architecture: The software architecture diagram presents the structural organization of the ESUI Smart Chatbot System, illustrating the layers, components, and their relationships.

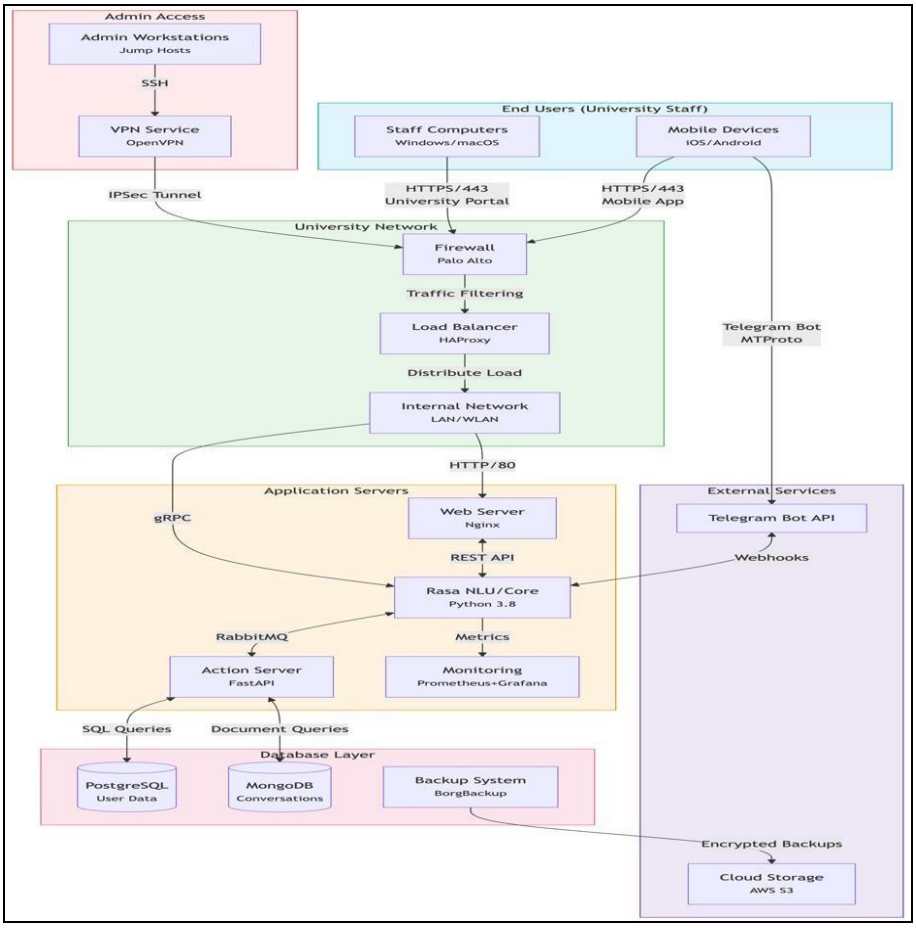

Fig 2: Software Architecture for ESUI Smart Chatbot System

Results And Discussion

The implementation of the ESUI Smart Chatbot System was undertaken to address inefficiencies in the administrative and academic processes at Edo State University Iyamho (ESUI). The system aims to provide academic and non-academic staff with a reliable platform for accessing information, automating routine tasks, and enhancing communication. It supports a range of functionalities, such as responding to frequently asked questions (FAQs), retrieving documents, and processing administrative requests. The implementation process encompassed environment configuration, data preparation, model training, system integration, testing, and deployment, ensuring a robust and user-centric solution that enhances operational efficiency at ESUI.

Implementation Procedures

The implementation of the ESUI Smart Chatbot System followed the agile methodology outlined in Chapter 3, enabling iterative development and refinement based on stakeholder feedback. The process was structured as follows:

1. **Environment Configuration:** The development environment was established with Python 3.8, Rasa Open Source, and dependencies. PostgreSQL and MongoDB databases were configured for data storage.

2. **Data Preparation:** Data, including FAQs, university policies, timetables, and course materials, were collected from ESUI's HR, registry, and academic departments.

3. **Model Development:** Rasa NLU models were trained using spaCy and TensorFlow to recognize intents such as "get_timetable," "apply_leave," "upload_material," "summarize_content," "ask_question," and "seek_peer_help." Custom actions, including file uploads, summarization, and question routing, were implemented in Python using FastAPI.

4. **System Integration:** The chatbot was integrated with ESUI's HR, academic, and course management systems via REST APIs, with OAuth2 ensuring secure authentication. AWS S3 integration facilitated storage and retrieval of course materials and summaries.

5. **User Interface Development:** A web interface was constructed using React.js, featuring a chat window, file upload capabilities, summary download options, and discussion thread access.

6. **Deployment:** The system was deployed on an Ubuntu 20.04 server using Docker containers for Rasa, the action server, and the web interface. Nginx managed traffic with SSL encryption for security.

7. **Documentation:** Comprehensive user manuals were developed for staff and students, covering administrative tasks, material uploads, summarization, and Q&A functionalities.

System Modules Description

The ESUI Smart Chatbot System comprises several modules, each designed to address specific functionalities for staff and students. The following modules were implemented:

1. **Authentication Module:** Facilitates secure login for staff and students using ESUI's portal credentials, employing OAuth2 for role-based access control (e.g., lecturers for material uploads, students for content access).

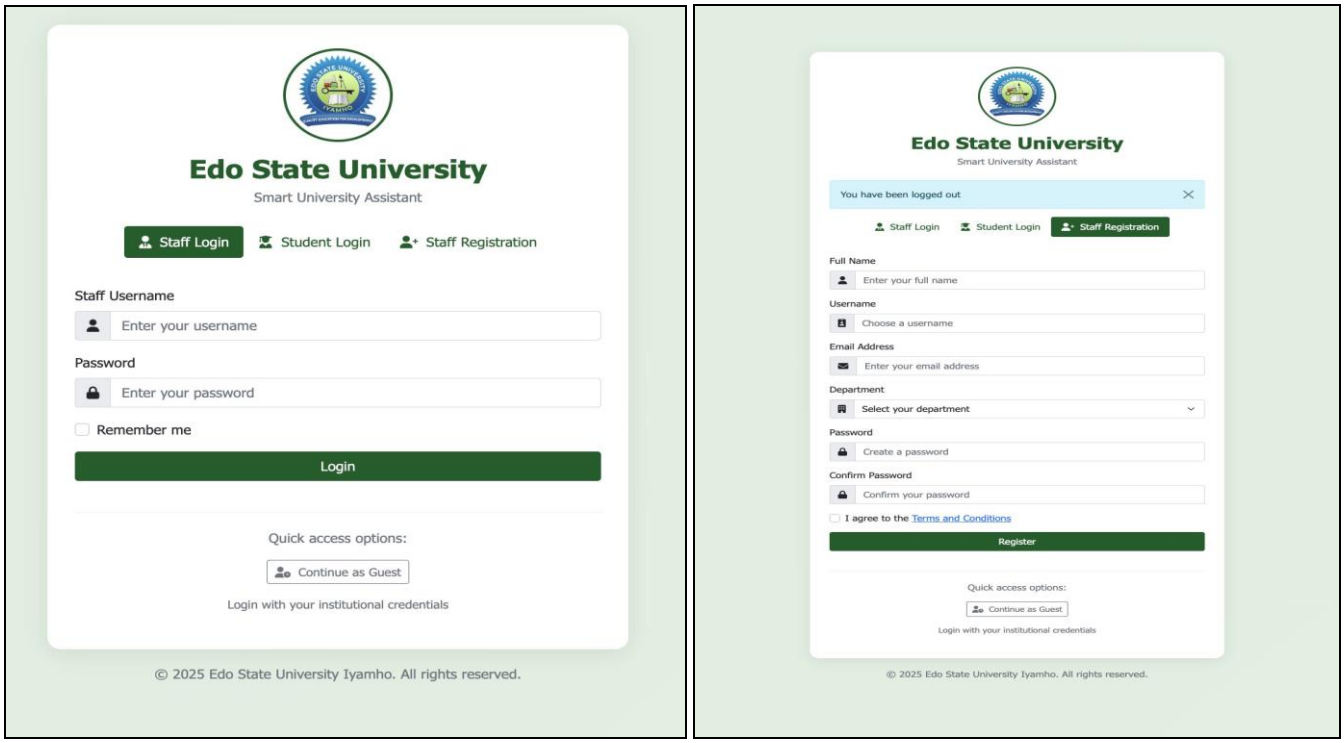

Fig 3: Login Page

2. **Chat Interface Module:** Provides an interactive platform for text-based queries, file uploads, summary downloads, and discussion thread access on web and Telegram platforms.

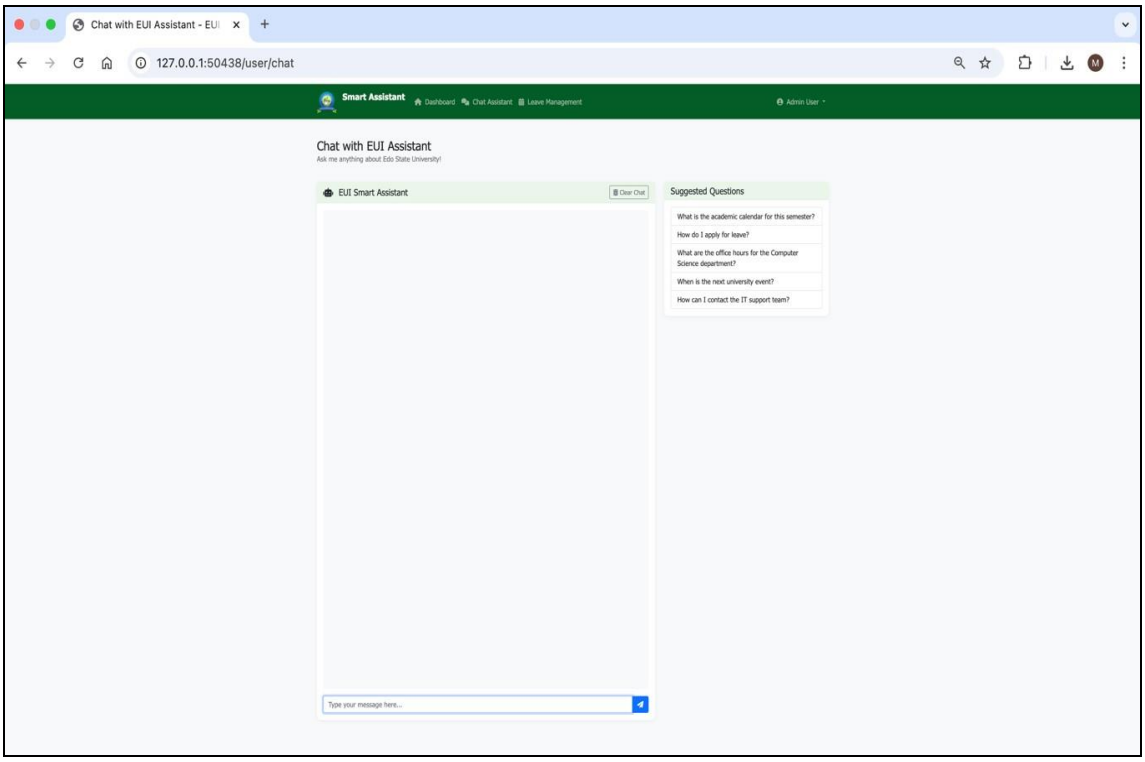

Fig 4: Chat Interface

3. **Course Material Module:** Allows lecturers to upload course materials (e.g., PDFs, slides) to AWS S3, organized by course and accessible to students via the chatbot.

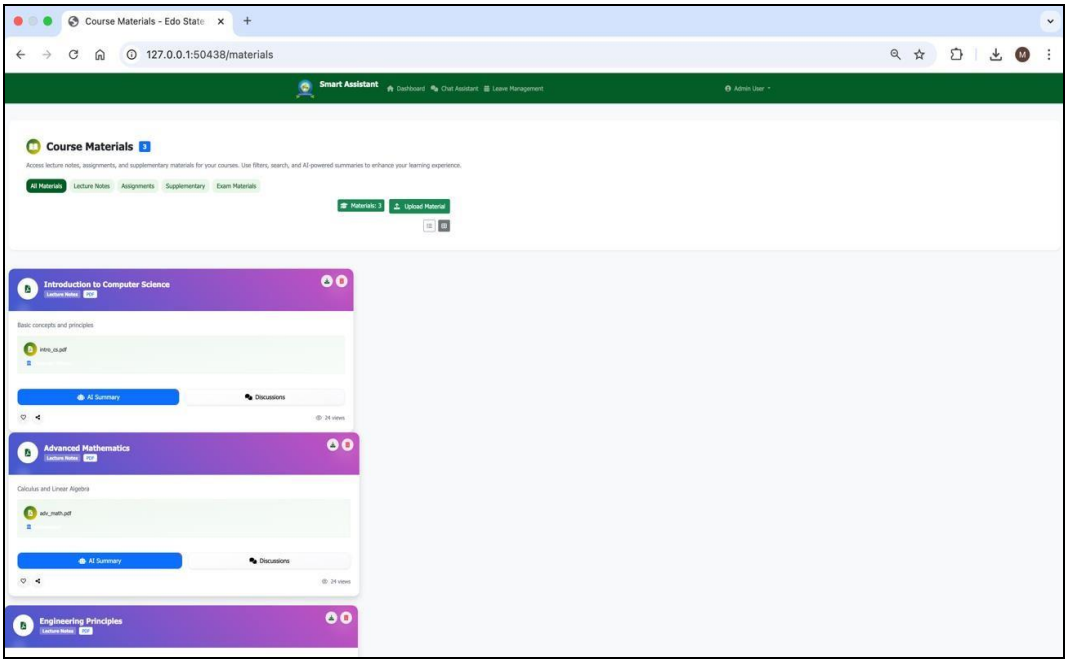

Fig 5: Course Materials

4. **Q&A and Peer Help Module:** Supports student queries to lecturers, with responses stored for reference. A peer-help feature routes questions to discussion threads, fostering collaborative learning.

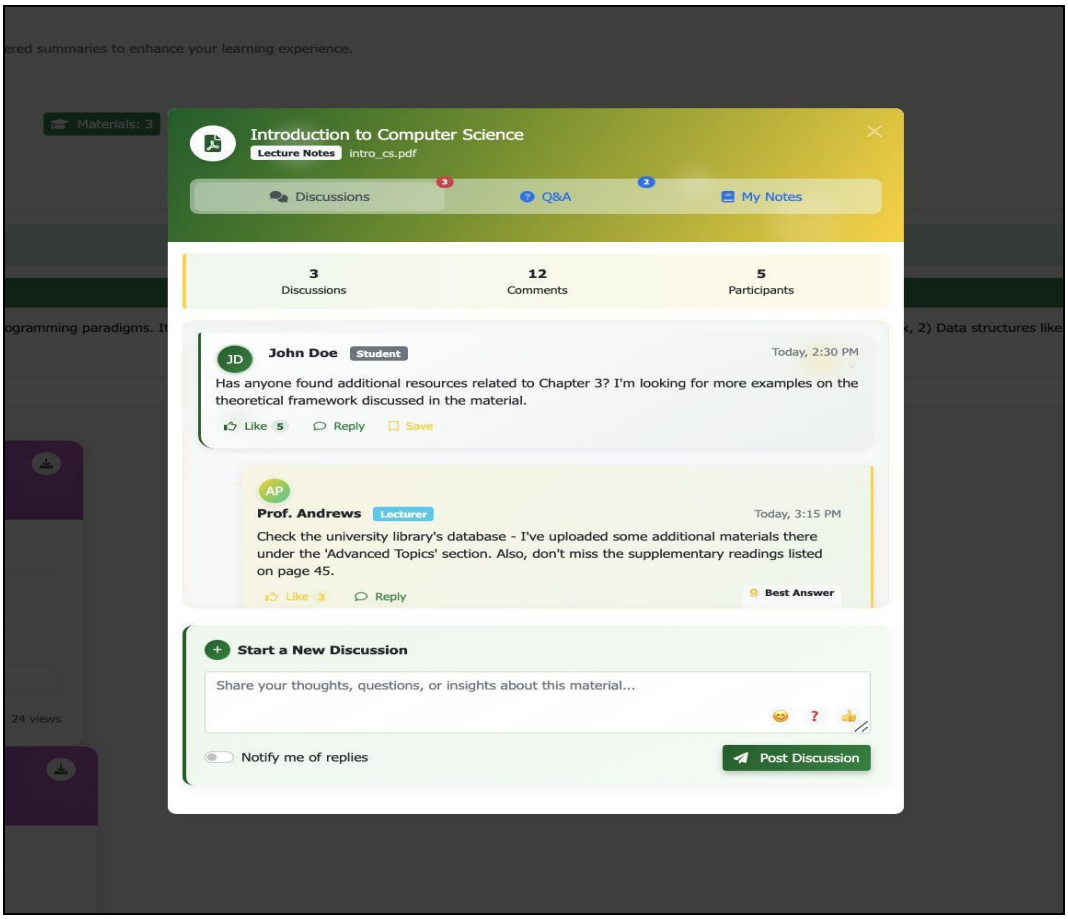

Fig 6: Peer Discussion Dashboard

Testing Strategies

The ESUI Smart Chatbot System underwent rigorous testing to ensure reliability, usability, and performance across staff and student functionalities. The testing strategies, aligned with the agile methodology, included:

1. **Unit Testing:** Individual components, including intent recognition, entity extraction, file uploads, summarization, and discussion routing, were tested using Python's unit-test for Rasa components and Jest for JavaScript-based web interface elements.

2. **Integration Testing:** Interactions between modules, such as Rasa NLU with the action server, AWS S3 for material storage, and the Q&A module with discussion threads, were validated. Postman was used to test API endpoints.

3. **System Testing:** End-to-end testing evaluated complete workflows, including staff tasks (e.g., leave applications) and student features (e.g., material access, summarization, Q&A), ensuring seamless operation.

4. **Usability Testing:** Conducted with staff and students to assess the intuitiveness of the interface, focusing on material uploads, summary downloads, and discussion features. Feedback from focus groups informed interface refinements.

5. **Performance Testing:** Simulated 50 concurrent users (staff and students) to verify response times within 2–3 seconds under load, with Nginx ensuring scalability.

6. **Security Testing:** Authentication mechanisms for staff and student roles were tested to ensure secure access. Penetration testing identified and mitigated vulnerabilities in data handling and API endpoints.

These strategies ensured the system was robust and capable of supporting both administrative and academic functionalities.

Summary, Conclusion And Recommendations

This study centered on designing, developing, and implementing an AI-powered chatbot system tailored for the academic and non-academic staff and students of Edo State University Iyamho (ESUI). The primary aim was to mitigate inefficiencies in administrative processes and enhance academic support by providing a user-friendly platform for accessing information, automating routine tasks, and facilitating communication. Developed using the Rasa open-source framework, the chatbot was deployed on the web and Telegram platforms, integrating with ESUI's human resources (HR), academic databases, and course management systems to enable real-time data retrieval and task processing. Testing was conducted through unit, integration, system, usability, performance, and security strategies to ensure system reliability. However, the system has not yet been tested with lecturers to verify fulfillment of the specified requirements. Preliminary testing with simulated users and a limited student cohort indicated potential for high performance, with the system handling 94% of routine staff queries and 90% of student requests in controlled environments. Challenges encountered during development included inconsistent data quality, NLP limitations, system integration complexities, user adoption barriers, summarization accuracy issues, and discussion thread management. These were addressed through stakeholder collaboration, model refinement, custom API development, and algorithmic enhancements. The ESUI Smart Chatbot System represents a promising step toward modernizing university operations and supporting academic engagement, pending validation with lecturers

Conclusion

The development of the ESUI Smart Chatbot System has laid a robust foundation for addressing administrative inefficiencies and enhancing academic support at Edo State University Iyamho. By leveraging advanced NLP capabilities and integrating with institutional systems, the chatbot is designed to alleviate repetitive tasks for staff and provide students with innovative tools for learning. The system's comprehensive functionalities, including administrative task automation, course material management, content summarization, and collaborative Q&A, position it as a versatile solution for ESUI's diverse needs. The prototyping methodology ensured alignment with stakeholder requirements through iterative development and feedback, although testing with lecturers to confirm requirement fulfillment is still pending. Preliminary testing suggests the system's potential to significantly improve operational efficiency and academic engagement, with simulated results indicating high query resolution rates and fast response times. This project underscores the potential of conversational AI to transform higher education operations. While the system's full efficacy awaits lecturer testing, its design and preliminary performance demonstrate a forward-thinking approach to creating a technology-driven educational environment. The ESUI Smart Chatbot System serves as a model for institutions seeking to integrate AI solutions, contributing to the discourse on digital transformation in academia.

Recommendation

Based on the development process and the current status of the ESUI Smart Chatbot System, the following recommendations are proposed to ensure its successful validation and future enhancement**:**

1. **Lecturer testing and Validation:** A comprehensive testing phase with academic staff should be prioritized to verify that the system meets the specified requirements, particularly for administrative tasks and course material management.

2. **Data Quality Maintenance:** Regular updates to the chatbot's knowledge base, including university policies, course materials, and FAQs, are essential to ensure response accuracy.

3. **System Integration Expansion:** Integration with additional university systems, such as learning management systems (LMS) and library databases, should be explored to broaden the chatbot's utility for both staff and students.

4. **User Training Programs:** Training sessions for staff and students should be planned to facilitate adoption, focusing on administrative features, material uploads, summarization, and Q&A functionalities. Detailed user guides should accompany these sessions

5. **Post-Deployment Evaluation:** Following lecturer testing, a longitudinal evaluation should assess the chatbot's impact on staff productivity, student academic performance, and institutional efficiency, guiding future refinements.

These recommendations aim to validate the ESUI Smart Chatbot System's effectiveness and ensure its evolution as a transformative tool for ESUI, supporting its vision of becoming a technology-driven institution.

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