An Overview of Conversational Agent: Applications, Challenges and Future Directions

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Abstract: Recent years have seen the increased use of artificial intelligence technologies such as conversational agents. Conversational agents, also referred to as chatbots, are used to interact with users using natural language. Thus, various fields have started to adopt conversational agents such as education, healthcare, marketing, customer service, and entertainment. However, determine the motivations that drive the use of conversational agents and clarify their usefulness are challenging. This paper presents an overview of the evolution of conversational agents from an initial model to an advanced intelligent system and their deployment in various real-world applications. Moreover, this paper contributes to information system literature by comparing the different types of conversational agents based on their roles and interaction styles. This paper also highlights the current challenges of conversational applications along with recommendations for future research.

1 INTRODUCTION

In recent years, a significant number of artificial intelligence (AI) applications have been developed for organizations to automatically manage users' inquiries. A conversational agent or a chatbot is a smart program that simulates human language through adopting machine learning and AI techniques. The modes of communication with conversational AI agents involve text, voice, emoji, and other types of inputs as interaction techniques with users. In the multichannel environment, conversational agents can reduce the time users spent seeking the right information. Consequently, the pervasive use of conversational AI technology has created a critical dependency on researchers that call for a specific focus on conversational AI application evaluation (Venkatesh et al. 2018).

Conversational systems can enhance the experience of digital users in various domains such as education, e-commerce, healthcare, finance, marketing, and business. Each conversational agent has access to specific knowledge of its domain to converse effectively. For instance, education conversational agents help tutor content and university-related information (Hiremath et al. 2018). The conversational applications in healthcare assist patients with answers to specific health-related queries (Kadariya et al. 2019). Business conversational agents act as a customer service tool to improve customer experience (Nuruzzaman and Hussain, 2018). Other conversational applications in a general domain are developed to conduct conversations on open topics and support users' needs.

Despite the rapid adoption of conversational AI in the industry, conversational AI and its applications have received limited attention in the academic literature. This paper synthesizes conversational AI applications and their evolution in various industries. Therefore, a literature review has been conducted to comprehensively compare conversational agents in different domains. This study also identifies the current challenges of conversational applications and provides future research directions towards the effectiveness of conversational AI usage.

The paper is organized as follows. The first section briefly describes the technological concepts of conversational agent applications; the second section discusses the history of conversational agents and the growing interest of the research studies; the third section presents a classification of conversational agents based on their roles and interaction styles; the fourth section highlights the conversational applications in various domains. The last section discusses the current challenges of conversational applications and highlights directions that need further research.

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2 RESEARCH BACKGROUND

2.1 Understanding Conversational Technology

Conversational agents or chatbots are considered as a type of dialogue system in the field of human-computer interaction (Følstad and Brandtzæg, 2017). As the name suggests, chatbots refer to an Internet robot that can chat with humans. Chatbots are not usually stand-alone applications that can be installed, but rather, they work in an integrated way within websites or messenger platforms (Parthornratt et al. 2018). Chatbots often use AI algorithms to analyse the users' input before sending an appropriate response (Rahman et al. 2017). In addition, speech recognition technology is critical here to understand the users' responses (Haridas et al. 2018).

A conversational user interface (CUI) bridges the interaction of humans with dialogue systems to mimic social chatting. CUI term referred to the collective term for a variety of assistants that mimic human conversation (Lister et al. 2020). CUI has usually two styles of interaction: voice-based and typing-based. Voice User Interfaces (VUI) is what users interact with when communicating with spoken language applications (Cohen et al. 2004). For example, Apple Siri, Amazon Alexa, Windows Cortana, and Google Assistant (aka voice assistants) are typical examples of CUIs using voice-based interaction. Typing-based chatbots rely on textual input and output and are usually integrated with social media sites such as Facebook Messenger bots. Furthermore, the chatbot applications enhance the CUI capability using natural language processing (NLP) and natural language understanding (NLU) techniques to smartly understand the intentions of each user input (Braun et al. 2017). User Experience (UX) is a major term in the discipline of human-computer interaction (HCI). UX concept has a variety of different definitions in the relevant literature. The ISO 9241-210 definition of user experience is "A person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service" (Mirnig et al. 2015). A critical factor that influences user experience with new technology is a user onboarding design. The user onboarding design is the introduction process that gives users a guided message to the new product to enhance the experience of using the product (Cascaes Cardoso 2017). A common type of onboarding method used in conversational interface is using greeting statements or menu-based questions. Further studies need to investigate the type of onboarding design that influences first-time interaction with users.

2.2 History

The interest in conversational technology has increased considerably since the 1950s when the initial studies focused on the interaction between humans and computers in accordance with the communication theory. Table 1 shows a summary of the conversational applications development timeline. In 1950, Alan Mathison published an article titled "Computing Machinery and Intelligence" to test computers' ability to think like humans. Alan Mathison's famous research establishes the foundations of AI conversational agents (Pinsky 1951). ELIZA was the first chatbot developed in1966 by Joseph Weizenbaum, which the main purpose is to act as a Rogerian psychotherapist based on the model of mirroring the previous user prompt. However, it was unable to keep the flow of conversation ongoing and had limited capability of recognizing human-like feelings (Weizenbaum 1966). PARRY was another historic chatbot, developed in 1972 by Kenneth Colby, at Stanford University, which simulates a person with paranoid schizophrenia. PARRY with its embodied conversational interface has more features than ELIZA (AbuShawar and Atwell, 2015).

Artificial linguistic Internet computer entity (ALICE) was developed in 1995 by Richard Wallace, which utilizes XML platform called AI mark-up language to determine the heuristic conversation rules (Tabet et al. 2000). In 2001, SmarterChild chatbot was developed, and integrated within windows messenger to communicate with users as a personalized conversational interface. Apple launched its voice assistant, Siri, in 2010, which communicates with users through a natural language interface employing both voice and textual interaction modalities (Aron 2011; Guzman 2017). In 2015, Amazon introduced a voice-based chatbot designed as a smart speaker called Alexa. Then, inspired by Alexa, Google released a smart speaker in 2016: Google Assistant. In 2017, Samsung, started developing Bixby, to have an intelligent voice-based assistant similar to Siri.

Recently, Google has launched the most state-of-the-art AI chatbot called Meena, a 2.6 billion parameter end-to-end trained neural conversational model. Meena can hold sensible conversations that are more specific than existing best-performing chatbots (Adiwardana et al. 2020). Facebook has also announced a new AI chatbot, Blender that has more human features than Meena. However, Blender is limited in filtering Reddit datasets that may have harmful languages that influence the responses (Gjurković and Šnajder, 2018). The following section proposes a classification of conversational agents

Table 1: Timeline of conversational agents' development.

Agent	Year	Creator	Interaction mode	Role
ELIZA	1966	Joseph Weizenbaum	Text	Rogerian psychotherapist
PARRY	1972	Kenneth Colby	Text	Simulate a person with paranoid schizophrenia
ALICE	1995	Richard Wallace	Text	Practice human-like conversation
SmarterChild	2001	Robert Hoffer	Text	Personal assistant
Siri	2011	Apple	Text/Voice	
Alexa	2015	Amazon	Voice	
Bixby	2017	Samsung	Text/Voice	
Meena	2020	Google	Text	
Blender	2020	Facebook	Text	

according to two categories based on their role and interaction styles. While the first one depends on showing the different roles conversational agents can take, the second classification focuses on technical aspects characterizing user interaction styles.

3 METHODOLOGY

This review aims to present an overview of the evolution of conversational agents and their deployment in various real-world applications. To review existing studies on conversational agents in various domains, we follow the literature review process based on the standard approaches (Nakano and Muniz, 2018; Webster and Watson, 2002). All searches were limited by the English language and publication date (2010– 2021). The review included two phases. The first stage was collecting studies regarding conversational agents from relevant journals and conferences. The second phase was analysing the literature based on the specific domains to present the potential role of conversational agents and derive directions for future studies. Furthermore, titles and abstracts were scanned to remove irrelevant articles. In addition, we conducted a forward snowballing search method by examining the citations to the included articles.

4 RESULTS

4.1 Types of Conversational Agents

Conversational applications may consist of a dialog system, an avatar, and an expert framework to process queries efficiently. Broadly, the conversational agents can be classified based on the role/tasks accomplished: general-purpose and task-specific. The second classification is based on interaction styles with users that involve two types of interaction styles: menu-based and text/voice-based. Figure 1 presents the broad classification of conversational agents. These criteria may influence the core design philosophy of conversational agents or which principle needs to be considered in understanding the communication or the tasks of the conversation for which the conversational agent needs to be designed (Braun and Matthes, 2019). The general-purpose conversational agent is a multi-tasking agent and plays the role of a personal virtual assistant. It is usually integrated as a virtual assistant on platforms such as mobile, desktop, and smart speaker (Siebra et al. 2018). These applications perform general tasks, and users can ask general questions. For example, users ask information about the weather, the nearest restaurants, opening email applications, adjusting the calendar, and any other personal inquiries. Siri, Bixby, Cortana, Alexa, and Google Home are examples of virtual assistants that play a general-purpose role (López et al. 2017). The task-specific conversational agent performs specific tasks for users, working as an assistant agent for a particular domain such as online tutor, therapist, and customer service (Kalia et al. 2017; Ko and Lin, 2018; Ranoliya et al. 2017).

The integrated platforms for this type of agent include websites and social media applications. For example, the Facebook messenger is a popular chatbot used by firms to target consumers (Pereira and Díaz, 2018). Social media platforms such as Twitter, Kik messenger, WhatsApp, and WeChat application also embed the chatbot platform (Xie et al. 2019; Yamaguchi et al. 2018). The menu/screen-based conversational agent uses pre-defined rules to produce limited numbers of answers. The users, in turn, can only ask pre-defined questions, and the subsequent responses are generated from the chatbots' knowledge base. The user interface of a menu-based conversational agent has a limited number of end-

users' prompts. The implementation of this type of conversational agent is straightforward and does not require any machine learning algorithm (Dahiya 2017). A limitation of this conversational application is unable to answer the different kinds of questions not included in the pre-defined list of options in the dataset. The benefits of a menu-based agent are enhancing the ease of use factor and navigating the conventional flow of information (Hornbæk and Hertzum, 2017). However, the limited number of response options constrain the users' expressive capacity. This type of conversational assistance is popularly used in the retailing industry. For example, Domino's Facebook Messenger bot offers buttons as communication modes with consumers (Sotolongo and Copulsky, 2018).

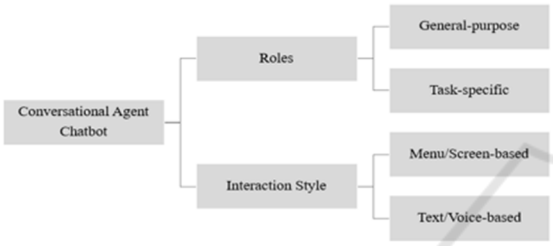

Figure 1: Classification of conversational agents.

The text/voice-based type of conversational agent is more advanced and utilizes machine learning algorithms to generate an appropriate response. This type of agent interacts with end-users allowing them to unconstrained input through typing text or voice by speech and long sentences during the conversation. For example, If the user asks, "*Where is the nearest store to my location?*" the agent uses the keywords "*nearest*", "*store*", and "*location*", to determine the best answer to reply to the end-user. The text and voice-based agents apply deep learning algorithms to develop the ability to detect and recognise keywords (Khanpour et al. 2016). A dialogue manager is the main part of the design, which collects keywords from the conversational interface and sends it to the knowledge engine. Then, the knowledge engine classifies the type of questions and searches for the answers from the knowledge database (Setiaji and Wibowo, 2016). Conversation datasets are available through many open source platforms (Serban et al. 2015). Compared to the menu-based ones, text/voice-based conversational agents provide higher levels of flexibility in the ways in which users can express their prompts. However, there is also a higher possibility of misrecognized prompts that may negatively affect user experience.

The next section discusses the application of conversational in various domains such as education, finance, banking, travel, healthcare, and E-commerce.

4.2 Applications in Various Domains

Conversational systems play an important role in many sectors such as education, healthcare, finance, travel, and business. Table 2 presents the role of chatbots in various domains. Figure 2 shows that chatbots' potential usage in the industry (Suhel et al. 2020). In education, a conversational application is useful for learning with the right conversation scenario design, leading to less complex knowledge structures. Prior research has focused on the role of a chatbot that can serve for teaching and learning purposes. Sánchez-Díaz et al. (2018) developed a formal methodology for implementing an intelligent chatbot as a tutor for a university-level course. Clarizia et al. (2018) proposed an ontology-based chatbot in the educational domain, which uses NLP techniques to develop keyword detection skills to provide the correct answers to students. Therefore, chatbots can work as assistants for teachers and students during the learning activities such as identifying grammatical and spelling mistakes, assigning projects, and checking homework.

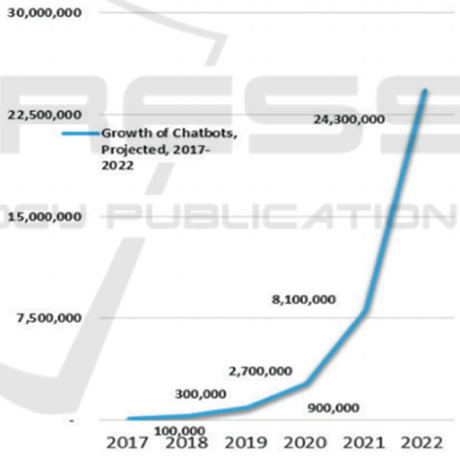

Figure 2: Chatbots usage in the industry (Suhel et al. 2020).

Kerlyl et al. (2006) focused on a negotiated open learner model to develop conversational agents and intelligent tutoring systems to support student reflection on their learning. A chatbot's ability to negotiate and incorporate small talk capabilities can positively influence the enjoyment of the interaction and engagement with a chatbot, thereby improving the learning experience for students. Hien et al. (2018) developed a chatbot that can provide services for students and academic staff with high accuracy of user intent identification and context extraction. Both user intent identification and context information have quite promising results i.e., a high score of the context information extraction indicates the ability of

a chatbot to provide the correct answers, as shown in Figure 3.

In the finance industry, chatbots are deployed as customer service agents in large-scale inquiries for financial industry clients to provide the information and features of services like car loans, home loans, and FAQ for customers who already have a car loan contract. Okuda and Shoda (2018) examined the features of 'Sony bank' chatbot and developed the user stream function to visualize how many users have passed through different contexts. Visualization of the user stream function can provide insights regarding which script locations require more detailed responses to develop the conversation suitability of the chatbot. Altinok (2018) proposed a framework for the finance-banking domain to build German language banking through the finance chatbot to keep the state of the conversation between the chatbot and customers. The achievement of Altinok (2018) is promising, and the project is still in progress to introduce the success metrics and evaluate the dialogue manager module. Duijst (2017) proposed a chatbot for banks, which investigates the factor of personalization for improving the user experience of chatbots in the finance section and found that personalization has no significant effect on the user experience of chatbots for the finance industry, as shown in Figure 4 (Duijst 2017).

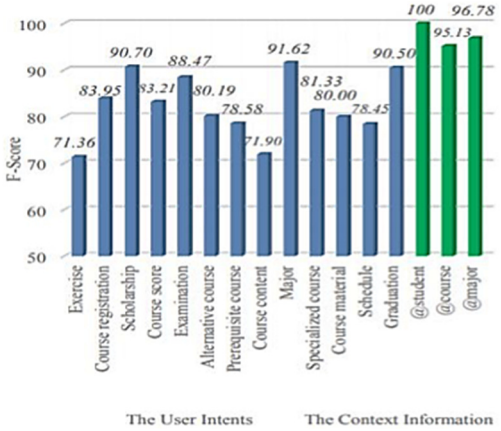

Figure 3: The F-score results (Hien et al.2018).

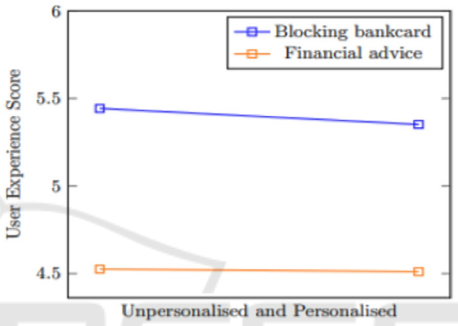

Figure 4: Plot of the effect of Task & Personalisation with the UX of chatbots (Duijst 2017).

Table 2: Chatbots' role in various domains.

Study	Chatbots' Role	Domain
Kerlyl et al. 2006; Sánchez-Díaz et al. 2018; Clarizia et al. 2018; Hien et al. 2018; Prasad and Ranjith, 2020	• An intelligent tutor for a university level course. • Providing education system information and services on behalf of the academic staff. • Improving the security and automation of a lab by the voice-based agent.	Education
Okuda and Shoda 2018; Altinok 2018, Duijst 2017; Milhorat et al. 2019; Suhel et al. 2020; Khan and Rabbani, 2021	• Providing financial-product sales. • Online customer support in banking industry. • Answering a question about customers account, bill payment, credit card payments, and schedule meetings	Bank/Finance
Kowatsch et al. 2017; Oh et al. 2017; Huang et al. 2018; Martin et al. 2020; Espinoza et al. (2020)	• Providing guidance for consumers or their carers when they have medical problems. • Providing diabetics with diets and information regarding foods to be avoided. • Providing information for preventing COVID-19 pandemic	Healthcare
Argal et al. 2018; Sano et al. (2018), Alotaibi et al. 2020	• Providing information or services through conversation-like interactions for tourism and travel. • Consumers use travel chatbots to book a trip, plan a vacation, discover new experiences, and make reservations at hotels.	Travel/Tourism
Gupta et al. 2015; Brynjolfsson and Mcafee, 2017; Chung et al. 2018; Zarouali et al. 2018; Rakhra et al. 2021;	• Offering features to brands, such as sending advertisement messages, asking for customer feedback, and collecting customers' preferences. • Providing an online experience and customer service through social media sites.	E-commerce

In the banking sector, a conversational agent can play several roles to help end-users, such as answering a question about users account, bill payment, make a transaction, credit card payments, and schedule meetings. Milhorat et al. (2019) investigated the power of chatbots in bank services by developing a dialogue management system to provide a suitable answer and avoid making generic fallback utterances. They experimented with 226 user interactions and provided 187 correct answers and 39 fallback utterances. Their result showed that user utterances could be handled if the system had the addition of a coherent statement response component.

Conversational agents are widely used in the healthcare industry with the primary aim to provide guidance for consumers or their carers when they have medical problems (Kowatsch et al. 2017; Oh et al. 2017). Huang et al. (2018) utilized user data to develop the AI healthcare chatbot that can provide people with diabetes with diets and information regarding foods to be avoided. AI medical applications can offer useful personalised information to individuals in efficient ways (Kocaballi et al. 2019a). However, further studies are needed to assess patient safety (Laranjo et al. 2018). Recent research investigates the power of AI technology to provide information for preventing COVID-19 pandemic (Miner et al. 2020). Developing AI-based chatbot applications can have a role in defeating COVID-19 and increase the efficiency of healthcare management (Martin et al. 2020). Espinoza et al. (2020) proposed a web-based chatbot for COVID-19 screening and redirecting users via links distributed through multiple channels (social media, email, text messages) to handle the screening questions to assign each question into a risk category with a specific set of actions and triage patients to the right health care option.

Chatbots can also provide information or services through conversation-like interactions for tourism and travel. Consumers use travel chatbots to book a trip, plan a vacation, discover new experiences, and make reservations at hotels with higher ratings. Argal et al. (2018) developed a chatbot to improve user-machine interactions in the travel domain through collective user preferences to provide better user-centric recommendations and accurate travel information to the user. Sano et al. (2018) implemented a tourism chatbot that is based on hierarchical cluster analysis and agglomerative nesting algorithm to give users a balance between time allocations versus the quality of their tour for tourism sites.

The main business objectives of the firms are to achieve sales, enhance customer service and engagements (Solem 2016), and these can be achieved using AI technologies (Brynjolfsson and Mcafee 2017). The researchers have investigated the effectiveness of the Facebook chatbot applications for brand engagement, and they found that the consumer engagement of brands on Facebook results in positive user-generated content and consumer involvement (Leong et al. 2018; Shareef et al. 2018). Lee and Ko (2019) reported that chatbots with customizing functionality, sociality, creativity, and hedonic value all influence perceived brand relationships and brand loyalty. Bhawiyuga et al. (2017) designed a chatbot system that can communicate with customers through the Telegram service and provide automatic answers to the customer-to-seller questions in less than 5 seconds.

Conversational agents can offer many features to brands, such as sending advertisement messages, asking for customer feedback, and collecting customers' preferences that often drive consumers' brand engagement. Luxury brands such as Burberry and Tommy Hilfiger started to adopt chatbots to communicate with their customers and provide an online experience through social media sites. At least two reviews of the literature found that chatbots can be effective for customer satisfaction and marketing strategies of brands (Chung et al. 2018; Zarouali et al. 2018). However, more studies are needed to investigate the impact of using conversational agents as a marketing channel with careful consideration of customers' perceptions. Conversational applications can enhance online shopping by providing recommendations and information for online customers, leading to improving browsing the products that can be challenging and time-consuming through websites given the variety of features a product can have. For example, Gupta et al. (2015) developed a website-based chatbot as an online automated assistant that is able to help customers to make a decision about which product is suitable for them and provide product suggestions.

5 CHALLENGES

Today most brands rely on social media sites to develop the customer-brand relationship and provide information to the customer. However, social media sites with a large amount of content and poorly structured posts can make it difficult for customers to find products and information easily and quickly. In this scenario, a conversational agent to make it easier for a customer to contact with a brand and find information. Making conversations relevant and designing and evaluating satisfactory user

experiences are still challenges for conversational applications design (Kocaballi et al. 2019b). However, conversational agents are a promising alternative as compared to using other marketing channels and customer service technologies. Existing chatbot applications in the customer service industry have many drawbacks such as poor interactive user interface, not multilingual, do not support third-party integration, and cannot detect customers' emotions (Nuruzzaman and Hussain, 2018).

6 CONCLUSION AND FUTURE DIRECTIONS

Conversational applications have received increasing attention in numerous fields like virtual assistance, education, finance, healthcare, and e-commerce due to their advantage of supporting the use of natural language interfaces. This paper describes the technological concepts of conversational agent applications, and the history of conversational agent development, and implementation of conversational applications in various domains. This paper compares the different types of conversational agents based on their roles and interaction modes. This paper highlights the areas for future research directions towards conversational agents for brands, especially for marketing and customer service toolkits, as the conversational applications may prove effective in improving customer-brand engagement and lead to the success of marketing strategies.

A few recent studies have focused on the effectiveness of conversational agents for online marketing and brand strategies (Chung et al. 2018; Zarouali et al. 2018). A promising area of research is to investigate the potential of online conversational agents as an online marketing tool and how conversational agents can enhance customer engagement. Future research can focus on developing a methodology to investigate the consumers' attitudes of using conversational applications and the factors that influence user satisfaction of using conversational agents. The UX quality assessment is a current research topic regarding the HCI discipline (Kocaballi et al. 2019b). Further improvement in conversational application design can be achieved by evaluating the UX of conversational agents for a specific domain and exploring the characteristics of conversational agents that need to be improved based on the users' perspectives to enhance the conversation outcomes and capabilities.

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