Innovative Chatbot Technologies and Trends

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Abstract. Artificial Intelligence (AI) technology, which was out of reach in today's society, has become commonplace, and chatbots are commonly used in a variety of industries. This paper describes the development of chatbots and their market potential. It describes the scenarios and innovations of three representative chatbots, Erica, Duolingo and ChatGPT. It is worth noting that almost all of them employ user-innovated technologies to drive innovation and progress. Ultimately, the authors conclude that the future of chatbots is promising as technology continues to advance and innovate.

Keywords: chatbot, natural language process, Erica, Duolingo, ChatGPT

1   INTRODUCTION

1.1   What is a chatbot?

A chatbot is an artificial intelligence program that can communicate with humans. It can chat with customers, provide information and emotional support, and even work individually, so that chatbots have become commonplace and enrich people's lives in today's society [1].

Chatbots have become a major development project for major companies due to the huge advancements in Artificial Intelligence (AI) [2]. Most implementations of chatbots are platform-independent and can be used immediately by users without installation. As shown in figure 1, it responds to questions and requests via text input, audio input, or image input [3]. Chatbots use Natural Language Processing (NLP) and Natural Language Understanding (NLU) to process and match messages, perform calculations through machine learning and deep learning, and finally return messages using NLP and emotive language, that allowing users to easily find information without human intervention or manual research [3][4].
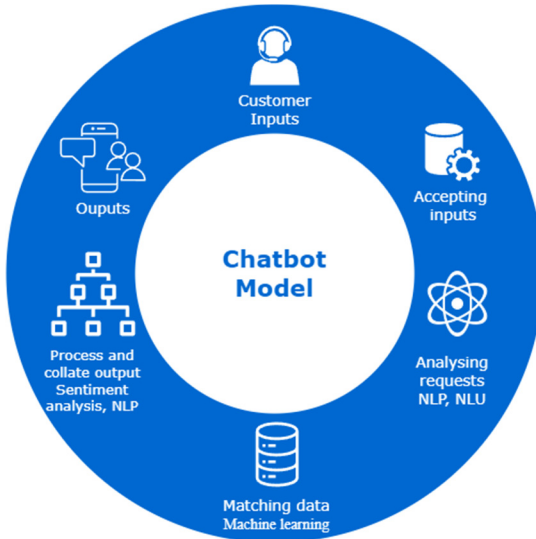
Fig. 1. Chatbot model

As technology continues to evolve, more and more types of chatbots are emerging to provide convenience and support to different industries and bring more innovation and value to the society. Fahem chatbot is integrated into the financial and banking industry to provide services around the clock [5]. eBay ShopBot is an e-commerce chatbot, which helps to answer all the shoppers' questions and provides instant answers to the customers [6]. provide instant answers, saving customers' time and manufacturers' labour costs [6]. ADA chatbot is used in the education industry to provide services such as online learning support and homework tutoring for students, while the workload of teachers is reduced [7]. WGHE is a Korean chatbot used in the healthcare industry to provide services such as health advice, drug information, and symptom assessment [8]. In the entertainment and social fields, chatbot can also provide services such as games, news, and weather forecasts, and simulate human dialogue to communicate and interact with users.

1.2   Current Technology and Key Strategies

Natural language is the main technology of chatbot. And using better strategies can make chatbot's perceptual understanding superior.

- Greedy: This is one of the fastest and simplest strategies. The Greedy strategy takes the most probable value at each step all the way to the end. But it has a disadvantage that the result may not be the optimal solution.
- Graph search: this is the strategy with the highest time complexity. As shown in figure 2, it requires listing all the possibilities and then searching for the optimal solution using depth-first or breadth-first. It is not very efficient, but it surely gives the optimal solution.
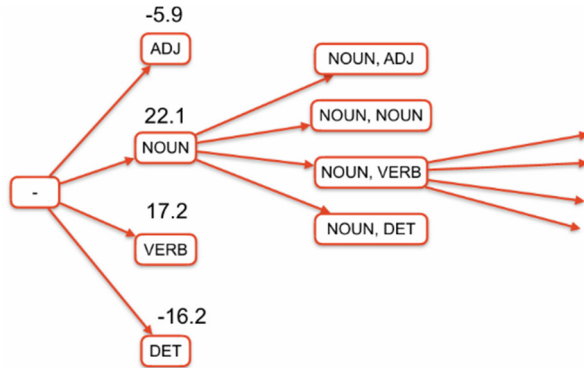
Fig. 2. Graph search

- Beam search: this is an optimised version of the greedy strategy. Figure 3 shows the steps of beam, it takes k maxima at each step and then records the optimal solution at the end. It is usually able to find relatively optimal solutions in a short time, however, it also suffers from, for example, the possibility of falling into local optima.
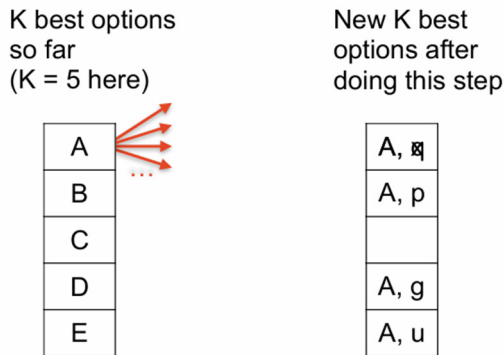

Fig. 3. Beam search

- LSTM: (Long Short-Term Memory) It updates the information through Cell State, Forget Gate, Input Gate, Output Gate and cell state update which are 5 parts to update the information. It can process long sequence data efficiently and learn long term dependencies.

1.3 Market potential

The global chatbot market size is $4.7 billion in 2022 and $5.4 billion in 2023 [9]. It is expected to grow at a CAGR of 23.3% to $15.5 billion in 2028 [9]. It is growing rapidly in the social media sector and has a great potential for growth in the financial sales industry, healthcare and e-commerce [10].

1.4   Current state of development

The first chatbot, Eliza, was developed in the 1960s by Joseph Weizenbaum, a professor at the Massachusetts Institute of Technology [1]. Eliza's functionality was limited to some simple pattern matching and substitution. Nowadays, the rise of neural networks and pre-trained models has led to the rapid development of chatbots [10]. ChatGPT as the most popular chatbot nowadays, helps people to quickly access information and knowledge in a variety of domains, and can be used as an educational aid or as a mental health support tool, or even to complete computational or clerical tasks.

1.5   Current disadvantages

Although chatbots have made significant advances in natural language processing, there are still drawbacks:

- Understanding complex contexts: some complex linguistic contexts are still difficult to understand. This can lead to bots misinterpreting the user's intent.
- Dialogue consistency: some chatbot replies are inconsistent or contradictory to the previous text. This can degrade the user experience.
- Lack of Emotional Understanding: Unable to understand exactly the current feelings of the customer and give inappropriate responses.
- Lack of knowledge: chatbots' knowledge is usually limited to what is covered by their training data. This can lead to bots performing poorly on some domains.
- Current deep learning techniques still suffer from adversarial vulnerabilities, in which minor code perturbations can mislead the inference as well as the results of deep learning models [11].

1.6   Innovative directions

- Semantic understanding improvement: understanding complex semantic structures, logical reasoning, and semantic associations in context.
- Dialogue consistency: improved models maintain consistency in long-term dialogues.
- Customisation for specific domains: customising the model for specific domains.
- Personalised dialogue: Understanding and adapting to the user's personality and preferences, from generating more personalised responses.
- Multi-modal understanding and generation: support for images, audio, and video as inputs as well as outputs.

2   INNOVATION CONCEPTS

2.1   Dominant design

Dominant design refers to the main framework of the current market offerings. There are five main development categories in the Chatbots market.

- Button based chatbots, the most basic type of chatbot, it interacts with them by clicking on button options. Essentially it works like a decision tree [12].
- Rule-based chatbots use simple decision trees and conditional logic to develop dialogue automation processes for answering frequently asked questions [12].
- Artificial Intelligence Chatbots make conversations smoother and more conversational by quickly detecting all relevant contextual information to understand the user's question through AI and NLU capabilities [12].
- Voice chatbots are another dialogue tool that allows users to interact with bots by speaking rather than typing [12].
- Generative AI functions can fluently understand general-purpose language, adapt to dialogue styles, and use empathy to respond to questions [12].

2.2   Disruptive innovation concepts

Disruptive innovation disrupts traditional chatbot industry technology, models.

- Intelligent personalised services: Through deep learning and big data analysis, chatbots can deeply understand user preferences thus providing more accurate and personalised services [13].
- Multi-channel interaction: Users can communicate with the robot through text, voice, image and other methods [14].
- Autonomous Learning and Continuous Improvement: Through interaction with users and feedback, it can continuously optimise its algorithms and models [14].
- Personal assistants and virtual partners: Help users handle daily tasks, manage schedules, access information, etc., providing them with a full range of support and services [14].

3   INDUSTRY DEVELOPMENT

Chatbots have been widely used and developed in education, social media platforms, gaming, and even business, providing a more efficient, convenient, and personalised service experience for both businesses and users [15].

3.1   Erica

Chatbots are already being used extensively in the financial sector and have even played a disruptive role [16]. In traditional banking services, customers usually rely on online banking, telephone customer service, and branch counters to handle their banking transactions and problems [17]. These channels have time constraints needing to be during working hours, as well as the need to book in advance or wait in queues, and some financial advice and analyses take a lot of time. This not only wastes a lot of customer's time but also increases the workload of the staff.

Erica is a chatbot launched by Bank of America that aims to be a virtual financial assistant for users [18]. As shown in figure 4, users can check their financial

information through Erica anytime and anywhere, while Erica also sends timely notifications of collections and credits [18]. In this way some simple account enquiries as well as analysed banking operations can be answered from Erica. It is convenient for customers and also saves the cost of manual service.

In terms of distributed innovation, Erica uses Web APIs to communicate with banking systems and databases for real-time data transfer and interaction, thus providing customers with account enquiries, transfers, payments, etc. [18]. Erica also employs the concept of user innovation. It collects user feedback and behavioural data so as to provide services that are more in line with users' expectations [18]. Erica is built into Bank of America's platform ecosystem. It integrates and interacts with other banking services and products to provide customers with a more comprehensive and integrated financial services experience [18].
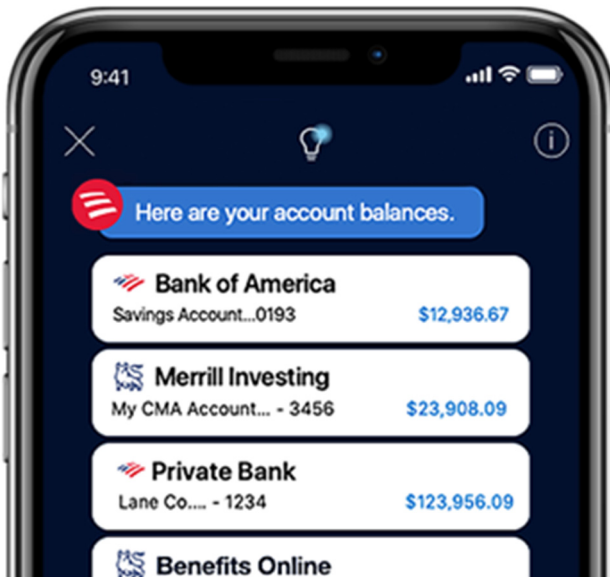

Fig. 4. Erica [18]

3.2   Duolingo

Duolingo is one of the leading chatbots in the educational application market [19]. As shown in figure 5, users learn languages by playing games through dialogue with the chatbot. It has a large number of users and user loyalty globally due to its unique learning style, rich language options and personalised learning paths [20].

Duolingo uses product platforms, open innovation and user innovation. Under the open innovation model, companies work with users' latter partners to share resources and knowledge to drive innovation and development [20. Meanwhile, the user innovation model promotes the continuous development of the application and the improvement of user satisfaction.
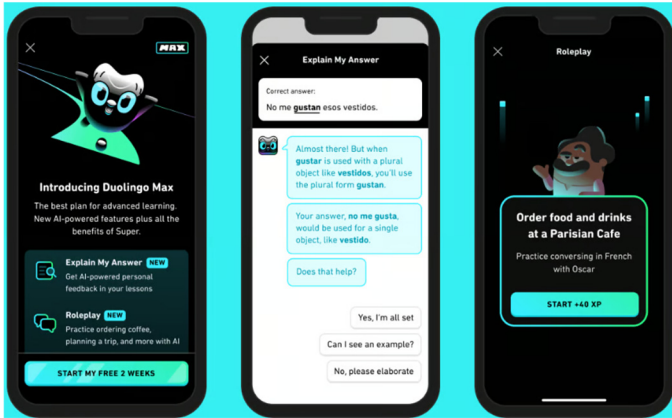
Fig. 5. Duolingo [21]

3.3   ChatGPT

ChatGPT is a chatbot developed by OpenAI based on artificial intelligence technology [22]. Figure 6 is a screenshot of ChatGPT's interactive interface. It uses pre-trained models, unsupervised learning, and generative dialogue to provide suggestions to users [23]. ChatGPT can be used in a variety of industries, including customer service, educational assistance, and virtual assistants.

ChatGPT is a free and open-source software. This means that ChatGPT is an open-source software making it available for free use and modification by developers and researchers [23]. This open-source model facilitates technology sharing and collaboration and accelerates the development and application of ChatGPT technology [23].
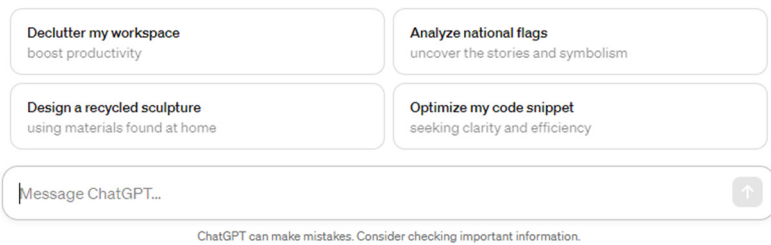

Fig. 6. ChatGPT

4   CONCLUSION

Chatbots have appeared in almost every industry. It will become an indispensable intelligent tool in people's life and work in the future development, providing people with more convenient, efficient and personalised services and support. chatbot can be developed innovatively by improving semantic understanding, enhancing dialogue

consistency, customisation for specific domains, multimodal understanding and generation, and other directions. Of course, with the continuous progress and innovation of technology, the application scenarios and functions of chatbots will be further expanded and enriched.

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