Chapter 11
Recent Advances in Chatbot Algorithms, Techniques, and Technologies: Designing Chatbots

Guendalina Caldarini
https://orcid.org/0000-0001-5317-0845
University of Sunderland, UK

Sardar Jaf
University of Sunderland, UK

ABSTRACT

Intelligent conversational computer systems, known as chatbots, have always been at the forefront of artificial intelligence. They are made to sound like humans in order for machines to communicate with humans. Because of the rising benefits of chatbots, numerous sectors have adopted them to give virtual support to clients. They are also used as companions and virtual assistants. Natural language processing and deep learning are two artificial intelligence disciplines that are used in chatbots. This chapter will examine current advancements in chatbot algorithms, approaches, and technologies that use artificial intelligence and/or natural language processing.

INTRODUCTION

Chatbots are intelligent conversational computer programs that simulate human dialogue (Sojasingarayar, 2020; Bala et al., 2017; Jia, 2003). A chatbot processes

DOI: 10.4018/978-1-6684-6234-8.ch011

user input and provides a response (Ayanouz et al., 2020; Kumar & Ali, 2008). Chatbots often use natural language (text or speech) as input, to provide the most appropriate output to the user input sentence. Chatbots have been at the forefront of many major AI (artificial intelligence) revolutions since their inception: human-computer interaction, knowledge engineering, expert systems, natural language processing, natural language understanding, deep learning, and many others (Yu et al., 2020). Several factors contributed to their prevalent growth in recent years, such as the commoditization of technology; increased computer power; and the sharing of open-source tools and frameworks. Moreover, recent advances in artificial intelligence and natural language processing methods made chatbots easy to construct, more versatile in terms of applicability and maintainability, and increasingly capable of mimicking human communication. However, there are still many challenges to be addressed.

This chapter aims to offer readers a detailed overview of the background of chatbots, recent advances in chatbots algorithms and technologies, evaluation tools and metrics, and some future research ideas.

BACKGROUND

Despite the popularity of chatbots, creating chatbots that deliver satisfactory responses to the requirements of specific users remains an arduous task. For example, a chatbot must understand any user's speech or text as an input request and respond appropriately (e.g., on the same topic, make sense), helpfully (e.g., contains useful and concrete information), and even be tone-aware (e.g., conveys feelings like empathy and passion) (Xu et al., 2017; Hu et al., 2018).

A common way to design chatbots is the rule-based method (Young et al., 2013; Mesnil et al., 2015). It defines the structure of a dialogue state as a series of slots to be filled throughout a discussion. The chatbot responses depend on certain hand-crafted rules.

However, one of the main limitations of rule-based chatbots is that they are domain dependent. Each set of rules developed applies only to a limited number of cases and a limited field.

The alternative approach to rule-based chatbot design is data-driven techniques, also known as Machine Learning techniques. This design approach may handle more diverse user inquiries than rule-based chatbots (Song et al., 2018). The main types of data-driven chatbots are Information retrieval-based and Generative chatbots. Information retrieval-based chatbots may retrieve an existing response to users' queries from a pre-compiled dataset. Generative chatbots build a new response word by word depending on the input sequence provided by the user (Yan et al.,