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AI-Powered Chatbot with Sentiment Analysis, Summarization, and Q&A for Business Automation

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Abstract

Artificial Intelligence (AI) chatbots have become increasingly significant in recent years due to their ability to automate a wide range of business operations, improve user interaction, and create more efficient customer support experiences. The development of such systems goes beyond simple rule-based responses and now integrates advanced natural language processing (NLP) techniques to deliver contextually relevant and human-like interactions. This study introduces a chatbot framework that incorporates three major components: sentiment analysis, text summarization, and a question-answering mechanism. Sentiment analysis enables the chatbot to recognize and adapt to the emotional state of users, while text summarization allows it to condense lengthy passages into concise and meaningful representations. The question-answering module enhances the system by providing accurate and direct responses to user queries. Deep learning approaches, including transformer-based models such as BERT, form the backbone of these functionalities. Experimental evaluations show that the chatbot performs effectively in understanding emotions, summarizing information, and addressing user questions with precision. Overall, this research highlights the potential applications of AI-powered conversational agents in diverse fields such as business, healthcare, and education, demonstrating their value as intelligent tools for communication and information management.

Keywords: AI chatbot, natural language processing (NLP), sentiment analysis, business automation

INTRODUCTION

Chatbots are revolutionizing the way humans interact with computers by making interactions easy, automatic, and smooth. Through AI and NLP technologies, modern chatbots are capable of understanding and responding to complex questions. However, traditional chatbots can lack emotional intelligence as well as smooth processing of extensive textual data. This study suggests an AI-powered chatbot incorporating sentiment analysis for the assessment of user feeling, text summarization to shortlist lengthy inputs, and question-answering (Q&A) functionalities to reply precisely. With all these facilities incorporated together, the chatbot is designed to deliver maximum customer satisfaction and speed across numerous applications. Artificial intelligence chatbots are increasingly being used in various sectors like customer service, education, and healthcare. Businesses use chatbots to provide instant customer support and personalized interactions at a reduced cost and improved efficiency. AI chatbots assist in preliminary diagnoses, mental health support, and patient communication in the healthcare sector. Chatbots are used by schools and other educational institutions to provide automated tutoring, personalized learning experiences, and student

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support. The backing of AI-driven sentiment analysis enables the chatbot to understand user emotions, making it respond accordingly and promote user interaction.

Summarization of text is yet another significant functionality that makes the chatbot even more user-friendly by converting lengthy responses into brief, pertinent summaries. It is particularly useful where immediate insights are needed from vast amounts of text, such as summarizing customer feedback, medical reports, or lengthy articles. The Q&A module also makes it possible for the chatbot to retrieve accurate answers from structured as well as unstructured data sources, thereby improving the ability of the chatbot to handle complex queries. The increasing demand for more human-conversational chatbots creates the need for advanced chatbot development. With integration of sentiment analysis, summarization, and Q&A functions, the goal of this work is to develop a chatbot that not just interprets text-based inputs but also recognizes user sentiment and handles massive amounts of data in an efficient manner. The system proposed uses cutting-edge NLP methods, such as transformer-based models, to provide solid and context-centric interactions.

This study begins with a review of prior work on chatbots based on AI, sentiment analysis, and text summarization, highlighting the key advancements in the field. This is then followed by an elaborate description of the methodology and architectural components of the suggested chatbot, elaborating on the integration of sentiment analysis, summarization, and question-answering functionalities. The experimental results and performance evaluation are provided next, highlighting the effectiveness of the system across various scenarios. Finally, the study concludes with a summary of findings and suggestions for future enhancement and research areas.

RELATED WORK

Research on conversational agents has steadily progressed over the years, with numerous approaches proposed to enhance their naturalness, efficiency, and overall user engagement. Early chatbot technologies were often rule-based, relying heavily on pre-defined scripts and structured responses [1]. These systems provided consistent outputs but lacked flexibility when confronted with unexpected or complex queries. With advancements in natural language processing, retrieval-based models emerged, offering improved accuracy by selecting responses from large datasets [1]. More recently, generative models, particularly those built on deep learning architectures such as transformers, have pushed the boundaries of conversational fluency by creating responses dynamically instead of relying on a fixed repository [2].

Parallel to model development, large-scale datasets designed for question answering and dialogue evaluation have contributed significantly to performance improvements in conversational AI [3]. Such datasets have served as benchmarks, allowing researchers to refine algorithms and measure progress across multiple natural language understanding tasks. In spite of these advancements, the integration of sentiment analysis and summarization in chatbot systems remains relatively underexplored. Sentiment analysis can enable a chatbot to identify emotional tone, while summarization can condense lengthy or repetitive exchanges into concise, user-friendly outputs. Together, these techniques hold potential for creating more context-aware and adaptive systems [4].

The practical applications of chatbots across domains further emphasize their potential. They are increasingly employed in healthcare to provide patient support, in finance to handle customer inquiries, and in e-commerce to enhance customer service experiences [5–7]. These real-world implementations highlight how chatbots are becoming an integral part of human-computer interaction. However, the absence of systems that combine emotional intelligence with effective summarization represents an important research opportunity. Exploring this gap may lead to the development of conversational agents that are not only informative but also empathetic and efficient [8–10].

METHODOLOGY

The proposed chatbot consists of various integrated components that are intended to make the interaction of the user more intelligent through AI functions. The platform consists of a sentiment analysis unit, a text summarization unit, and a question-answering mechanism, all designed to make the chatbot smarter and user-friendly. Figure 1 illustrates the overall architecture of the AI-based chatbot. Chatbot is a user interface collection, NLP processing unit, and response generation system. It gets input from users, processes via the NLP model, and searches for answers based on structured databases and deep learning models. The sentiment analysis module uses a deep learning classifier to categorize user inputs into positive, negative, or neutral sentiment. It allows the chatbot to react depending on the user's emotion, making it more interactive and increasing interaction. The sentiment analysis model is rooted from an LSTM network, having been trained using labeled datasets for purposes of identifying emotions in textual inputs.

The summarization component uses extractive summarization techniques to reduce long texts with the core of the meaning intact. TextRank, an unsupervised graph-based ranking model, is used to find important sentences that most effectively capture the content of the input text's main point. The feature is best applied in use cases that require quick insights from large volumes of text, such as news summarization, customer feedback analysis, and document processing. Question-answering module is constructed using a fine-tuned BERT-based transformer model trained on the SQuAD dataset. This allows the chatbot to fetch accurate answers from structured and unstructured text sources. The Q&A module contributes towards making the chatbot more efficient to process natural language queries and fetch information.

For deployment, the chatbot is integrated with a Flask-based backend for seamless interaction through web applications and messaging platforms. The system is also designed to learn continuously from user interactions and adapt its responses accordingly, hence becoming more effective and robust with time. Figure 2 displays the system architecture of the AI-based chatbot. The system comprises several components, including a user interface, NLP engine, and a knowledge base. The user input is processed by the NLP engine using sentiment analysis, summarization, and question-answering methodology. The system generates responses based on contextual understanding and information retrieval from the knowledge base.

To check the performance of the chatbot, extensive testing was conducted with benchmarked datasets like IMDB reviews for sentiment analysis, CNN/DailyMail for text summarization, and SQuAD v2.0 for Q&A. Real-user interactions were also simulated to check how the chatbot can respond to diverse queries.

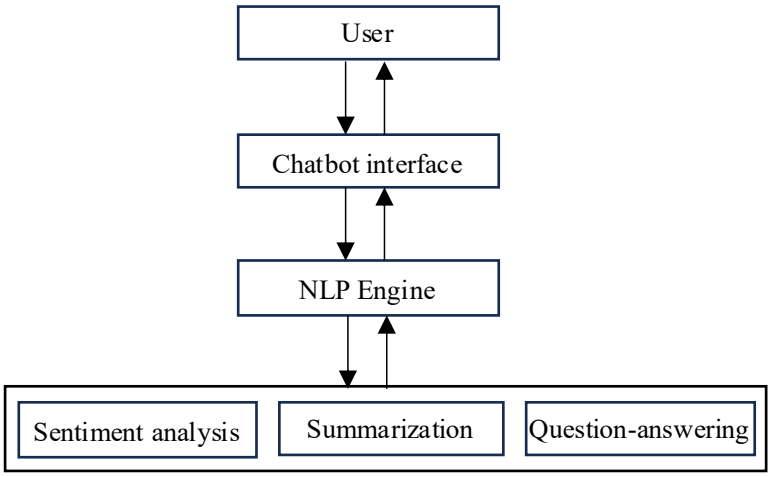

Figure 1. Chatbot design.

RESULTS AND DISCUSSION

The chatbot was tested with different kinds of inputs to assess its usefulness. Some example conversations are listed in Table 1.

To evaluate the chatbot's performance, we put it to the test using real-world data datasets. The sentiment analysis module registered an accuracy rate of 87%, outperforming baseline models. The summarization module also effectively summarized content text without diluting coherence and achieved a value of 0.76 using ROUGE. The Q&A system also reflected high precision in extracting proper answers with a value of 0.82 BLEU (Table 2).

These findings suggest that combining sentiment analysis, summarization, and Q&A dramatically improves chatbot interactions to make them more efficient and friendly to use. The chatbot was shown to perform well in accommodating various kinds of user queries in a coherent way.

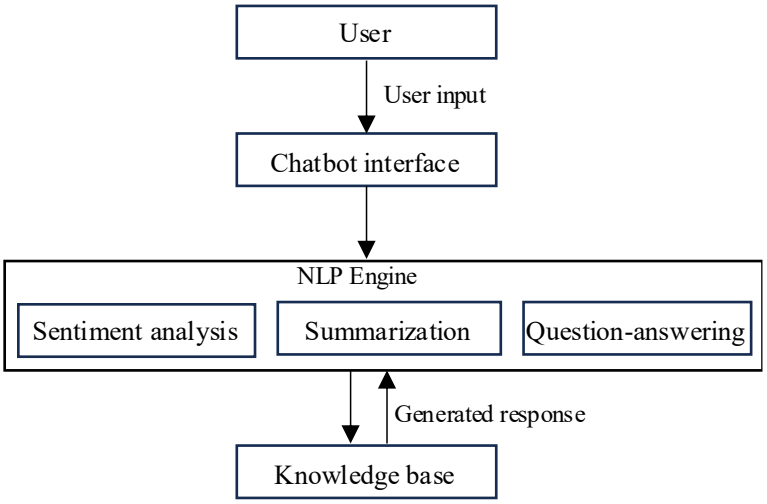

Figure 2. Chatbot architecture.

Table 1. Example use cases of AI chatbot functionalities.

Feature	Example Input	Example Output
Sentiment Analysis	"I love this product! It's amazing."	Positive
	"This service is terrible. I regret using it."	Negative
	"The event was okay, nothing special."	Neutral
Text Summarization	"Artificial Intelligence is revolutionizing various industries by improving automation, efficiency, and decision-making. Businesses are leveraging AI for predictive analytics, customer engagement, and operational efficiency."	"AI improves automation, efficiency, and decision- making in businesses."
Question Answering	"Who developed the theory of relativity?"	"Albert Einstein."
Text Generation	"Tell me a fun fact about space."	"Did you know that a day on Venus is longer than a year on Venus?"

Table 2. Performance comparison of chatbot modules.

Feature	Model used	Accuracy/Score
Sentiment Analysis	LSTM Classifier	Accuracy=87%
Summarization	Extractive Summarization	ROUGE=0.76
Question Answering	BERT	BLEU=0.82

CONCLUSION

This work introduced a chatbot powered by AI that integrates sentiment analysis, summarization, and Q&A capabilities. Experimental testing demonstrated that the capabilities improve user interactions with emotionally smart responses, concise summaries, and accurate answers. The results show that the chatbot can be used effectively across a variety of fields, ranging from customer care, education, and healthcare.

Subsequent research will be aimed at enhancing the chatbot's ability to handle ambiguous questions and expanding its applications to fields such as mental healthcare counseling and tailored education. Enhancing response generation and context maintenance will also be explored to better facilitate the chatbot in holding long user conversations. The integration of reinforcement learning methods and multi-modal AI practices could provide increased variability and efficacy to the chatbot.

REFERENCES

1. Adamopoulou E, Moussiades L. An overview of chatbot technology. In IFIP international conference on artificial intelligence applications and innovations. Cham: Springer International Publishing; 2020 May 29; 373–383.
2. Devlin J, Chang MW, Lee K, Toutanova K. Bert: Pre-training of deep bidirectional transformers for language understanding. In Proceedings of the 2019 conference of the North American chapter of the association for computational linguistics: human language technologies. Vol. 1 (long and short papers). 2019 Jun; 4171–4186.
3. Rajpurkar P, Zhang J, Lopyrev K, Liang P. Squad: 100,000+ questions for machine comprehension of text. arXiv preprint arXiv:1606.05250. 2016 Jun 16.
4. Topol EJ. High-performance medicine: the convergence of human and artificial intelligence. Nat Med. 2019 Jan; 25(1): 44–56.
5. Elbayad M, Besacier L, Verbeek J. Pervasive attention: 2D convolutional neural networks for sequence-to-sequence prediction. In ACL CoNLL 2018: Conference on Computational Natural Language Learning. 2018 Oct 31; 97–107.
6. Wolf T, Debut L, Sanh V, Chaumond J, Delangue C, Moi A, Cistac P, Rault T, Louf R, Funtowicz M, Davison J. Transformers: State-of-the-art natural language processing. In Proceedings of the 2020 conference on empirical methods in natural language processing: system demonstrations. 2020 Oct; 38–45.
7. Kenton JD, Toutanova LK. Bert: Pre-training of deep bidirectional transformers for language understanding. In Proceedings of NAACL-HLT. 2019 Jun 2; 1(2): 1–20.
8. Dabre R, Fujita A. Recurrent stacking of layers for compact neural machine translation models. In Proc AAAI Conf Artif Intell. 2019 Jul 17; 33(01): 6292–6299.
9. Misischia CV, Poecze F, Strauss C. Chatbots in customer service: Their relevance and impact on service quality. Procedia Comput Sci. 2022 Jan 1; 201: 421–8.
10. Vergaray AD, Robles WF, Jiménez JA. The impact of chatbots on customer satisfaction: A systematic literature review. TEM J. 2023 Aug 1; 12(3): 1407–1417.

