# Integrating LLMs for Intelligent Chatbot Support in University Web Platforms

**A PROJECT REPORT**

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***Under the guidance of,***

**Dr. MADHUSUDHAN M V**

***in partial fulfillment for the award of the degree of***

**BACHELOR OF TECHNOLOGY**

**IN**

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**PRESIDENCY UNIVERSITY**

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# PRESIDENCY UNIVERSITY

## SCHOOL OF COMPUTER SCIENCE ENGINEERING

## CERTIFICATE

This is to certify that the Project report "Integrating LLMs for Intelligent Chatbot Support in University Web Platforms" being submitted by SPARSHA P, CHANDANA H, SUSHMITHA B S, SANJEETHA C M, S YASWANTH bearing roll number(s): 20211CSD0202, 20211CSD0183, 20211CSD0178, 20211CSD0200, 20211CSD0025 in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology in Computer Science and Engineering is a bonafide work carried out under my supervision.

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## DECLARATION

We hereby declare that the work, which is being presented in the project report entitled **Integrating LLMs for Intelligent Chatbot Support in University Web Platforms** in partial fulfillment for the award of Degree of **Bachelor of Technology** in **Computer Science and Engineering**, is a record of our own investigations carried under the guidance of **Dr. Madhusudhan M V, Associate Professor, School of Computer Science Engineering, Presidency University, Bengaluru.**

We have not submitted the matter presented in this report anywhere for the award of any other Degree.

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# ABSTRACT

Nowadays, artificial intelligence has become an integral part of digital communication, transforming how institutions interact with users. Universities, in particular, are leveraging AI-powered chatbots to improve accessibility, streamline information delivery, and enhance the student experience. In this proposed method, large language models (LLMs) are integrated in order to create an intelligent chatbot for university websites in order to facilitate the services to all the stakeholders of the university in an ease and efficient way. It provides real-time, enquiries regarding admissions, campus resources, and academic support, among other topics. The chatbot is accessible 24/7, reducing the administrative workload by answering routine queries and supporting student engagement. The implementation includes several technical features, such as a user-friendly front end, a secure authentication module, a broadcast system fo2 real-time announcements, and a knowledge base for efficient information retrieval. Additionally, a logging system tracks unhandled queries, enabling continuous improvement by administrators. This chatbot not only automates responses but also personalizes interactions by managing user data, making it an adaptive, scalable solution for academic environments. The approach promises future enhancements in scalability, personalization, and potential multilingual support to meet the growing and diverse needs of the university community.

**Keywords**: LLM, Chatbot, Authentication, multilingual support, NLP, etc.

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# INTRODUCTION

Chatbots, driven by artificial intelligence (AI), have become an integral part of modern digital communication [1]. They are software applications designed to simulate human conversations, providing users with immediate responses to queries and automating various tasks. Through advancements in natural language processing (NLP) and machine learning, chatbots are now capable of understanding and interacting with users in a human-like manner. From answering frequently asked questions to offering personalized recommendations, chatbots have reshaped how we engage with technology across various platforms.

## 1.1 Chatbots in different domains

Chatbots have significantly enhanced efficiency, accessibility, and user experience across various sectors. In customer service, they provide instant responses to queries and manage orders 24/7, relieving human agents and boosting customer satisfaction. In healthcare, chatbots facilitate appointment scheduling, symptom checking, and medication information, enabling healthcare providers to focus on critical tasks [2]. In education, they guide students through admissions and offer academic support, ensuring access to essential information and enriching the learning experience [3]. In the banking and finance sector, chatbots manage balance inquiries and transaction histories, allowing users immediate access to account details while handling routine financial tasks autonomously [4]. Lastly, in travel and hospitality, chatbots streamline flight and hotel bookings and provide real-time itinerary updates, simplifying travel planning and enhancing user convenience.

## 1.Customer Service

- **Role of Chatbots**: Chatbots in customer service are designed to engage with customers, answering their questions and resolving issues in real-time. They can handle a wide variety of queries ranging from simple FAQs to more complex troubleshooting steps. Many companies integrate chatbots into their websites, mobile
- **Benefits**:
    - **24/7 Availability**: Chatbots can provide round-the-clock service, ensuring customers don't have to wait for business hours for assistance.
    - **Reduced Human Workload**: By handling repetitive or straightforward inquiries, chatbots free up human agents to focus on more complex and personalized customer needs.

- **Instant Responses**: Chatbots can process requests instantly, leading to quicker problem resolution and higher customer satisfaction.

## 2. Healthcare

- **Role of Chatbots**: In the healthcare domain, chatbots act as virtual assistants, guiding patients through various services. They can help schedule appointments, remind patients of upcoming appointments, check symptoms, and provide basic health advice or information on medications and treatments.
- **Benefits**:
  - **Access to Medical Information**: Patients can ask chatbots questions about symptoms or medications, receiving reliable information without needing to wait for a healthcare professional.
  - **Streamlined Operations**: For healthcare providers, chatbots can ease the administrative load, like managing appointments and reminders, allowing staff to focus on more critical tasks.
  - **Improved Patient Engagement**: Chatbots can encourage patients to engage with their health, offering proactive reminders for medication, health check-ups, and wellness programs.

## 3. Education

- **Role of Chatbots**: Chatbots in education support both prospective students and current learners. They can help prospective students through the admissions process, answer questions about courses or deadlines, and provide detailed information on campuses, tuition fees, or scholarship opportunities.
- **Benefits**:
  - **Personalized Learning Support**: Chatbots can offer academic assistance to students, whether it's answering questions about assignments, explaining concepts, or providing links to resources.
  - **Enhanced Accessibility**: With chatbots available online, students can receive answers anytime, making education more accessible to all, especially for those in different time zones or with varying schedules.
  - **Administrative Assistance**: Chatbots assist with administrative tasks such as course registration, deadlines, or exam schedules, helping students stay on top of their academic requirements.

## 4. Banking and Finance

- **Role of Chatbots**: Chatbots in the banking sector can handle a wide range of financial tasks. They assist customers by providing information about account balances, recent transactions, upcoming bills, and even help in transferring money or setting up automatic payments.
- **Benefits**:
    - **Real-Time Financial Assistance**: Chatbots offer instant access to banking details, allowing customers to quickly view account summaries, transaction histories, or investment portfolios.
    - **Automated Financial Management**: Chatbots can assist users in budgeting, managing savings, or even recommending financial products based on user behavior and preferences.
    - **Security**: Many banking chatbots have integrated security features, such as multi-factor authentication, ensuring safe transactions and preventing fraud.

## 5. Travel and Hospitality

- **Role of Chatbots**: In the travel and hospitality industry, chatbots help travelers with booking flights, hotels, car rentals, and even suggesting itineraries based on the user's preferences. They can also provide updates on flight statuses, room availability, and destination details.
- **Benefits**:
    - **Simplified Booking Process**: Chatbots can guide customers through the booking process in a conversational manner, answering questions and recommending options, helping travelers make decisions faster.
    - **Real-Time Updates**: Travel-related chatbots can offer up-to-the-minute information on flights, gate changes, delays, or weather conditions, which is crucial for smooth travel experiences.
    - **Personalized Travel Recommendations**: By collecting user preferences, chatbots can suggest personalized travel packages, excursions, or restaurants, making the travel experience more enjoyable and tailored to individual tastes.

## 6. E-commerce and Retail

- **Role of Chatbots**: In e-commerce, chatbots act as virtual shopping assistants, guiding customers through product searches, making personalized recommendations based on browsing history, and assisting with the checkout process.

- **Benefits**:
    - **Personalized Shopping Experience**: Chatbots can track customer preferences and offer product recommendations or special promotions, enhancing the shopping experience.
    - **Inventory Management**: Chatbots can provide up-to-date inventory information and inform customers if products are out of stock, suggest similar items, or facilitate back-in-stock notifications.
    - **Post-purchase Support**: After a purchase, chatbots can help customers with order tracking, returns, and refunds, ensuring smooth post-purchase experiences.

## 7. Telecommunications

- **Role of Chatbots**: Telecom companies use chatbots to help customers with issues related to their mobile plans, data usage, service disruptions, and billing inquiries.
- **Benefits**:
    - **Efficient Troubleshooting**: Chatbots can identify problems, such as service outages or plan discrepancies, and offer troubleshooting steps without the need for human intervention.
    - **Self-Service**: Customers can easily update their account details, change their plans, or pay bills through chatbot interfaces, reducing the need for long customer support calls.
    - **Proactive Alerts**: Chatbots can notify customers about usage limits, data overages, or upcoming payment dates, ensuring customers stay informed about their plans.

## 8. Human Resources and Recruitment

- **Role of Chatbots**: In recruitment, chatbots can assist HR teams in the initial stages of hiring by screening resumes, answering candidates' questions, and scheduling interviews.
- **Benefits**:
    - **Efficient Candidate Screening**: Chatbots can quickly evaluate resumes and answer preliminary questions about job openings, saving time for HR teams.
    - **Enhanced Candidate Experience**: Candidates can interact with chatbots to get updates on their application status or ask questions about the company, leading to a more engaging hiring process.

- **Faster Onboarding**: Once hired, chatbots can assist new employees with onboarding tasks, such as filling out paperwork, learning about company policies, and accessing training materials.

## 1.2 Chatbots for university

In our project, the integration of an LLM-powered chatbot is crucial for enhancing communication and support within the university [5]. By providing instant, personalized responses to student inquiries, the chatbot facilitates seamless access to essential information, such as course details, admission procedures, and campus resources. This immediate support not only improves student engagement but also alleviates the workload on administrative staff, allowing them to focus on more complex tasks.

Furthermore, the chatbot's ability to operate 24/7 ensures that students can access assistance at any time, catering to diverse schedules and learning preferences. As a result, it fosters a more inclusive environment where all students can receive timely help, enhancing their overall university experience. By leveraging advanced LLM technology, our chatbot aims to deliver intelligent, context-aware interactions that further empower students to navigate their academic journey effectively [6].

**1.Enhancing Communication and Access to Information**

- **Instant Responses**: An LLM-powered chatbot can handle a wide range of student inquiries, such as questions about course offerings, class schedules, exam dates, campus events, and even faculty office hours. By providing immediate responses, the chatbot reduces wait times for students, ensuring they can get the information they need without delay.
- **Personalized Interactions**: By leveraging the power of LLM technology, the chatbot can tailor its responses based on individual student needs, preferences, and academic history. For example, it could offer personalized course recommendations based on a student's program of study or assist with locating specific resources, like libraries, labs, or academic advisors.
- **Seamless Integration with Existing Systems**: The chatbot can be integrated with existing university systems such as the student portal, course registration platforms, and learning management systems (LMS). This allows the chatbot to provide real-time updates on course availability, assignment deadlines, grades, and even application status, making it a one-stop information hub.

**2. Reducing the Administrative Burden**

- **Alleviating Staff Workload**: University administrative staff are often overwhelmed with repetitive tasks, including answering questions about deadlines, office hours, admissions, and financial aid. The chatbot can take over these routine inquiries, freeing up staff to focus on more complex, high-touch tasks such as student advising, crisis management, or academic counseling.
- **Efficiency in Task Management**: The chatbot can handle large volumes of student inquiries simultaneously, which would otherwise require a team of human agents to manage. This efficiency allows the university to scale its support services without increasing staffing costs, ensuring that all students, regardless of class size or enrollment numbers, can access timely assistance.
- **Cost-Effective Support**: Implementing a chatbot reduces the need for human resources for tasks that can be easily automated. This allows universities to allocate their budgets to other areas that may need more personalized or hands-on attention.

**3. 24/7 Availability for Diverse Schedules**

- **Catering to Global and Non-Traditional Students**: Students come from different time zones, have varying schedules, and may have unique academic needs. The chatbot's 24/7 availability ensures that students—whether undergraduate, graduate, part-time, or international—can get support outside of regular office hours. This feature is particularly beneficial for non-traditional students, such as those balancing work, family, or other responsibilities alongside their studies.
- **Improved Accessibility**: The chatbot's round-the-clock service ensures that students in remote locations or those with differing time preferences are not limited to seeking help during traditional business hours. For instance, students working late or those enrolled in evening classes can still get assistance without needing to wait for the next working day.

**4. Fostering a More Inclusive University Environment**

- **Cultural and Linguistic Sensitivity**: LLM-powered chatbots can be designed to understand and communicate in multiple languages, which is especially important in diverse, multicultural university environments. This enhances accessibility for international students or those who speak different languages, promoting inclusion and reducing communication barriers.
- **Support for Diverse Learning Preferences**: Beyond linguistic diversity, the chatbot can cater to various learning styles and preferences. For example, students who are

more visual may appreciate being given links to resources such as video tutorials or visual course content. Others may prefer text-based answers or further explanations, which the chatbot can adjust to based on the nature of the query.

- **Empowering Students**: The chatbot's ability to provide timely and personalized assistance empowers students to make more informed decisions about their academic journey. Whether it's understanding financial aid options, registering for courses, or exploring extracurricular activities, students are better equipped to navigate their university experience confidently.

**5. Providing Intelligent, Context-Aware Interactions**

- **Contextual Awareness**: One of the key advantages of using advanced LLM technology is its ability to understand context and nuances in student interactions. For example, if a student asks about a specific course, the chatbot can not only provide the course details but also remind them of relevant prerequisites or suggest complementary courses that align with their program of study. This adds a layer of intelligent assistance that goes beyond simple responses, making the chatbot a valuable tool in academic advising.
- **Predictive Assistance**: An LLM-powered chatbot can predict student needs based on historical data or trends. For example, if the chatbot notices a student frequently asking about exam dates during certain periods, it might proactively remind them of upcoming deadlines or offer study tips. This predictive assistance helps students stay ahead of important tasks and manage their time effectively.
- **Proactive Guidance**: Beyond responding to inquiries, the chatbot can offer proactive support. For instance, if a student is falling behind in their coursework or has missed several assignments, the chatbot could send a gentle reminder or suggest resources such as tutoring services, academic counseling, or time management workshops. This proactive approach helps ensure that students receive the necessary support before they encounter academic difficulties.

**6. Enhancing Student Engagement**

- **Personalized Experience**: By using natural language processing and machine learning algorithms, the chatbot can learn from each interaction and offer increasingly personalized support over time. For example, if a student frequently asks about research opportunities or academic papers, the chatbot can recommend relevant research projects, academic journals, or faculty members to connect with.

- **Interactive Support**: Students are more likely to engage with a chatbot that feels like a friendly and supportive companion in their academic journey. Instead of receiving robotic or scripted responses, an LLM-powered chatbot offers conversational, human-like interactions that make students feel heard and understood.
- **Student Retention**: Engaging students through timely, personalized interactions has the potential to improve student retention. When students feel supported, whether it's navigating administrative processes, handling academic pressures, or finding extracurricular opportunities, they are more likely to stay connected to the university community and complete their degree programs successfully.

**7. Feedback and Continuous Improvement**

- **Gathering Student Feedback**: Chatbots can collect feedback from students on various aspects of their university experience, from course quality to campus facilities. By analyzing this data, universities can gain valuable insights into student satisfaction and identify areas for improvement.
- **Adapting to Evolving Needs**: As student needs and the academic environment evolve, the chatbot can continuously adapt through updates and improvements. With feedback from students and analytics on usage patterns, the chatbot's responses and functionalities can be fine-tuned to better meet the demands of the university community.

# CHAPTER-2

# LITERATURE SURVEY

The application of AI-driven chatbots has been explored extensively across various domains, demonstrating their potential to enhance communication and streamline processes, while also revealing limitations and challenges.

Chung et al. [7] implemented a chatbot for college websites, integrating various NLP techniques such as keyword extraction, lemmatization, and semantic similarity analysis to improve interaction accuracy. By utilizing Artificial Intelligence Markup Language (AIML), the system was able to deliver contextually relevant responses, thereby reducing the need for manual search efforts. However, the chatbot's reliance on keyword extraction posed challenges, as misidentified keywords could lead to incorrect interpretations of user queries. Despite this limitation, the chatbot significantly enhanced user experiences by providing real-time, automated responses to common inquiries, saving both staff and student's valuable time. The study by Untari [8] focused on the use of chatbots in government communications during the COVID-19 pandemic, analyzing real-world chatbots such as COVID19 GO.ID, WHO, and GOV.UK. Through the lens of Media Richness Theory (MRT), the research examined the ability of these chatbots to provide immediate feedback and offer diverse communication cues, including videos and infographics. Comparative analysis between these chatbots revealed key insights for improving Indonesia's own systems. While effective for rapid dissemination of critical information, the case study method limited the ability to generalize findings beyond the pandemic context or the specific chatbots studied.

Chizhik and Zherebtsova [9] explored the development of a retrieval-based chatbot, which selects responses from a pre-existing dataset based on semantic similarity between user input and conversation context. By employing text vectorization techniques like TF-IDF, Word2Vec, and FastText, the chatbot could provide quick and grammatically correct responses. Although retrieval-based chatbots require less training time than generative models, their performance is heavily dependent on the quality of their dataset. The inability to generate novel responses restricts the chatbot's effectiveness in handling complex or out-of-scope queries, often resulting in repetitive or irrelevant replies.

In the marketing sector, Wagobera Edgar Kedi et al. [10] studied the integration of AI chatbots in small and medium enterprises (SMEs), highlighting their transformative impact on customer interaction and operational efficiency. By leveraging advancements in NLP, machine learning (ML), and data analytics, these chatbots offer personalized experiences, automate routine tasks, and ensure 24/7 customer support. However, challenges such as high initial implementation costs, difficulties in handling complex queries, data privacy concerns, and the need for continuous updates hinder widespread adoption, especially for smaller businesses with limited resources.

Ethical considerations in chatbot use were explored by Nkoulou Mvondo et al. [11], who applied Social Cognitive Theory (SCT) and Rational Choice Theory (RCT) to examine the factors influencing ethical chatbot use among students in the U.S. The study utilized Partial Least Squares Structural Equation Modelling (PLS-SEM) to analyze personal, environmental, and risk-related factors, and employed Fuzzy Set Qualitative Comparative Analysis (fsQCA) to identify conditions leading to ethical or unethical behavior. While the study provided valuable insights into chatbot ethics, the U.S.-centric focus and reliance on self-reported data limited its applicability in broader, global contexts.

Cherednichenko et al. [12] focused on selecting and integrating large language models (LLMs) for chatbot development in Software as a Service (SaaS) platforms. The researchers implemented a system using platforms like Telegram for its robust API and Node.js for handling real-time interactions. ChatGPT was selected for its cost-effectiveness and response speed, while Langchain facilitated the seamless switching between different LLMs. Despite its strengths, the project encountered issues with real-time conversation tracking and the narrow scope of models tested, excluding key competitors like Google’s Gemini.

In education, Zhang and Huang [13] conducted a mixed-methods study to evaluate the use of AI chatbots in enhancing vocabulary acquisition among Mandarin-speaking students learning English. The experimental group using chatbots significantly outperformed the control group, with improved retention rates and engagement. However, the study's focus on written vocabulary limited its insights into speaking skills development, highlighting the need for more comprehensive chatbot systems capable of addressing all aspects of language acquisition.

Modran et al. [14] developed an intelligent tutoring system using Retrieval-Augmented Generation (RAG), combining retrieval-based and generative approaches to provide personalized responses in educational contexts. Indexed educational materials were retrieved via LlamaIndex, while machine learning was used to adapt responses to individual learning styles. Though effective in providing contextually accurate tutoring and quizzes, the system's reliance on high-quality content posed a challenge, especially when dealing with incomplete or outdated data. Early testing demonstrated promise, but further development and testing are required to expand the system's subject coverage.

Lajčinová et al. [15] examined the use of large language models (LLMs) like BERT for intent classification in the banking sector. By fine-tuning SlovakBERT with user query datasets, they achieved significant accuracy improvements, outperforming general-purpose multilingual models like Gemma 7b and Llama 8b. The study underscored the importance of localized models for specific industries, but also highlighted the challenges of data translation and the limited scalability of fine-tuned models compared to their zero-shot learning counterparts.

Yigci et al. [16] explored the integration of LLM-based chatbots in higher education, particularly their role in personalized learning and curriculum development. While these chatbots provided efficient support in tasks like coding and subject-specific tutoring, concerns regarding academic integrity and potential over-reliance on AI raised significant ethical questions. The study recommended the cautious integration of AI tools to ensure they enhance, rather than hinder, critical thinking and learning autonomy.

Giudici et al. [17] developed GreenIFTTT, an automation tool using GPT-4 to promote sustainable energy consumption through smart home routines. An exploratory study with users demonstrated the system's ease of use and engagement, but slower response times due to the LLM integration and reliance on accurate AI outputs were noted as potential areas for improvement. The system, while promoting sustainability, had limited testing in real-world environments, which could affect its performance when deployed on a larger scale.

In healthcare, Athota et al. [18] investigated the integration of LLMs like ChatGPT and Med-PaLM 2 into clinical workflows. These models were shown to reduce the administrative burden on healthcare providers by automating tasks such as patient documentation and appointment scheduling. However, concerns regarding patient data privacy, the accuracy of

AI-generated diagnostic information, and the potential for over-reliance on these tools in critical situations raised important ethical and practical considerations for the future of AI in healthcare.

Finally, Xue et al. [19] examined the ethical challenges posed by chatbot biases, which stem from training data, developer backgrounds, and user interactions. These biases can propagate harmful stereotypes or offensive content, particularly in industries like customer service. The study recommended the use of fairness toolkits and diverse development teams to mitigate bias.

Cortés-Cediel et al. [20] conducted a systematic review on e-government chatbots, providing a comprehensive overview of their deployment in public administration. However, the study's context-specific nature, focusing primarily on Spanish public administration, limited its applicability to other regions, and it did not fully account for emerging trends in chatbot technology.

# CHAPTER-3

# RESEARCH GAPS OF EXISTING METHODS

Chatbots have become an integral part of university systems, facilitating communication, improving accessibility, and enhancing operational efficiency. However, many existing chatbot solutions fall short of meeting the diverse and evolving needs of students and institutions. These systems often struggle with limitations such as a lack of contextual understanding, inadequate personalization, and reliance on static knowledge bases, which restrict their ability to deliver dynamic and adaptive responses. Furthermore, challenges like insufficient multilingual support, scalability issues, and limited integration with other university systems further reduce their effectiveness. The rapid advancements in AI technologies, including large language models (LLMs), present an opportunity to overcome these limitations, but the high costs and complexity of implementation act as barriers, especially for smaller institutions. Additionally, concerns around data security, privacy, and ethical use remain pressing issues that must be addressed. To bridge these gaps, it is crucial to critically examine the limitations of current methods and explore innovative approaches that can ensure inclusivity, scalability, and a user-centric experience. Below, we delve into the key research gaps that underscore the challenges and opportunities for improving university chatbot systems.

## ➢ Limited Contextual Understanding:

- Many existing chatbot systems rely on predefined rules or retrieval-based methods, which struggle to handle complex, context-sensitive, or ambiguous queries. This limits their ability to provide nuanced, personalized, and adaptive responses.

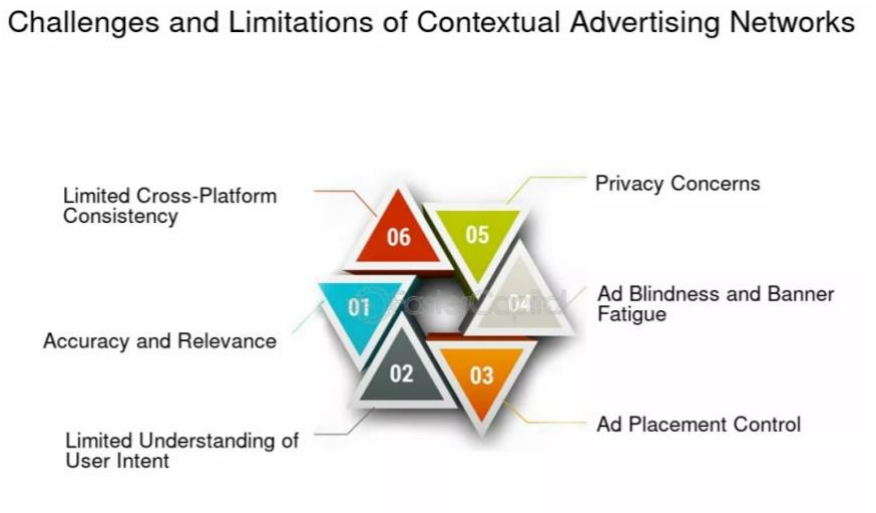


**Fig 1**: Challenges and Limitations of Contextual Advertising Networks

- **Dependency on Keyword-Based Processing:**

- Systems using techniques like keyword extraction or basic semantic matching (e.g., AIML or TF-IDF) often misinterpret user intent, leading to inaccurate or irrelevant responses. This reduces reliability and user satisfaction.

- **Lack of Multilingual Support:**

- Most current university chatbots are designed to operate in a single language, which poses a challenge for institutions with diverse student populations. The lack of multilingual capabilities creates barriers to accessibility and inclusivity.


**Fig 2**: Lack of Multilingual Support

- **Inadequate Personalization:**

- While some systems provide generic responses, they often lack advanced user authentication and session management to deliver truly personalized experiences based on user profiles or previous interactions.

- **Static Knowledge Bases:**

- Existing systems often use fixed, static knowledge bases that cannot adapt dynamically to new information or learn from unhandled queries. This results in outdated content and reduced chatbot effectiveness over time.

## ➢ Underutilization of Advanced AI Technologies:

- While LLMs like GPT offer superior natural language understanding, many implementations fail to integrate them effectively due to challenges like high costs, model fine-tuning complexity, or lack of modular frameworks for hybrid systems.

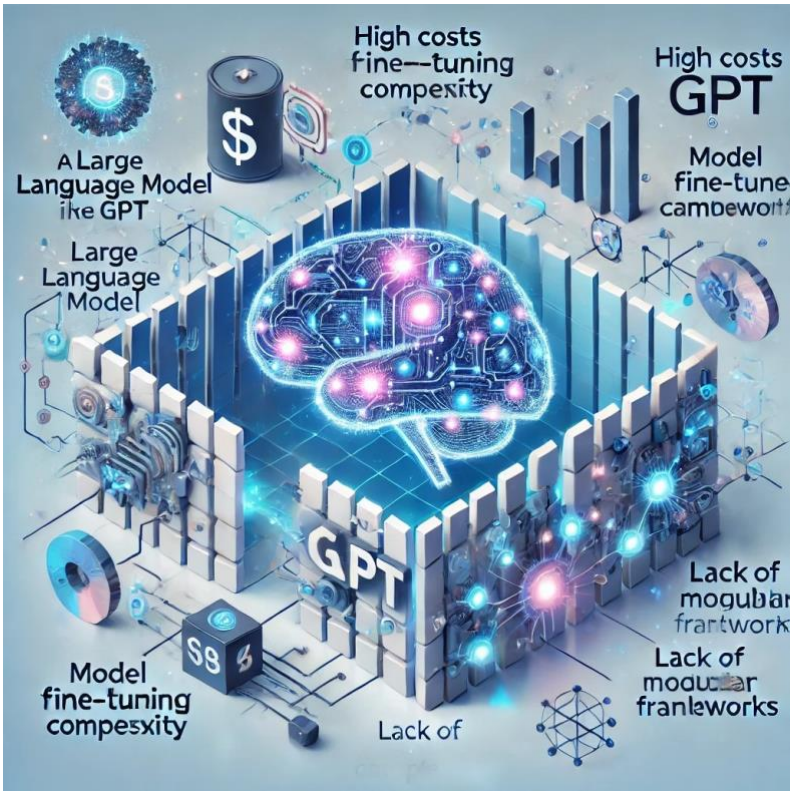


**Fig 3:** Underutilization of Advanced AI Technologies

## ➢ Scalability Limitations:

- Chatbots built on legacy architectures struggle to scale effectively with increasing user demands. This results in reduced performance and response delays during peak usage times.

## ➢ Security and Data Privacy Concerns:

- Existing chatbots often lack robust security measures to protect sensitive user information. Many systems do not comply with data protection regulations such as GDPR, raising trust and ethical concerns.

**Fig 4**: Data privacy concerns

## ➢ One-Way Communication:

- Most chatbots serve as information providers but lack interactivity in features like announcements. For instance, users cannot respond to or interact with broadcast messages, limiting engagement and user feedback.

**Fig 5**: One way communication

- **Lack of Dynamic Map Features:**

- While some chatbots offer static campus navigation, they lack interactive map features or the ability to adapt to real-time changes, such as construction zones or event-specific directions.

- **Ethical and Bias Challenges:**

- Existing chatbot systems often propagate biases from training data, leading to unintended discrimination or inaccurate recommendations. Few solutions have mechanisms to detect or mitigate biases effectively.

- **Cost and Resource Barriers:**

- Small and mid-sized institutions face challenges in adopting advanced chatbot solutions due to high implementation costs, lack of technical expertise, and maintenance requirements.

- **Insufficient Feedback Loops:**

- Many chatbots lack mechanisms for capturing, analyzing, and acting on user feedback or unhandled queries. This results in limited system evolution and stagnant user experience improvements.

- **Integration Challenges:**

- Existing methods often fail to integrate seamlessly with other university systems, such as learning management systems (LMS), student portals, or event management platforms, reducing overall utility.

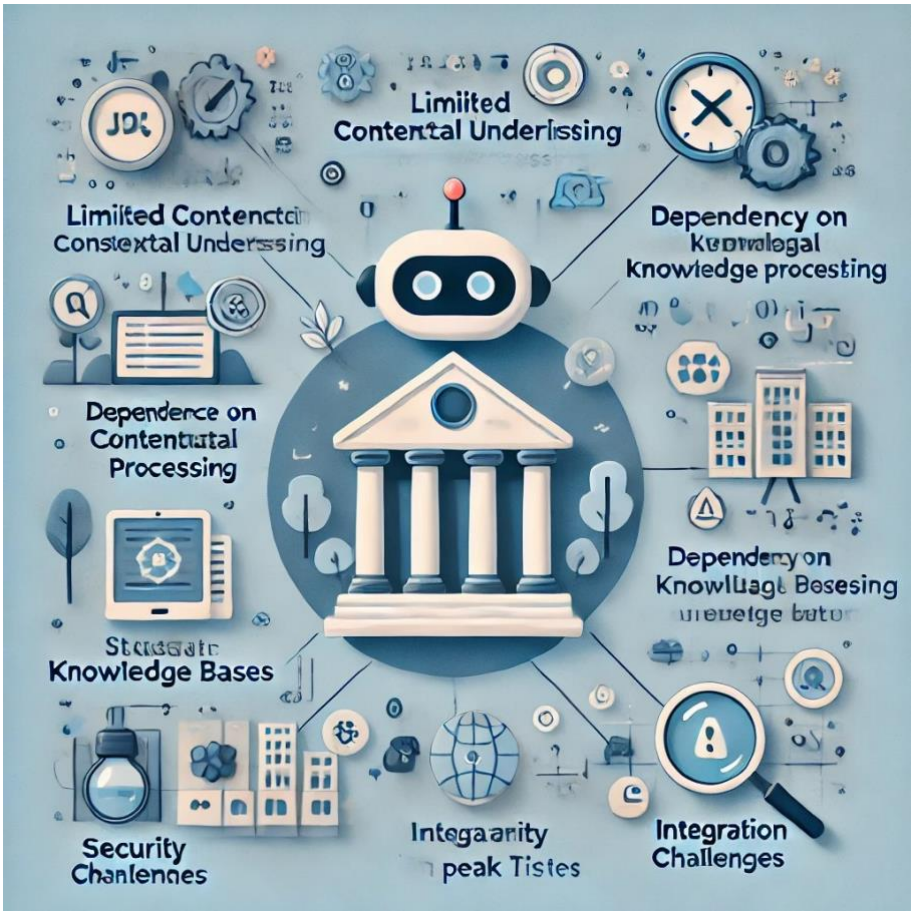


**Fig 6**: Limitations of AI based Chatbots

Existing university chatbot systems face significant limitations that hinder their effectiveness in meeting user needs. Key challenges include limited contextual understanding, dependency on keyword-based processing, and a lack of personalization, which restrict their ability to provide accurate and adaptive responses. Many chatbots rely on static knowledge bases, struggle with multilingual support, and fail to scale effectively during peak usage. Additional concerns include integration challenges with other university systems, insufficient mechanisms for user feedback, and inadequate security measures, raising privacy and ethical issues. While advanced AI technologies like large language models (LLMs) offer potential solutions, high implementation costs and resource barriers make them inaccessible for smaller institutions. Addressing these gaps requires innovative, inclusive, and scalable approaches to enhance chatbot capabilities and ensure a user-centric experience.

| **Feature** | **LLM-Based Chatbots** | **Traditional Chatbots** |
|---|---|---|
| Understanding Complexity | Can handle complex, open-ended, and ambiguous queries with context-aware responses. | Limited to structured or pre-defined queries. Often fail with ambiguous or poorly worded user inputs. |
| Natural Language Processing | Advanced NLP capabilities with deep contextual understanding. | Relies on rule-based or keyword-based NLP techniques, which may misinterpret user intent. |
| Learning Capability | Continuously improves through fine-tuning and interaction data | Static; limited to predefined scripts and intent libraries unless manually updated. |
| Flexibility | Capable of generating novel responses for queries outside predefined patterns. | Restricted to scripted responses; fails with out-of-scope queries. |
| Personalization | Leverages user data to provide highly personalized, context-sensitive interactions. | Basic personalization using static user profiles or authentication; limited adaptability. |
| Multilingual Support | Natively supports multiple languages using advanced LLM capabilities. | Requires custom modules or separate models for each language, increasing complexity. |
| Scalability | Scales effectively, handling diverse user queries with high accuracy. | Limited scalability; performance drops as the range of queries and user traffic increase. |
| Response Accuracy | Provides nuanced, context-aware, and grammatically correct responses. | Responses may lack nuance and often rely on rigid patterns, leading to inaccuracies. |

| | | |
|---|---|---|
| Adaptability | Highly adaptable to diverse domains by fine-tuning models with domain-specific data. | Customization requires extensive manual effort, making it less adaptable to new domains or changing requirements. |
| Integration with Knowledge Base | Can dynamically retrieve and incorporate knowledge base data for responses. | Relies heavily on static knowledge bases and struggles with dynamic updates. |
| Query Logging and Improvement | Automatically logs and adapts to unhandled queries for continuous improvement. | Requires manual updates to logs and scripts, making iterative improvement slower. |
| User Engagement | Engages in fluid, human-like conversations, enhancing user satisfaction | Often perceived as robotic due to rigid conversational flows. |
| Development Complexity | Requires significant resources for integration, training, and fine-tuning. | Easier to build and maintain, often using frameworks like Dialogflow, Botpress, or AIML. |
| Real-Time Query Handling | Handles both structured and unstructured queries efficiently. | Performs well with structured queries but struggles with unstructured or unexpected inputs. |
| Cost of Implementation | High initial costs for model training, infrastructure, and API usage (e.g., OpenAI API). | Lower initial costs; suitable for small-scale applications or limited functionality. |
| Data Privacy and Security | Requires robust mechanisms to ensure compliance with privacy laws like GDPR due to extensive data use. | Handles less user data, simplifying compliance with privacy laws, but limits the scope of personalization. |
| Handling Biases | Risk of bias due to training data but can be mitigated using fairness toolkits and diverse datasets | Lesser risk of bias as responses are predefined, but |

| | | |
|---|---|---|
| | | less capable of handling sensitive or nuanced topics. |
| Real-Time Information | Can integrate with APIs to fetch live data (e.g., announcements, events). | Struggles with dynamic, real-time data integration without manual updates. |
| Use Cases | Suitable for education, healthcare, customer service, and other domains requiring complex conversations. | Best for FAQs, simple customer service tasks, and rule-based workflows. |
| Maintenance | - Requires ongoing model updates, fine-tuning, and infrastructure upgrades | Requires manual updates to scripts and workflows but is easier to maintain in static environments. |
| Performance with Volume | Performs well even with high query volumes due to efficient scaling. | - May experience delays or drop in accuracy under high traffic or query diversity |

**Table – 1:** Comparison Between LLM based and Traditional Chatbots

# CHAPTER-4

# OBJECTIVES

The primary objective of integrating an LLM-powered chatbot into university web platforms is to enhance user engagement by providing 24/7 accessibility to essential university resources. The chatbot aims to deliver real-time responses to inquiries about admissions, academic support, campus events, and more, ensuring that students, faculty, and visitors receive instant assistance. By automating routine and frequently asked questions, the chatbot significantly reduces the administrative workload, allowing staff to focus on more complex and high-priority tasks.

- **Enhance User Engagement:**
  - Provide 24/7 accessibility to university resources through an intelligent chatbot. Offer real-time responses to inquiries about admissions, academic support, campus events, and more.
- **Streamline Administrative Tasks:**
  - Reduce administrative workload by automating responses to routine and frequently asked questions. Enable staff to focus on complex and non-repetitive tasks.
- **Deliver Personalized Interactions:**
  - Implement a secure user authentication system to personalize responses based on user profiles. Use session management for consistent and tailored user experiences.
- **Facilitate Seamless Navigation:**
  - Provide map-based directions for easier navigation within the university campus. Assist new students and visitors in locating facilities with step-by-step instructions.
- **Improve Communication Efficiency:**
  - Enable a broadcast system for real-time announcements, keeping the university community informed. Allow non-technical staff to manage announcements via an intuitive admin panel.
- **Leverage Advanced AI Capabilities:**
  - Use a modular framework like Botpress for handling structured queries effectively. Integrate a Large Language Model (LLM) to process complex, open-ended, and context-sensitive queries.
- **Promote Continuous Improvement:**
  - Track unhandled queries using a log system and update the knowledge base accordingly. Enhance chatbot accuracy and relevance through continuous learning and fine-tuning of the LLM.

- **Ensure Scalability and Security:**
  - Design a scalable backend infrastructure to accommodate growing user demands. Implement strict data privacy measures to comply with regulations like GDPR.
- **Support Future Enhancements:**
  - Lay the foundation for multilingual support to cater to diverse student populations. Explore location-based services and additional interactive features for future iterations.
- **Advance Inclusivity in Education:**
  - Create an inclusive platform where students from various backgrounds can access equal assistance. Foster a supportive digital environment that aligns with the university's mission and values.

# CHAPTER-5

# PROPOSED METHODOLOGY

The proposed methodology for developing the university chatbot is built on a modular architecture, integrating cutting-edge technologies to deliver efficient and intelligent query handling. This chapter elaborates on the technical implementation, mathematical models, and architectural details of each component, with a focus on the integration of Large Language Models (LLMs), natural language processing (NLP) through Botpress, and the broadcast module.

## 5.1 Chatbot Framework: Botpress

The Botpress framework was chosen for its modular, open-source architecture that supports the rapid development of conversational agents. Its built-in NLP engine is utilized for structured query handling, while advanced integration capabilities enable seamless communication with other components like the LLM.

Components and Workflow:

1. Intent Recognition: Botpress employs a classification model to identify user intents. For a given query Q, the intent $I \in \{I1, I2, \ldots, In\}$ is determined by maximizing the probability:

$$P(I/Q) = \frac{P(Q/I)P(I)}{P(Q)}$$

   Here, P(Q|I) is modelled using labeled training data, and P(I)P(I) represents the prior probability of each intent.
2. Entity Extraction: NLP algorithms in Botpress extract entities like dates, locations, or course names using pattern matching and machine learning techniques.
3. Flow Design: Structured conversations are implemented through decision trees. For example, admissions-related queries are routed to specific workflows for predefined responses.

Architecture:

- Frontend: Receives user inputs and forwards them to the backend.
- Backend: Processes user intents and resolves queries using a combination of predefined workflows and dynamic escalation to the LLM.

Application in the Project:

- Handles structured queries, such as "What are the library hours?" or "How can I apply for a scholarship?".
- Integrates with the LLM to handle queries beyond predefined workflows.

## 5.2 Integration of Large Language Models (LLMs)

To address context-sensitive and open-ended queries, the chatbot incorporates a GPT-based LLM built on the Transformer architecture.

Technical Details:

**For LLM (Transformer Architecture):**

**Self-Attention Mechanism**

The attention mechanism can be described as:

$$\text{Attention}(\text{Q}, \text{k}, \text{V}) = \text{softmax} \times \frac{\text{QK}^{\text{T}}}{\sqrt{\text{dk}}} \times \text{V}$$

where:

Q, K, V: Query, Key, and Value matrices derived from the input embeddings.

dk: Dimensionality of the Key vectors, which scales the dot product for numerical stability.

**Output of Transformer Layer:**

The output ZZZ from one Transformer layer combines attention output Attention (Q, K, V) with feedforward components:

$$\text{Z} = \text{LayerNorm}(\text{Attention}(\text{Q}, \text{K}, \text{V}) + \text{input})$$

Positional Encoding (to handle sequence order):

$$PE(\text{pos}, 2\text{i}) = \sin \times \frac{\text{pos}}{10000^{2\frac{\text{i}}{\text{d}}}}, \ \text{PE}(\text{pos}, 2\text{i} + 1) = \cos \times \frac{\text{pos}}{10000^{2\frac{\text{i}}{\text{d}}}}$$

where pos is the position and i is the dimension.

**Transformer Architecture:** The LLM leverages self-attention mechanisms to compute relationships between tokens in input sequences.

- Fine-Tuning: The model is fine-tuned using university-specific datasets, including FAQs, policies, and academic resources, to ensure relevance and accuracy.

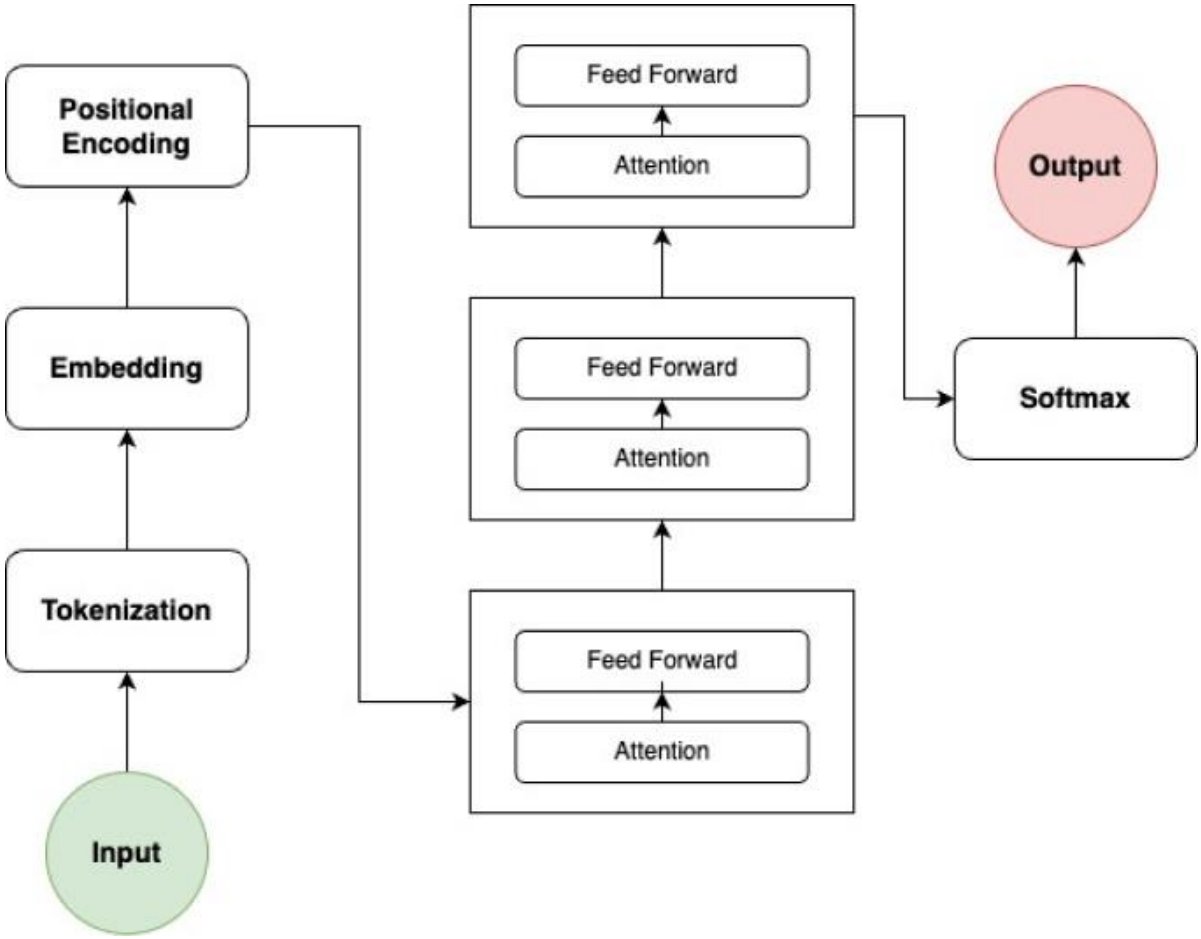


**Fig 7**: Transformer Workflow

**NLP in Botpress:**

Natural Language Processing (NLP) is a subfield of artificial intelligence (AI) that focuses on enabling computers to understand, interpret, and generate human language. It combines linguistics, machine learning, and computational techniques to process and analyze natural language data. NLP encompasses a wide range of tasks, including text classification, sentiment analysis, machine translation, and question-answering systems. A critical aspect of NLP is its ability to process unstructured text, transforming raw language input into structured data that can be used for analysis or decision-making. Techniques like tokenization, stemming, and lemmatization break down text into manageable components, while more advanced methods, such as word embeddings (e.g., Word2Vec or GloVe) and Transformer-based architectures (e.g., BERT, GPT), enable semantic understanding of language. In chatbot systems, NLP is essential for understanding user queries, identifying intents, and generating contextually relevant responses.

1. **Intent Classification** (Softmax for classification):

   The probability of intent Ik given a query Q is:

$$(IK|Q) = \frac{\exp(wk \times Q + bk)}{\sum_{j=1}^{n} \exp(wj \times Q + bj)}$$

where:

- wk, bk : Weights and biases for intent k.
- n: Total number of intents.

2. **Named Entity Recognition (NER)**:

Named Entity Recognition (NER) is a key task in NLP that involves identifying and classifying entities mentioned in a text into predefined categories such as names of people, locations, organizations, dates, and numerical values. For example, in the sentence, "John is visiting New York on January 15," NER would extract entities like "John" (Person), "New York" (Location), and "January 15" (Date). NER is often implemented using statistical models, rule-based methods, or deep learning approaches, such as Conditional Random Fields (CRFs), Recurrent Neural Networks (RNNs), or Transformer-based models. The extracted entities help systems like chatbots understand the context and retrieve more accurate information. In the context of university chatbots, NER is crucial for extracting important details from user queries, such as course names, faculty members, or event dates, enabling precise and personalized responses. By combining NER with intent recognition, chatbots can deliver a more intelligent and human-like conversational experience.
A conditional probability model identifies entities EEE in a query:

$$\mathrm{P(E|Q)} = \Pi\, \mathrm{P(e|Q, e\_1{:}\, i - 1)}$$

where ei is the label for token i.

**Workflow:**

1. User inputs are processed by Botpress. If the query is complex or unrecognized, it is forwarded to the LLM.
2. The LLM generates context-aware responses by leveraging its fine-tuned knowledge.

**Application in the Project:**

- Responds to complex queries like "What are the eligibility criteria for scholarships?" or "Can you recommend study spots on campus?".
- Enables adaptive learning by updating the model with new data from unhandled queries.

## 5.3 Broadcast Module

The broadcast module ensures real-time dissemination of important announcements to the university community.

Technical Details:

- Backend Design: Announcements are stored in a relational database (e.g., MySQL) and pushed to users via WebSocket connections.
- Real-Time Updates: The module dynamically updates the frontend when new announcements are made.

Equation for Real-Time Updates: The system distributes an announcement A to n users through WebSocket channels, where the broadcast load L is:

$$L = i = 1\sum nTi \cdot Ri1$$

Here, Ti is the transmission time for user i, and Ri is the bandwidth available for user i.

Architecture:

1. Admin Panel: Allows administrators to create and manage announcements.
2. Backend Server: Validates announcements and pushes updates to clients.
3. User Interface: Displays announcements dynamically as a scrolling ticker or pop-up notification.

Application in the Project:

- Communicates critical updates, such as exam schedules or event cancellations, in real-time.
- Enables administrators to update announcements easily through an intuitive interface.

## 5.4 Knowledge Base and Log Management

Knowledge Base: A structured knowledge base managed through Botpress stores predefined responses for FAQs. Administrators can update this database using a graphical interface.

Log Management: Unhandled queries are recorded for analysis, ensuring continuous system improvement.

- Log Analysis Workflow:
    1. Logs are categorized based on query type.
    2. High-frequency unhandled queries are prioritized for inclusion in the knowledge base.

Mathematical Model: The iterative update process for the knowledge base can be expressed as:

$$Fnew = Fold + \eta \cdot \nabla L(Qunhandled)$$

where Fnew represents the updated knowledge base, L is the loss function calculated from unhandled queries Qunhandled, and η is the learning rate.

Application in the Project:

- Updates knowledge dynamically based on real-world interactions.
- Ensures that recurring queries are addressed in future iterations

## 5.5 Backend and Database Design

The backend manages all data storage and processing requirements.

Technical Details:

- Database Schema: Relational tables store user credentials, session data, chatbot logs, and announcements.
- Scalability: Horizontal scaling ensures performance under high traffic.

Data Flow:

1. User authentication triggers a database query to validate credentials.
2. Queries are processed either by Botpress or the LLM.
3. Responses and interactions are logged for analysis.

Application in the Project:

- Provides secure and reliable data management.
- Supports real-time interactions and future scalability.

## 5.6 Overall System Architecture

The system integrates modular components to create a cohesive architecture:

1. Frontend: HTML, CSS, and JavaScript ensure user interaction is seamless and responsive.
2. Backend: A Node.js server handles routing, database queries, and communication between components.
3. Botpress Engine: Processes structured queries efficiently.
4. LLM Integration: Handles complex, context-sensitive queries.
5. Broadcast Module: Manages real-time updates for announcements.

Application in the Project:

- Combines the strengths of rule-based and AI-driven approaches for comprehensive query handling.
- Ensures scalability, user satisfaction, and adaptability to evolving university needs.

This detailed methodology incorporates the technical underpinnings and architectural components of the chatbot system, highlighting its ability to address diverse user needs effectively while remaining adaptable for future enhancements.

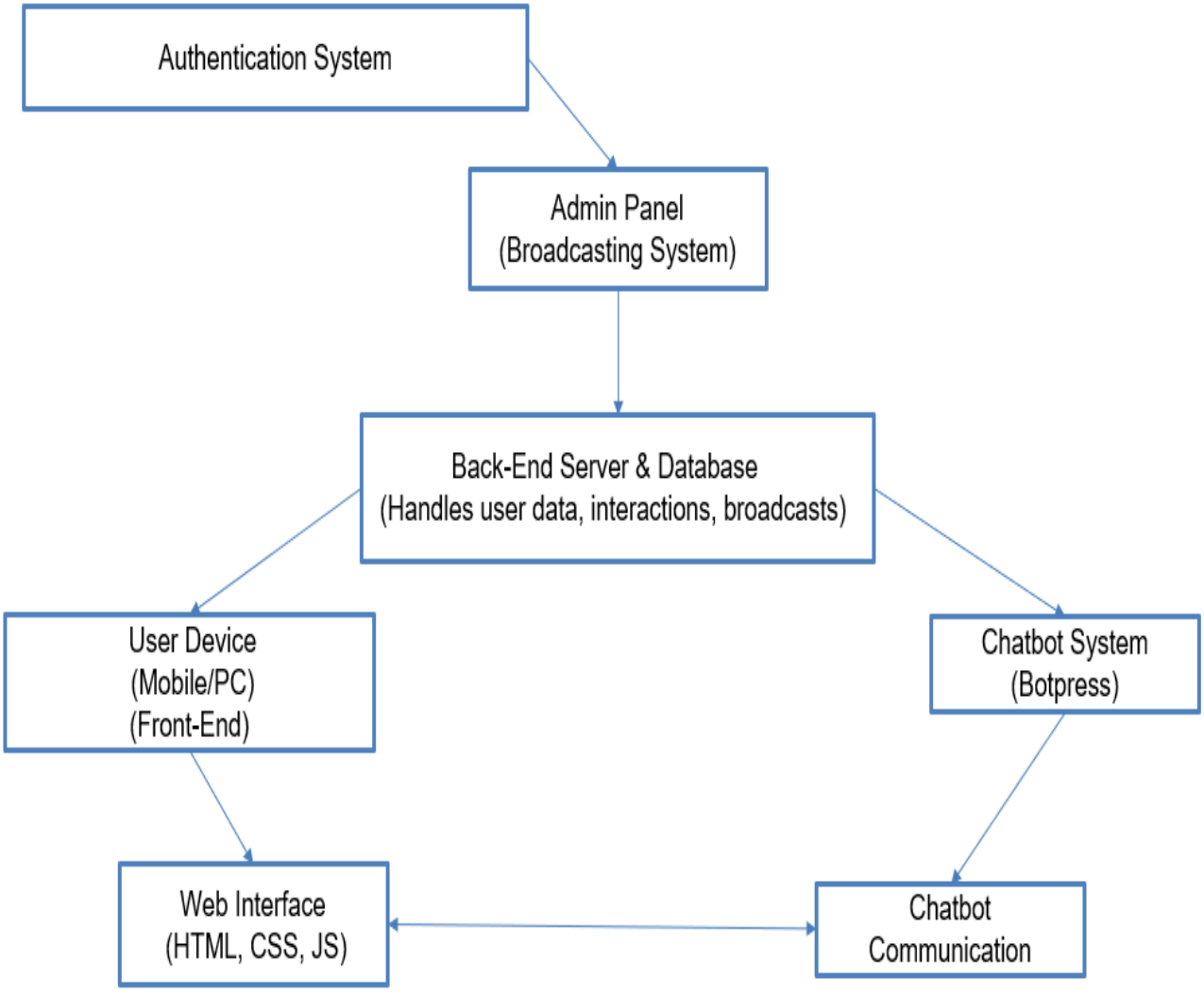


**Fig 8:** User Authentication

# CHAPTER-6

# SYSTEM DESIGN & IMPLEMENTATION

The chatbot for the university website aims to simplify access to key university services and improve the user experience. Built using Botpress and powered by a Large Language Model (LLM), the chatbot provides automated assistance to students, faculty, and visitors. It handles a wide range of tasks, including answering common queries, providing directions using a university map, and broadcasting important announcements.

## A. Frontend Development

The frontend of the chatbot website is developed using HTML, CSS, and JavaScript, ensuring a responsive and dynamic user interface:

- HTML structures the web pages.
- CSS ensures the aesthetic and branding consistency of the site.
- JavaScript enables interactive elements, such as form validation and real-time chatbot responses.

## B. Chatbot Development Using Botpress and LLM

The core chatbot functionalities were developed using Botpress integrated with a Large Language Model (LLM) for enhanced natural language understanding and responses.

### 1. BOTPRESS FOR STRUCTURED CONVERSATIONS:

Botpress handles frequently asked questions (FAQs) and structured queries related to the university, such as admissions, directions, and event details. It leverages predefined intents and decision trees for handling standard user requests.

The chatbot is trained with a university map to provide campus directions. When a user asks, “Where is the administration building?”, the chatbot consults the map and provides accurate directions.

### 2. LLM INTEGRATION FOR COMPLEX QUERIES:

For more complex, open-ended queries, the chatbot is integrated with an LLM. This model allows the chatbot to provide more nuanced, context-aware responses that go beyond simple FAQ patterns.

The LLM enhances the chatbot's ability to handle diverse natural language inputs, offering flexible and intelligent responses. For instance, when users ask questions like, "What are the steps to apply for financial aid?" or "Can you suggest some good study spots on campus?".

### 3. HANDLING UNKNOWN QUERIES:

Queries that cannot be handled by predefined responses or the LLM are logged for further analysis and improvements to the knowledge base. This ensures that the chatbot continuously improves over time.

### C. USER AUTHENTICATION MODULE

To ensure personalized user interactions, the chatbot requires users to authenticate themselves:
Users provide their name and phone number for authentication.
The JavaScript-based frontend validation ensures the correct format of input, and the data is securely stored in the backend database.
Once authenticated, user sessions are managed, allowing the chatbot to greet users by name and provide a personalized experience.

### D. Knowledge Base and Log Management

#### 1. Knowledge Base

The chatbot has a dual knowledge system: a structured knowledge base managed in Botpress and the dynamic capabilities of the LLM.
The structured knowledge base covers frequently asked queries about admissions, campus navigation, and event details. The knowledge base is managed using Botpress's content management system, allowing easy updates by administrators.

#### 2. Log File System

A log file system tracks queries that cannot be answered by either the Botpress knowledge base or the LLM. These unhandled queries are reviewed by administrators, who can update the chatbot's knowledge base with appropriate responses.

This feedback loop ensures the chatbot continuously evolves and improves, becoming more robust over time.

#### 3. Broadcast Module

A Broadcast Module allows administrators to send important announcements to users:
Admin Functionality: Admins can post announcements through a dedicated panel. These messages appear as a scrolling ticker at the bottom of the webpage, providing real-time updates to all users.
Dynamic Updates: The broadcast ticker is automatically updated whenever a new message is posted, ensuring timely information dissemination.

**4. Backend Infrastructure**

Database: The backend uses a database to store user data (names, phone numbers) and chatbot logs. This database ensures persistent storage of user sessions and enables personalized chatbot interactions.

Server: The chatbot is hosted on a server that processes user queries, handles communication with the Botpress engine, the LLM, and manages database operations.

**5. Map-Based Directions**

One of the chatbot's standout features is its ability to provide directions within the university campus:

The chatbot is trained with a digital map of the university, which is integrated into its knowledge base. When users ask for directions, the chatbot retrieves map coordinates and provides step-by-step instructions to the desired location.

This feature is particularly useful for new students and visitors navigating the campus.

**6. Continuous Learning and Improvement**

The chatbot system is designed for continuous improvement:

LLM Updates: The LLM's ability to handle complex and open-ended queries allows for flexible learning. As new types of queries are encountered, the LLM adapts and improves its responses.

Admin Feedback Loop: Administrators review the log files of unhandled queries, and these are used to expand the knowledge base in Botpress, ensuring the chatbot stays up-to-date with current user needs.

## Technical Workflow

1. **User Authentication:** Users provide their name and phone number → JavaScript validates the input → User session is created and personalized.

2. **Query Handling:**

    - Simple queries: Processed by Botpress, returning responses from a structured knowledge base.
    - Complex queries: Routed to the LLM for more intelligent, context-aware responses.
    - Unhandled queries: Logged for admin review and future system updates.

3. **Broadcast Module:** Admin posts an announcement → Broadcast ticker updated in real-time at the bottom of the webpage.
4. **Log Management:** Logs of unanswered queries are reviewed and the knowledge base is updated according

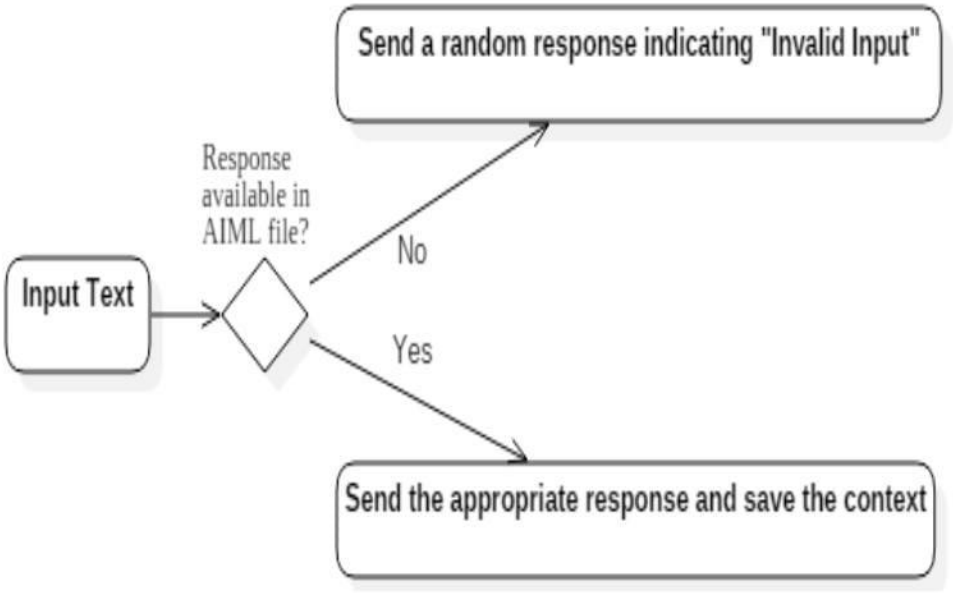


**Fig 9:** Activity Diagram of Normal Conversation Response

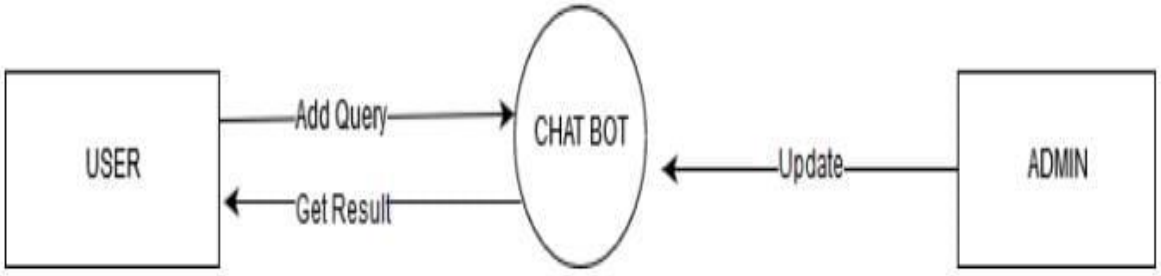


**Fig 10:** Chatbot training and Updating by Admin

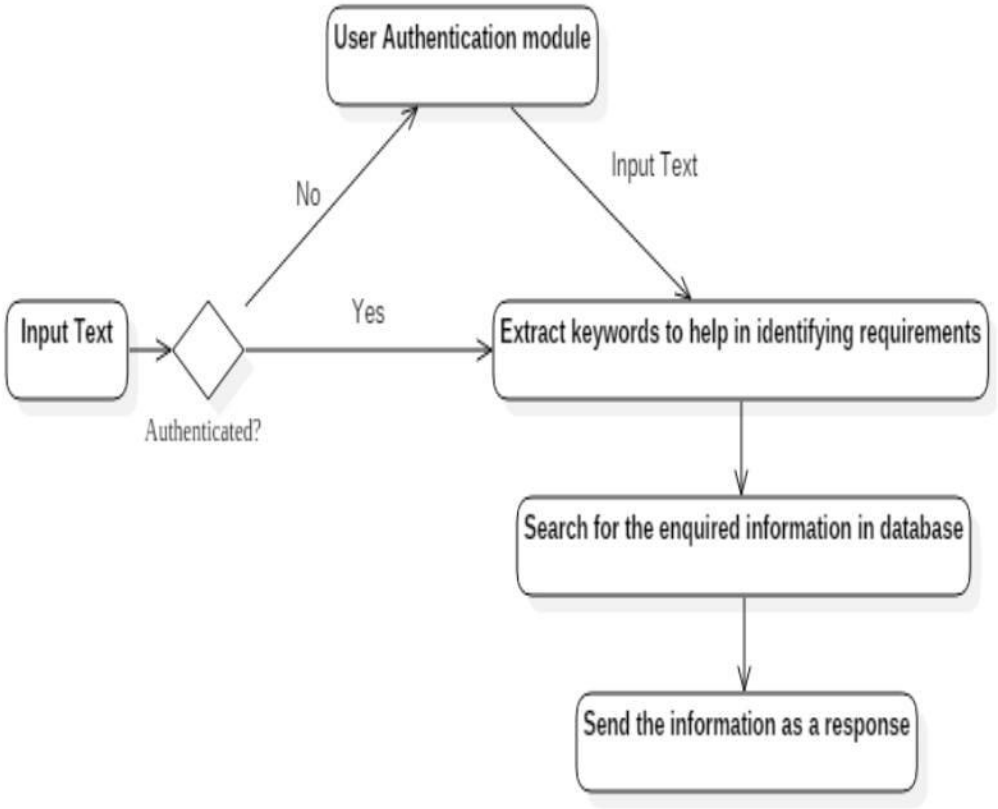


**Fig 11:** Activity Diagram of Personal Query Response Activity

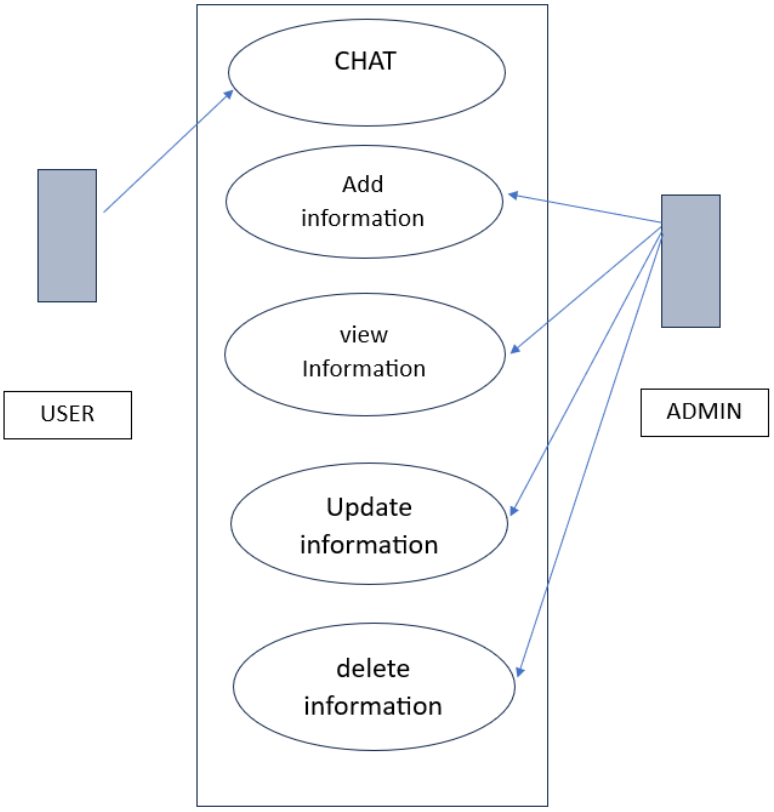


**Fig 12:** User and Admin modules

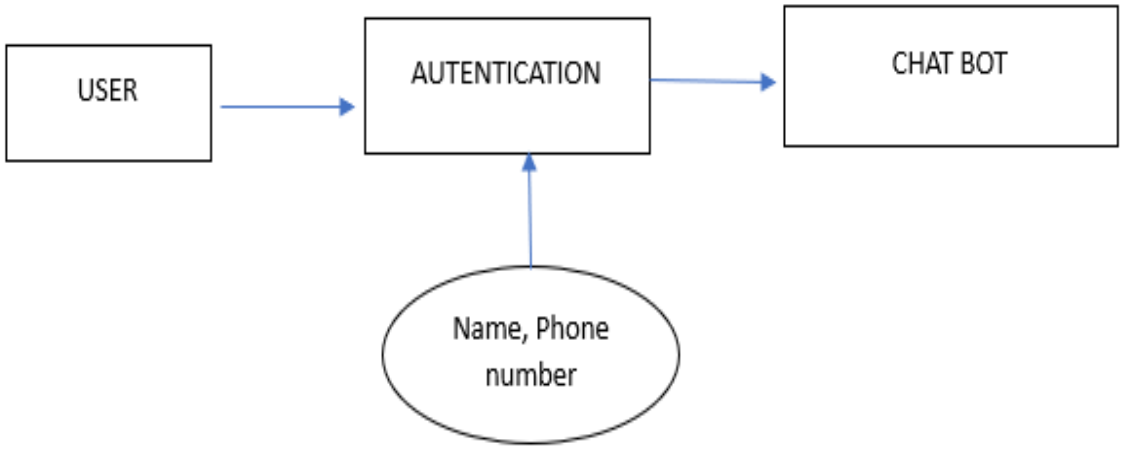


**Fig 13:** User Authentication

# CHAPTER-7

# RESULTS AND DISCUSSIONS

The development and implementation of a university chatbot using Botpress and a Large Language Model (LLM) demonstrate the significant benefits of modular, scalable, and adaptive systems in addressing diverse user needs. This discussion reflects on the key aspects of the methodology, evaluating the success of the approach and identifying areas for future improvement.

## 1. Effectiveness of the Chatbot Framework (Botpress)

Botpress proved to be a strong choice for building the chatbot's core functionality, mainly due to its modular architecture. The ability to add or update specific functionalities, such as the broadcast module and authentication system, has simplified system management and allowed for rapid iterations. The modularity ensures that the system is adaptable to changing requirements, an essential feature given the dynamic nature of university environments.

The Natural Language Processing (NLP) capabilities of Botpress effectively handle structured queries, such as frequently asked questions related to admissions, schedules, and campus events. However, the framework’s reliance on predefined conversational flows limits its ability to handle more complex, open-ended questions. This shortcoming was addressed by the integration of an LLM, which brings us to the next point of discussion.

## 2. The Role of LLM in Enhancing User Interaction

The integration of an LLM significantly improved the chatbot's ability to handle complex and context-sensitive queries. The LLM's advanced NLP capabilities allowed the system to go beyond predefined conversational patterns, providing users with more natural and fluid interactions. This integration added a layer of sophistication to the chatbot, allowing it to understand and respond to queries that require deeper context, such as "How do I apply for a scholarship?" or "What are some study recommendations for my major?"

However, while the LLM enhances user experience, it also introduces challenges. The primary concern is the system's dependency on external data sources, which might lead to occasional inaccuracies or responses that do not align perfectly with the university's specific guidelines or policies. Continuous monitoring and fine-tuning of the LLM, combined with frequent updates to the knowledge base, are necessary to ensure that the responses remain accurate and relevant.

## 3. Security and Personalization Through User Authentication

The decision to implement a user authentication system contributed to both the security and personalization of the chatbot service. By collecting basic user data (name, phone number), the system ensures that only authenticated users can access the chatbot's personalized features. The addition of session management also ensures that user interactions are consistent and continuous, enhancing the overall user experience.

However, data security is an area that requires ongoing vigilance. Ensuring that user data is handled according to strict privacy standards, such as the General Data Protection Regulation (GDPR), is critical for maintaining trust, especially in environments like universities, where large volumes of sensitive data are processed.

## 4. Real-Time Communication with the Broadcast Module

The inclusion of a broadcast module in the chatbot was a strategic decision, allowing the university to push real-time announcements to users. This feature ensures that users are informed about important events or urgent notifications, such as class cancellations or campus safety updates. The ease of use provided by the admin panel enables non-technical university staff to manage announcements effectively.

One limitation of the current broadcast system is that it primarily serves a one-way communication function. Future iterations could consider making the broadcast system more interactive, where users can respond to announcements, ask for more details, or request personalized updates based on their preferences.

## 5. Continuous Improvement Through Log Management

A key strength of the project is the log management system, which records unhandled queries. This feature ensures that the chatbot can continuously evolve by updating the knowledge base based on real user interactions. By tracking these logs, administrators can refine the chatbot's responses and incorporate new information, thereby enhancing the system’s long-term adaptability.

The challenge here lies in managing the volume of logs. As the system scales and the number of users grows, manually reviewing logs and updating the knowledge base could become time-consuming. Automating parts of this process, such as categorizing unhandled queries or prioritizing them based on frequency, would be beneficial.

## 6. Scalability and Future Considerations

The backend and database design, focusing on scalability, ensures that the system can handle an increasing number of users without compromising performance. The use of a relational database allows for secure storage of user data, chatbot logs, and admin-generated content. As the university grows, the system's ability to handle higher traffic and more complex queries will be tested. Ensuring the database and server infrastructure can handle this expansion is a priority.

Future developments could also explore additional features like Wi-Fi detection for location-based services, which could further improve campus navigation and user personalization. Additionally, incorporating multilingual support could be valuable for universities with diverse student populations.

| FEATURES | Standard AI Chatbots | LLM-Integrated Chatbots |
|---|---|---|
| Natural Language Processing | Basic; relies on rule-based and keyword matching | Advanced; understands context, intent, and nuanced language |
| Response Accuracy | Moderate; limited by predefined responses and simpler models | High; uses large datasets to generate accurate, relevant responses |
| Adaptability | Limited; struggles with complex, unseen queries | Flexible; adapts to new topics and queries dynamically |
| **Context Awareness** | Low; requires specific inputs to maintain flow | High; can remember conversation context and maintain coherence |
| Language Support | Limited; may require separate training for multiple languages | Wide; supports multiple languages with higher fluency and accuracy |
| Handling Ambiguity | Low; may respond incorrectly to vague or ambiguous questions | High; can interpret ambiguous queries effectively, providing clarification when needed |
| Use of Data | Requires structured data; limited by specific input types | Can utilize unstructured and diverse data for enhanced learning and understanding |

**Fig 14:** Comparison of different types of chatbots

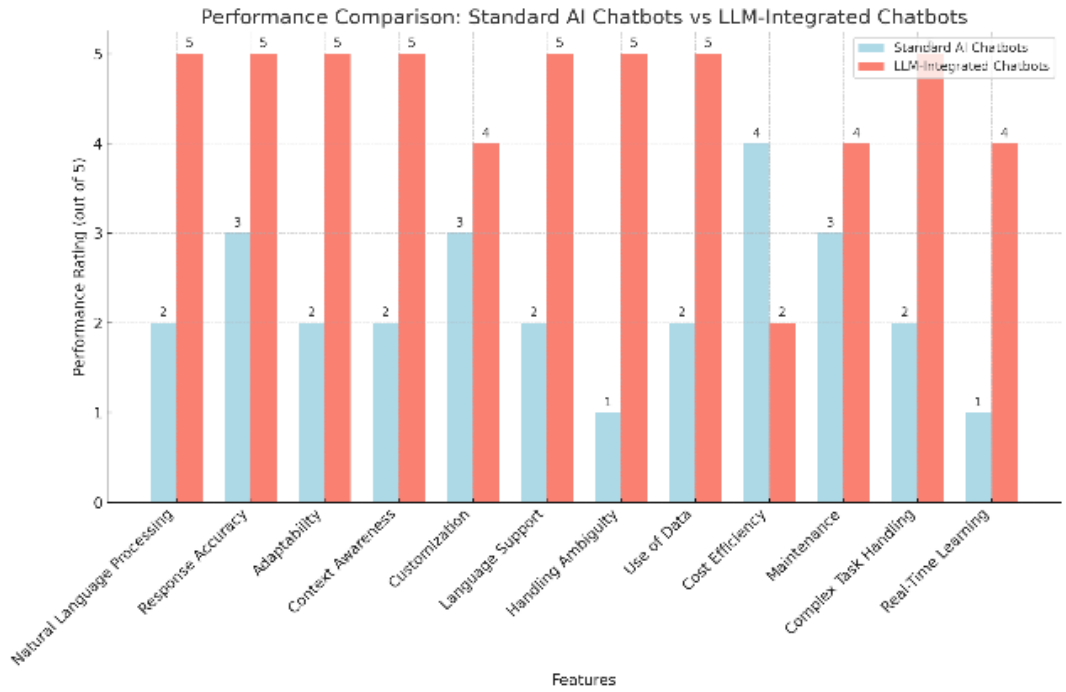


**Fig 15:** Performance comparison of different chatbots

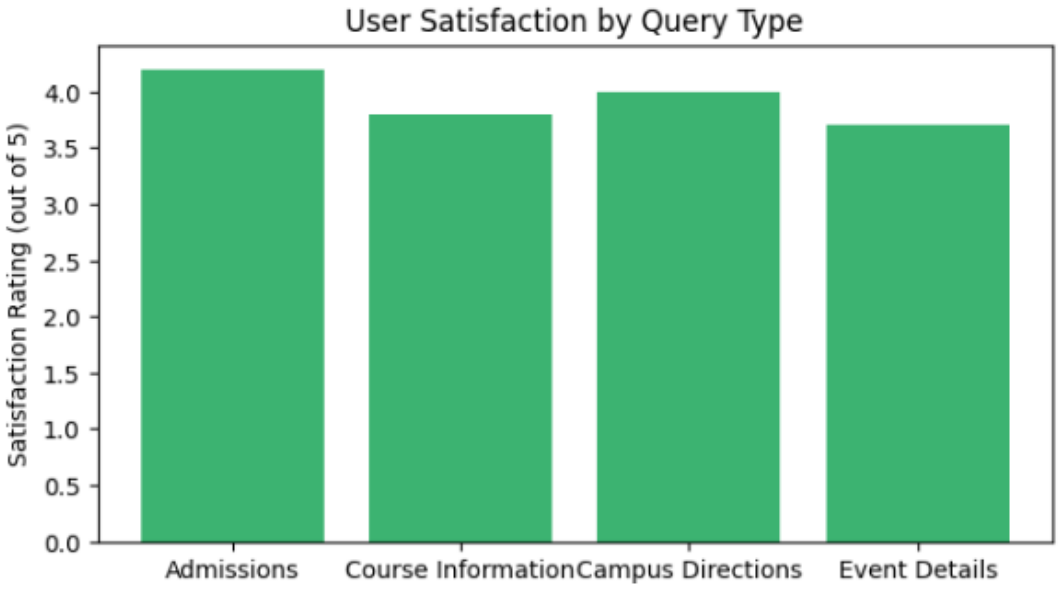


**Fig 16:** User satisfaction by query type

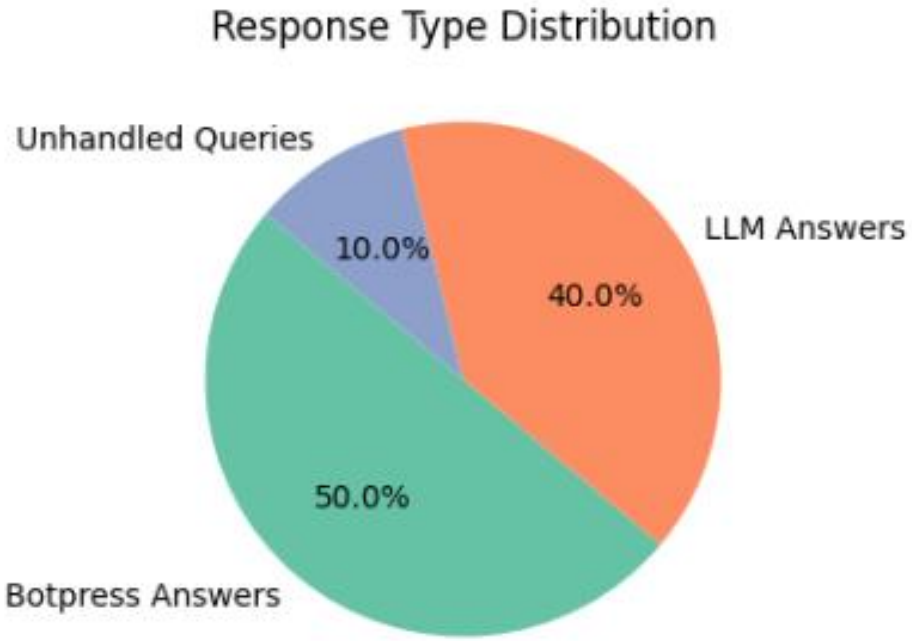


**Fig 17:** Response type distribution

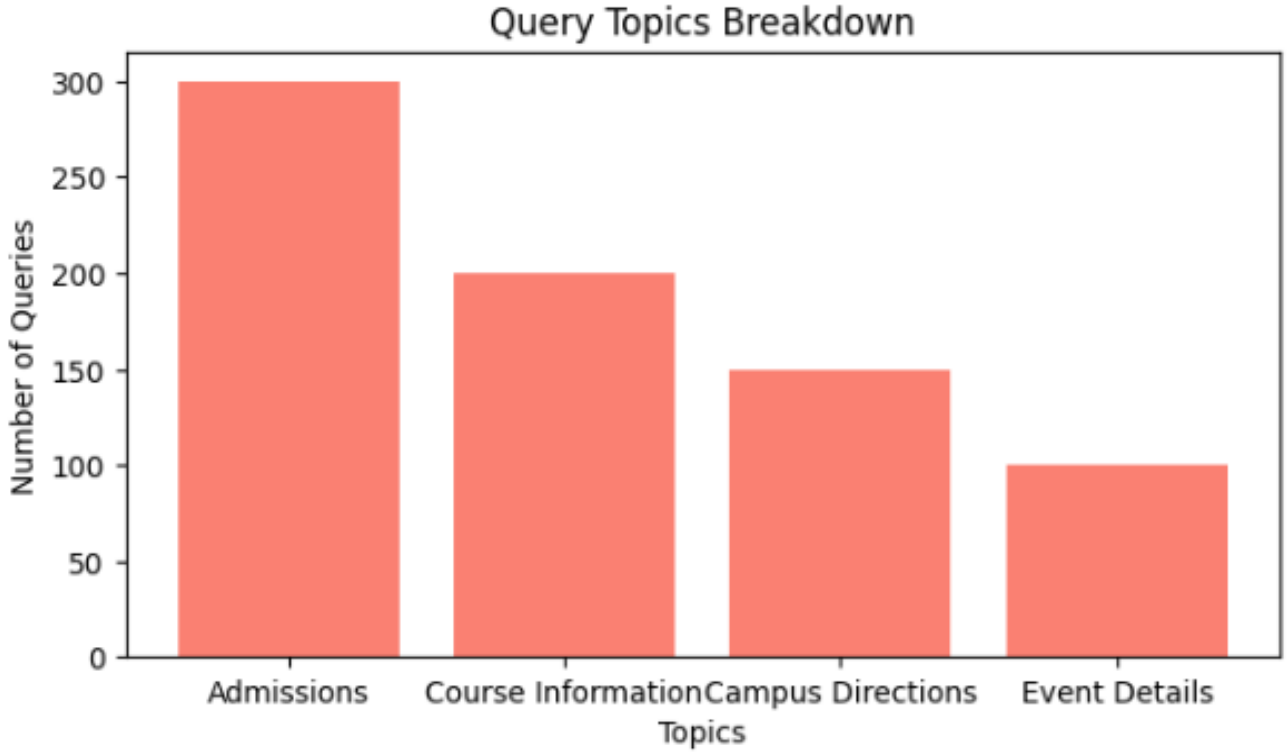


**Fig 18:** Breakdown of query topics

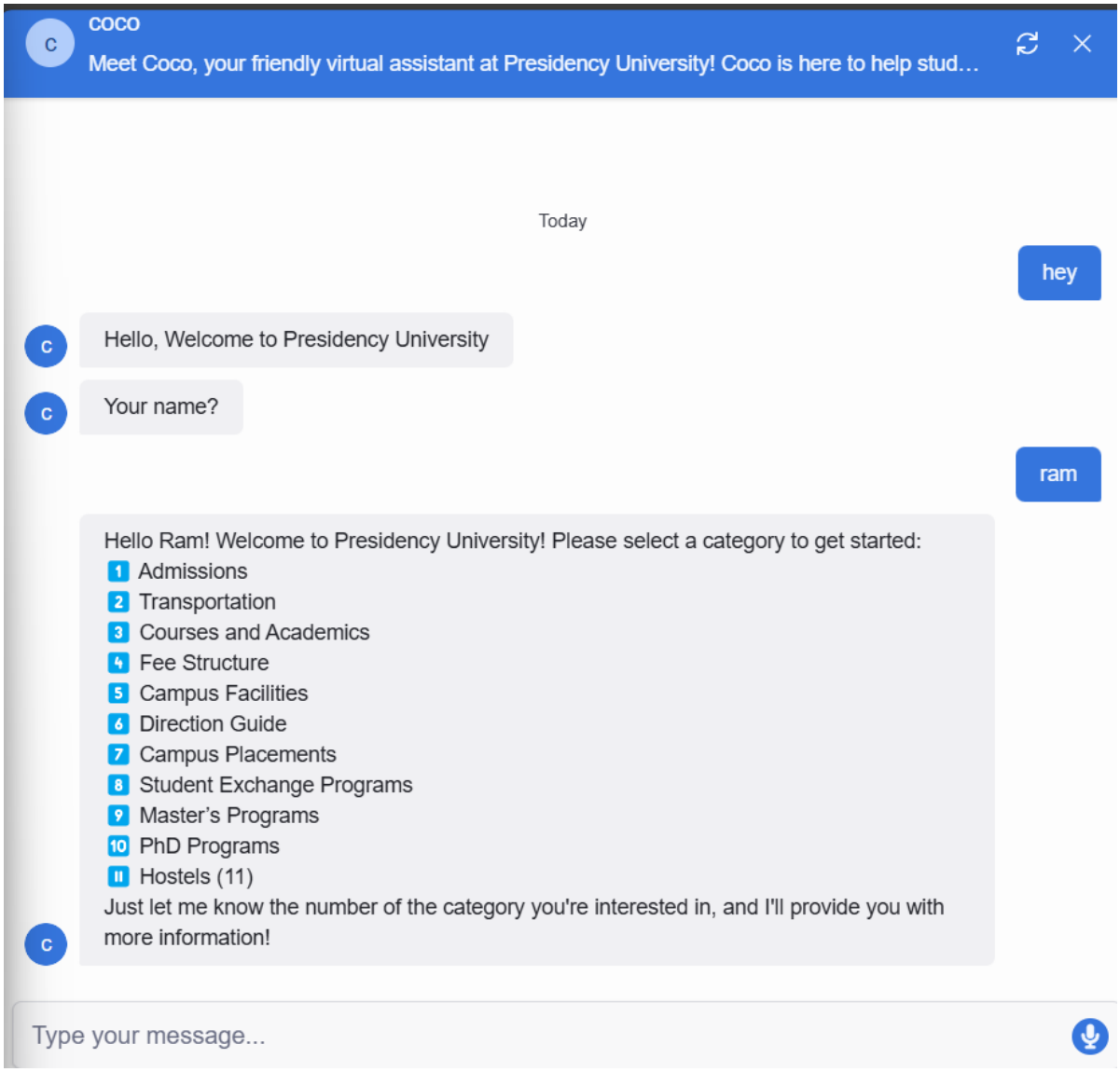


**Fig 19:** Conversation with Chatbot

# CONCLUSION

The university chatbot developed using Botpress, with LLM integration and modular components like user authentication and broadcast systems, has created a flexible, secure, and scalable solution. The methodology ensures that the chatbot meets immediate user needs while remaining adaptable for future improvements. However, continuous monitoring, refinement, and scalability considerations will be essential as the system evolves to accommodate more complex user requirements and larger user bases.

Despite the system's overall success, opportunities for improvement remain. Future development should focus on refining the chatbot's response accuracy, automating log analysis, and expanding interactive features within the broadcast system. Furthermore, ensuring scalability to accommodate growing user demands and integrating advanced technologies such as location-based services will solidify the chatbot's role as an essential tool for enhancing the university's digital infrastructure.

This project demonstrates the potential of combining modular frameworks like Botpress with cutting-edge language models to create a dynamic, user-centric chatbot that meets the evolving needs of a university environment. By continuously iterating and improving on this foundation, the system can continue to provide value to students, faculty, and administrators alike. Future enhancements for the university chatbot focus on expanding its capabilities, improving user engagement, and ensuring scalability. To enhance natural language understanding, integrating context awareness, sentiment analysis, and multi-language support will ensure more personalized and inclusive interactions. Advanced features such as voice interaction, personalized recommendations, and interactive campus maps can further elevate the user experience. Automating log analysis, introducing a usage analytics dashboard, and leveraging predictive analytics will streamline operations and proactively address user needs. Scalability and integration with third-party systems, cloud infrastructure, and APIs will future-proof the system for growing user demands. Security upgrades, including two-factor authentication, data anonymization, and real-time threat detection, will reinforce user trust and data privacy. Engaging features like gamification, event subscriptions. Lastly, expanding the broadcast system with segmented notifications, interactive polls, and event registration will solidify the chatbot as a central tool in the university's digital ecosystem.

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# APPENDIX-A

# PSUEDOCODE

## Login Page

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>University Chatbot - Login</title>
    <style>
        body {
            font-family: 'Roboto', Arial, sans-serif;
            background: url('https://college4u.in/wp-content/uploads/2018/04/pres-1024x398.jpg') no-repeat center center fixed;
            background-size: cover;
            margin: 0;
            padding: 0;
            height: 100vh;
            display: flex;
            justify-content: center;
            align-items: center;
            color: white;
        }

        .container {
            background: rgba(255, 255, 255, 0.9);
            padding: 40px;
            border-radius: 12px;
            box-shadow: 0px 10px 30px rgba(0, 0, 0, 0.3);
            max-width: 400px;
            width: 100%;
            text-align: center;
            color: #333;
        }

        h2 {
            font-size: 1.8rem;
            margin-bottom: 20px;
            color: #333;
        }
```

**Fig A1:** Pseudo code Part – 1

```css
form {
    display: flex;
    flex-direction: column;
    gap: 20px;
}

label {
    font-size: 0.9rem;
    text-align: left;
    font-weight: bold;
    margin-bottom: 5px;
    color: #555;
}

input {
    padding: 12px;
    font-size: 1rem;
    border: 1px solid #ddd;
    border-radius: 8px;
    transition: border-color 0.3s;
}

input:focus {
    border-color: #007bff;
    outline: none;
    box-shadow: 0 0 5px rgba(0, 123, 255, 0.5);
}

.password-container {
    width: 100%;
    text-align: left;
}
```

**Fig A2:** Pseudo Code Part – 2

```
loginForm.addEventListener('submit', (e) => {
    e.preventDefault();

    const rollNumber = document.getElementById('roll-number').value;
    const password = document.getElementById('password').value;

    // Validate roll number format
    const rollNumberPattern = /^(20211|20221|20231|20241)(csd|csg|cst|cse|cai|lsd|

    if (!rollNumberPattern.test(rollNumber)) {
        alert('Invalid roll number format. Please check and try again.');
        return;
    }

    // Validate password
    if (password !== 'pu@123') {
        alert('Invalid password. Please enter the correct password.');
        return;
    }

    // Redirect to the homepage
    window.location.href = 'homepage3.html';
});

function togglePassword() {
    const passwordInput = document.getElementById('password');
    const toggle = document.querySelector('.toggle-password');
    if (passwordInput.type === 'password') {
        passwordInput.type = 'text';
        toggle.textContent = 'Hide';
    } else {
        passwordInput.type = 'password';
        toggle.textContent = 'Show';
```

**Fig A3:** Pseudo Code Part – 3

## Homepage

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Presidency University Chatbot</title>
    <style>
        body {
            font-family: 'Roboto', Arial, sans-serif;
            margin: 0;
            padding: 0;
            background: linear-gradient(135deg, #5795d7, #8c39e5);
            color: rgb(14, 12, 12);
            display: flex;
            flex-direction: column;
            align-items: center;
            justify-content: space-between;
            height: 100vh;
            position: relative;
        }

        /* Faded background image */
        body::before {
            content: "";
            position: absolute;
            top: 0;
            left: 0;
            right: 0;
            bottom: 0;
            background: url('https://presidencyuniversity.in/uploads/home/banner_images/6720b3bbe8
            background-size: cover;
            opacity: 0.3; /* Adjust opacity to control the fade */
            z-index: -1; /* Put the image behind all content */
        }
```

**Fig A4:** Pseudo Code Part – 4

```
 lang="en">
>
meta charset="UTF-8">
meta name="viewport" content="width=device-width, initial-scale=1.0">
title>Presidency University Chatbot</title>
style>
    body {
        font-family: 'Roboto', Arial, sans-serif;
        margin: 0;
        padding: 0;
        background: linear-gradient(135deg, #5795d7, #8c39e5);
        color: rgb(14, 12, 12);
        display: flex;
        flex-direction: column;
        align-items: center;
        justify-content: space-between;
        height: 100vh;
        position: relative;
    }

    /* Faded background image */
    body::before {
        content: "";
        position: absolute;
        top: 0;
        left: 0;
        right: 0;
        bottom: 0;
        background: url('https://presidencyuniversity.in/uploads/home/banner_images/672
        background-size: cover;
        opacity: 0.3; /* Adjust opacity to control the fade */
        z-index: -1; /* Put the image behind all content */
    }

    header {
        width: 100%;
        padding: 20px;
```

**Fig A5:** Pseudo Code Part – 5

# APPENDIX-B

# SCREENSHOTS

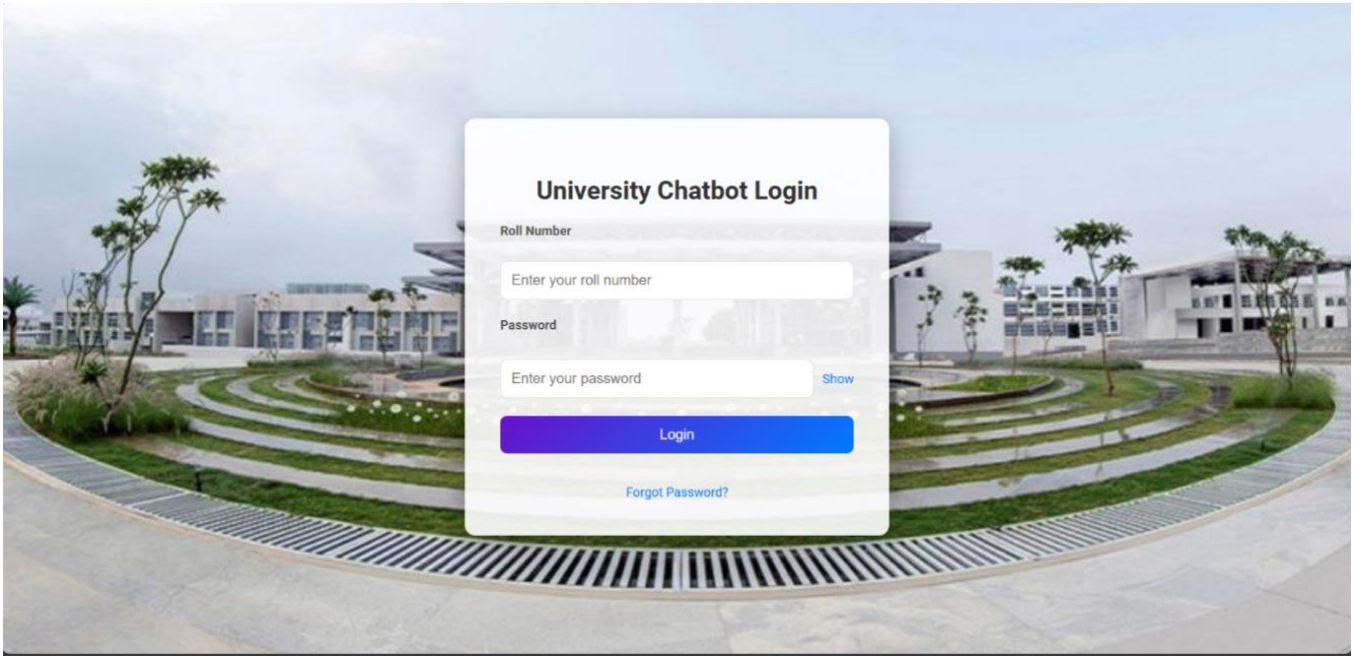



**Fig B1:** Login Page

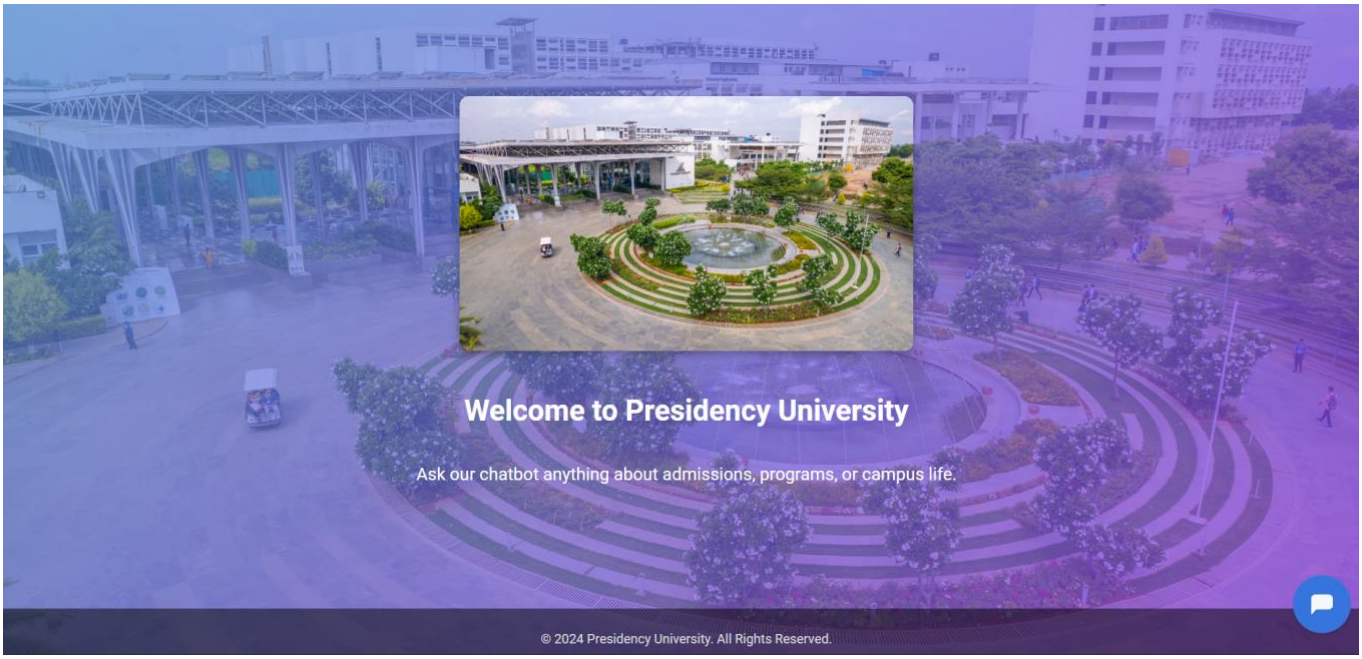



**Fig B2:** Home Page

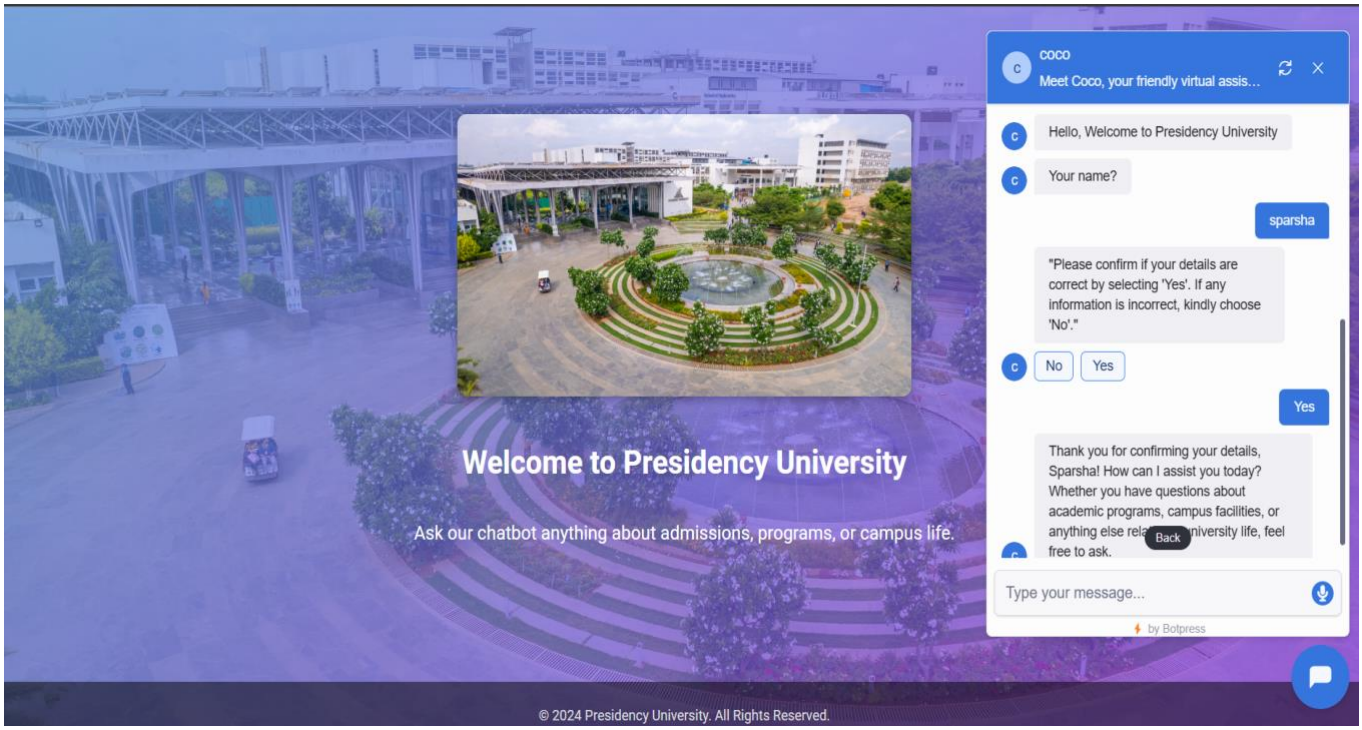
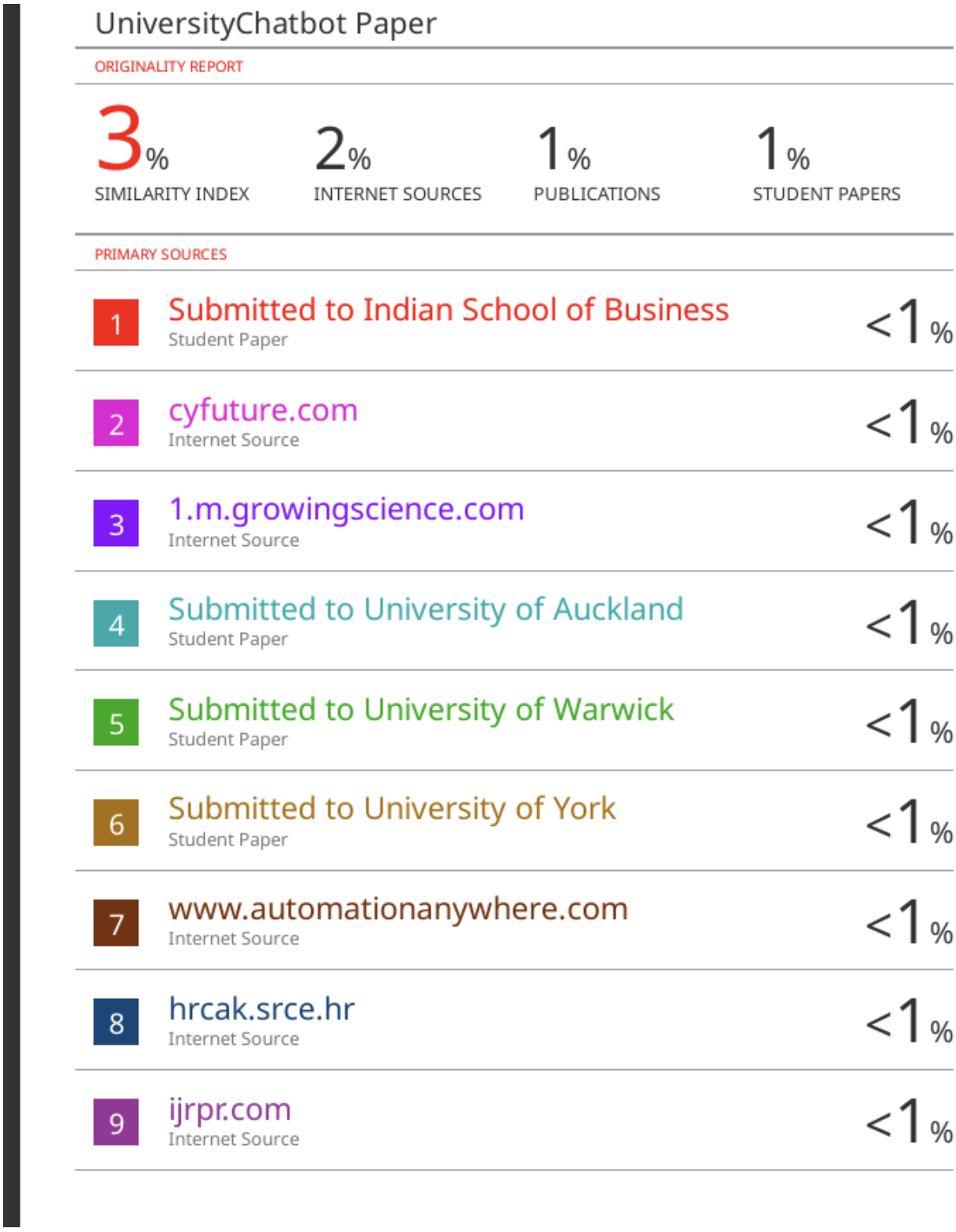



**Fig B3:** Chatbot Working

# APPENDIX-C

# ENCLOSURES



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