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Intelligent Conversational Agents Using RASA Framework: Applications in Education and Mental Health.

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Abstract—The advancement of Artificial Intelligence (AI), Natural Language Processing (NLP), and neural networks has significantly enhanced chatbot applications across various domains, including education, e-commerce, mental health, and customer service. Among various chatbot frameworks, RASA, an open-source conversational AI framework, provides a flexible and customizable solution for developing intelligent chatbots. This study explores the features and implementation of RASA, including its NLU and Core components, which facilitate intent recognition, entity extraction, and interactive learning. The chatbot system is designed to handle user queries, interact with databases and APIs, and personalize responses based on user preferences. Additionally, we examine the integration of RASA with reinforcement learning, database interaction, and Tracker Store modifications to capture user metadata, such as IP and port. A specialized use case in education is also presented, where a chatbot supports rural students by providing course recommendations, quiz tracking, and faculty appointment scheduling. Another application focuses on mental health, offering AI-driven conversational support to individuals facing anxiety and depression. Furthermore,

experimental comparisons between RASA NLU and neural networks in entity classification and intent recognition demonstrate the strengths of RASA in chatbot development. The findings suggest that AI-powered chatbots significantly improve user engagement and efficiency in various sectors, reinforcing the necessity of intelligent conversational agents in modern digital interactions.

Keywords—Chatbots, Artificial Intelligence, Natural Language Processing, RASA, Reinforcement Learning, Neural Networks, Conversational AI, Intent Recognition, Entity Extraction, Educational Chatbots, Mental Health Chatbots.

I. INTRODUCTION

Chatbots have significantly evolved beyond traditional FAQ- based interactions. Unlike earlier systems, modern conversational AI assistants, such as those built using Rasa, engage in natural conversations by considering previous context, determining appropriate actions, and managing unexpected user inputs. These AI-driven assistants not only ensure a smoother conversational flow but also enhance their performance over time, making them far superior to simple FAQ bots. Rasa-powered conversational AI assistants consist of two key components: Rasa NLU and Rasa Core. Rasa NLU functions as the system's "ear," processing user inputs, while Rasa Core acts as the "brain," making decisions based on received information [1]. A chatbot is a software application designed to understand human input and provide relevant responses. These systems leverage Artificial Intelligence (AI) and Natural Language Processing

(NLP) to minimize human effort in repetitive tasks. Chatbots are extensively used in customer service, healthcare, e-commerce, and education. With the rise of chatbot adoption, numerous processes that previously required manual intervention have been automated, improving efficiency. For instance, in the past, handling large volumes of customer inquiries required dedicated personnel, leading to long wait times. AI-powered chatbots now alleviate this issue by instantly responding to frequently asked questions (FAQs), reducing operational costs and improving customer experience [2]. Chatbots can be classified into five levels based on their complexity and Capabalities. At Level 0, simple bots send notifications or messages to a broad audience. Level 1 chatbots respond to predefined FAQs, which are commonly used in customer support services. Level 2 conversational bots, often integrated into e-commerce and social media platforms, provide more interactive experiences. Level 3 chatbots employ personalization techniques by tracking user preferences and past interactions. The most advanced, Level 4 chatbots, leverage AI-driven communication between multiple bots, enabling autonomous learning and decision-making. The integration of AI chatbots in education has gained attention in recent years. Many universities and educational institutions are adopting chatbot technology to streamline administrative processes. Admission-related inquiries often overwhelm college admission departments, causing delays and inefficiencies. To address this issue, AI chatbots can provide instant answers to student queries, reducing the burden on administrative staff and minimizing the need for manual intervention [5].

This research focuses on the development of a chatbot that assists students with admission-related inquiries. The proposed system will be integrated into the college website, allowing students to obtain information related to courses, faculty, fees, academic schedules, and admission processes. The chatbot will provide responses in text, images, and other formats to ensure an interactive user experience.

Rasa, an open-source machine learning framework, has been chosen for chatbot development due to its flexibility and self-hosted capabilities. While major chatbot platforms such as AWS, IBM Watson, and Google Dialog flow offer chatbot development tools, Rasa provides greater adaptability and control over data [7]. Natural Language Processing (NLP) plays a crucial role in chatbot development. NLP enables machines to comprehend human language by analysing text structure, recognizing word relationships, and drawing meaningful conclusions. Early NLP models utilized feed-forward neural networks for language processing. However, recent advancements have led to the adoption of deep learning techniques such as recurrent neural networks (RNNs) and long short-term memory networks (LSTMs), significantly improving chatbot performance [6].

Today, AI-powered virtual assistants, including Siri, Google Assistant, and Alexa, have become an integral part of daily life. Traditional rule-based chatbots are often limited in their ability to handle unpredictable user queries. In contrast, AI-driven chatbots use machine learning to continuously improve their responses, enhancing user engagement and efficiency. With the growing popularity of chatbot platforms like Facebook Messenger, WhatsApp, and Telegram, AI- powered chatbots are expanding beyond customer service to sectors such as healthcare and education [7].

The research aims to develop an AI-powered chatbot that enhances the student admission process by providing instant responses to queries, improving efficiency, and minimizing human workload. Future enhancements will include expanding the chatbot's capabilities with more diverse datasets and refining its ability to handle complex queries.

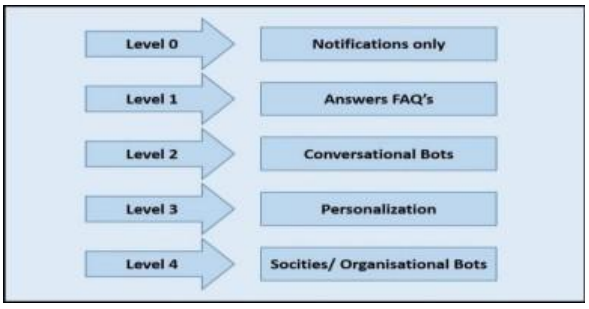

Fig.1 Levels of Chatbot.

II. RELATED WORKS

Chatbots are software applications that simulate human- like conversations, responding to user queries effectively. In recent years, chatbot development has advanced significantly, enabling them to perform complex tasks such as retrieving data from APIs, booking tickets, and handling management- related functions. Traditionally, chatbot development required a team of experts, but open-source frameworks have emerged to save time and resources [1]. Bocklisch et al. introduced Rasa NLU and Rasa Core under an open-source license, aiming to provide a machine-learning-based dialogue system accessible to individuals without extensive technical expertise. Their lightweight package has undergone continuous improvements, benefiting from contributions from 344 developers, 244 releases, and 18,023 commits [2]. Lacerda leveraged the Rasa framework to develop Rasa-ptbr- boilerplate, a software stack designed for non-specialists who view chatbots as black-box systems. His work aimed to simplify chatbot development for users with limited technical knowledge [3]. With advancements in artificial intelligence, chatbots have evolved into intelligent systems widely used in customer service, robotics, and natural language processing applications. Jiao proposed a functional framework integrating Rasa NLU with neural networks, enhancing entity extraction and intent recognition. His study demonstrated that combining neural networks with Rasa NLU improves chatbot accuracy [4].

A comparative study evaluated Rasa, Microsoft Bot Framework, and Google Dialog flow based on various performance metrics. The findings highlighted Rasa's extensibility and open-source nature as key advantages over proprietary chatbot platforms [5]. The study also explored chatbot implementation in social networks, showing how chatbots can be integrated into platforms like Slack. One example discussed was a football-related chatbot that answered queries about the Spanish football league, providing information on players, teams, and coaches [6].

Conversational assistants have become integral to daily life. Rasa Core and Rasa NLU offer powerful tools for building AI chatbots, enabling complex functionalities such as API integration, database management, and supervised interactive learning. Gan grade et al. demonstrated that Rasa's core features, including slots, forms, and supervised learning, make it a comprehensive framework for handling advanced tasks beyond what other open-source alternatives offer [7].

A study on chatbot development for Vietnamese and Japanese languages introduced custom tokenizers and sentiment analysers to improve performance. The research found that these enhancements made Rasa's NLU model more suitable for these languages. However, it noted a lack of

studies on integrating modern pre-trained models such as Fast Text, MITIE, and BERT into custom Rasa NLU pipelines [7].

Study Focus	***Key Findings***	***Technology used***
Evolution of chatbots	Chatbots can now perform complex tasks like API fetching, ticket booking, and management tasks	AI, NLP
Development of Rasa NLU & Core	Introduced Rasa NLU and Core as an open-source framework for ML-based chatbot development	Rasa, Machine Learning
Rasa-ptbr-boilerplate	Simplified chatbot development for non-technical users using Rasa as a black box	Rasa Core
Rasa NLU with Neural Networks	Integrated Rasa NLU with neural networks for better intent recognition and entity extraction	Rasa, Neural Networks
Comparison of Rasa, Microsoft Bot Framework, and Dialogflow	Rasa's open-source flexibility makes it superior to enterprise chatbots	Rasa, Microsoft Bot, Dialog flow
Advanced Rasa chatbot	Showcased Rasa's advanced capabilities such as API integration, supervised learning, and database interaction	Rasa Core, API, ML

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Table no. 1 - Chatbot Development and Research Summary

III. INTRODUCTION OF RASA

Rasa is an advanced open-source framework designed for building AI-powered chatbots and virtual assistants. Unlike traditional chatbot platforms that operate on rule-based interactions and pre-defined scripts, Rasa leverages machine learning techniques to enhance natural language understanding (NLU) and contextual dialogue

management. By processing user inputs dynamically, it allows chatbots to provide more personalized and interactive conversations.

The demand for intelligent conversational agents has surged across industries such as e-commerce, healthcare, and customer service. Businesses are increasingly integrating AI chatbots to enhance user engagement, automate responses, and optimize workflows. Rasa's open-source nature, supported by an active developer community, provides flexibility and customizability, making it a preferred choice for enterprises that require tailored chatbot solutions without the constraints of proprietary software.

Unlike many commercial chatbot frameworks, Rasa gives developers full control over data, security, and customization. Its modular architecture enables the creation of highly adaptable conversational AI systems, ensuring chatbots can improve over time through continuous learning. This paper explores the core features, training methodologies, comparisons with alternative tools, real-world applications, challenges, and the future of Rasa in the evolving landscape of conversational AI.

Key Features of Rasa:

Rasa is an advanced open-source framework for building AI- powered chatbots and virtual assistants. Unlike traditional rule-based chatbots, Rasa leverages machine learning to enable dynamic, context-aware conversations. The following are the key features of Rasa that make it a preferred choice for chatbot development:

1. Natural Language Understanding (NLU)

Rasa's NLU component processes user inputs and extracts relevant information such as:

- **Intent Recognition:** Identifies the purpose of the user's query.
- **Entity Extraction:** Detects specific data points like names, dates, or locations.
- **Synonym Mapping:** Maps different words with similar meanings to improve response accuracy.

2. Dialogue Management

Rasa Core manages conversations by predicting the next best action based on past interactions. It supports:

- **Stories:** Predefined conversation flows for structured interactions.
- **Policies:** Rules and machine learning models that guide responses.
- **Slot Filling:** Retaining user-provided information to personalize responses.

3. Customization & Extensibility

Rasa offers full flexibility for developers to customize the chatbot behaviour by:

- Writing custom Python-based actions.
- Integrating with external APIs, databases, and third- party services.
- Using custom NLP components for enhanced language processing.

4. Machine Learning-Based Approach

Rasa utilizes deep learning models to:

- Enhance intent classification and response generation.
- Adapt dynamically to user conversations over time.
- Leverage reinforcement learning to improve chatbot accuracy.

5. On-Premises Deployment & Data Privacy

Unlike cloud-based chatbot frameworks, Rasa allows self- hosted deployment, ensuring:

- Full control over user data and compliance with security standards.
- No reliance on third-party cloud services, reducing privacy concerns.

IV. LITERATURE REVIEW

This section explores various research studies focused on chatbot development across different domains. One study highlights the benefits of chatbots in education, emphasizing how they assist both students and teachers. In this approach, teachers pre-feed a chatbot with a predefined set of questions and answers. As students interact with the chatbot, it provides relevant responses, thereby saving time. The model utilizes Natural Language Understanding (NLU) and Deep Learning (DL); however, its limitation lies in its inability to go beyond the pre-fed responses, making it less interactive [2].

Another study examines the development of chatbots integrated into messaging applications like Facebook Messenger. The study found that approximately 47 chatbots exhibited good quality in terms of information retrieval, user interaction, and personalization. Despite these advantages, one of the major challenges faced is the discoverability of chatbots within social media platforms. Effective text processing and extensive training are required to achieve accurate responses [2].

Research on chatbot implementation in e-commerce reveals that these AI-driven assistants suggest products based on users' social media activities and preferences. While chatbots provide personalized recommendations, there is a challenge in ensuring user satisfaction, as the recommendations may not always align with user preferences [2].

A study focused on English language learning chatbots discusses a model that aids users in pronunciation, meaning, and the contextual usage of words. The chatbot operates through four stages: Automatic Speech Recognition (ASR), Dialog Management (DM), Natural Language Generation (NLG), and Speech Synthesis (SS). ASR captures user input, DM processes the input, NLG generates a text or voice-based response, and SS converts the text output into speech. However, accurately understanding user input remains a significant challenge, requiring enhanced text processing and training for better accuracy [2].

Another chatbot model designed for answering frequently asked questions (FAQs) incorporates a neural network-based Sequence-to-Sequence (Seq2Seq) model with an attention mechanism. This framework provides insights into question-answering systems, particularly in educational chatbots. Despite its usefulness, the model's accuracy remains an area for improvement [2].

In an effort to engage elderly individuals, a study introduces a chatbot that delivers news through text and voice, functioning as an intelligent radio system. Machine learning models help in selecting suitable news or radio content for users. While the system aims to reduce loneliness among elderly individuals, only 80% of users reported satisfaction with its performance [2].

A chatbot-driven Android application has been developed to assist visually impaired individuals by providing educational support through voice-based interactions. However, widespread adoption is hindered by the need for proper training and user familiarity. The study also highlights key challenges such as understanding user input, sentiment analysis, and generating appropriate responses [2].

E-learning chatbots have also been explored, showcasing their ability to facilitate personalized learning experiences with immediate responses. However, these chatbots still lack the capability to fully replace human educators due to the limitations of their knowledge bases, which are still in early development stages [2].

A study on unified learning platforms suggests that chatbots can help students grasp concepts more efficiently by offering access to video and article-based knowledge repositories. Despite these advantages, the model suffers from insufficient training, leading to suboptimal accuracy [2].

Comparing AI and non-AI chatbots, research findings indicate that non-AI chatbots rely on keyword-based responses, where subsequent questions are determined by predefined answers. In contrast, AI-driven chatbots utilize context-

driven approaches, comprehending user queries before providing appropriate responses. While non-AI chatbots require less training time, AI chatbots demand extensive training to achieve effective interactions [2].

The field of conversational AI has seen rapid advancements in recent years. One of the earliest natural language processing (NLP) chatbots, Eliza, was developed in 1964 by Joseph Weizenbaum at MIT's Artificial Intelligence Laboratory. Though rudimentary, Eliza set the foundation for modern chatbot development. Over the years, conversational AI has progressed significantly, leading to the emergence of mental health chatbots such as Woe Bot, Wysa, and Joy able. Woe Bot is a chatbot designed to monitor users' moods and assist in improving mental well-being. It incorporates humour, puns, GIFs, and jokes to make interactions more engaging. The chatbot employs Cognitive Behavioural Therapy (CBT) techniques to help users cope with anxiety and depression. Similarly, Wysa uses humor and CBT-based interactions but sometimes generates repetitive conversations. A key feature of Wysa is the diary of positive thoughts, which aims to uplift users during stressful periods. Unlike Woebot, Wysa also provides an option for booking therapy sessions with human professionals. Although these chatbots cannot replace professional therapists, they serve as an accessible resource for individuals reluctant to seek traditional therapy. They play a crucial role in offering support to users who may not have alternative options for discussing mental health concerns [3].

In summary, chatbots have demonstrated significant potential across various domains, from education and e-commerce to mental health and social engagement. However, key challenges such as accuracy, training requirements, and user satisfaction remain areas for further development.

V. PROPOSED SYSTEM

The proposed chatbot system is designed to assist students, faculty, and parents by providing essential college-related information in an interactive and efficient manner. It ensures that new users can ask only ten questions, while registered users have unlimited access to queries. This restriction is implemented to minimize irrelevant or non-academic inquiries, assuming that signed-up users are more serious about their academic needs. To make interactions seamless, the chatbot is directly integrated with WhatsApp, allowing users to access its features without navigating through additional platforms. One of its notable features is the ability to provide a virtual campus tour, where students can request videos of various departments, laboratories, and nearby locations to familiarize themselves with the college environment.

To enhance accessibility, the chatbot incorporates speech recognition and text-to-speech functionality, making it more interactive and user-friendly. Users can input queries via voice commands, and the chatbot responds both in text and voice formats. This feature is particularly beneficial for visually impaired users and those who prefer verbal communication. The system also includes a robust admin panel that facilitates efficient management of student data, courses, schedules, and academic materials. Admins can register students, assign login credentials, and upload timetables, schedules, booklets, and test solutions in formats such as .jpg and PDF. Additionally, the chatbot enables the sharing of video links and keeps track of academic performance by updating weekly marks, periodic test scores (PT1/PT2), and other assessment-related data. College- related announcements, including workshops and events, can also be shared through the chatbot to ensure that students and parents remain well-informed.

For students, the chatbot provides a platform where they can easily access course-specific timetables, schedules, booklets, test solutions, and educational video links. Their academic progress is displayed through graphical reports,

such as bar charts for weekly marks and line and pie charts for PT1 and PT2 scores, allowing them to assess their performance more effectively. The chatbot also includes a text-to-speech feature, where responses are provided in both text and voice formats, making it more interactive. Furthermore, it offers university-related information through web redirections and delivers real-time updates on college events and workshops. Parents also benefit from the chatbot system, as they can log in to monitor their child's academic progress, access marks, and stay updated with college-related notifications and announcements.

This chatbot system is beneficial as it reduces the workload on faculty and administrative staff by providing instant responses to student queries and ensuring a streamlined communication process. It fosters personalized learning by incorporating voice-based interactions and offering well- structured educational resources. Additionally, it ensures secure and organized data management for student performance tracking, while keeping parents engaged in their child's academic journey. By integrating artificial intelligence, voice recognition, and multi-platform accessibility, the proposed chatbot system enhances the learning experience and makes academic interactions more efficient. Its seamless integration with WhatsApp makes it a highly accessible and convenient tool for students, parents, and faculty members. Thus, this chatbot system serves as an intelligent, interactive, and automated solution for academic support and institutional communication [4][5].

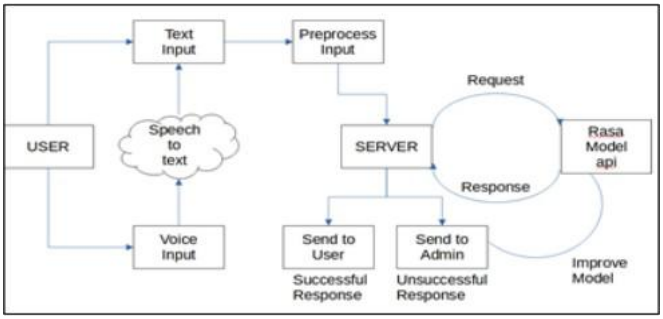

Fig.2: A working model of the chatbot system

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CONCLUSION

The rapid advancement of Artificial Intelligence and Natural Language Processing has significantly transformed chatbot development, enabling intelligent conversational agents to provide efficient and context-aware responses. This study explored the implementation of RASA, an open-source chatbot framework, emphasizing its core

components—Rasa NLU and Rasa Core. These components empower chatbots with intent recognition, entity extraction, and dialogue management, making them suitable for diverse applications across education, healthcare, and customer service. The research highlights the advantages of using RASA over proprietary chatbot platforms, particularly in terms of flexibility, data privacy, and customization. The integration of reinforcement learning further enhances the chatbot's capability to improve over time, adapting to user preferences and real-world interactions. Additionally, experimental comparisons indicate that RASA's machine learning-based approach to intent classification and entity recognition performs effectively in real-world scenarios.

A specialized use case was presented in the education sector, where a chatbot assists students with admission-related queries, course recommendations, and faculty appointment scheduling. Another application in mental health demonstrated how AI-driven chatbots can provide emotional support, contributing to the well-being of users. These case

studies reinforce the growing significance of AI-powered chatbots in modern digital interactions, proving their efficiency in automating processes and enhancing user engagement. Despite the promising outcomes, challenges such as improving chatbot accuracy, handling ambiguous queries, and ensuring seamless human-bot interactions remain areas for future research. The integration of advanced NLP techniques, such as transformer-based models (BERT, GPT), could further enhance chatbot performance. Future work will focus on optimizing chatbot responses using deep learning methodologies and expanding its functionality to cater to a wider audience.

In conclusion, AI-powered chatbots built using RASA exhibit significant potential in automating user interactions, streamlining business operations, and providing personalized assistance across various domains. As technology continues to evolve, intelligent conversational agents will play an increasingly vital role in improving user experiences, making AI-driven chatbots an essential component of the digital landscape.

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