A Review on Approaches in Arabic Chatbot for Open and Closed Domain Dialog

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***Abstract*—A Chatbot is a computer program which facilitates human-to-human communication between an artificial agent and humans. The Arabic language unlike the other languages has been used in Natural Language Processing in relatively fewer works owing to the lack of corpus along with the complexity of the language which has a number of dialects extending across various countries across the world. In the current scenario, little research has been conducted in the case of Arabic chatbots. This study presents a review about the existing literature on Arabic chatbot studies to determine knowledge gaps and suggests areas that require additional study and research. Additionally, this research observes that all relevant research relies on pattern matching or AIML techniques. The searching process was conducted utilizing keywords like 'utterance' 'chatbot', 'ArabChat', 'chat agent', 'dialogue', 'interactive agent', 'chatterbot', 'conversational robot', 'artificial conversational', and 'conversational agent'. Further the study deals with the existing studies and the various approaches in Open and Closed domain dialog system and their working in the case of Arabic Chatbots. The study identified a severe lack of studies on Arabic chatbots, and it was observed that the majority of those studies were retrieval-based or rule-based.**

***Keywords*—Arabic chatbot; artificial intelligence; arabchat; human-machine interaction; conversational agent**

I. Introduction

Artificial Intelligence (AI) research works like natural language processing (NLP) aids in developing new software solutions in computer science. One of them is the Chatbot or Chatterbot which is a high-intelligence technology. It was created to increase human-computer interaction by simulating a true human conversation by the use of diverse technologies and computer applications. Numerous areas of life, including customer support and companions for mental health, have seen extensive usage of chatbots. Arabic language chatbots powered by NLP and AI have been relatively rare because of the Arabic language complexity, despite advances in attaining human-like interactions. NLP advances are more readily accessible to computing resources and the communication techniques have facilitated the chatbot's rapid growth and deployment in several industries. One of the earliest systems of dialogue is Eliza which was created in 1966. Later, Weizenbaum created the ELIZA chatbot to mimic a psychotherapist[1]. PARRY attempted to imitate a paranoid agent in 1971[2], ALICE (Artificial Linguistic Internet Computer Entity) established by Wallace in 1995[3], inspired by ELIZA. They were created to mimic human behaviour in a text-based discussion and to pass the Turing Test within a certain domain.

A. Research Problem

The literature review reveals the chatbot development goals range from specific to wide range. In particular domains, such as healthcare, education, and industry, Chatbots primarily focused on specific topics. Thus, this paper aims to summarize classic, modern and dialect Chatbots for Arabic language. The work comprises of chatbots from close domain as well as open domain. Though English is the most frequently used language for chatbots, the technology has extended to other languages as well. Lack of Arabic corpuses has led to the reduced utilization of the language in several natural language processing technologies like chatbots. Moreover, the complexity of the Arabic language like rich morphology, higher intent of ambiguity, frequent orthographic variants and the number of dialects are also the reason behind the reduced usage of Arabic in Natural Language Processing.

B. Research Question

What are the techniques utilized to overcome the existing researches?

What are the keywords utilized in this study for searching process?

What are the purposes of open and closed domain dialog system?

C. Research Objectives

The study utilized Pattern matching and an AIML technique which documents the chatbots that interacted with users while speaking Arabic. The searching process was conducted utilizing keywords like 'utterance' 'chatbot', 'ArabChat', 'chat agent', 'dialogue', 'interactive agent', 'chatterbot', 'conversational robot', 'artificial conversational', and 'conversational agent'. The closed domain is used in situations where the amount of information needed to produce an appropriate response to an input is restricted. Similar to human conversation, the open domain will grow over time to support multiple conversation domains

D. Research Significance

The purpose of this study is to analyse the body of literature on Arabic chatbot studies, identify knowledge gaps, and suggest areas for further investigation. Additionally, this research notes that pattern matching or AIML approaches are used in every pertinent research. The study also discusses previous research and different Open and Closed domain dialogue system methodologies, as well as how they apply to Arabic chatbots. The study found a severe paucity of research

on Arabic chatbots and found that most of the research was retrieval - or rule-based.

The standard orthographic representation of Arabic not only determines the intended pronunciation of a written word in the language but also sets a special diacritic which is required to indicate the corresponding pronunciation. Various diacritics produce different kinds of words with different possible meanings for the same spelling form. In the case of most genres of written Arabic, however, these diacritics are usually omitted, resulting in an extensive ambiguity in the case of pronunciation and even meaning (in some cases). Even though native learners can typically infer the desired meaning as well as intonation from the sense, Arabic is frequently difficult to analyse automatically. While native speakers can quickly recognise the intended purpose and intonation from the background context, automated Arabic processing is often hindered by the lack of diacritics [4]. The subject of this paper is 'Arabic Chatbots'. The well-established approaches in closed and open domain dialogue system for Arabic language and the Chatbot applications are available for research in Arabic are numerous in number which are studied to a certain extent.

II. Background

The Chatter Bot's system design comprises three main components:

- Chat Interface - It is the component that communicates with users directly. Its primary role is to take in chat text as from users, pre-process them, and then send it to the Knowledge Engine and Conversation Engine for processing. It then relays chat text again to the users after receiving input from engines. It features a number of sub modules that make this work easier.
- Knowledge Engine - The variety of topics, which fall inside the purview of the chatbot's conversation are organized in the Knowledge Engine's Topic Hash Table. Every topic covers a wide range of information relevant to the specific domain being used. A series of contextual maps are used to encrypt specific data about every topic item in the hash table. Various goal fulfillment maps have been now used to realize the context maps.
- Conversation Engine - Based on the pre-coded criteria with in goal-fulfillment mappings chosen by the Knowledge Engine; moreover, the Conversation Engine component regulates the conversation path. This controls how the dialogue moves forward [3].

In Artificial Intelligence-Based Systems, machine learning algorithms are frequently utilized to generate replies to the input of the user. Since this system is primarily based on machine learning techniques, it is regarded to be more efficient than rule-based systems. Artificial intelligence-based systems can be categorized into two types[5]. They are:

- Retrieval-based model.
- Generative-based model [2].

Retrieval-based chatbots benefit from providing knowledgeable and fluent answers; they use response selection algorithms to find the appropriate reply for the present discussion from a repository [3]. According to Wang et al., most of the researches on retrieval-based chatbots emphasize on answer assortment of single-turn dialogues which take into account the most recent input message [4]. This kind of chatbot is well suited for use in domain-specific conversational systems [2]. According to Arfan Ahmed et al., scoping review, most of the chatbots are developed based on retrieval-based model [49]. Despite the fact that there are many chatbots in use today, Arabic-language chatbots are rather rare. Furthermore, compared to chatbots for other languages, Arabic chatbots have become less sophisticated. Moreover, the research suggested that extensive generative-based models, input and output modes, and NLP-based Arabic chatbots must be developed by researchers.

The generative learning model is a knowledge-based unsupervised learning paradigm. Large volumes of conversational information can be used by generative-based chatbots to start a new discussion. The generative-based model can combine different learning methods, such as supervised learning, adversarial learning, unsupervised learning, and reinforcement learning. Some trials and investigations were started when Wittrock first presented the sub-model in 1974 [6]. The system is trained so that it can create a reply in the process of a new query. While the Support Vector Machine (SVM) method generates output based on stated rules or database matching, a vast amount of data for training is used by generative model. The system then tries to produce newer replies in response to a new inquiry.

A. Dialogue System

A dialogue seems to be a discussion between two or more entities, whether they are artificial or human. Human-human conversation and human-computer conversation are the two main areas of dialogue studies. The latter participates in a dialogue system, a computerised system its aim is to converse in natural language with people. The development of dialogue systems nowadays includes graphic, spoken, written, and multimodal platforms. The systems which are adapted for the purpose of on-the-job learning are the dialogue frameworks. They have the ability to communicate with the users and ensure that proper feedbacks are received for further advancements[8]. Dialogue Systems are studied in a number of papers[4, 8-13].

1) Dialogue system design: As compared to the other speech and language processing domains, the user holds a great part in the dialogue systems. This makes it closely inclined to Human-Computer Interaction (HCI). The term Voice Strategy is used to describe the error messages, dialogue strategies and prompts. It follows the principles which is user-centred[15].The first of the principles is the studying the user and task concerned. Similarly, after the process, building of simulations and prototypes must be done followed by an iterative testing of the design on the users. The step by interpretation is shown in the form of a Fig. 1 as shown.

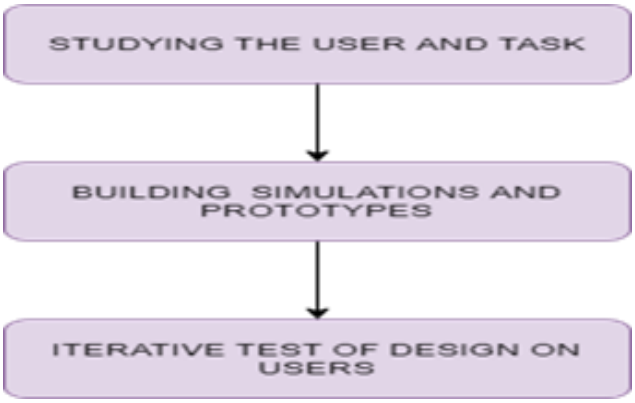

Fig. 1. Steps in Dialogue System Design.

*2) Classification of dialogue systems.*The dialogue systems' classification is an important aspect of all the research papers involved[4, 9, 16-18]. The Dialogue systems are basically divided into two types[14]. It is shown in the Fig. 2.

- Task-Oriented and
- Non-Task Oriented/ Chatbots.

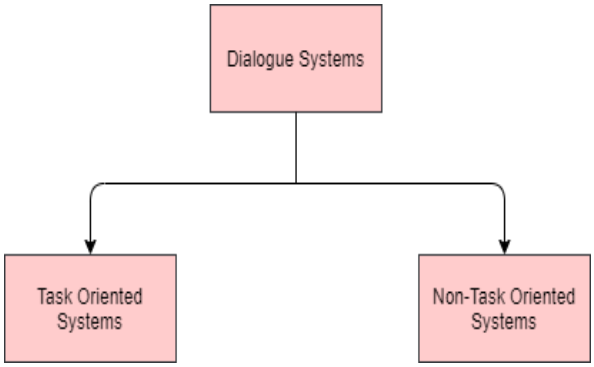

Fig. 2. Types of Dialogue Systems.

According to (Gao et al., 2019; Zhang et al., 2020) the conversational systems are classified into three main types as shown in Fig. 3. They are

- Answering Agents for questions.
- Task-Oriented Dialogue Agents.
- Chatbots.

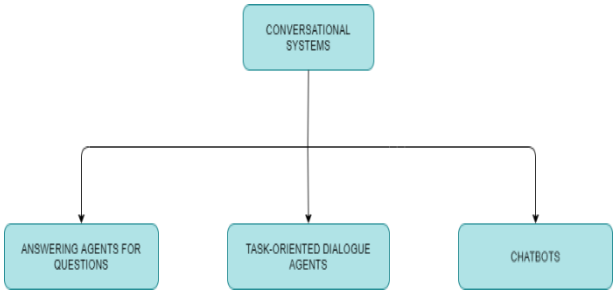

Fig. 3. Classification of Conversational Systems.

The classification of Dialog system has been studied by many researchers. Lee and Dernoncourt studied the recurrent and convolutional neural network with regard to preceding short texts. In the case of dialog prediction it achieves results based upon three different datasets. The model though produces predictions and performance of better quality, it is restricted to the sequential model it uses(Lee and Dernoncourt, 2016). The study makes it very evident that the Dialogue system seems to be an excellent instrument for user communication with any programme. This is a useful tool that can be employed with a variety of gadgets, including smartphones, PCs, and telephones. It might be a useful tool for helping users navigate websites that deal with topics like stock transactions, online shopping, information search, remote banking, route planning, etc.

B. Chat bots: An Overview

The human lives are integrated with Artificial Intelligence and this is evident from the creation of intelligent software as well as hardware along with the analysis of the same. One of them is the work of Himanshu and Rizwan who studied the mental model in Human Computer Interaction[19]. It has the capability to understand multiple languages of humans through the technology of NLP[20]. The functioning of AI systems were studied in[20], the turning tests and the concerned problems thereby redefining the machine intelligence. The importance of the work relies on its discussion over businesses like e-commerce and the other related domains. A much more detailed working of the chatbot system with the language processing system is needed in the work[21].

Chatbots can be categorized into Rule-Based or Corpus-Based systems, which are discussed as follows:

3) Rule-based chatbots: The Rule-based Chatbots or the Decision Tree Bots work based upon a series of well-defined rules or principle. A sample conversation of a Rule-based Chatbot is shown in Fig. 4. Conversations are mapped out by these chatbots in order to lay out a plan meeting the expectation of the customer and the chatbots must respond. Some of the famous rule based chatbots are ELIZA and PARRY[22].

4) Corpus-based chatbots: The Corpus-based Chatbots unlike the rule based chatbos mine the human-human conversation. A sample conversation of a Corpus-based chatbot is discussed by various researchers in one of his papers on spoken dialogue systems[18]. It is shown in Fig. 5. One of the advantages of using them is they are not based on framed out rules. Hence they require huge amounts of data for training[23].

General intent Chatbot's knowledge base must have been small, simple, and user-friendly to understand. Despite the fact that certain of the commercial solutions have only recently appeared, advancements must be done to discover a standard method for creating Chatbots.

The majority of corpus-based chatbots respond to user turns in contexts either utilising retrieval techniques (employing information retrieval to find a reply from a corpus,

which is suitable provided the dialogue contexts) or generation techniques (employing a language prototype or encoder-decoder to produce the reply provided the dialogue contexts). For interactions that are brief enough to fit into a particular model's frame, systems typically produce a solitary respond turn that is acceptable given the entirety of the dialogue up to that point. They are frequently referred to as response generation algorithms for this purpose. Thus, corpus-based chatbot methods borrow from question answering framework methods, which also emphasise single replies while disregarding longer-term conversational objectives.

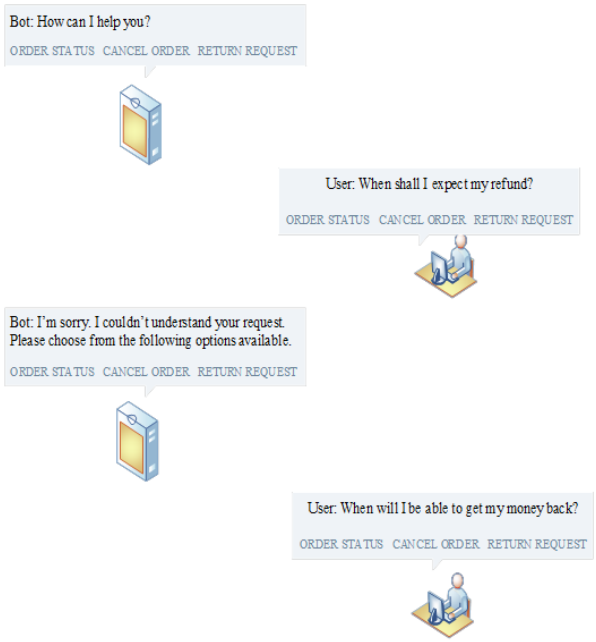

Fig. 4. Sample Conversation of Genius.

Fig. 5. Conversation of a Corpus based Chatbot.

A part of the research survey, databases of different literatures were used similar to the literature review of any paper[24]. The bibliography was compiled using widely referenced computer science resources such as Google Scholar, IEEE, Science Direct, Springer, and ACM. The searching process was conducted utilizing keywords like 'utterance' 'chatbot', 'ArabChat', 'chat agent', 'dialogue', 'interactive agent', 'chatterbot', 'conversational robot', 'artificial conversational', and 'conversational agent'. Papers were collected in the years ranging between 2004 and 2021 and reviewed based on their title and abstract, omitting those that did not demonstrate an Arabic chatbot implementation, which has been from the Google Scholar, Springer libraries, and IEEE. Studies documenting chatbots that interacted with users while speaking Arabic were considered in this investigation, irrespective of the users' categories, input and output methods, platforms, or topic of interaction. Nevertheless, chatbots that have been managed by a human operator were not included in this study.

III. Related Work of Arabic Chatbot

Despite the fact that Arabic chatbot implementations have been built, little research has been done on them. Al-Haj Bot, El-Kahwagy, Msa3ed, Theyabi, Rammas, and other services that offer Arabic chatbot applications created for commercial use seem to be some instances of the former. Additionally, there have been platforms like Watson by Telegram Bot, Messenger Bot via Facebook, IBM, and PandoraBot that offer creators coding assistance. Due to the paucity of published studies on these systems and apps, it was difficult to conduct a fair analysis and comparison. This study's objective is to showcase cutting-edge Arabic chatbot investigation. The Arabic language is classified into three dialects:

- Classical Arabic - Old Written type.
- Modern Standard Arabic (MSA) – The commonly used type.
- Dialectal Arabic – The dialect of natives across various regions.

Since the Middle Ages, the language's written form has deviated from dialectic Arabic. Although Modern Standard Arabic is basically written, the regional dialects are frequently used in spoken communication and daily interactions. In contrast to MSA, the dialects lack written grammatical rules and have their own morphology, syntax, and phonetics [4]. Chatbots are often created using either generative or retrieval-based methods. While retrieval-based methods profit from relevant and eloquent replies, generative approaches can produce additional relevant replies that wouldn't have surfaced in the corpus [25]. Pattern matching is a common technique for constructing the conversational agent in a retrieval-based model. In question-and-answer chatbots, where the machine compares the inputs to a specified framework and creates a reply, pattern matching has been most frequently used. Additionally, chatbots can have either brief interactions (one reply is generated for each Q&A session) or lengthy interactions (large number of data exchanged throughout interactions). Chatbots might be open (i.e., strive to serve various sorts of communication on various topics) or closed (i.e., fulfill a specific goal or topic; the information necessary for output answer is restricted) [49]. Chatbots have been

further splitted into two subcategories predicated on their domain of usage. They are:

- Closed domain.
- Open domain.

A. Closed Domain

The closed domain is used in situations where the amount of information needed to produce an appropriate response to an input is restricted. The creation of the ArabChat has taken a significant amount of time and effort. Table I shows a list of the closed conversation chatbots that has been discussed. In [26] Brini, Ellouze, Mesfar, and Belguith suggest the Question-Answering System for Arabic Language (QASAL) as an Arabic Question-Answering (Q-A) framework. A natural language question typed in Modern Standard Arabic (MSA) is provided to QASAL, which then outputs the best possible response. The system consists of three subsystems: a question assessment module, a text retrieval subsystem, and a reply extracting subsystem. These three components were processed using the language development tools known as the NooJ Platform. The content of the Quran restricts the conversation's scope. The foundations of the chatbot database are therefore retrieval-based. The group of the greatest crucial terms from the "Ayhas" that indeed java implementation pulls restricts the chatbot's interactivity and responses. The dialogue is brief since the chatbot responds to single user input with a single response.

Shawar demonstrates the usage of a chatbot in accessing Arabic Web Question Answering (QA) corpus without resorting to advanced natural language processing or inference. Java application was developed for converting textual corpus to AIML[27] chatbot linguistic model format, and the chatbot dataset was retrieved from multiple sources. Since it is impossible to predict regardless of whether a client will query the ALICE information base with the same queries, the standard file has been built using the initial and most important word techniques. Users could use Spanish, English, and Arabic to engage FAQ chatbot platforms. A modest collection of 412 Arabic QA spanning five themes was also created from a variety of Web sites, including fasting and its linked health concerns, women and their reproductive wellness, dental care, blood illnesses like diabetic and cholesterol, and donating blood. Additionally, the user submits a textual query in MSA to the chatbot regarding one of the available domains, and the chatbot responds with the appropriate response[28] [29]. The user enters a text inquiry in MSA regarding one of the allowed domains, as well as the chatbot responds with the appropriate response even without usage of complicated NLP. The text corpus has also been converted using Java software to produce the explosive and standard AIML documents. The queries and responses that occur in the corpus are contained in the binary file. The utilization of the usual file ensures that the customer's query is translated to the relevant query kept in the information base. Additionally, the file is constructed utilising the first word as well as most important word method. The most important word seems to be the least common in the query, while the first word serves as a classifier for the query. After tokenizing the query, the latter is accomplished by creating a list of frequently asked questions. The terms in the query, together with respective frequencies, are included in the created list. The method then takes the two least common terms from the list—which are also the two most prominent words—and uses them as keywords to connect the inquiry to a response. The most crucial word strategy was used to boost the anticipated output's rate. The chatbot was evaluated with fifteen questions, with a success rate of 93 percent. The primary disadvantage of this paradigm is that if the structure of the question is in an altered form in the knowledge base, then what will be stored, then the replies of the chatbot will be an incorrect one. The chatbot doesn't employ a heuristic to choose the appropriate response but instead relies on a direct retrieval mechanism. Additionally, when the Arabic query is rewritten in its original form, one of two things occurs: either no response is generated, or a similar but erroneous response is obtained. Moreover, a success rate of 93 percent is unjustifiable when using a sample of only fifteen questions.

Abdullah [4] implements an approach known as Pattern Matching. Abdullah CITS has been basically an Arabic Conversational Intelligent Tutoring System (CITS) which educates about 10 to 12 fundamental Islamic concepts. This online system is capable of communicating with MSA students. These pupils are given a series of questions and then addressed their responses in Classical Arabic, citing evidence from the Hadith and Quran or the traditions and sayings of the Prophet Muhammed of Islam. The system communicates with pupils via pictures and sound effects, and it is capable of determining a student's level of expertise and guiding the dialogue. Abdullah CITS is capable of distinguishing between a user's questions and responses. A comprehension base with subject-specific data, a communicative agent coding language for providing tutorial conversations to trainees, and a tutorial comprehension base for assessing every student's abilities of subject-specific insight make up the system, which uses a Pattern Matching method [30].

A. Shawar and E. Atwell published one of the early studies on Arabic chatbot applications [31]. They communicated with the ALICE chatbot (Artificial Linguistic Internet Computer Entity). Here, the techniques of Machine learning (ML) were employed to create an Arabic chatbot that receives input of the user in Arabic and answers with Quranic quotes. The Quran is comprised of 'Ayahs' or 6236 verses and 114 'Surahs', or collections of verses. The user provides the Arabic words with 'Tashkil' or diacritics in the form of phonetic guidance. The chatbot then responds by searching the Quran for "Ayahs," containing the user's comments. Since Quran text is not conversational, Java software was designed to establish a learning mechanism. The learning process is guided by the Ayah, the most critical word in the AIML file and prototype's "Ayha" category. The Java software creates an AIML file in Arabic. The chatbot dataset origins are retrieval-based. However, feedback from Arabic evaluators indicates that entering vowels in Arabic words is difficult. Another argument that does not satisfy users is the random selection of an object from the list; if the word(s) is repeated in more than one Ayya, one is chosen randomly. They also found that not all words have a response related to the least frequently used word technique. The content of the Quran also limits the

dataset; hence this is a retrieval-based model. This project aims to demonstrate how the ALICE chatbot has evolved to learn from non-conversational content. The chatbot's ability to engage and respond is constrained by the set of "Ayhas" words, which the java programme has identified as being the most important.

Hijjawi, Bandar [32] develops ArabChat, the first version of Chatbot of Arabic. ArabChat is a web-based conversational agent system. The chatbot conversation is Arabic task-oriented, and it was created to support students at Jordan's Applied Science University. Pattern Matching is used to manage user conversations in the system for creating the Arabic Conversational Agent (ArabChat). The hybrid rule mechanism and the user classification approach were used to solve issues in the first version of ArabChat.

ArabChat Mobile [33] is a mobile-based conversational agent which serves as a student counselor at Amman's Applied Science University based on ArabChat's original code[32]. It is a streamlined Android version of ArabChat. The ArabChat CA and Mobile ArabChat system are rule-based CAs that include a scripting language, a temporal memory, an information container brain, a scripting engine, and a user interface. Additionally, the Mobile ArabChat employs the Pattern Matching PM method to handle Arabic textual chats. Although users in Arab nations suffer several obstacles, including poor and inconsistent internet connections and limited capacity, this program operates despite these limitations. Mobile ArabChat employed a pattern matching method predicated on text. In terms of its programming engines, programming language, as well as knowledge repository, this architecture is similar to ArabChat. 96 percent of customers concur that utilizing Mobile ArabChat on a smart phone is preferable to doing so on a computer. On the other hand, mobile ArabChat requires internet connection for working. This result may appear satisfactory at first glance, but for the most reliable results, manual analysis of the Mobile ArabChat logs is required. The outcome revealed that 83.2 percent of the inputs corresponded to the anticipated outcome. However, Mobile ArabChat requires an internet connection to function.

In [34] an Arabic interaction platform or conversational interface is presented by Moubaiddin, Shalbak, Hammo, and Obeid. It is intended to communicate with hotel guests and generate responses about booking hotel rooms and other operations. The technology makes use of text-based human language conversation. The two key components in this architecture are the analyzer and the dialogue controller. They have chosen to use the Government and Binding (GB) theory to construct a GB-based analyzer [35]. Users can bargain a desired appointment, as well as question about the rooms and amenities offered by the hotel. They report the findings of an actual study that involved 500 participants who've been total newcomers to the method. The system was to be used by the customers, who have been then asked to score the conversations as "extremely bad," "bad," "moderate," "good," or "extremely good." 92.3 % of the conversations received "good" or "extremely good" ratings, making up 66.92 percentage of the total. The usage of an Arabic conversation system to solve the issue of participatory Arabic dialogues is supported by these outcomes. The system, which allows users to make hotel reservations using written Arabic text, could be improved. The system does not employ a morphological analyzer to provide important word characteristics such as clitics, number, and gender. Additional criteria for including more phrase patterns and other grammatical elements, including subject-verb alignment on numbers and gender, aren't also included.

Al-Ajmi, A. H., & Al-Twairesh, N. suggest a hybrid rule-based/data-driven method in [36] for a text-based flight booking DS ability of handling consumer utterances. The suggested DS was developed using the natural language interface Wit.ai. The Wizard of Oz technique was used to establish the conversation flow, and crowdsourced training samples were used to develop the DS intents and entities. The evaluation outcomes indicate that the designed system has been capable of comprehending user words and self-feeding effectively. They proposed a hybrid method to data science development that addresses the difficulty of establishing a data science system with limited training data. Furthermore, they designed a DS that utilises a hybrid method to fulfil flight booking tasks by leveraging current DS programming frameworks. Additionally, they evaluated the method in two steps to ascertain the DS's capacity for self-feeding. They use a pipeline architecture methodology and a combination of rule-based and data-driven methodologies. Users can text-book airline tickets in Arabic using this method. According to the assessment results, the suggested methodology was a quick and easy way to book tickets as users gained experience. As more information about member booking times was provided, the system learned. Effectiveness of the DS was severely hampered by the lack of training examples, which researchers tried to lessen by giving the DS self-feeding capacities. They did not, however, imitate real-world flight booking systems. In addition, they did not integrate their DS with an existing reservation system. Although the total experience of ordering a flight ticket via the created flight booking DS was favourable, 52 per cent of participants reported having difficulties comprehending Telegram commands, believing they needed to restart the discussion in order to begin booking. As a result of the misunderstanding, the orders' explanation message is displayed. Additionally, there are no buttons or a greeting message to send following the description of the commands. Another issue was that their system did not notify the user when to begin the booking.

Hijjawi, Bandar [37] and Hijjawi, Bandar [38] developed a previous research project called ArabChat. ArabChat closed domain in Jordan’s Applied Science University was chosen as a knowledge point guide for their innate Arabic students in the chat. They use a hybrid rule mechanism as well as a user classification approach. After that, the revisions were included in the final output. The utterance classification function makes an attempt to distinguish between utterances that are and are not inquiries. It accomplishes keyword matching by supplementing the pattern of the question-based rule with additional keywords. The second function is Hybrid Rule, which is concerned with responding to and dealing with an utterance that encompasses multiple themes. Manual examination generated more precise results and shown

performance enhancement, even if ArabChat provided a Ratio of Matched Utterances to the Total (RMUT) outcome that was more precise than the enhanced one brought about by unintellectual users. While carefully reviewing logs, Improved ArabChat correctly processes 82% of phrases with two subjects, and this proportion decreases as the amount of items in the phrase increases. Al Humoud and Al Wazrah [7] claim that is manually classifying utterances reveal a large proportion of query-based phrases because of three factors: the area chosen, the users' demands, which lead them to ask rather than discuss, and the complexity of scripting multiple rules.

TABLE I. SHOWS A LIST OF THE CLOSED CONVERSATION CHATBOTS

Author	Language	Domain	Approach
Shawar, B. A., & Atwell, E 2004	English/ classical Arabic	Closed (Quran book)	AIML
Shawar, B. A. 2011 and Brini, W., Ellouze, M., Mesfar, S., & Belguith, L. H. 2009	Arabic MSA	Closed Medical care	AIML
Shawar, A., & Atwell, E. S. 2013	Classical Arabic	close domain, quran book	AIML
Alobaidi, O. G., Crockett, K. A., O'Shea, J. D., & Jarad, T. M. 2013	Classical Arabic /MSA	Close(teach Islam for children)	Pattern matching
M. Hijjawi, Z. Bandar, K. Crockett, & D. Mclean 2014	Arabic MSA	Closed (for students of Applied Science University)	Pattern matching Rule-base
Hijjawi, M., Qattous, H., & Alsheiksalem, O 2015	Arabic MSA	Closed (for students of Applied Science University)	Pattern matching Rule-base
Moubaiddin, A., Shalbak, O., Hammo, B., & Obeid, N. 2015	Arabic MSA	Closed Hotel reservation	GBbased parser
M. Hijjawi, Z. Bandar, & K. Crockett 2016	Arabic MSA	Closed (for students of Applied Science University)	AIML
Aljameel, S. S., O'Shea, J. D., Crockett, K. A., Latham, A., & Kaleem, M. 2018	English/ Arabic MSA	Close (for children with Autism Spectrum Disorder)	Pattern matching Rule-base
Al-Ghadhban, D. and N. Al-Twairesh 2020	Arabic MSA	Close for student of King Saud University Information Technology (IT) acting as an academic advisor	AIML
Al-Ajmi, A. H., & Al-Twairesh, N. (2021)	MSA	One domain for flight booking	hybrid rule-based and data-driven

LANA was developed to help autistic children with Autism Spectrum Disorder (ASD) aged 10-16 years old learn more effectively by adapting Visual Auditory Kinaesthetic (VAK) learning styles. They have a basic understanding of the mechanics of Arabic writing and can use MSA to teach them science topics. For kids with ASD, conventional education is challenging since the teacher can't cater to the requirements of every single student. Using pattern matching as well as a short text similarity method, LANA seems to be equivalent to Abdullah CITS (Arabic Conversational Intelligent Tutoring Sys-tem), but still it endorses a wide range of learning genres, such as visual, hearing, and proprioceptive. This allows kids to practise training skills autonomously predicated on their unique needs [39].

In [40] created "Nabiha," a chatbot that can converse with King Saud University Information Technology (IT) students employing the Saudi Arabia language. Nabiha is accessible on Twitter, web, and Android, among other platforms. As an academic adviser, the Nabiha can converse with students and answer their questions about the IT department's courses or their academic achievement at KSU. Thirteen students practice the Nabiha chatbot and offer replies via a survey to ensure the chatbot's usefulness. Twitter have tried Android and web technologies because its textual area only supports a limited number of characters. Several learners who were asked to envision who Nabiha was thought of her as a professional in the IT division, whereas others thought of her as a graduate candidate with substantial training. Nabiha is a robot, according to only one human. The AIML files were created by converting the readable text from the corpus into AIML format using a java program. Nabiha chatbot was launched on the Pandorabots platform after ALIM files were generated, and it was later integrated with Android, Twitter, and the Web. However, even though the dataset contained 1104 categories, Nabiha still needs to be enhanced. HTML tags have an issue, and some sentences are incompatible with Twitter's text area scale, which is very large.

Bendjamaa and Nora proposed a discussion method based on Quranic ontology. The ontology under consideration comprises Quranic chapters and verses and each Quranic term, its origin, and lemma. The system is an Arabic-language natural language communication system. The user's input must be processed first, followed by segmentation, and finally by establishing a semantic route. Additionally, a module is required to access the ontology and retrieve the data. The system admits as input an Arabic spelling string (arrived by the client). This project, which was developed in Java, was implemented using the CoreNLP plugin. Its purpose is to make Islamic knowledge more participatory. The performance, however, is either in Arabic or English, depending on the ontology and the response to the inquiry. If an Arabic version of the answer is available, the output will be in Arabic; otherwise, it will be in English [41]. Although this project permits easy admit to Qur'anic data, it needs to add more querying functionalities. As a result, it does not help a lot of non-Arabic speakers. Syntactic mistakes in the inquiry are some other problems that are not addressed. Additionally, it does not extensively cover Islamic scholarship and legal sources.

B. Open Domain

Similar to human conversation, the open domain will grow over time to support multiple conversation domains.[42] Makatchev and co-authors Hala discusses a bilingual (English

and Arabic) robot administrator at Qatar's Carnegie Mellon University. The investigators compare Hala's English conversation vocabulary to that of a comparable monolingual robotic on the campuses of Carnegie Mellon University in Pittsburgh to verify the installation of Hala (named "Tank"). Hala's purpose is to provide information on campus directions, weather, and area events and respond to inquiries about her personal life. A rule-based conversation manager, which consists of an information base with prepared statements and criteria that trigger responses in English as well as Arabic, has been used by the robot to interact with people. The English information base currently has a much wider range of topics covered. In addition to Hala's spoken answer, a text appears on the monitor next to her image.

IbnSina [43, 44] is a dual-language conversational robot capable of communicating Arabic and English. The user controls it via text or voice inputs. The IbnSina robot responds with audio output in the language specified by the user. The IbnSina robot develops human-to-human contact discourse by utilizing Wikipedia and a locally stored Quran database. As a result, the Chabot of the IbnSina robot can address a wide variety of subjects. As a result, it responds to general inquiries by translating terms, providing online resources, or referring to books stored in its database. Additionally, it warns the user when certain pieces of information are missing or incorrectly spelled. As a result, IbnSina's approach to dialogue is open and extensive. However, because it relies on the information that has already been described in the database to react with the proper output, it does not produce new responses. The IbnSina dialogue system is built on object-oriented methods like the Quran class and Wikipedia class, which permit the robot to respond with the required response, as well as the chatterbot class, which allows for simple discussion and user query responses. Additionally, a chatterbot module has been developed that responds to human input.

In [32] and [45] the ArabChat's effectiveness was increased by differentiating between statements that contained questions and those that did not by classifying Arabic phrases as conversation activities predicated on structural traits found in Arabic function phrases. To study the approaches for categorizing statements into inquiries and non-inquiries using function words, a database of statements has been compiled from diverse sources. These sites were chosen to reflect various issues in the Arabic language, including politics, religion, sports education, and business. 1000 statements make up the resultant database, known as the "CA Database" (500 queries and 500 non-queries). The artificial non-inquiry phrases and the indirect inquiry, in contrast side, were absent from the "CA Database." As the first step in creating the ArabChat categorization method, the "CA Database" was loaded into a ML toolkit for categorization and rule creation. Researchers chose WEKA (Waikato Environment for Information Analysis) as that of the ML toolbox because of its open-source nature. The outcome reveals that 73.56 percent of the inputs corresponded to the anticipated output.

However, ArabChat requires a technique that distinguishes between query-based and non-query-based statements that resolves the same rule. This is because each utterance type (query-based and non-query-based) requires a unique response, even though they target the same rule. Additionally, the number of predefined patterns per rule increases, reducing ArabChat's ability to respond with appropriate responses. Additionally, there is the requirement for a technique that deals with utterances discussing various themes, which necessitates the firing of several rules (each rule has one topic). Finally, it is beneficial to keep the number of required patterns to write to a minimum.

The authors introduce "BOTTA," an Arabic dialect chatbot, in[46]. BOTTA seems to be a communication partner that mimics friendly human interaction by speaking Egyptian Arabic (Cairene). BOTTA is the first Arabic-language chatbot in the world. BOTTA strives to be the Rosie of Arabic dialects; Rosie is a chatbot that communicates in English. BOTTA was created using artificial intelligence and is now available on the Pandorabots platform. The information base of BOTTA has been made up of set data contains themed terms and phrases,, mapping documents storing pairings of linked words and sentences, and AIML documents containing categories including its replies to user inputs. Additionally, the BOTTA chatbot collects essential information about the user during each discussion via questions, resulting in an open dialogue due to the chatbot's ability to react to various topics. It is constructed based on a retrieval-based paradigm. It uses a retrieval-based approach rather than adding new answers or updating the information base. It makes use of algorithms to select a suitable response from a range of pre-written ones. Furthermore, before answering properly, the chatbot doesn't perform text normalisation on the user input. When performing orthographic changes, it also fixes common spelling errors in user input. By employing this technique, BOTTA has been able to fix 85.1% of typical spelling mistakes in Arabic typing. Three people also put BOTTA towards the test. One Levantine Arabic person and two native Egyptian Arabic learners make up the total, which does not meet the requirements for a passing grade.

The authors of [47] give the Arabic Reading Comprehension Dataset (ARCD), which contains 1,395 questions posed by crowd workers on Wikipedia articles, as well as a machine translation of the Stanford Question Answering Dataset (Arabic-SQuAD). The system for open-domain question answering in Arabic (SOQAL) is composed of two components: (1) a document retrieval component that utilizes the hierarchical TF-IDF approach, and (2) a neural reading comprehension component that utilizes the pre-trained bidirectional transformer BERT [24]. Their ARCD trials demonstrate the efficiency of their methodology, with their BERT-based reader attaining a 61.3 F1 score and their open-domain system SOQAL attaining a 27.6 F1 score. However, this approach should increase the size of ARCD. Additionally, this work is not focused on paragraph selection but rather on improving the end-to-end system.

To construct a CA in the Arabic Gulf dialect, T. Alshareef and M. A. Siddiqui used a deep-learning architecture dubbed the Seq2Seq neural network. They framed the CA problem as a machine translation task and trained and evaluated the model using post–reply to tweets. They employed the Bilingual Examination Understudy (BLEU) scores and professional reviewers to assess how pre-trained encoders affected a

convolutional neural network's efficiency. The model fared better than earlier deep learning systems since it was trained on more databases and in more languages [48]. The method has attained the BLEU score as 25.1. However, they do not concentrate on the mechanism for developing a baseline against which this work can be compared. Additionally, when doing the automatic measurement, BLEU, it is necessary to compare the result to many references, as each sentence does not have a single accurate response. Table II shows the table type styles. To improve the model's ability to engage in fluent discourse (i.e., a dialogue with numerous turns), rather than simply reacting to a single remark.

TABLE II. TABLE TYPE STYLES

Author	**Language**	**Domain**	**Approach**	**Interaction**	
				Input	***output***
Maxim Makatchev , Imran Fanaswala, Ameer Abdulsalam, Brett Browning 2010	English / Arabic (Arabizi / MSA)	Open	AIML Rule-base	Text	Text /voice
Riek, L. D., Mavridis, N., Antali, S., Darmaki, N., Ahmed, Z., Al-Neyadi, M., & Alketheri, A 2010 ,and Mavridis, N., AlDhaheri, A., AlDhaheri, L., Khanii, M., & AlDarmaki, N 2011	**English / Arabic (MSA)**	Open	**Pattern Matching**	Text /voice	**Voice**
Hijjawi, M., Bandar, Z., & Crockett, K 2013 Hijjawi, M., Bandar, Z., Crockett, K., & Mclean, D. 2014	Arabic MSA	Open	**Pattern Matching**	Text	Text
Ali, D. A., & Habash, N. 2016	**Egyptian Arabic dialect**	Open	AIML	Text	Text
Hijjawi, M., Bandar, Z., & Crockett, K 2016&2013	Arabic MSA	Open	Hybrid Rule	Text	Text
Mozannar, H., et al. 2019	Arabic (MSA)	Open	hierarchical TF-IDF and BERT	Text	Text
Alshareef, T., & Siddiqui, M. A. 2020	Arabic Gulf dialect	Open	Rule-based	Text	Text

According to the evaluated papers, retrieval-based modeling is used in all of the work that has been done on Arabic chatbot implementations. In other words, the information pool from AIML documents, databases, or web pages is what the chatbot answers are built on. The key finding of this study is the scarcity of Arabic chatbot literature. Most chatbots were built using a rule-based model. This once more demonstrates how little Arabic is used in more sophisticated systems. Because of the language intricacy, Arabic NLP has been developing more slowly than other languages. Relatively fewer Arabic chatbots use NLP methods. Future research might likely concentrate on figuring out the best way to combine many approaches to chatbot development in order to maximize the usefulness of each approach, even the most straightforward.

IV. DISCUSSION

According to the evaluated papers, retrieval-based modelling is used in all of the work that has been done on Arabic chatbot applications. In other words, the data pool from AIML files, databases, or web pages is what the chatbot responses are built on. It may restrict the chatbot's functionality and usability. Additionally, it should be noted that all relevant work relies on AIML or pattern matching techniques. This could result in 1) a tiny dataset for the chatbot as well as a limitation to closed domains. 2) Limits the chatbot's response to the user, in which the right answer can only be obtained if the user's input fits the chatbot database. Additionally, one of the causes Arabic chatbots in the literature lack certain features is due to the intricacy of Arabic grammar and user errors in spelling and grammar, which explains why there aren't many Arabic chatbot programmes available in both text and speech.

V. CONCLUSION

A review on the available Arabic chatbots is done in the study. The papers collected were basically divided into two categories based on the form of chatbot conversation or interaction as closed and open domain. Because of the complexity of the language and the lack of Arabic Corpuses, the available chatbots in the language is low compared to that of English and hence limited papers are available for the research. This study discovered the dearth of researches on Arabic chatbots and among those works, it is found that the major part of the available literature is retrieval-based or rule-based. Furthermore, the majority of the Arabic Dialog Systems discussed earlier is text-based and employ a rule or pattern-matching technique. Only a fewer of them have developed enhanced system functionality through the use of Short Text Similarity in conjunction with a rule-based approach. Additionally, it has been suggested[30] that the pattern matching approach is preferred despite its limitations due to the difficulties associated with developing Dialog Systems in Arabic. Future studies should perhaps focus on determining the optimal way to integrate many ways to chatbot development in order to maximise the utility of each method, even the simplest.

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