Review Article

AI in Chatbots: A Primer

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Abstract A chatbot is a computer program that imitates human conversation. It will usually respond in a conversational style, and it may carry out actions in response to your conversation. Designed to simulate the way a human would behave as a conversational partner, chatbot systems typically require continuous tuning and testing. Amazon, Apple, Google, Microsoft, and Slack support chatbots. This paper provides a primer on artificial intelligence-based chatbots.

Keywords chatbots, virtual assistants, conversational AI, conversational agents

Introduction

We are in the age, where the intelligent machines are all around us. Tasks that were once performed only by humans are now optimized, automated, and completed significantly faster by machines. There are number of new kinds of computer machines and software available which are collectively known as chatbots or bots. A chatbot is a software system that allows humans to interact with technology using a variety of input methods such as voice, text, gesture and touch, 24/7 365. It may also be regarded as a service that allow people interact with via a chat interface. It is a virtual assistant capable of answering a certain number of questions from human users, providing the correct answers. Figure 1 shows a typical chatbot icon [1].
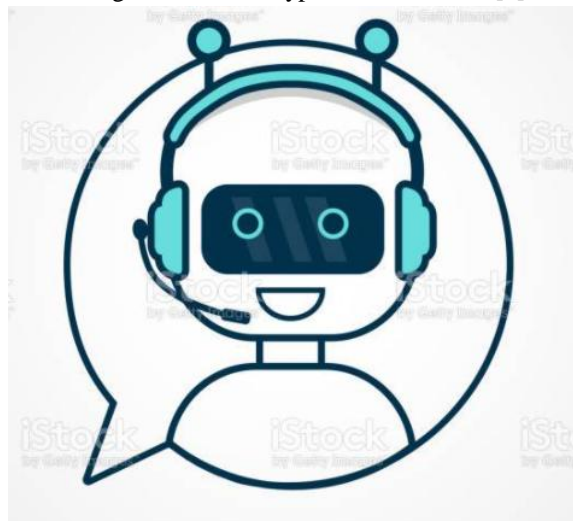

Figure 1: A typical chatbot icon [1]

Chatbots are currently used in various online applications [2]. Chatbots are now taking pizza orders, reserving hotel rooms, booking airflight, and scheduling doctor appointments. In short, these robots are becoming pervasive.

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Chatbots or virtual assistants are the latest industry's newest tools designed to simplify the interaction between humans and computer machines. Since chatbots have entered the digital world, marketers are curious to use them as a major tool to interact with their customers on daily basis.
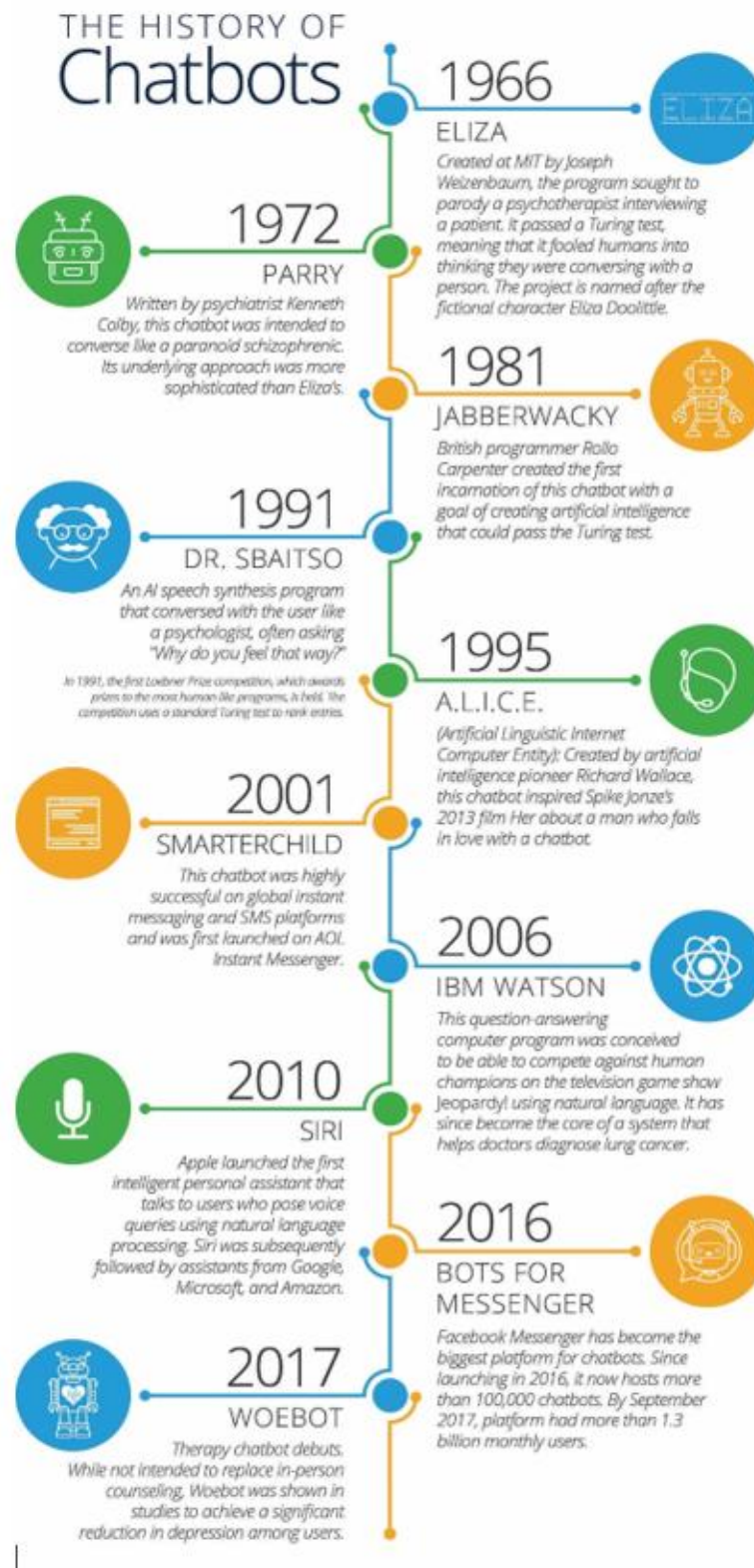
Figure 2 shows a brief history of chatbots [3].

Figure 2: A brief history of chatbots [3]

Among the most notable early chatbots are ELIZA (1966) and PARRY (1972), which were designed to see if chatbot systems could fool users that they were real humans. Since ELIZA was introduced by Joseph Weizenbaum in 1966 at MIT AI Laboratory, chatbots have gone through a lot improvement. The newer generation of chatbots include IBM Watson (introduced in February 2017) which allows you to build conversational interfaces into any device, channel, use, or any cloud. Other popular chatbots or virtual assistants include the following [4,5]:

- Siri first came to the public's attention in February 2010 when it was launched as a new iPhone app.
- Alexa was launched by Amazon in 2015 as mobile voice assistant.
- Google Now was developed by Google, created specifically for the Google Search Mobile App.
- Cortana is an intelligent personal assistant that was developed by Microsoft in 2015.
- Gengobot is a chatbot-based dictionary application about multi-language grammar developed in Japan.

Overview on Artificial Intelligence

The term "artificial intelligence" (AI) was first used at a Dartmouth College conference in 1956. AI is now one of the most important global issues of the 21st century. AI is the branch of computer science that deals with designing intelligent computer systems that mimic human intelligence, e.g. visual perception, speech recognition, decision-making, and language translation. The ability of machines to process natural language, to learn, to plan makes it possible for new tasks to be performed by intelligent systems. The main purpose of AI is to mimic the cognitive function of human beings and perform activities that would typically be performed by a human being. Without being taught by humans, machines use their own experience to solve a problem.

AI is stand-alone independent electronic entity that functions much like human expert. Today, AI is integrated into our daily lives in several forms, such as personal assistants, automated mass transportation, aviation, computer gaming, facial recognition at passport control, voice recognition on virtual assistants, driverless cars, companion robots, etc.   AI is not a single technology but a range of computational models and algorithms.

Some forms of AI that are most commonly used in different applications include the following [6,7]:

- *Expert systems:* They solve problems with an inference engine that draws from a knowledge base equipped with information about a specialized domain, mainly in the form of if-then rules. Expert systems are the earliest, most extensive, the most active and most fruitful area.
- *Fuzzy logic:* This makes it possible to create rules for how machines respond to inputs that account for a continuum of possible conditions, rather than straightforward binary.
- *Neural networks:* These are specific types of machine learning systems that consist of artificial synapses designed to imitate the structure and function of brains.   They are similar to the human brain. They are made up of artificial neurons, take in multiple inputs, and produce a single output. The network observes and learns as the synapses transmit data to one another, processing information as it passes through multiple layers.
- *Machine learning:* This includes a broad range of algorithms and statistical models that make it possible for systems to find patterns, draw inferences, and learn to perform tasks without specific instructions. Machine learning is a process that involves the application of AI to automatically perform a specific task without explicitly programming it. ML techniques may result in data insights that increase production efficiency. Today, artificial intelligence is narrow and mainly based on machine learning.
- *Deep learning*: This is a form of machine learning based on artificial neural networks. Deep learning architectures are able to process hierarchies of increasingly abstract features, making them especially useful for purposes like speech and image recognition and natural language processing. Deep learning networks can deal with complex non-linear problems.
- *Natural Language Processors*: For AI to be useful to us humans, it needs to be able to communicate with us in our language. Computer programs can translate or interpret language as it is spoken by normal people.
- *Robots*: These are computer-based programmable machines that have physical manipulators and sensors. Sensors can monitor temperature, humidity, pressure, time, record data, and make critical

decisions in some cases. Robots have moved from science fiction to your local hospital. In jobs with repetitive and monotonous functions they might even completely replace humans. Robotics and autonomous systems are regarded as the fourth industrial revolution. Robot police with facial recognition technology have started to patrol the streets in China.

These AI tools are illustrated in Figure 3 [8]. Each AI tool has its own advantages. Using a combination of these models, rather than a single model, is recommended. AI systems are designed to make decisions using real-time data. They have the ability to learn and adapt as they make decisions.
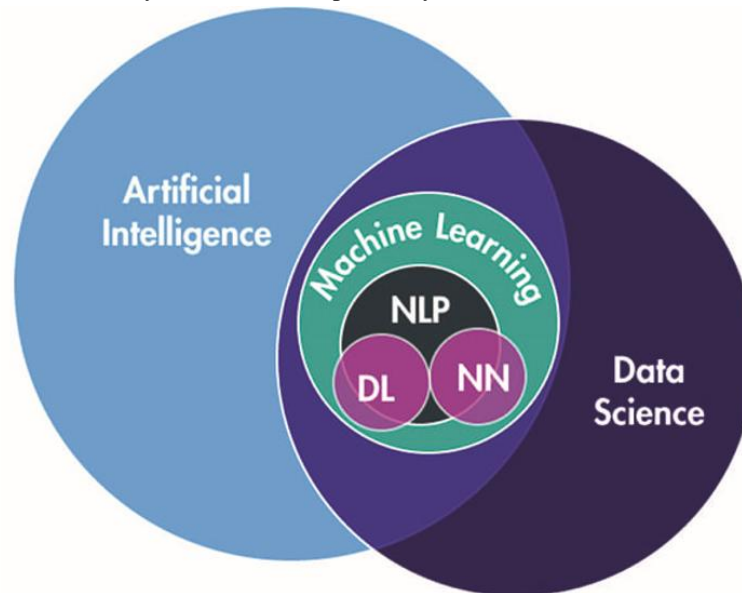

Figure 3: Artificial intelligence (AI) encapsulates several concepts including natural language processing (NLP), deep learning (DL), and neural networks (NN) [8].

AI in Chatbots

In essence, an AI chatbot is fed input data, the message sent by the user. The message is then processed by NLP and chatbot interprets and translates it into a relevant output according to the existing database, creating a forth-and-back conversation. Figure 4 shows how chatbot works [9]. AI chatbot builders often use Java, C++ or Python. There are two types of chatbots: AI chatbots or rule-based chatbots. A chatbot without AI is just a FAQ answering bot.
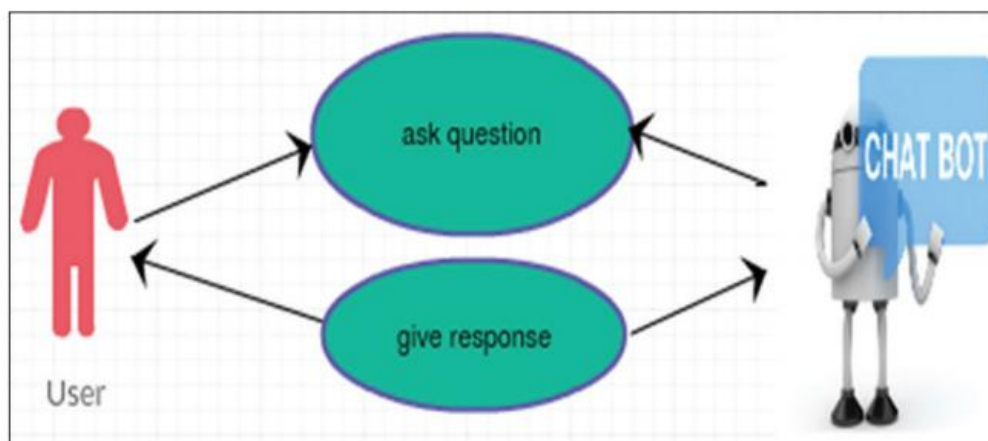

Figure 4: How chatbot works [9]

AI chatbot is a software that can simulate a user conversation with a natural language through messaging applications. AI chatbots are variably known bot, talkbot, bot, intelligent chatbot, conversation bot, interactive agent, artificial conversation entity, or virtual talk chatbot. Artificial Intelligence gives a human touch to every

conversation chatbot makes. AI uses two important tools that help the chatbot to understand, react, and learn from every interaction: machine learning and natural language processing (NLP). Machine learning helps the chatbot to learn from every conversation it has with the users. Through the use of NLP, chatbots are able to respond to a remarkable variety of customer inquiries with correct information. A chatbot using NLP allows users to pose a question as they would to another human being. AI-enabled chatbot makes the bot capable and intelligent to answer complex queries.

Applications of AI in Chatbots

Chatbot applications streamline interactions between humans and services. Chatbots are used in dialog systems for various purposes including customer service, request routing, or information gathering. They can be classified into usage categories that include: commerce, education, entertainment, finance, health, news, and productivity. Some common applications include [10].

- *Business:* The business community has capitalized on chatbots and they are increasingly employed in businesses. There are banking bots, customer service bots, bots for taking purchase orders, etc. Many banks, insurers, media companies, e-commerce companies, airlines, hotel chains, retailers, healthcare providers, government entities, and restaurant chains have used chatbots to answer simple questions, increase customer engagement, promote their products and services, offer different ways to order from them, and provide faster and cheaper assistance to their customers.
- *Healthcare:* Chatbots are increasing been used in the healthcare industry. Chatbots are beneficial for scheduling doctor appointments, locating health clinics, or providing medication information. A chatbot aims to make medical diagnoses faster, easier, and more transparent for both patients and physicians. Chatbots can increase access to healthcare, improve doctor–patient and clinic–patient communication, manage remote testing, medication adherence monitoring or teleconsultations.
- *Government:* Motivated by the efficiency gains reported by private organizations, chatbot technology has also started being adopted by government agencies. As the public sector is seeking to improve citizens' services and government functions, more sophisticated chatbot applications have emerged, mainly targeted to automated information provision by governments [11].
- *Library:* Many libraries continue to see technology as a way to make up for reductions in funding. Chatbots offer a self-service option for our online customers in the context of information services. Chatbots can also ease the burden of basic or routine questions so that library staff can focus their attention on more demanding inquiries and duties. Also, 24/7 availability allows users to immediately access library services at their convenience, even when the library is closed [12].
- *Education:* The educational sector can greatly benefit from chatbot technology. Chatbot has a long history of use as pedagogical agents in educational settings. It can improve productivity, communication, student learning experience, efficient teaching assistance, and minimize ambiguity from interaction. Building chatbots in education (Edu Chatbots) that can interact with learners through natural language has great value and has attracted the attention of researchers in recent years. Education chatbots improve communication, increase productivity, and simplify learning interaction [13]. Chatbots are available 24 hours 7 days a week for someone to learn foreign language on their own mobile device. They provide an easy and cheap way to master the basics of a foreign language and gain some communication skills [14].

Other applications include e-commerce, online banking, hospitality industry, customer service, customer care, politics, toys, troubleshooting, and social media

Benefits

A chatbot is an AI creature which can converse with humans. Its objective is to stay connected, simulate conversation, and minimize human intervention. Chatbots can efficiently conduct a dialogue and usually replace other communication tools such as email, or phone. Chatbots can help you order a pizza, make hotel reservations, schedule doctor appointments, or guide you through a complex B2B sales process. AI chatbot can act as

automated conversational agents, capable of promoting health, providing education, and potentially prompting behavior change.

Chatbots have brought a revolution in the business communication process as well as helped in attaining customer satisfaction. The major benefit of using chatbots in banking include cost reduction, financial advice, and 24/7 support.

Other benefits of chatbots include [12].

- They can understand a spoken language and use speech communication as user interface
- They make asking questions easier (by providing a natural language interface)
- They provide instant responses
- They can personalize the user experience
- They are anonymous (which encouraged shy users or those who thought their questions might be "stupid")
- They provide a marketing tool for reference services
- They are patient and polite and remain unruffled by rude customers, high traffic, or repeated requests

Challenges

In spite of the benefits of AI chatbots, they have some important limitations. There are privacy and security concerns, lack of personality and lack of research resulting in errors and financial expenses. Besides the risk of implementing chatbots, there are high financial costs associated with acquiring, updating, and hiring specialists [15]. Human–chatbot communication has noticeable differences in quality in comparison to the human–human discussion. Other challenges include [10].

- As the database, used for output generation, is fixed and limited, chatbots can fail while dealing with an unsaved query.
- A chatbot's efficiency highly depends on language processing and is limited because of irregularities, such as accents and mistakes.
- Chatbots are unable to deal with multiple questions at the same time and so conversation opportunities are limited.
- Chatbots require a large amount of conversational data to train.
- Chatbots have difficulty managing non-linear conversations that must go back and forth on a topic with a user.
- As it happens usually with technology-led changes in existing services, some consumers are uncomfortable with chatbots due to their limited understanding, making it obvious that their requests are being dealt with by machines.

It is needless to say that these chatbot limitations can frustrate customers.

Conclusion

Chatbots are basically software applications that mimic written or spoken human speech for the purposes of simulating a conversation or interaction with a real person.

Empowered by AI, chatbots are emergng as new technologies with great business potentials. The last few years has witnessed an exponential growth of tools to design, build, deploy, manage, and monetize chatbots. Although AI chatbot technology is still in its developmental phase, AI chatbots are getting smarter over time. Today, organizations are becoming more comfortable with integrating chatbots into their activities.

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