IRJSE International Research Journal of Science & Engineering
Int. Res. J. of Science & Engineering, Special Issue A14, June, 2024
ISSN: 2322-0015
SJIF Impact Factor 6.70
https://doi.org/10.5281/zenodo.12699233
RESEARCH ARTICLE OPEN ACCESS

Research on challenges in ChatBot development

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Manuscript Details

Available online on https://www.irjse.in
ISSN: 2322-0015

Editor: Dr. Arvind Chavhan

Cite this article as:
Bhalchandra PU, Khamitkar SD, Lokhande SN, Mekewad SR, and Kurundkar GD. Research on challenges in ChatBot development, *Int. Res. Journal of Science & Engineering*, 2024, Special Issue A14: 23-28.
https://doi.org/10.5281/zenodo.12699233

Article published in Special issue of National Conference on Machine Learning and Data Science (NCMLDS-2024)" organized by College of Computer Science and Information Technology (COCSIT) Ambajogai Road, Latur, Maharashtra, India on date April 16th to 17th 2024

Abstract

Chatbots are becoming increasingly valuable tools in various domains, ranging from customer service to virtual assistants. As more companies integrate chatbots into their operations. This study explores challenges in developing chatbots using artificial intelligence (AI). It outlines the development of chatbots, from early virtual assistants to their widespread usage across several sectors today. Highlighting the integral role of natural language processing (NLP) in enabling chatbot technologies, the study examines key programming challenges: leveraging NLP machine learning and integrating speech recognition and sentiment analysis into chatbots. Furthermore, potential solutions and strategies for advancing chatbot technologies are explored, thereby enhancing the understanding of the barriers to chatbot development and offering valuable perspectives to drive future progress in this rapidly evolving field.

Keywords: Chatbot, Artificial Intelligence, Machine Learning, Natural Language Processing.

1. Introduction

Artificial Intelligence (AI) is more common in daily life due to the development and analysis of intelligent software and hardware called intelligent agents. Intelligent agents can carry out a diverse array of tasks, ranging from physical work to intricate operations [1]. A chatbot is a prevalent AI system and a fundamental example of intelligent Human-Computer Interaction (HCI). A chatbot, also known as a conversational agent, is a software application capable of analyzing natural language input and producing immediate conversational replies [2]. The interaction between humans and chatbots usually occurs through a graphical user interface that follows principles of human-computer interaction [3] [4]. In 1950, Alan Turing initially suggested the idea of a smart computer engaging in human relationships.

virtual assistants known as "bots" were developed to mimic human conversation [5] [6]. Now chatbots can communicate via voice. Figure 1 displays several types of chatbots utilized across many areas. The virtual assistant can respond to many customer inquiries with accurate answers. Recently, there has been a rapid increase in the utilization of chatbots across several sectors like health care, marketing, education, support systems, cultural heritage, entertainment, and customer service applications such as Skype, Facebook Messenger, and Kik, etc.

Leading organizations have created several Chatbots for both industrial applications and research, including well-known ones like Apple Siri, Microsoft Cortana, Facebook M, and IBM Watson. These are a few of the most often used systems. Developing successful Chatbots to emulate human discussions is a tough research challenge that incorporates issues within the discipline of Natural Language Processing (NLP). NLP algorithms and approaches enable understanding of the user's written content and requests [8] [9].

1.1 Design and Development

Developing a chatbot requires the use of many strategies. Designers can choose suitable algorithms, platforms, and tools for creating a chatbot by studying it's features and category. Simultaneously, it helps end-users in understanding what they may expect [10].

Designing a chatbot requires precise knowledge representation, a technique for generating replies, and a collection of predetermined neutral responses for cases when user input is not comprehended. The initial phase in constructing a system involves partitioning it into distinct sections based on a standard, facilitating the adoption of a modular development approaches[11]. Figure 2 presents a general chatbot architecture.

Figure 1: Chatbot in Different Domains [7]

The chatbot process begins with a user's request, which is analyzed by the Language Understanding Component to ascertain intent and relevant information. The chatbot then decides on the proper action, either directly performing it, waiting for further information, or asking for clarification. Action execution requires getting data from a knowledge base or other sources. The answer Generation Component provides a human-like answer depending on the purpose and context, leveraging rule-based, retrieval-based, or generative models. The Dialogue Management Component preserves discussion context, managing missing information and follow-up queries. Various development alternatives exist, including programming languages and Natural Language Understanding (NLU) cloud platforms each with specific characteristics [13]

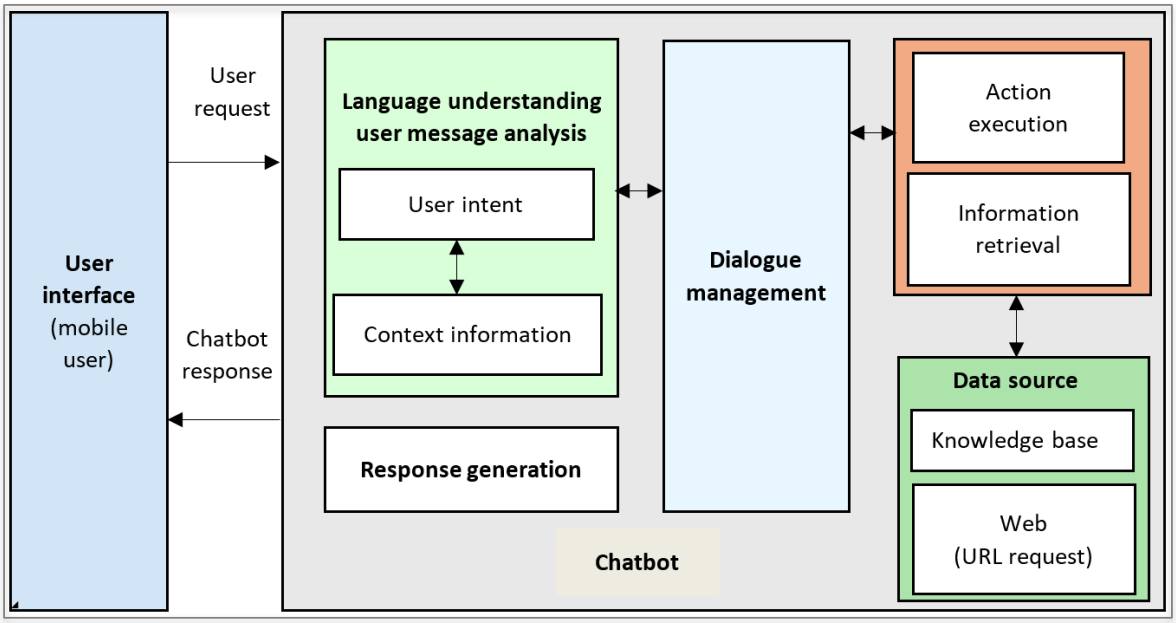

Figure 2: General chatbot architecture [12].

1.2 Key Programming Challenges in Chatbot Development

There are a lot of challenges which are associated with chatbots. Some of them are as follows.

NLP Algorithms Used in Chatbot Technology:

NLP algorithms are essential in chatbot technology, especially in healthcare. Through NLP, chatbots can comprehend and analyze user inquiries, offering suitable replies and assistance. One of the first stages in NLP processing is NLU, which interprets the semantic meaning of user input and identifies morphemes [7] [14]. For chat interfaces, NLU is at the initial processing level due to the absence of audio-to-text conversion. The chatbot utilizes NLU to identify items and associate them with certain intentions, employing technologies such as Dialog flow. NLP algorithms allow the chatbot to imitate human behavior, resulting in a user-friendly chat system that offers basic healthcare education, symptoms, healthcare tips, preventative measures, home remedies, guidance, and food suggestions depending on location.

ML Models for Chatbot Training and Response Generation:

Chatbot training and answer creation are increasingly focusing on the utilization of machine learning models and algorithms. One strategy is integrating artificial intelligence (AI) technology to improve interaction and consumer contentment with chatbot services. Researchers are working on creating a model that connects engagement-facilitating technology, such as chatbot services, with customer satisfaction by including theories like the elaboration likelihood model (ELM) and technological satisfaction [15]. This integration enables a more comprehensive comprehension of the influence of AI-powered chatbots on user experience and behavior.

Integration with Other Technologies to Enhance Chatbot Capabilities:

Integrating technologies like speech recognition and sentiment analysis may significantly improve the functionalities of chatbots. These technologies are essential for enhancing user pleasure and increasing overall chatbot usage. Users may now improve their experience with chatbots by eliminating the need for manual typing and instead interacting with the system using voice commands made possible by speech recognition technology. Sentiment analysis allows chatbots to evaluate and comprehend users' emotions and feelings, leading to more tailored and compassio-nate answers. Implementing this functionality may greatly enhance customer happiness and interaction with the chatbot [16].

2. Current Research on chatbot

Current research on chatbot development focuses on understanding and addressing programming challenges. This examination highlights the significance of resolving issues in natural language processing, machine learning, and integrating technologies like speech recognition.

Chow et al. [17] focused on educational requirements in radiotherapy by creating a chatbot using AI. The chatbot is designed with a layered structure and dialogue tree, using elements such as NLP. It is adaptable and may be used on platforms like IBM Watson Assistant and integrated into websites or social media. The result revealed that the chatbot, using a question-and-answer method, provides human-like conversation, efficiently addressing user inquiries and offering information about radiation.

Assayed et al., [18] used a neural network model and natural language processing (NLP) to create a low-cost chatbot designed for students in high school. The dataset of 968 question-and-tag pairs was compiled from several scholarly sources, focusing on a pivotal point in students' lives when they are making decisions about their future careers. The model's output is a sigmoid function, and it was built with an embedding layer and a Long short-term memory (LSTM) layer. Findings from this study demonstrated that the chatbot is useful for kids at a pivotal point in their high school careers.

Giordano et al. [19] proposed a Natural Language Processing (NLP) system utilizing transformer language models to find technical issues, solutions, and benefits from patents. Researchers utilized a training dataset consisting of 480,000 patent phrases from parts that had been manually labelled by inventors or attorneys. The model achieved an F1 score of 90%.

Pandey et al. [20] presented "Ted," an artificial intelligence web chatbot that uses deep learning and natural language processing to assist people with mental health questions. The user's message undergoes lemmatization and pre-processing before to being fed into the deep-learning model. The author used an AI Network using Softmax to classify the queries. The chatbot enables users to engage by accepting natural language input and providing corresponding responses. The suggested chatbot has an accuracy rate of 98.13% in delivering the correct response.

Khan et al.,[21] developed an AI and NLP-powered chatbot model to provide advice to consumers in the Islamic banking and financial sector. The result indicated that it enables Islamic finance and banking consumers to engage in real-time interactions and receive Islamic financial guidance tailored to their specific financial requirements based on Sharia rules.

Mittal et al. [22] introduced a chatbot framework utilizing web technologies and incorporating machine learning techniques, specifically gradient descent (GD) and natural language processing (NLP) algorithms. The integration of these ML algorithms proved successful in effectively coordinating the synchronization of text and voice messages within the chatbot.

Nguyen et al. [23] created an AI chatbot utilizing deep learning models within the Rasa framework, tailored for the Vietnamese language. This logical sequence for Vietnamese chatbots improves precision and mitigates overfitting. The chatbot model can identify more than 50 categories of customer inquiries and has reached an impressive test accuracy of 97.1%. The authors showcase the broad use of methods such as deep learning and Rasa in creating AI-driven conversational bots by providing comprehensive instructions for constructing a precise chatbot from the ground up to address the increasing need for effective online services.

Xu et al. [24] created a novel conversational system to generate social media responses for users automatically. Utilizing advanced deep learning algorithms, the system was trained using almost one million Twitter conversations involving users and representatives from over sixty different firms. The results demonstrated that the approach surpasses an information retrieval system based on both human assessments and an automated evaluation criterion.

Cui et al. [25] introduced Super Agent, an AI-powered chatbot for customer support that makes use of massive amounts of publicly accessible e-commerce data. Compared to its competitors, Super Agent takes information from e-commerce websites' user-generated content and product descriptions embedded inside pages to provide better answers to frequent questions. This allows human support staff to focus on answering higher-value questions. The results revealed the introduction of Super-Agent, an add-on designed for popular web browsers. The author discussed its potential to enhance the online shopping experience for users.

Conclusion

This study provides light on the primary obstacles to developing chatbots, which should make it easier to build conversational interfaces. It establishes research findings into a comprehensive roadmap of critical issues and suggests remedies to promote more sustainable approaches and exemplary techniques for the rapidly growing chatbot community. By gaining a better understanding of these obstacles and can collectively design more advanced interfaces that meet the requirements of comprehension, convenience, and personalization, all while effectively managing complex trade-offs. This enables higher customer satisfaction, optimized allocation of organizational resources, accelerated innovation, and ultimately, the goal of augmenting intelligence.

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Conflicts of interest: The authors stated that no conflicts of interest.

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Peer review information
IRJSE thanks the anonymous reviewers for their contribution to the peer review of this work. A peer review file is available.