

# Development of Chatbots: A Review

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**Abstract**—Using text or voice communications, a chatbot is a computer software that mimics a conversation with human users. They can be included into websites, mobile apps, and chat services to offer users quick and convenient support. Natural language processing (NLP) and machine learning techniques are used by chatbots to comprehend user input and provide real-time responses. They have been designed to carry out predetermined duties like resolving disputes, processing transactions, and responding to frequently requested questions. Several industries, including customer service, e-commerce, healthcare, and education, are adopting chatbots more frequently as they provide users a more streamlined and customized experience. Understanding customer needs, defining the chatbot's capabilities, and developing and training the system with the necessary technologies and programming languages are all steps in this process. In order for the chatbot to achieve its objectives and provide a seamless user experience, its performance must be tested during the development process, and any necessary tweaks must be made. User interface, conversational flow, error handling, and appropriate system integration are all important aspects of effective chatbot design. This paper reviews all the different technologies used to develop chatbots.

**Keywords**—Chatbot, Natural language Processing, Rule-based, ML, Natural language understanding

## I. INTRODUCTION

Interactions between humans and computers has been a sought after technology for time immemorial by various researchers. To facilitate this, computer programmes called chatbots have been designed to mimic conversations with real users. Chatbots are a pioneering technology that are taking us one step closer to automating various industries and sectors by minimizing human interactions and increasing the efficiency of an organization. Though the main focus of chatbot technology has been mimicking human conversations as a tool for entertainment their scope for application transcends into many different levels, including information retrieval, customer service, and

education. Chatbots come in a variety of forms, each with a unique set of features and functionalities. Chatbots are becoming more and more important access points to digital services and information as they are implemented in sectors like customer service, health, education, and employment aid. The impact of chatbots on individuals, teams, and society as a whole, however, is little known. There are still a few problems to be resolved before the full potential of chatbots can be realized. The use of chatbots has increased dramatically as a result in recent years.

This paper aims to understand the motivations behind chatbots and their varied types, how they have been progressing at a steady pace due to technological advances and the key considerations that are taken during the entire design, development and implementation process. The metrics for evaluation of varied types of chatbots have been discussed and an attempt has been made to highlight the future of this revolutionary technology.

## II. LITERATURE REVIEW

As technology has progressed and evolved extensive research has been carried out into the design and development of chatbots. Exploring different types of chatbots and different use cases that exist in the real world has enabled researchers to classify them and inspect the integration of various chatbot technologies. This is extensively discussed by the authors in paper [1] where they classify chatbots based on several factors, including the area of expertise they address, the need they address as well as detailing the basic design of contemporary chatbots.

The author, Anran Jiao in [2] designed a chatbot to answer questions on finance based on recognizing the intent by using the RASA NLU framework along with integration of neural networks.

M. Dahiya, in paper [3] provides an overview of the process of designing and implementing a chatbot elaborating on the tools required.

In [4], the authors evaluate a number of chatbot prototypes using metrics such as dialogue quality, dialog efficiency, user satisfaction etc. and conclude that the same metric cannot be universally applied to all chat bots but has to be catered to the specific application.

This paper [5] elaborates the various challenges that arise with respect to NLP and ML technologies while programming chatbots. Intent and syntax analysis is still an area where challenges need to be overcome.

Paper [6] proposes using python in the design of a chatbot's API constructed using a Cascading Style Sheet, which takes care of every aspect of styling, and Javascript, which is needed to run the chatbot. Additionally, it includes different machine learning techniques that allow the Chatbot to learn from the responses and requests of different users.

Aafiya Shaikh and the authors in [7], emphasize on chatbots' capacity to provide customers with mental support, much like a friend which demonstrates its adaptability in the field of customer service. The chatbot HappySoul is one such tactic.

In paper [8], the authors describe cross-encoders, which conduct word matching over the pair, and bi-encoders, which encode the pair independently, which can be divided into two categories for the majority of sequence pair matching that can be used in retrieval-based chatbots.

Kyoko Sugisaki describes Chat-Bot-Kit [9], a web-based chat tool created for research on computer-mediated communication. Together with the timestamp of the message submission, the application automatically measures the pause, pace, rhythm, and mouse movement which are known as language performance data.

Authors conduct a study [10] that offers a survey based on the many platforms utilized to create chatbots that can serve a variety of people with diverse services. The design methods used to create the chatbot depend on the services that are intended to be offered to users.

The study in [11] looks at the future of six interesting topics: (1) users and implications, (2) frameworks and platforms, (3) user experience and design, (4) chatbots for collaboration, (5) ethics and privacy, and (6) democratizing chatbots while commenting on the future for chatbot technology.

In [12] authors suggest a system that automates learning without manual annotation by utilizing feedback signals from user-system interactions.

Authors integrate deep learning techniques with the chatbot model in [13], to increase the model's goal function, provide richer and more varied results, and improve user experience. This study incorporates the concept of mutual information.

The overarching goal of this paper [14] is to establish a methodical foundation for investigating the client maintenance process while incorporating the concepts of customer loyalty and relationship quality. For this, Enquiry Chatbots are developed with the use of the chatterbot calculation, a Python module that streamlines the process to generate automated responses to user input.

While offering a general framework for chatbot architecture, authors in [15], discuss the tools and algorithms that may be used for developing different types of chatbot.

Implementing an AI chatbot for a college website, paper [16] discusses the design and implementation for the fast answer to queries by using both language and computational models.

In paper [17], they review the process of creating a business specific chatbot using AI MarkupLanguage and natural processing. The authors highlight developed approaches for handling chatbot development that are linked to several technologies like APIs, web platforms, prearranging languages, and so on.

The suggested chatbot in [18], recognises the user context that results in a specific purpose for a response. The user will receive the desired response because it is a dynamic response by observing different user answers and requests using sequence-to-sequence neural network models.

Rohit Tamrakar and Niraj Wani in [19] conduct a detailed review of the history and different types of chatbot technology along with the processes detailing the design and development of chatbots while presenting the general architecture used.

Bei Luo and other authors in [20] delve into the numerous computational techniques used to create cutting-edge chatbots, as well as the usefulness and uses of chatbots for various business sectors. To address the drawbacks of current studies and implementations, they also identify gaps in the literature linked to chatbots and suggest new study avenues.

### III.HISTORY

The history of chatbot technology dates back to the 1950s, when pioneering computer scientists began experimenting with the idea of creating machines that could simulate conversation with humans. One of the earliest examples of a chatbot was ELIZA, developed in 1966 by Joseph Weizenbaum at MIT. ELIZA was a simple program that used a set of predefined rules to respond to user input, and was able to simulate a conversation with a psychotherapist.

In the 1970s and 1980s, more complex chatbots were created due to developments in artificial intelligence (AI) and natural language processing (NLP). For example, Stanford University psychiatrist Kenneth Colby created PARRY to simulate a discussion with a patient suffering from paranoid schizophrenia. In the 1990s, the rise of the internet and the World Wide Web led to the development of more advanced chatbots, such as ALICE (Artificial Linguistic Internet Computer Entity) and A.L.I.C.E (Artificial Language Internet Computer Entity). These chatbots were able to understand and respond to more complex user input, and were considered a major step forward in the field of AI and NLP.

### IV.CHATBOT TECHNOLOGIES

The field of chatbot technology is rapidly evolving, with new developments and advancements being made on a regular basis as discussed in Fig 1. Some of the most current and advanced state-of-the-art chatbot technologies and applications include:

**Natural Language Processing (NLP):** It entails the application of algorithms and methods that allow computers to process, create, and evaluate natural language data, including text and speech. Natural Language Understanding (NLU) is a branch of NLP that focuses on making it possible for computers to comprehend human language in a manner that is comparable to how humans perceive it. Advancements in NLP have led to the development of more sophisticated and human-like chatbots, with improved ability to understand context and intent.

**Machine Learning (ML):** ML is the technology that enables chatbots to learn and adapt to new situations and user inputs. Advancements in ML have led to the development of more intelligent and self-learning chatbots, with the ability to improve their performance over time by recognizing pattern in data

and learning from past interactions.

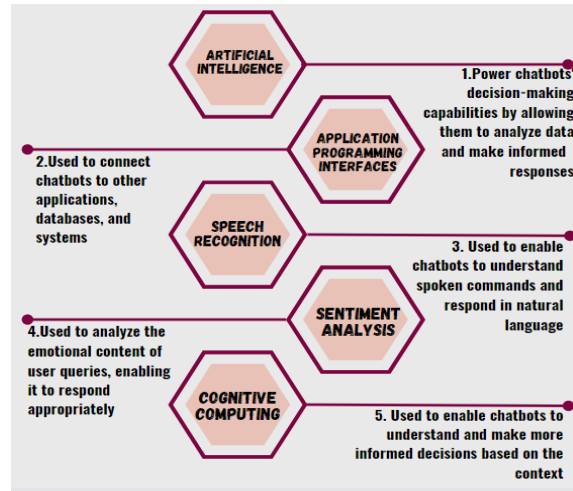


Fig 1: More Key Chatbot Technologies

### V.TYPES OF CHATBOT

**Rule-based chatbots:** The chatbot determines the appropriate response when a user inputs a message by comparing the input to its set of rules and patterns. They are often straightforward and simple to construct, but they lack the flexibility and intelligence of other kinds of chatbots.

**Retrieval-based chatbots:** These chatbots respond to user inquiries by selecting from a database of pre-written comments. They are still constrained by the caliber and volume of the pre-written responses, albeit they can be more intelligent than rule-based chatbots.

**Generative and AI based chatbots:** These chatbots use machine learning algorithms and artificial intelligence techniques to generate responses to user input. These chatbots can comprehend more sophisticated and unstructured user input and can replicate human-like conversation and behavior. They combine machine learning techniques like decision trees, neural networks, and deep learning with methods for natural language processing including language understanding and sentiment analysis. They can be more flexible and intelligent than rule-based or retrieval-based chatbots, but are also more complex and difficult to build and maintain.

**Hybrid chatbots:** These chatbots use a combination of rule-based, retrieval-based, and generative techniques to provide more sophisticated and flexible responses to user input.

**Self-learning chatbots:** These chatbots use machine learning algorithms to improve their performance over time, by learning from interactions with users.

**Voice-enabled chatbots:** These chatbots are designed to respond to voice commands and natural language speech, making them more convenient and accessible to users.

**Multi-modal chatbots:** These chatbots can handle different modalities like voice, image, text, and video inputs. They are becoming more prevalent in industries such as healthcare, entertainment, and gaming as they provide a more immersive experience to the users.

**Conversational AI:** This technology is aimed at creating chatbots that can engage in more complex and nuanced conversations, with the ability to understand and respond to emotions and social cues.

#### IV. DESIGNING A CHATBOT

The design process is a key phase in the development of a chatbot. It involves a series of steps that enable the developer to uniquely understand user preferences and allows for tailor-made chatbots for specific use cases. For successful chatbot design the steps are discussed in Fig 2:



Fig 2: Chatbot Design process

#### V. DEVELOPMENT AND IMPLEMENTATION

The development of chatbots involves the following steps:

1. **Choosing a chatbot platform:** There are numerous chatbot platforms out there that offer the resources and tools required for creating and deploying chatbots, including Dialog Flow, Botkit, and Microsoft Bot Framework.
2. **Building the user interface:** The chatbot's user interface (UI) may be created to have a similar aesthetic to the messaging service with which it is integrated. It may also have interactive elements like buttons, cards, and images.
3. **Create a knowledge base:** Develop a knowledge base that contains information that the chatbot can use to answer user queries. This may include FAQs, product information, and other resources.
4. **Train the chatbot:** In order to train the chatbot's machine learning algorithms, this step entails giving it access to a sizable dataset of sample conversations and user inputs. The effectiveness of the chatbot's comprehension and responses to user input depends on this step.
5. **Connecting the chatbot to external systems and APIs:** Chatbots can be integrated with external systems and APIs, such as databases, customer relationship management systems, and weather services, to provide users with more precise and thorough responses.
6. **Testing and debugging:** In this step, the chatbot's usability, accuracy, and functionality are tested, and any necessary modifications or enhancements are made.
7. **Deployment:** The chatbot can be deployed to the messaging platform and made accessible to users after it has been tested and debugged.
8. **Integrating the chatbot with messaging platforms:** To reach a large audience, chatbots can be integrated with well-known messaging services like Facebook Messenger, WhatsApp, and Telegram.
9. **Maintenance and updates:** In order to maintain proper operation, make necessary adjustments, and add new features, chatbots require regular upkeep and updates.

Steps involved in implementing a chatbot can change depending on the platform and type of chatbot being used.

#### VI. METRICS TO EVALUATE A CHATBOT

**Task completion rate:** This metric counts the proportion of users who were able to use the chatbot to successfully

fulfill the task they set out to do.

**User satisfaction:** This metric measures the level of satisfaction of users who interacted with the chatbot, which can be determined through surveys or user feedback.

**Response time:** This metric measures the time it takes for the chatbot to respond to a user's input.

**Error rate:** This metric measures the percentage of errors made by the chatbot in its responses to users.

**Engagement:** This metric measures how long users engage with the chatbot, and how many interactions they have with it.

**Retention rate:** This metric calculates the proportion of consumers who utilize the chatbot again following their initial interaction.

**Conversion rate:** This metric counts how many users actually carried out the requested action. (e.g. making a purchase) after interacting with the chatbot.

**Sentiment Analysis:** This metric measures the overall sentiment of the user's messages and the chatbot's responses.

The metrics used to evaluate a chatbot's performance will depend on the specific use case and goals of the chatbot.

## VII. FUTURE OF CHATBOTS

Future of chatbot development includes:

- **Voice-Enabled:** Virtual assistants, often known as voice assistants, are chatbots that can converse with users utilizing natural language processing (NLP) technology and voice instructions. These may do a range of jobs, including making reservations, answering inquiries, giving advice, and operating smart home appliances. Chatbots with voice capabilities make technology increasingly accessible for those with physical or visual impairments, as well as for those with disabilities.
- **Multilingual support:** These chatbots are perfect for companies and institutions with a global reach due to their ability to support many languages. It offers a cost-effective method to support diverse customer interactions as well as facilitates the breaking down of barriers to improve communication with people speaking multiple languages.
- **Emotional intelligence:** Chatbots may be developed with emotional intelligence, allowing

them to detect and respond appropriately to users' emotional states. Building trust and creating deeper connections with users using emotional intelligence in chatbots can enhance user engagement and loyalty.

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