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Chatbots & Its Techniques using AI: A Review

Santosh Maher[1], Sangramsing Kayte[2], Sunil Nimbhore[3]
[1, 3]*Department of Computer Science And IT, Dr. Babasaheb Ambedkar Marathwada University Aurangabad, Maharashtra, India.*
[2]*Department of Mathematics and Computer Science, University of Southern Denmark, Odense M, Denmark*

Abstract: ***The next major feature of the age of conversational services is chatbots in the new era of technology. A Chatbot framework is a software program that uses natural language to communi- cate with users. Chatbots is a virtual entity that can effectively explore the use of digital textual competencies with any hu- man being. Recently, their growth as a medium of conversa- tion between people and computers has taken a great step for- ward. The aim of the chatbot framework for machine learn- ing and artificial intelligence is to simulate a human conver- sation, maybe through text or speech. Natural Language Pro- cessing understands one or more human languages through chatbot software. To simulate informal chat communication, the chatbot structure combines a language model and compu- tational algorithms covering enormous natural language pro- cessing techniques. This paper discusses other applications that may be useful for chatbots, such as a computer conversa- tion system, virtual agent, dialogue system, retrieval of infor- mation, industry, telecommunications, banking, health, cus- tomer call centers, and e-commerce. It also offers an overview of cloud-based chatbots technology along with the program- ming of chatbots and programming problems in the chatbot's present and future periods.***

Index Terms: NLP, NLU, Gated Recurrent Unit, AI, Deep Learning, Machine Intelligence, Pattern Matching, Chatbots, LSTM.

I. INTRODUCTION

Chatbots are computer programs that use natural languages to communicate with users [1]. In various industries, Chat- bot has been used to provide data or perform tasks, such as telling the weather, making flight reservations, answering ed- ucational queries, or buying goods, often used in call centers to minimize the number of customer calls, Customer service handling time and expense are also used by various common applications such as Telegram, Cortana, Slack, WeChat, Face- book Messenger, Google Assistant and Siri, [1]. Graphical user interfaces emerged in the eighties, web interfaces in the nineties, and touch panel interfaces in the last decade, while the command line was once sufficient in the seventies. Un- restricted textual content and speech as input would be man- aged by subsequent interface technologies. Navigation de- vices, Apple's Siri, Google's Voice Assistance Search using the voice command line, Amazon's Alexa, and quite a few translation services created by Google and other large organi- zations are examples of talking to computer systems. [2]. In the 1960s, the first technology was initiated. A chatbot sys- tem aims to simulate human conversation; a language model and computational algorithms are implemented into the chat- bot architecture to replicate informal chat communication us- ing natural language between a human user and a machine. Lately, conversational chatbots have focused on the imple- mentation of deep learning techniques on a broad text corpus. In this group, the most representative chat generation model is seq2seq, which is an aggregate of two neural LSTM net- works, the first generates the dialogue state, and the second outputs the response of the bot.[3]. Due to the wide use of messaging offerings and the growth of NLU, chatbots have recently become popular. [4]. With the widespread use of personal computers with the desire to communicate and the need of their producers to have natural language interfaces, the need for conversational agents has increased. [5].

II. LITERATURE REVIEW

By simulating human interaction to its fullest, Chatbots have presented a new wave of automation. Smart assistants will now take charge of certain guiding duties, such as handling schedules, making reservations, booking tickets, placing meal orders, etc. But this is simply the beginning of chatbots' abil- ity. With smart homes and voice assistants finding their way into the market (such as Amazon Alexa and Google Home), bots will soon be able to perform even larger acts. In real- ity, the chatbot market is projected to expand and expand at a CAGR (compound annual increase rate) of 35.2 percent be- tween 2016 and 2021. [6]. Tech giant corporations build these networks and, somehow, they already serve a norm or are at least on their way to being one:

1) Dialogflow (Google, formerly Api.ai)
2) Wit.ai (Facebook)
3) LUIS (Microsoft)
4) Watson (IBM)
5) Lex (Amazon)
6) ChatScript
7) Mitsuku

A. *Elizabot*

In its long history, Elizabot is one of the earliest known chat- bots. It was developed in 1966 at the MIT Lab. To provide Rogerian psychotherapy, it was once the objective to demon- strate natural language conversations between people and ma- chines. [7]. Using Rogerian psychotherapy to encourage the patient to speak to the engaging debate, responses are also non-public questions intended to interact with the patient to continue the conversation. It uses a rule-based script to re- spond from a set of templates and context identification to patient questions with keyword matching. The downside of Elizabot is to keep a discussion going. Also, Eliza is unable to learn new expressions or word patterns, finding meaning through the interplay and logical reasoning skills. [8].

B. *Chat Script*

ChatScript is an industrial chatbot focused on scripting that uses pattern matching techniques close to the Language of Artificial Intelligence Markup (AIML). It's a mix of the en- gine of NLP and the method of dialogue management. Any management scripts were enclosed. This can only be an- other standard rule subject that invokes the engine's appli- cation programming interface (API) functions. A rule con- sists of a form, mark, output, and pattern. Engine to scan the topic mechanically for appropriate rules based on user feed- back. ChatScript initially finds the simplest subject match, unlike AIML, which finds the simplest pattern match for as- sociate degree input, then executes a rule embedded in this subject.CharScript 's downside is that it's hard to figure out and there are no hosting options. Also, it is difficult to launch an online page. [9].

C. *IBM Watson*

As the name of IBM Watson chatbot, International Business Machine (IBM) is a rule-based AI chatbot developed by the DeepQA project of IBM. It is designed for the processing of natural language and machine-learning methods for infor- mation retrieval(IR) and question-answering(Q / A) systems. Watson uses DeepQA tools from IBM and the Apache UIMA (Unstructured Architecture for Information Management) system. The IBM Watson Conversation service integrates various technologies, such as machine learning (ML), nat- ural language processing (NLP), and advanced dialogue tools, to create conversation flows between applications and users. [10]. Mechanisms for Watson to define characteristic qualities such as names, dates, geographic locations, etc. It ranks all possible answers and selects one as its top response, the Watson working score level, or probability-based score. Apache Unstructured Information Management Architecture (UIMA) platform is often used in many technologies, includ- ing Hadoop, to analyze the phrase shape and the syntax of the query to gauge what is being asked by the user. Watson's ben- efits are that it does not explicitly document system structure, no relational databases, higher maintenance costs, targeting higher organizations, and it takes a longer time and effort to teach Watson to use its full potential. [11].

D. *Microsoft*

Language Understanding Information Service (LUIS) is a machine-based learning service for developing natural lan- guage into apps, bots, and IoT devices. LUIS is an AI engine developed by Microsoft that is domain-specific. [12]. Three Microsoft bots were used on the first day of the day. *In- formational Bot* You can answer questions specified in the information set or FAQ using the QnA Creator Cognitive Re- sources and answer more open-ended questions using Azure Search. Any other chatbot is Commerce bot Together, Lan- guage Comprehension, and Azure Bot Service, which helps developers to create conversational interfaces for a range of scenarios, such as banking, travel, and entertainment. [13]. For example, a hotel concierge may use a bot to embellish conventional email and phone call experiences by validating the customer via Azure Active Directory and using Cognitive Resources for higher contextually technological consumer re- quests using textual content and voice. You may add a voice recognition service to enable voice commands [14].

E. *Google Dialogflow*

Dialogflow is recognized as Api.ai and was developed by Google as part of the Google Cloud Platform. App devel- opers provide users with the ability to communicate with interfaces through voice and text exchanges, powered by ma- chine learning and natural language processing techniques. [15]. Focus on other essential aspects of the app advent as an alternative to specifying in-depth grammar rules. Recently, automated spelling corrections have been made available in Dialogflow API v2 Dialogflow, which has made major changes to their operation. Automatic spelling correction is given if there are types in user messages [16]. Dialogflow un- derstands the intent and meaning of what the user says. Then match user feedback to specific objectives and use entities to obtain meaningful information from them. Finally, allow the conversational interface to respond. Dialogflow downside is its use of minimal language support [17].

F. Amazon Lex

Amazon Lex is an AWS service for developing conversational interfaces for voice and text applications. It's been produced by Amazon. It offers NLU and Automatic Speech Recogni- tion (ASR) deep learning capabilities and versatility to create highly engaging user interfaces with vibrant, conversational interactions. Amazon Lex integrates with AWS Lambda, which helps users to quickly activate back-end business logic for data retrieval and updates. [18]. Amazon Lex's drawback is not multilingual, it actually supports English only. Unlike Watson, Lex has a crucial web integration process to follow. Also, the training of the data set is difficult, the statements and the mapping of entities are highly important. [19].

G. Mitsuku

The Mitsuku chatbot is a commonly used standalone human- like chatbot that uses AIML. It was designed for a general style of communication and interaction based on rules writ- ten in AIML and an integrated social media such as Twitter, telegram, firebase, Twilio to serve as a personality layer. The Mitsuku bot uses NLP with heuristic patterns and is hosted by Pandorabot.Whenever the bot fails to find a better fit for the data, it automatically redirects it to the default fallback group. Mitsuku has the ability to keep a long conversation history, learn from the conversation history, remember personal de- tails about the user (name, age, place, gender, address, etc.). Its function involves the ability to reason with particular ob- jects. For example, if someone asks, "Can you eat a bike?" "Mitsuku will look up the properties for" rocket "and find that the value of" class "is set to" vehicle "and respond" No "be- cause the rocket is not edible. [20]

III. NEURAL NETWORK LANGUAGE MODELS

Neural Network Language Models (NNLMs) such as the Re- current Neural Network (RNN) and Long Short Term Mem- ory (LSTMs) [21]. Deep learning and neural networks are gaining prominence in the field of NLP, with hidden states between input and output and robust networking to produce the best performance. [22].

A. Recurrent Neural Network

RNN is designed to take text sequences as inputs or return text information sequences as outputs, or both. They are referred to as recurrent because the hidden layers of the network have a loop in which the output and the cell status of each step turn out to be entered in the next step. RNN can recall just that since it's inside the memory. It generates data, copies the data, and loops returned to the network. The primary strength of the RNN is the ability to memorize the consequences of previous computations and to use certain records in the current computation. Unlike con- ventional translation models, where only a finite window of previous words can be considered to condition the language model, RNN is effective in conditioning the model to all the preceding words in the corpus. We should consider the sentence as a mini-batch and the sentence as a mini-batch. **k** words would have **k** word vectors to be stored in memory.

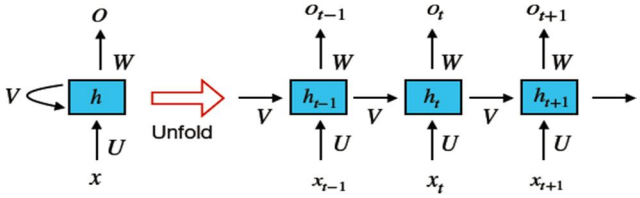


Fig. 1. RNN architecture for sequence to sequence

B. Long Short Term Memory (LSTM)

Sequence-to-sequence (SEQ2SEQ) model [23]. In deep learning (DL), there are 2 key assignments. The first is to derive from the input the value. The second is to produce output from that, in the case of a chatbot application, either a translation or an answer. The Principal The difficulty of cre- ating a decent model is that it produces an appropriate sense of meaning and output inputs that are essentially connected. In deep recurrent neural networks (DRNN) with an attention mechanism, the sequence-to-sequence (seq2seq) model [24]. The capacity of the deep neural network to communicate in human spoken language, although a number of the restric- tions of applied mathematics models and implementation mechanisms are sidetracked at the same time. Long Short Term Memory networks are a special form of RNN, capa- ble of learning long-term dependencies, usually only called "LSTM". Hochreiter & Schmidhuber (1997) introduced them. [25].In place of our regular neural network layers, LSTM cell blocks. An LSTM consists of three gates (gates of input, for- getting, and output), and a combination of the three calculates the hidden state.

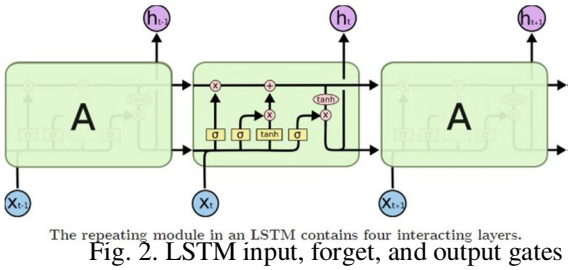


Fig. 2. LSTM input, forget, and output gates

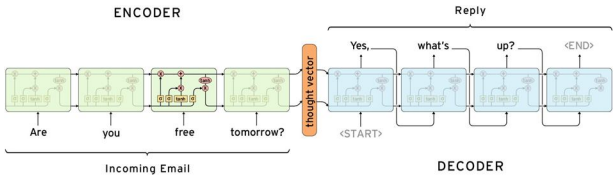


Fig. 3. Encoder Decoder(LSTM) network architecture .

The input sequence shown in Fig.3 is ’ ”*Are you free tomorrow?* . Thus, when such an input sequence is passed through the encoder-decoder network of LSTM blocks (a type of RNN architecture), the decoder produces words one by one at each stage of the iteration of the decoder. The generated output sequence is generated after an entire it- eration. “*Yes what’s up?*”. For sequence mapping (via encoder-decoder frameworks), various LSTM-based models have been proposed that are suitable for machine translation, text summarization, modeling human conversations, question answering, generation of image-based language, among other tasks. For recurrent neural networks, which broaden their memory, LSTM networks are an extension. [26].

C. Natural Language Processing(NLP)

Natural Language Processing is part of computer science and Artificial Intelligence(AI) that deals with human language in the age of information. [27].With the rise of voice interfaces and chatbots, NLP is a vital part of AI as one of the most sig- nificant innovations of the information age. NLP, like speech and text, is commonly known as the automatic manipulation of natural languages. To understand human language, NLP applies computers to the words we use. To mechanically an- alyze and represent human language, NLP deals with build- ing process algorithms. A wide range of uses has been made possible by NLP-based systems such as Google’s powerful search engine and, more recently, Amazon’s voice assistant called Alexa, Microsoft Cortana, etc. [28]. NLP is often use- ful for training machines with the ability to perform complex tasks related to natural languages, such as machine translation and dialogue generation, often used in many other ap- plications such as Spell Checking, Keyword Search, Finding Synonyms, Extracting website information such as Classify- ing: reading level of school texts, positive/negative sentiment of longer documents, Machine Translation, the field of text classification and categorization, Question Answering, sen- timent analysis, Paraphrase Detection, Language Generation and Multi-document Summarization, product price, dates, lo- cation, individuals, or company names. Machine Translation, Speech Recognition, Character Recognition, Spell Checking, etc, Text Extraction, Entity extraction, Syntactic Analysis, Se- mantic Analysis, Pragmatic analysis.

D. Natural Language Understanding (NLU)

Similarly called, the terms both deals with the relationship between natural language (as humans speak) are two compo- nents of NLP (NLP and NLU). In the field of AI, NLU is a fundamental part of achieving a good NLP. To explain the context and create human language, NLP attempts to do two things. You might call these the passive and active sides of NLP.[29].

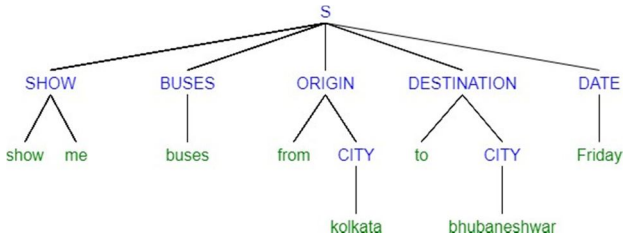


Fig. 4. NLU slot filling and intent parsing tree.

NLU can come in various forms. The NLU component's objective is to derive three items from the utterance of the consumer. Domain classification is the first difficulty based on the purpose of matching the user talking about airlines, booking a hotel, booking a bus, programming an alarm clock, or dealing with their calendar? The second is user intent de- termination of what familiar challenge or aim the user is try- ing to accomplish, for example, to find a movie, the task may want to be, Show a flight or delete an appointment from a calendar, order pizza, etc. Third, the slot filling extracts the unique slots and fillers that the user slot filling intends the device to recognize from their declaration about their intent. [30]. NLU is the interpretation of the context of what means are given to the consumer or the input. NLU served with In- tents and Entities: Intents is nothing more than verbs (the user has to do the activity). Use an intention if we want to catch a submission, or execute an action. Entities: The enti- ties are the nouns or material that must be performed for the operation. Currently, chatbots are the best tool we have for Software that is native to humans because it gives any other person an experience of speaking. Since chatbots imitate a real human, methods of Artificial Intelligence (AI) are used to create them. Deep learning that imitates the human brain is one such technique within AI. It discovers patterns from the training data and uses the same patterns to process new infor- mation. Software that is native to humans because it gives any other person an experience of speaking. Since chatbots imi- tate a real human, methods of Artificial Intelligence (AI) are used to create them. Deep learning that imitates the human brain is one such technique within AI. It discovers patterns from the training data and uses the same patterns to process new information.

E. Gated Recurrent Unit

Similar to LSTM, GRU stands for Gated Recurrent Device. GRU is an LSTM variant and it consists of only two gates, integrating the forgotten gate and the input gate into a single update gate, and is more efficient because it is less complex. The GRU objectives to solve the problem of the vanishing gradient that comes with a general recurrent neural network also enhanced the standard recurrent neural network model [31].

IV. DESIGN PRINCIPLES

Three kinds of chatbot are rule-based, retrieval(IR), and gen- erative chatbot based. A predefined collection of phrases in a question-answer framework is described in the rule-based chatbot where each question is described as answers in a type pair. Rule-based development of XML-based chatbots called AIML Releases-ed in 2001 [32]. The retrieval(IR) chatbot retrieves the answers/responses from a collection of prede- fined answers and some kind of heuristic to select input and context-based acceptable response. The heuristic could be as easy as matching a rule-based expression. Any prede- fined repository is not used by a generative model chatbot. This form of the chatbot is more advanced because it learns from scratch how to use a "Deep Learning" algorithm. The retrieval(IR) chatbot retrieves the answers/responses from a collection of predefined answers and some kind of heuristic to select input and context-based acceptable response. The heuristic could be as easy as matching a rule-based expres- sion. Any predefined repository is not used by a generative model chatbot. This form of a chatbot is more advanced be- cause it learns from scratch how to use a "Deep Learning" algorithm.

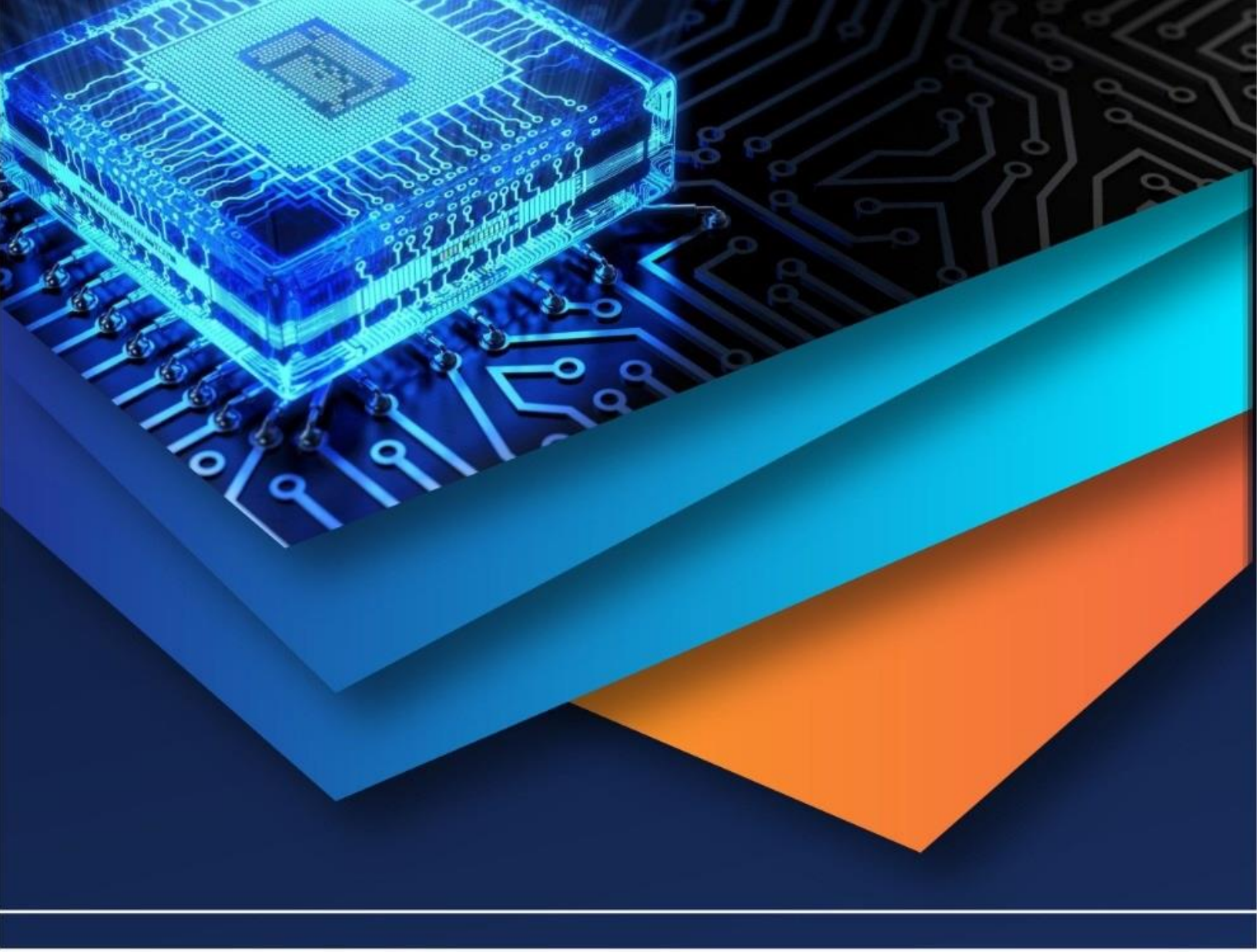
V. CONCLUSION

In this paper, the literature review covered a variety of se- lected articles that have primarily focused on Chatbot design techniques over the last decade. We checked Artificial In- telligence, Deep Learning, Natural Language Processing All Chatbot-based technology is on the rise and Chatbot improves the efficiency of human communication with a computer us- ing voice-based, health-care, and even chatbot-based business use by offering a better low-cost experience.

REFERENCES

[1] Sameera A Abdul-Kader and JC Woods, "Survey on chatbot design techniques in speech conversation sys- tems," International Journal of Advanced Computer Science and Applications, vol. 6, no. 7, pp. 1–6.
[2] Sebastian Weigelt and Walter F Tichy, "Pronat: an agent-based system design for programming in spoken natural language," in Proceedings of the 37th Interna- tional Conference on Software Engineering-Volume 2. IEEE Press, 2015, pp. 819–820.
[3] AM Rahman, Abdullah Al Mamun, and Alma Islam, "Programming challenges of chatbot: Current and fu- ture prospective," in 2017 IEEE Region 10 Humanitar- ian Technology Conference (R10-HTC). IEEE, 2017, pp. 75–78.
[4] Patrick Bii, "Chatbot technology: A possible means of unlocking student potential to learn how to learn," Edu- cational Research, vol. 4, no. 2, pp. 218–221, 2013.
[5] Naz Albayrak, Aydeniz Özdemir, and Engin Zeydan, "An Overview of artificial intelligence based chatbots and an example chatbot application," in 2018 26th Sig- nal processing and communications applications con- ference (SIU). IEEE, 2018, pp. 1–4.
[6] A Vandana1, DC Jhansi Rani, V Anusha Goud, Mr C Kishor Kumar Reddy, and B V Ramana Murthy, "A STUDY OF CHATBOTS THROUGH ARTIFICIAL INTELLIGENCE," pp. 341–354,2019.
[7] J Epstein and WD Klinkenberg, "From eliza tointernet: A brief history of computerized assessment," Computers in Human Behavior, vol. 17, no. 3, pp. 295–314, 2001.

[8] RE Horn, "Parsing the turing test: Philosophical and methodological issues in the quest for the thinking," Computer Dordrecht, pp. 73–88, 2009.
[9] Jennifer Hill, W Randolph Ford, and Ingrid G Far- reras, "Real conversations with artificial intelligence: A comparison between human–human online conversations and human–chatbot conversations," Computers in Human Behavior, vol. 49, pp. 245–250, 2015.
[10] N. A. Godse, S. Deodhar, S. Raut, and P. Jagdale, "Implementation of chatbot for itsm application using ibm watson," in 2018 Fourth International Conference on Computing Communication Control and Automation (ICCUBEA), Aug 2018, pp. 1–5.
[11] Jon Lenchner, "Knowing what it knows: se- lected nuances of watsons strategy," WWW- page, URL: http://ibmresearchnews. blogspot. com/2011/02/knowing-what-itknows-selected-nuances. html (26.3. 2011), 2011.
[12] Tsung-Yi Lin, Michael Maire, Serge Belongie, James Hays, Pietro Perona, Deva Ramanan, Piotr Dollár, and C Lawrence Zitnick, "Microsoft coco: Common objects in context," in European conference on computer vision. Springer, 2014, pp. 740–755.
[13] David S Platt, Introducing Microsoft. Net, Microsoft press, 2002.
[14] David M Levine, Mark L Berenson, David Stephan, and Donna Lysell, Statistics for managers using Microsoft Excel, vol. 660, Prentice Hall Upper Saddle River, NJ, 1999.
[15] Patrick TM Nguyen, Jesus Lopez Amaro, Amit V Desai, and Adeeb WM Shana'a, "Multi-slot dialog systems and methods," June 5 2007, US Patent 7,228,278.
[16] Anjishnu Kumar, Arpit Gupta, Julian Chan, Sam Tucker, Bjorn Hoffmeister, Markus Dreyer, Stanislav Peshterliev, Ankur Gandhe, Denis Filiminov, Ariya Rastrow, et al., "Just ask: building an architecture for extensible self-service spoken languageunderstanding," arXiv preprint arXiv:1711.00549, 2017.
[17] Narendra K Gupta, Mazin G Rahim, and Giuseppe Ric- cardi, "System for handling frequently asked questions in a natural language dialog service," Mar. 27 2007, US Patent 7,197,460.
[18] Danielle Celentano, Guillaume Xavier Rousseau, Vera Lex Engel, Cristiane Lima Façanha, Elivaldo Mor- eira de Oliveira, and Emanoel Gomes de Moura, "Perceptions of environmental change and use of traditional knowledge to plan riparian forest restoration with relo- cated communities in alcântara, eastern amazon," Jour- nal of ethnobiology and ethnomedicine, vol. 10, no. 1, pp. 11, 2014.
[19] Greg Wilson, Jennifer Bryan, Karen Cranston, Justin Kitzes, Lex Nederbragt, and Tracy K Teal, "Good enough practices in scientific computing," PLoS computational biology, vol. 13, no. 6, pp. e1005510, 2017.
[20] Ryuichiro Higashinaka, Kenji Imamura, Toyomi Me- guro, Chiaki Miyazaki, Nozomi Kobayashi, Hiroaki Sugiyama, Toru Hirano, Toshiro Makino, and Yoshihiro Matsuo, "Towards an open-domain conversational sys- tem fully based on natural language processing," in Pro- ceedings of COLING 2014, the 25th International Con- ference on Computational Linguistics: Technical Pa- pers, 2014, pp. 928–939.
[21] Cenk Anil Bahcevan, Emirhan Kutlu, and Tugba Yildiz, "Deep neural network architecture for part-of-speech tagging for turkish language," in 2018 3rd International Conference on Computer Science and Engineer- ing (UBMK). IEEE, 2018, pp. 235–238.
[22] Siwei Lai, Liheng Xu, Kang Liu, and Jun Zhao, "Re- current convolutional neural networks for text classifi- cation," in Twenty-ninth AAAI conference on artificial intelligence, 2015, pp. 1–6.
[23] Sara Westberg, "Applying a chatbot for assistance in the onboarding process: A process of requirements elicita- tion and prototype creation," 2019.
[24] Mohammad Nuruzzaman and Omar Khadeer Hussain, "A survey on chatbot implementation in customer ser- vice industry through deep neural networks," in 2018 IEEE 15th International Conference on e-Business En- gineering (ICEBE). IEEE, 2018, pp. 54–61.
[25] Sepp Hochreiter and Jürgen Schmidhuber, "Long short- term memory," Neural computation, vol. 9, no. 8, pp. 1735–1780, 1997.
[26] Kai Sheng Tai, Richard Socher, and Christopher D Man- ning, "Improved semantic representations from tree- structured long short-term memory networks," arXiv preprint arXiv:1503.00075, 2015.
[27] Hang Li, "Deep learning for natural language process- ing: advantages and challenges," National Science Re- view, pp. 1–6, 2017.
[28] Ali Hamid Meftah, Yousef Ajami Alotaibi, and Sid- Ahmed Selouani, "Evaluation of an arabic speech cor- pus of emotions: A perceptual and statistical analysis," IEEE Access, vol. 6, pp. 72845–72861, 2018.
[29] Steven Bird, Ewan Klein, and Edward Loper, Natural language processing with Python: analyzing text with the natural language toolkit, " O'Reilly Media, Inc.", 2009.
[30] Robert Dale, "The return of the chatbots," Natural Lan- guage Engineering, vol. 22, no. 5, pp. 811–817, 2016.
[31] Junyoung Chung, Caglar Gulcehre, KyungHyun Cho, and Yoshua Bengio, "Empirical evaluation of gated re- current neural networks on sequence modeling," arXiv preprint arXiv:1412.3555, 2014.
[32] Jeffrey D Ullman and Alfred V Aho, "Principles of com- piler design," Reading: Addison Wesley, 1977.



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