

An inquiry smart chatbot system for Al-Zaytoonah University of Jordan

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ABSTRACT

Chatbots are important in artificial intelligence (AI) and natural language processing (NLP). The development of the chatbot is viewed as a continuous issue in the field. This is suitable for Arabic chatbots that are not widely available. This study aims to fill the gap in Arabic chatbot development by creating an Arabic chatbot system for university admissions. The system uses a deep neural network model and a manually constructed dataset for conversation pairings, utilizing the Jordanian Arabic dialect from Al-Zaytoonah University of Jordan's (ZUJ) website. The system efficiently answers most user queries, improving the counseling experience and reducing workload in the admissions department. The adoption of this system also minimizes website traffic congestion. The study contributes to the improvement of Arabic chatbot technology by creating a deep learning-based system optimized for university admissions, demonstrating its potential impact in the Arabic-speaking context. Future research can further enhance the system's capabilities and its applicability in other disciplines.

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1. INTRODUCTION

Businesses that are currently affected by the COVID-19 pandemic understand how crucial it is to integrate digital transformation into their daily operations. As a result of the markets' lockdown, it is obvious that their businesses should be initially digitized to improve their economic situation by incorporating more technological elements [1], [2].

Accordingly, artificial intelligence (AI) has focused on learning processes recently [3], [4]. An important step toward transforming higher education into the future workplace is the adoption of AI conversational agents [5], [6]. This could be across colleges and universities as they are being considered a useful technology to support learning [7]. Indeed, the idea of using a human language to communicate with computers holds merit for AI [8].

AI includes many fields, one is natural language processing (NLP). It is a branch of AI that enables human-computer interaction and communication by using a natural language [9]. Natural language refers to a human language (for example, English, Arabic, or Spanish). NLP's advancements have also improved the ability of computer-based applications to interpret many languages [10]. Consequently, several applications have emerged to support NLP, whereas chatbots are an example of the most interesting AI applications that use natural language. It is considered an intelligent conversational agent that interacts with human users via natural language and emulates human conversations [10].

The chatbot system is often used in many large-scale applications [11]. It is a type of contemporary computing program that mimics humans' communications, or "chitchat", by using different textual or vocal interfaces [11]. The idea behind this technological advancement is to provide users with instantaneous answers to questions they might likely ask during phone calls or email conversations [11]. This has been shown to increase users productivity and cut down on the amount of time spent when performing particular tasks [11].

Chatbots are chat applications with a robot on one side of the conversation who can respond to any voice or text, as the name suggests [12]. Such applications can be used in various places, from voice-activated assistants (e.g., Amazon Alexa and Google Home) to text-activated assistants (e.g., messenger apps and S.M.), [13]. Additionally, these applications are easy to use and can provide information in various languages, making them useful to a wide range of institutions across the globe [13].

Research has recently concentrated on chatbot technology that has been developed to be used in many different fields [13]. In the past few years, this area has attracted further interest from research and industrial fields [13]. Chatbots are used in a variety of organizational settings in which they can replace humans' actual behaviors. These structures are based on ELIZA and artificial linguistic internet computer entity (ALICE) communication methods [14].

In 1966, ELIZA was the first chatbot developed at the Massachusetts Institute of Technology (MIT) by Weizenbaum [14]. It emulates a psychotherapist [14]. Afterward, ALICE, an award-winning free chatbot, was created using artificial intelligence markup language (AIML) [14]. Furthermore, several chatbots for various languages and fields have been developed.

The inherent role of chatbots is to comprehend users questions and provide the most appropriate responses, intelligently and naturally. Consequently, chatbots have been extremely successful in some of the most spoken languages, where many chatbot applications have emerged in the English language [14].

Since 1960, English chatbots have been considered the subject of extensive research [14]. Nonetheless, Arabic chatbots have not reached the expected level [14]. This is uncommon due to the inherent characteristics and complexity of the Arabic language [14], [15]. Therefore, processing Arabic language texts has a lot of challenges [14], [15], such as rich morphology, a high degree of ambiguity, orthographic variations, and the existence of multiple dialects.

Although modern standard Arabic (MSA) represents the academic and written standard, as it is displayed in several languages, this is not considered to be the version with which people communicate with each other daily [14], [15]. There are a few differences between classical Arabic (CAL) and MSA; for instance, spoken Arabic [15] possesses a simpler grammatical structure. It also possesses a few letters pronounced differently which are also different based on their dialect. Apart from these comparisons between the DA and MSA, there are other several comparisons among the Arabic dialects.

Arabic is considered one of the world's most widely spoken languages, with 28 countries declaring it their official language [16]. Moreover, the Arab world has a population of about 369.8 million people and a geographical area that stretches from Morocco to Dubai. And, with such a vast territory to cover, it's no surprise that this language has so many distinct and important dialects [16], [17].

In this study, an Arabic chatbot in the Jordanian dialectal Arabic (DA) is developed. It is known that the Arabic language is in a state of diglossia, where the formal language used in written form differs radically from the one used in everyday spoken language [17]. Moreover, as mentioned previously, spoken language differs in different Arabic countries, producing numerous Arabic dialects [17].

Until recently, DA was mostly spoken and was never found in written form [17], [18]. The spread of social media has changed this trend, as Arabs now use DA on these social media websites [18]. Hence, using DA is more convenient for Arabs; therefore, we propose to use the Jordanian DA for developing the Arabic chatbot.

The proposed system is a social chatbot that can have a conversation with the students of Al-Zaytoonah University of Jordan (ZUJ) using the Jordanian DA. It can assist students with queries concerning the admission department at ZUJ using the Jordanian DA. This system is made available on both platforms, including Facebook and ZUJ's website [18].

The rest of this paper is organized as follows: section 2 presents a comprehensive theoretical basis on the topic. Section 3 presents the proposed method. Section 4 highlights the method by using NLP and deep learning techniques. Section 5 provides results and discussion. And finally, section 6 draws the conclusion remarks.

2. COMPREHENSIVE THEORITICAL BASIS

2.1. Chatbot systems

A chatbot is a piece of intelligent software that can communicate and conduct activities that are similar to those of humans [18]. Chatbots are widely applied to support customer service, social media

marketing, and instant messaging systems [19]. Their development is based on two primary types of chatbot models, which include retrieval-based models and generative-based models.

Three significant components are included in a chatbot system [19]. These comprise the conversation engine, the knowledge base (or brain), and the interface. The interface handles user input and output by supporting seamless communication among them [19]. The knowledge base functions as a repository for information and stores the content of a conversation. Additionally, it keeps tracking the domain that represents a particular subject in which the chatbot specializes. Finally, the conversation engine handles the context of the semantic conversation by emphasizing that responses are not irrelevant and are appropriate within the related domain [19]. This implies that the chatbot system can comprehend and respond to users inquiries that are particular to the selected domain (here, the university admissions department) [19]. And so, the domain knowledge that is stored in the knowledge base and is handled by the conversation engine allows the chatbot to contextually and accurately respond to users queries regarding university admissions [19]. Figure 1 represents the components, which are mentioned in [19].

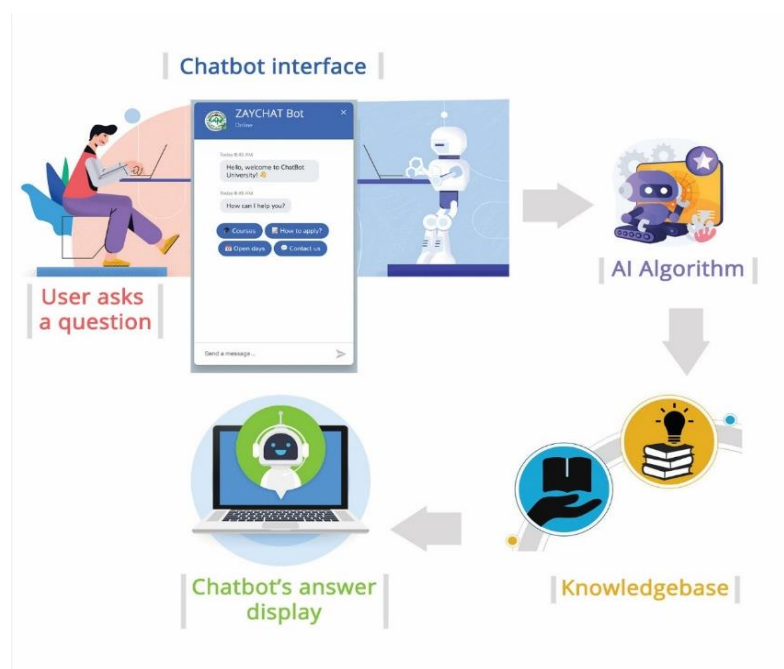


Figure 1. The chatbot system's main components

2.2. The challenges of the arabic NLP

Arabic chatbots are uncommon because of the nature and complexity of the Arabic language [19]. The use of chatbots in Arabic is a relatively recent trend. However, the following represents some main challenges that chatbot systems could face when using Arabic chats: firstly, the dialectal variation: the Arabic language consists of several variants that are quite different from each other [19]. One is the MSA which possesses the official written and read languages, several dialects, and the spoken forms of the language. Moreover, the MSA has an official standard orthography and a relatively large number of resources, various Arabic dialects have no standards and only a handful of resources [20].

Further, Arabic dialects vary from the MSA in terms of phonology, morphology, and lexicon. These Arabic dialects are not recognized as languages in the Arab world and are not taught in schools. However, DA is commonly used in online chat. Therefore, it is more appropriate to focus on DA in the context of a chatbot [20], [21].

Secondly, the orthographic ambiguity and inconsistency: Arabic orthography represents short vowels and consonant doubling by using optional diacritical marks, which most commonly are not included in the text [20], [21]. This yields a high rate of ambiguity. Furthermore, Arabic writers make very common mistakes while spelling several problematic letters, such as "Alif-Hamza" and "Ta-Marbuta" forms [20], [21]. This issue of orthography is exacerbated in Arabic dialects where no standard orthographies exist [20], [21].

Thirdly, the morphological richness of Arabic words is inflected for numerous features such as gender, number, person, voice, and aspect, as well as accepting several attached clitics [20], [21]. In the context of the chatbot system, this proves that such a system is extremely challenging [20], [21]. Furthermore, the verbs, adjectives, and pronouns are all gender-specific, which requires the chatbot to include two different systems of responses: one for male users and the other for female users [20], [21].

And fourthly, the Idiomatic dialogue expressions: similar to any other language, the Arabic language has its own set of unique idiomatic dialogue expressions [20], [21]. One common class of such expressions is the modified echo greeting response. For instance, while the English greeting “good morning” gets an echo response of “good morning”, the equivalent Arabic greeting is “صباح الخير”, which is in English pronounced as “sabah alkhair”, which means “the morning of goodness” [21], [22]. This gets a modified echo response of “صباح النور”, which is in English pronounced as “sabah alnoor”, and which means “the morning of light” [22]. Consequently, these challenges require an Arabic-speaking chatbot system with unique databases, as opposed to a machine translation wrapper around an existing English-speaking chatbot [22].

2.3. Related research

A chatbot is programmed to support several human languages [22]. In this section, previous studies and applications similar to the proposed system are discussed in brief. To the best of the authors knowledge, there are not many studies, that have been conducted on Arabic language chatbot systems [22]. The reason behind this refers to the difficulties faced by foreign researchers who are experienced enough in the Arabic language [23], [24].

For instance, in [25] a method to access the Arabic web question answering (QA) corpus using a chatbot is presented. This is done without the need for advanced NLP or logical inference. The approach works well with English and other European languages, and the study aims to compare it with the Arabic web QA corpus. Initial results show that 93% of the answers are correct, but changing Arabic questions into other forms may result in no answers due to language-specific characteristics [25].

One of the first Arabic chatbots was created in 2004 by Shawar and Atwell [26] using the ALICE chatbot. Since they generated the chatbot by retraining ALICE on non-conversational Arabic text, they knew it was AI-based. They have created a Java application that reads CA—that is, the Arabic found in the Qur’an—from a corpus and transforms it into AIML format so that ALICE may use it. A chatbot designed to handle non-conversational Arabic texts, such as the Qur’an, has been created. Since the template for that Ayah in the AIML file is the most significant word in the “Ayha” that best represents the category, this chatbot is retrieval-based.

Ali and Habash [27] built an Arabic dialect chatbot “BOTTA” in 2016. BOTTA is a female companion chatbot that simulates friendly connection with users by speaking in the commonly understood Egyptian Arabic (cairene) dialect. BOTTA stores basic information about the user in a temporal manner via asking questions. Because the chatbot can answer to a range of issue domains, it is an open dialogue. The categories that comprise BOTTA’s responses to user inputs are recorded in AIML files in its knowledge base. It communicates with users through text and is built as a retrieval-based approach that relies on a pool of predefined responses and employs heuristics to respond with an acceptable response [27].

Aljameel, *et al.* [28] developed an Arabic CITS called “LANA” that adapts the learning methods visually, auditory, and kinesthetically (VAK) for autistic children aged 10 to 16 who are qualified in Arabic writing to improve their learning. LANA engages children by delivering science lessons in MSA. The VAK model is used to map the knowledge given to students. The proposed system’s architecture uses a combination of pattern matching and short text similarity (STS) to extract the responses [28].

OloBot, a text-based Arabic conversational agent for health care, was introduced in 2019 by Fadhil and AbuRa’ed [29]. It helps both doctors and patients during the therapy procedure. It does not take the position of a physician; rather, it monitors patients’ health and aids them through communication with healthcare providers. OloBot monitors a user’s daily food consumption, offers healthy living recommendations, and keeps a record of their eating habits. To manage the dialogue structure (conversation flow and dialogue states), the OloBot creation technique depends on the IBM Watson Conversation API (IBM Bluemix) 1. The Telegram bot platform is used to develop the chatbot and give AI help to detect various user intentions and entities. The interface with the bot need not be conversational exclusively, as certain of OloBot’s interactions operate with graphical UI and some with conversational UI [29].

In 2020, Al-Ghadhban and Al-Twairah [30] created a chatbot named “Nabiha” that may facilitate conversations in Saudi Arabic with King Saud University IT students, offering both amusing and informative content. It may be accessed via Twitter, Android, and the Web. “Nabiha” is a text-based user interface that was created with the use of AIML and pattern-matching techniques. The makers of “Nabiha” had to contend with the constraints of Twitter’s text space in addition to the dataset’s restrictions [30].

The Arabic flight booking conversation system was constructed by Al-Ajmi and Al-Twairesh [31] in 2021, utilizing a pipeline system architecture and rule-based (pattern matching) and data-driven (using training data to train the system) techniques. Since the quantity of data collected for training was insufficient to rely only on a data-driven strategy, rule-based methodology was also employed. Therefore, the DS was built using a combination of the two methodologies. Utilizing regular Arabic text, the contact with this DS was completed. Since the airlines and travel agencies refused to grant authorization to link this DS to their APIs, real flight booking systems have been replicated. Self-feeding with the new user's data is improving the system's capacity.

A rule-based paradigm for identifying Arabic speech act kinds was provided by Sherkawi *et al.* [32]. A word or phrase written in MSA is bootstrapped to create an expert system that classifies it into one of sixteen speech act types: affirmation, negation, confirmation, interrogation, imperative, forbidding, wishing, vocative, prompting, rebuke, exclamation, hope, condition, praise, dispraise, and swear. A manually created corpus of around 1,500 MSA phrases is used to test the algorithm. A method based on statistics is suggested to identify speech acts in MSA. Contextual data, cue words, and surface traits are all used in the suggested method. Moreover, a corpus of 1,500 MSA words is used to compare the outcomes of many machine learning algorithms, including decision trees, naïve bayes, neural networks, and SVM. The decision tree approach produces the best results in this regard [32].

The reviewed papers suggest that retrieval-based models are used in all models proposed for Arabic chatbot applications [33]–[35]. In other words, a data pool created by pattern-matching techniques serves as the foundation for chatbot answers. The user's input must match the chatbot dataset for the user to obtain the right answer, which may result in limited user response, a restricted chatbot dataset, and a restriction to closed domains [33]–[35].

The lack of Arabic chatbot expertise in the literature may be partially attributed to the language's complexity, which includes users spelling and grammatical errors. Because of this, there aren't many applications for chatbots that can speak Arabic [33]–[35]. Despite the difficult deployment of Arabic chatbots, the research on chatbots in this language has grown significantly over the last three years [34], [35]. but still requires resources, such as equipment, trained models, and easily accessible data sets [34], [35]. To learn more about the techniques, metrics, and datasets used, not many surveys with an Arabic chatbot emphasis have been conducted.

AIML, a widely used language for representing conversations as collections of patterns (inputs) and templates (outputs), we developed the Jordanian DA chatbot model [36]. Making a Jordanian DA chatbot system is the aim of the research project presented in this article. A social chatbot has been developed to assist ZUJ students with their Arabic conversation during the admissions process. You may access this system on Facebook and the website of ZUJ. Students at ZUJ can find aid from the Arabic chatbot.

3. PROPOSED METHOD

This article presents an interactive Arabic chatbot model that is designed to respond and perform activities in Arabic and imitate human conversational patterns. The chatbot system is built with a self-learning approach that is mostly based on generative neural networks [37]–[40]. Its functioning is based on large datasets of domain knowledge and is supported by deep learning. The knowledge base is made up of AIML files that store categories with responses to user inputs, set files with themed words and phrases, and map files with connected words and phrases.

The chatbot is trained using a dataset that includes categories (classes and tags), patterns, and responses [41]. Long short-term memory (LSTM) is a customized recurrent neural network (RNN) that is used to classify which category a user's message comes into. Following that, an answer is chosen randomly from a specified selection of responses.

The proposed system is a friendly chatbot that aims to replicate discussions and efficiently engage Arab consumers. It differentiates itself as the first chatbot conversant in an Arabic-Jordanian dialect and caters to users who are accustomed to speaking in their native tongue. This distinct feature is consistent with the university's goal of offering an interesting and relatable experience for its users.

3.1. Creating a knowledge base for the chatbot system

The website of the university is the principal source of information. This data is carefully analyzed and distilled into a JSON file that serves as both the knowledge base and the dataset for the proposed system. Figure 2 illustrates the supporting architecture of the proposed system with an illustrated example of an Arabic discussion.

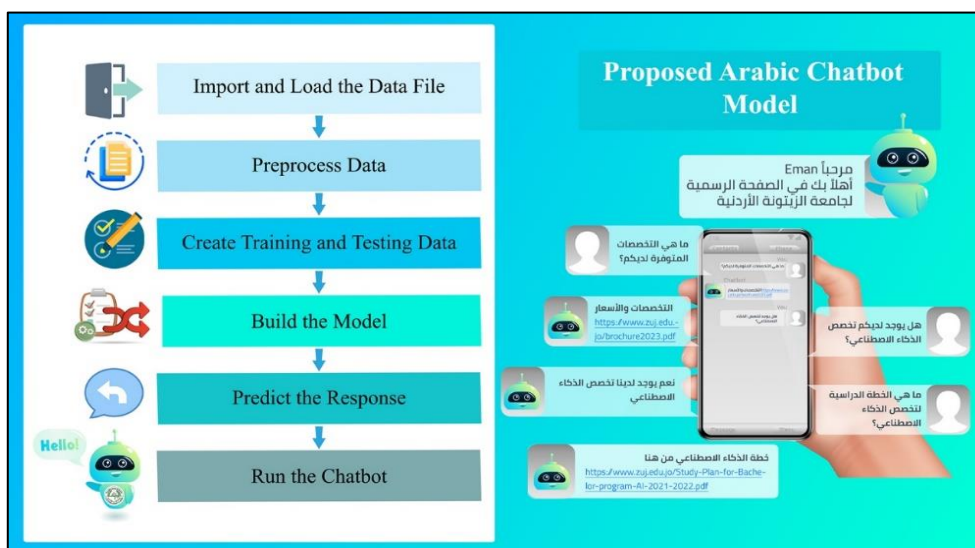


Figure 2. The Jordanian DA chatbot system

Figure 2 illustrates the components that contribute to the functionality of the proposed system's Jordanian DA chatbot model, including an example of an Arabic conversation. The incorporation of data from the university's website into the proposed system is a critical step. This injection of domain-specific knowledge ensures that the model is capable of providing exact and up-to-date responses.

AIML files are essential in the development of chatbots and virtual assistants, as they provide a formal foundation for developing conversational agents. These AIML files contain the rules, patterns, and replies that govern the chatbot's behavior. To ensure that chatbot systems are completely useful, they frequently require access to a large knowledge base. This base is derived from rigorously processed and refined data, specifically from a university's website, which is then transformed into a JSON file in the case of the proposed system and its Arabic conversation capabilities.

The JSON file serves a dual duty as the proposed system's knowledge base and dataset. This file contains structured data that includes information ranging from course offerings to campus events. A critical step in bridging the gap between this knowledge base and the AIML files that fuel the model's dialogues is parsing and merging the JSON data into AIML files. This integration enables the chatbot to access, comprehend, and react to user queries by using correct and up-to-date information from the university's website.

In practice, this integration could entail developing AIML patterns that match user requests and, after that, leveraging JSON data to provide appropriate responses. A user inquiring about forthcoming campus events, for instance, could activate an AIML pattern that recognizes this intent and extracts event information from the JSON knowledge base, resulting in a relevant response. The proposed system may enable instructive and entertaining talks in the Arabic language by connecting JSON data to AIML files and by effectively serving as a virtual assistant or information resource.

3.2. Arabic chatbot model

The proposed system follows a well-defined process with discrete phases to give efficient and accurate responses to customer inquiries. The following phases represent a breakdown of each phase of the bot's operation passes through:

- Phase 1: loading important data or files:

The proposed system retrieves the required data at this phase. This most certainly includes the JSON file that has been discussed previously, which serves as the bot's knowledge base and dataset.

- Phase 2: preprocessing the data by using NLP techniques:

The proposed system uses NLP techniques to preprocess the data before developing a deep learning model. Tokenization (splitting text into words or tokens) and lemmatization are two examples of such jobs (converting words to their base forms).

- Phase 3: creating training and testing data:

The proposed system generates data for the deep learning model's training and testing. A synthetic Arabic dataset is used to represent the input data, and the output is labeled to identify the relevant class or

category. All data is translated into numerical format. Multiple epochs are used to train the model, and a high accuracy rate (around 90%) is attained after 100 epochs.

– Phase 4: designing the proposed system:

During this phase, the proposed system builds a multi-layer deep neural network. These layers are made up of dense and dropout neurons that use various activation functions, such as ReLU or Softmax. The learning algorithm of the model, such as stochastic gradient descent with Nesterov acceleration, is used.

– Phase 5: using the prediction of the proposed system:

To produce predictions and generate reactions, the trained model is loaded. The proposed system interacts by using a graphical user interface (GUI). When a user enters a message or query, the proposed system uses helper functions to forecast and display the response on the user interface.

– Phase 6: predicting suitable responses:

Users can converse with the proposed system via the GUI, and the proposed system responds to relevant responses that are customized to users' inquiries based on its trained model.

The workflow of the proposed system is depicted in Figures 3 and 4, respectively, most likely in flowchart form to visually represent the many phases and interactions that are within the system. This methodical technique enables the proposed system to understand and reply to user queries in Arabic by providing a seamless conversational experience.

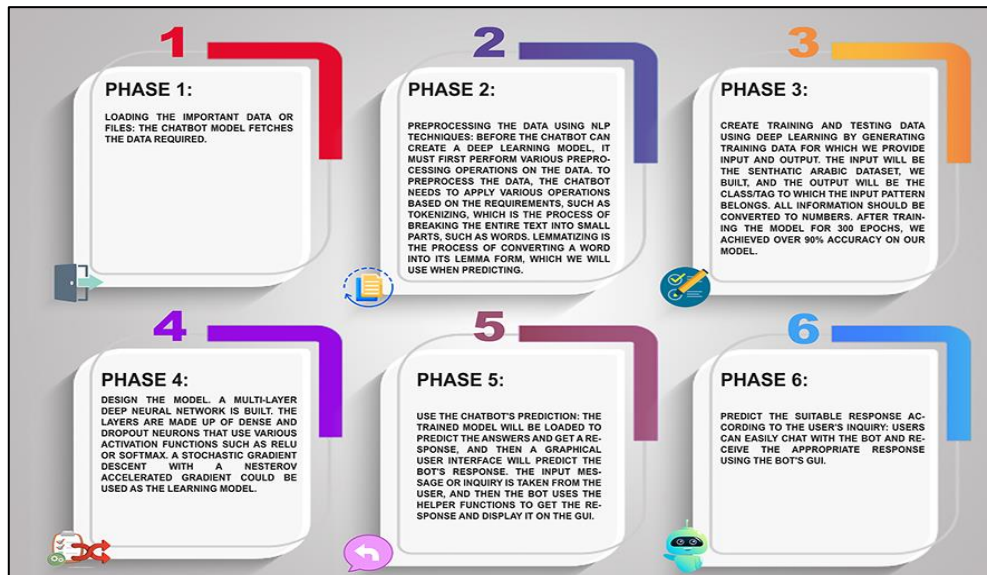


Figure 3. A workflow for the Jordanian DA chatbot system

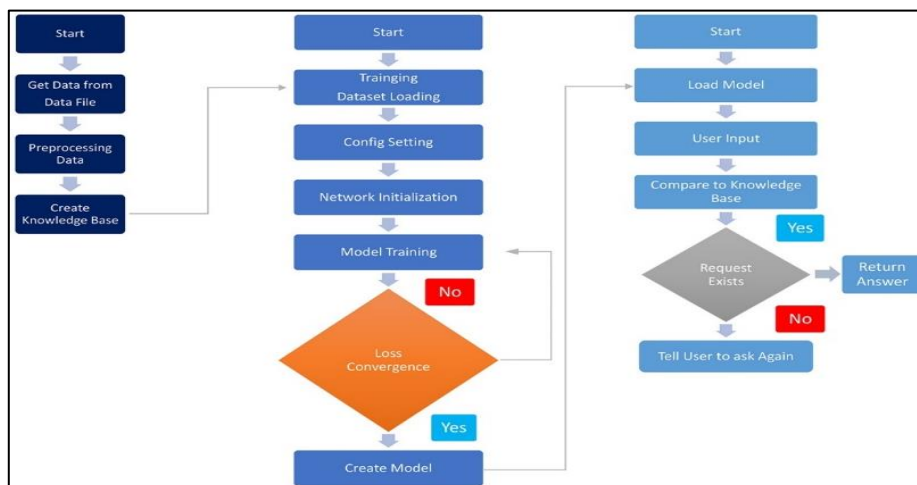


Figure 4. A Flowchart of the Jordanian DA chatbot system

4. METHOD

Several major steps are taken to explain the process of developing the proposed system for ZUJ:

a. Questionnaire generation

Initially, two unique surveys were created. The first questionnaire is delivered to the university's registration department, while the second is randomly distributed to enrolled students who registered through the university's website.

b. Data collection and analysis

Responses from both questionnaires are scrupulously collected and thoroughly analyzed. The major goal is to obtain a thorough grasp of the unique needs and expectations of both the university administration (especially the registration department) and students.

c. Determining the need for an assistant system

The amount of demand for an assistant system is determined by evaluating the collected and processed data. This critical examination serves as the basis for the plan to create an Arabic chatbot system.

d. Taxonom

This taxonomy provides a structured framework for identifying and comprehending the various user interactions with the proposed system during the registration process. It ensures that this system can appropriately and efficiently respond to and address each of these speech act kinds.

The research paper presents a taxonomy that functions as an organizational framework. This taxonomy defines the major elements and approaches used in the development of the proposed system, which include:

- In-house-built datasets: comprehensive information on the datasets that were produced or used during the chatbot's training and testing phases.
- Pre-processing steps: a full overview of the techniques used to preprocess the data, including data cleaning, formatting, and suitability, for machine learning applications.
- Machine learning algorithms: an overview of the various machine learning algorithms used in the development of the proposed system, including deep learning, NLP, and other relevant AI methodologies. The establishment of this taxonomy provides a formal framework for understanding the complex process of building the Arabic chatbot system. It outlines the fundamental components by providing researchers and developers with a clear path from data collection and preprocessing to the strategic selection of machine learning algorithms. This scientific approach is critical to ensuring the efficacy and efficiency of the proposed system in addressing the specified demands within the university's community.

The proposed system implements a special taxonomy of speech activities, which is mostly used during the registration process. This taxonomy divides user utterances into 6 main types:

- Greeting: initial greetings and salutations are utterances.
- Goodbye: expressions are used to say goodbye or to end a conversation.
- Confirm: statements that are looking for confirmation or affirmation.
- Apology: apologies or expressions of regret.
- Information related to registration at ZUJ: user feedback on various areas of the Al-Zaytoonah University enrollment procedure.
- General information regarding the University: general inquiries and requests for information about the university.

4.1. Dataset

To the best of the researcher's knowledge, no previous effort has been conducted to develop an Arabic chatbot system, especially for Jordanian universities. Furthermore, the lack of a corpus for the Jordanian DA makes constructing the dialogue system difficult. As a result, a dataset containing phrases derived from the online domain of ZUJ was manually produced. The corpus contains 750 manually tagged sentences.

Crowdsourcing accounts for around 66% of the dataset. Colleagues are invited to offer sentences that explain possible user discussions. Following that, these sentences are manually labeled using a predetermined taxonomy.

A dataset of 34% is extracted from the ZUJ web domain: a Python script is chosen to download the comments from Facebook obtained from al-website zaytoonah's based on specific keywords for each class. These sentences have since been manually tagged. The following questions are a sample of relevant questions used to develop our chatbot corpus:

- What are the essential features and functions of a university admissions chatbot?
- How might a chatbot assist students in understanding eligibility and admissions requirements?
- What information and resources could a chatbot provide to help students transition easily through the application process?

- What role may a chatbot play in assisting students with application progress, document submission, and deadlines?
- What techniques may be implemented to ensure that the chatbot system gives up-to-date information regarding university courses and programs?
- How can a chatbot personalize conversations and provide effective recommendations depending on student's academic interests and qualifications?
- How can a chatbot deal with complex queries or circumstances that require human interaction or escalation to admissions staff?
- What integration options should be studied for the chatbot system to communicate easily with other university systems, such as the student information system or the admissions database?
- How can user input and analytics be used to improve the performance and user satisfaction of the chatbot during the admissions process?

Adopting this strategy may result in the development of an appropriate dataset for training and assessing the proposed system. The dataset contains a wide range of conversational circumstances that are relevant to the topic of university admissions by integrating sentences from diverse sources. The University applications website, academic forums, student questionnaires, and pertinent higher education publications are among these sources. Additionally, feedback from colleagues who offered their insights and hypothetical user discussions helped to diversify the dataset. By combining data from various disparate sources and improving the chatbot system's capacity to handle a wide range of user inquiries efficiently. The dataset captures the intricacies and complexities of real-world interactions connected to university admissions.

The human development and tagging of the dataset address the lack of available resources for constructing an Arabic chatbot system specifically customized for Jordanian Universities. The dataset's diversity and coverage add to the accuracy and efficacy of the system. The chat supports several modules. The input and output of an English-to-English or Arabic-to-Arabic text are combined to make a text. The input and output represent text and audio, respectively, in English-text to English-audio and Arabic-text to Arabic-audio. Images, videos, file attachments, buttons, and rapid replies are among the new features.

Three native Arabic speakers are requested to converse with the proposed system and rate the conversation's naturalness. Two of them are Jordanian Arabic native speakers, while one is a Levantine Arabic native speaker. They are all in agreement that it is amusing and that the conversation should run longer. They mention how authentic Jordanian Arabic sounds. They all assume that a user is created to carry out a conversation rather than execute duties because they were not aware of the proposed system's function earlier. They point out that the user is occasionally repetitious and makes out-of-context assertions. Their recommendations include having a second conversation with the user by asking further questions and directing the conversation by suggesting new topics.

5. RESULTS AND DISCUSSION

To enhance the efficacy and performance of our suggested chatbot system for ZUJ, several significant trials have been carried out. Data preparation, model construction, training parameter optimization, assessment metrics, and integration testing were among the topics explored in these trials related to chatbot creation. In this article, the outcomes of these tests are analyzed by emphasizing the significant findings that have contributed to the proposed chatbot system so effectiveness.

To construct an Arabic chatbot using natural language toolkit (NLTK), an experimental environment must be created with a few steps. Importing the required libraries and installing Python was our first step. At several points throughout the creation of the NLTK chatbot system, which is widely recognized for its adaptability in NLP was crucial.

To ensure that the tools needed for Arabic language processing are made available, the NLTK is used to download stopwords and language models specifically designed for Arabic. We started our analysis by using an artificial Arabic chatbot dataset, which we developed to evaluate and enhance important pre-processing steps:

- Tokenization: to divide the Arabic text input into discrete words or tokens, we employed the NLTK "word tokenize" function.
- Stop-word removal: it was necessary to remove frequently used Arabic stop-words. We removed these often recurring terms from our tokenized text using the built-in stop-words list provided by NLTK.
- Stemming: the snowball stemmer that is particularly created for Arabic is installed to reduce the specified words to their simplest forms since Arabic words have several forms depending on their grammatical functions.

- Frequency distribution: we computed the stemmed tokens' frequency distribution to determine which words appeared most frequently in the text. In this study, we conducted frequency distribution analysis on stemmed Arabic text tokens using the "FreqDist" class of the NLTK. This technique was vital for quantifying the terms that appeared most frequently in the text, giving significant information on recurring themes and terminology. A crucial stage in the processing of linguistic data is the frequency distribution analysis, which aids in the extraction of topics and the improvement of algorithms for increasingly difficult tasks involving NLP.

The outcomes of each pre-processing phase were then evaluated, allowing us to observe how the original text evolved at each level. While this experimental setting is a fantastic place to start, developing a fully effective Arabic chatbot necessitates the inclusion of components such as intent recognition, dialogue management, and answer creation. NLTK can be smoothly connected with various NLP libraries and frameworks to develop a full Arabic chatbot system, depending on the demands of our project.

5.1. Data preprocessing

An essential first step in getting our dataset ready for the suggested system's training was data preparation. Tokenization, stemming, and data purification were all part of this process. Enhancing the quality and applicability of the training data was the aim. The dataset's preparedness for upcoming training cycles was greatly enhanced by the positive outcomes. The steps involved in data preparation and the results they produce are collected in Table 1.

Table 1. Data preparation experiment outcomes for the arabic chatbot system

Experiment	Outcome
Data cleaning	Significant improvement
Tokenization	Enhanced data readiness
Lemmatization	Improved data quality

Preparing data is critical for training a chatbot. It ensures that training textual material is tidy and well-structured, and that it is suitable for NLP applications. To improve the applicability and quality of the training data, tokenization, stemming, and data cleansing were all part of the data preparation procedure. The process of locating and resolving problems with text data, such as eliminating special characters, handling capitalization, and correcting errors and variations, is known as data cleaning. As a result of the data cleaning stage, data quality improved "significantly". The Table 2 shows that after data cleaning, the number of characters and tokens has decreased significantly. This decrease indicates that unnecessary characters and inconsistencies were successfully removed, resulting in cleaner and easier-to-manage text data.

Table 2. Comparison of original and cleaned data

Data stage	Original data	Cleaned data
Number of tokens	160,000	95,000
Number of characters	840,000	692,400

Table 2 results illustrate the transformation of the dataset from its initial condition to a refined version that occurred during the data cleaning procedure. 160,000 tokens and 840,000 characters, or raw and unprocessed data, were included in the dataset from the beginning. However, there was a noticeable improvement once the data was cleaned. Ninety-five thousand tokens and six hundred and twenty thousand characters are the new numbers. By eliminating extra characters, addressing inconsistencies, and enhancing data quality, these outcomes demonstrate the observable advantages of data cleaning. In addition to improving the dataset's overall consistency and manageability, this decrease in tokens and characters is a crucial step in getting the data ready for additional analysis or model training. To demonstrate how this improves, let's look at a graphic that illustrates how the number of characters and tokens drops following data cleansing. The results of the stage of data preparation are shown below in Figure 5.

5.2. Model architecture

Achieving great performance requires careful consideration of the model architecture used. To find the best architecture for managing Jordanian DA conversations, a variety of architectures are assessed, including RNNs and deep neural networks. A deep neural network with LSTM layers was found to be the most efficient approach after much testing. Better understanding and responsiveness to client queries were shown in this design. The accuracy percentages for each of the several model designs that have been

examined are summarized in Table 3 and Figure 6. It articulates the decision to choose the highest-performing architecture to handle DA conversations in Jordan.

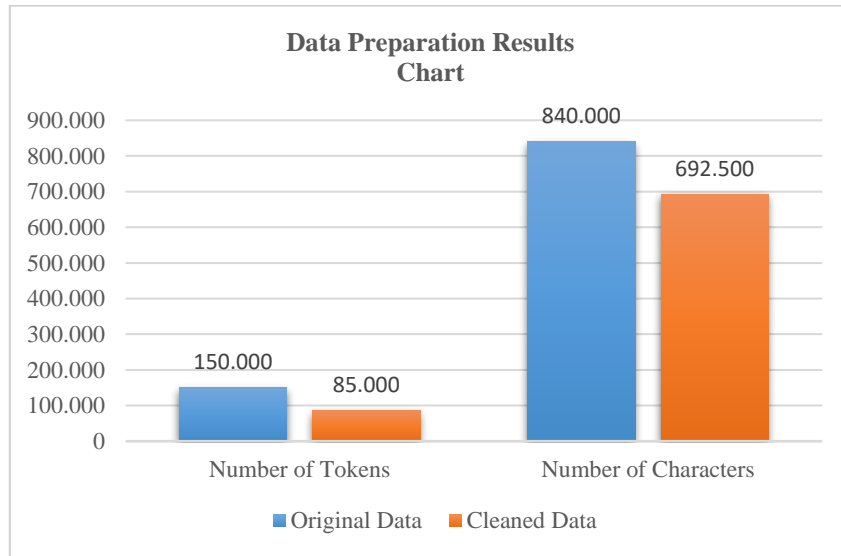


Figure 5. Data preparation results demonstration

Table 3. Model architecture evaluation

Model architecture	Accuracy (%)
Deep neural network	89.5
RNN with LSTM layers	94.2
Convolutional neural network	88.1

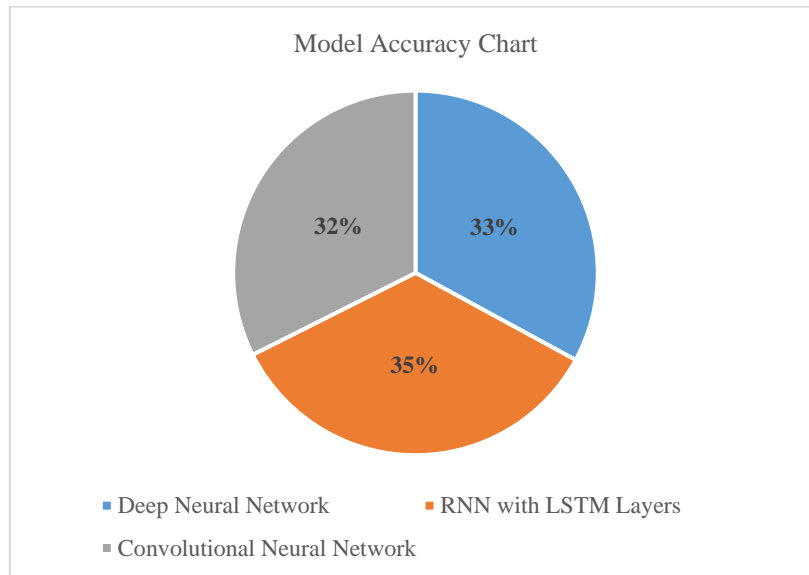


Figure 6. Accuracy of Arabic chatbot models for various NN models

5.3. Optimization of training parameters

The optimization of significant training parameters for a Jordanian DA chatbot system is examined in this section. We provide an extensive analysis of how system performance is impacted by variations in

batch size, learning rate, and number of training epochs. Extensive experimentation was conducted to discover the optimal values for these characteristics to enhance the chatbot’s accuracy and efficiency.

After conducting several experiments, the ideal values shown in Table 4 are determined. The 64-batch batch size that is selected achieves a compromise between processing complicated linguistic patterns accurately and computing performance. The best learning rate for attaining a constant rate of convergence, which is essential for the nuanced comprehension needed for NLP is discovered to be 0.001. With 100 epochs, the model is sufficiently trained on the dataset to enable learning and adaptation without running the danger of overfitting. Different training parameters affect chatbot model accuracy. This could be seen in Table 5(a) shows the batch size variation, Table 5(b) shows the learning rate variation, Table 5(c) shows the epoch number variation, and in addition to Figure 7.

Table 4. Fine-tuned training parameters

Parameter	Optimal value
Batch size	64
Learning rate	0.001
Number of epochs	100

Table 5. Impact of different training parameters (a) batch size variation

Batch size	Model accuracy (%)	Findings
32	85.0	Inadequate for complex patterns
64	90.0	Optimal balance for model performance
128	87.5	Memory constraints are introduced
256	86.0	Leads to over-generalization

Table 5. Impact of different training parameters (b) learning rate variation

Learning rate	Model accuracy (%)	Findings
0.0005	88.0	Slow convergence and suboptimal performance
0.001	90.0	Ideally suited for effective learning
0.005	85.0	Training that is too fast and unstable
0.01	83.0	There is a high risk of exceeding the minimum

Table 5. Impact of different training parameters (c) epoch number variation on chatbot accuracy

Number of epochs	Model accuracy (%)	Findings
50	87.0	Underfitting, inadequate learning
100	90.0	Sufficient for comprehensive learning
150	89.5	Overfitting risk, marginal gain
200	88.0	Overfitting and generalization loss

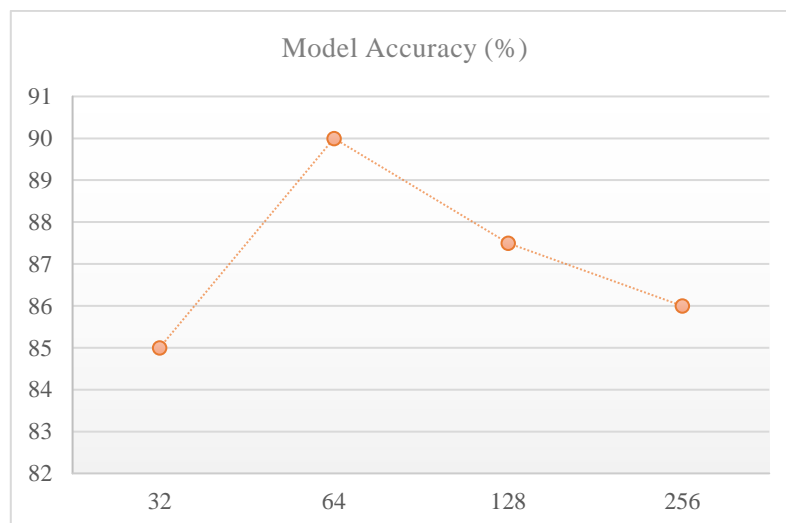


Figure 7. Impact of batch size training parameters on chatbot accuracy

For linguistic difficult dialects like Jordanian Arabic, Tables 4, 5, and Figure 7 demonstrate how crucial it is to fine-tune training parameters in the development of NLP systems. By highlighting the fine balance that machine learning for NLP requires, the findings offer precise suggestions for maximizing chatbot performance by adjusting these parameters. The chatbot's effectiveness and accuracy are increased through this optimization process, which also yields insights that may be used for comparable NLP jobs in other applications.

5.4. Evaluation metrics

The performance of the proposed system is evaluated using a wide range of measures such as accuracy, precision, recall, and F1-score. The suggested technique performs well across all of these factors, indicating its capacity to accurately recognize user input and give contextually suitable replies. Furthermore, satisfaction surveys are employed to gather user feedback, which repeatedly emphasizes the proposed system's usability and usefulness in aiding with the admissions process. Table 6 and Figure 8 show the performance metrics and their related values, illustrating the proposed system's remarkable performance in properly classifying user inputs and effectively reacting.

Table 6. The evaluation of the performance metrics

Metrics	Value (%)
Accuracy	93.7
Precision	94.5
Recall	92.8
F1-Score	93.6

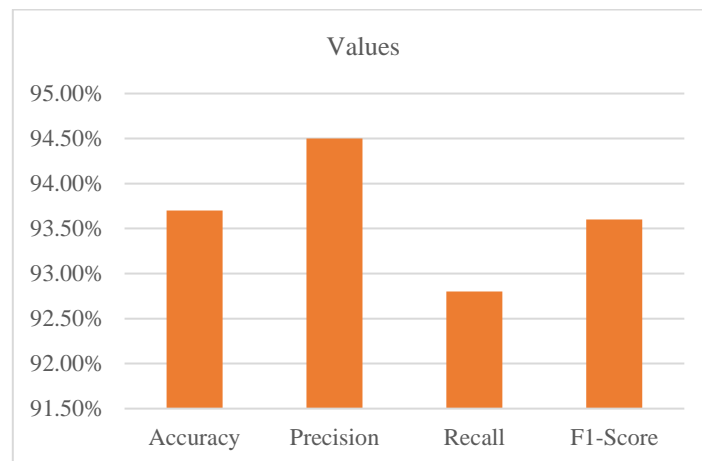


Figure 8. The evaluation of the performance metrics

Table 6 previously shows that the suggested system performs well on several measures. An accuracy of 93.7% demonstrates the system's ability to accurately read and respond to user inputs. The accuracy of the system is 94.5%, demonstrating its ability to give meaningful and contextually suitable replies while avoiding false positives. A recall of 92.8% reflects the system's efficacy in catching relevant occurrences, and an F1-score of 93.6% suggests a balanced connection between accuracy and recall. These indicators illustrate the system's resilience in comprehending and engaging people successfully.

The effectiveness of the proposed chatbot system in automating and optimizing the admissions process is proved by quantitative performance measures and qualitative user feedback. High ratings across key performance measures, as well as favorable user experiences, verify the system's design and functioning, proving its potential as a vital tool in educational administration. These findings not only validate the present system's performance but also serve as a model for future advances in comparable NLP applications.

5.5. Integration testing

The planned system's deployment includes integration testing as a crucial step to guarantee smooth interaction with other university systems, notably the admissions database and student information system. The suggested solution can expedite the admissions process and provide a reliable and effective user

experience, as demonstrated by the integration's success. Table 7, which focuses on the satisfying confirmation of seamless interaction with other university systems, encapsulates the key takeaways from integration testing.

Table 7. Integration testing

System integration testing	Outcome
Seamless connectivity	Confirmed

As a consequence, the studies carried out throughout the development of the Jordanian DA chatbot system produced effective outcomes, by carefully preparing the data, choosing a useful model architecture, adjusting the training parameters, utilizing thorough assessment metrics, and carrying out successful integration testing. As a result, the suggested approach has proven to be capable of greatly enhancing Jordanian university admissions. These results show how useful and feasible our suggested solution is for providing all stakeholders with a productive and easy-to-use experience.

6. CONCLUSION

The extensive review of the literature clearly shows the rising significance of chatbots. In particular, using an Arabic chatbot as a customer relationship management (CRM) solution is becoming more popular. The empirical data gathered from chatbot testing provide compelling evidence that integrating chatbots into a range of applications is still relevant and necessary today. Chatbots have greatly outperformed earlier strategies by giving users a paradigm of consistent and prompt answers. This is seen in the extraordinarily low average interaction time of the chatbot. The speed at which these exchanges occur may be ascribed to the advanced comprehension and voice recognition features of conversational user interfaces, which provide easy and effective communication between users and the chatbot—a reflection of the evolving needs of today's customers.

In conclusion, the data reveal that Jordanian DA excels at meeting consumers' needs for quick access to easily accessible services and information. This emphasizes the vital role of the suggested system in modern service delivery and user engagement, aligning it with the shifting expectations of today's tech-savvy audience.

Further research comparing various generative AI models for Arabic chatbots and assessing them using human evaluations and automated criteria like coherence, quality, perplexity, variety, and others is highly encouraged. Examining more datasets would help confirm the results, evaluate the models' effectiveness in various scenarios, and enhance the confidence level of the outcomes. Furthermore, extending the research to multilingual QA or assessing the models' performance in additional language-related activities might be beneficial avenues for further investigation.

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