
Artificial Intelligence in the Delivery of Healthcare Service Using Chatbot

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ABSTRACT

Artificial Intelligence and its application in healthcare delivery has led to the development of chatbot. Artificial Intelligence is concerned with development of machines that simulates intelligence of human expert in a domain to perform complex task associated with human. The need for urgent healthcare delivery is essential to all humans. Artificial Intelligence provides the platform to meet this need and resolve the associated challenges through the use of chatbot in healthcare delivery. Chatbot leverages branches of Artificial Intelligence such as Natural Language Processing and Machine Learning and features like word segmentation and tokenization to provide appropriate response to patients requiring immediate healthcare service. This paper aim to review the process of chatbot in healthcare delivery.

Keywords: Artificial Intelligence, Delivery, Healthcare Service, Chatbot, Natural Language Processing

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I. INTRODUCTION

The need to provide quality and constant availability of healthcare services cannot be overemphasized. The immigration of medical service staff to developed countries has impacted negatively on the availability of quality healthcare services to the growing populace especially in Africa. In order to mitigate this challenge, Artificial Intelligence technology would need to be adopted to mitigate this problem as quickly as possible. A feature of Artificial Intelligence that could resolve this challenge is the use of chatbot in healthcare services. Chatbot is a messaging platform that facilitate conversation between human and computer system. The human communicates with the computer using natural language. Chatbot is used in healthcare to provide effective medical advice to patients and staff in healthcare institutions. It uses Machine Learning and Natural language Processing to comprehend human text or voice and respond appropriately using Machine Learning algorithm to process database or dialogue stored on the platform.

This Artificial Intelligence component has enabled chatbot to perform automated processes without human intervention. It can respond to multiple patients' request without limit of time and location.

2. RELATED WORKS

2.1 Chatbot in Healthcare

The problem of availability of healthcare personnel at odd hours of the day is a challenge in many societies especially in Africa. Security of patients and caregivers is also important at this queer period. The use of technology is to provide solution in a problem domain. Artificial Intelligence has been adopted to mitigate these challenges on humans. Chatbots are conversational system developed in the field of Artificial Intelligence to facilitate interaction between humans and computer system. When it is pre-installed with medical service database, using Machine Learning and Natural Language Processing, it can carry out the functions of healthcare experts in a specific field. This mitigates risks, save time and lives through communication and response of the computer system performing the roles of human.

Kumar et al (2016) proposed a healthcare conversational agent that will allow end-user to input their health queries. This can facilitate instant replies to users when they are needed to stay long ages of time. In response to a user's input that doesn't match the keywords specified, Kumar et al (2016) have specified that a user's contact details will be submitted. Chatbots can be used to help diabetic patients control their diabetes and proffer professional advice. Ilić et al (2016), in their review of Artificial Intelligence in healthcare, present the advantages of using conversational agents in healthcare, including cost reduction, perfecting effectiveness and reduction of time spent asking questions to make the right opinion.

2.2 Chatbot Systems

The adoption of Artificial Intelligence has led to progressive advancement in healthcare delivery. The advancement in Artificial Intelligence techniques such as Machine Learning and Natural Language Processing has led to the development of efficient and dependable chatbot system in healthcare delivery. In relation to health care delivery, a chatbot is a computer system that provides the service of conversation between man and machine using natural language. It uses Natural Language Processing to facilitate improved communication between machine and patient and patient's satisfaction is improved upon through dialogue between man and machine using

Machine Learning

Machine Learning is a process that allows computers to learn without being explicitly programmed. It is a science that makes it possible for machines to translate, process, and study data to address real-world issues. The chatbot system uses artificial neural network in its operation.

An artificial neural network in a chatbot that uses machine learning is modeled after the neural pathways in the human brain. When a chatbot hears new voice or text conversations, its ability to respond to more questions and the precision of each response it provides grow. This is because the chatbot is designed to self-learn as it is exposed to new conversations, vocabularies and words.

According to I. Garrigós et al (2018), chatbot may look like a normal messaging app, they have the application layer, a database and also APIs (Application Programming Interface) working at the background. User interface represents the interface to make easy contact with user. While chatbot is easy to use, at the background it has the complexity to achieve. Most of chatbots have logs of conversation and the developer use the logs in order to understand user requests. The logs is then used to improve the chatbot conversation. With the aid of machine learning, chatbots function by matching user questions. By providing the identical output in response to similar inquiries, the developer must train the chatbot to comprehend several enquiries using Machine Learning and Natural Language Processing. I. Garrigós et al (2018) further stated that if there are more logs, the chatbots becomes more intelligent. According to Masche (2018), the chatbot is being trained through the analysis of thousands of logs from human conversation.

3. CHATBOT IN HEALTHCARE DESIGN AND ARCHITECTURE

3.1 Chatbot Design

The design of chatbot in healthcare is the blueprint or conception of the operation of the chatbot. It consists of interface in which user can interact with the computer system. The chatbot uses modular design. Modular design allows the chatbot to be linked with any kind of web-based or native mobile application. The chatbot was created using an artificial intelligence technology, which enables it to anticipate text suggestions and afterwards deliver intelligent responses based on reviewing previous conversations. The chatbot picks up knowledge through the discussion process and from human input. The algorithm searches for the exact phrase to match the user's input once they enter some text. By determining how people react to that input, it provides a reaction to the user's input.

3.2 Chatbot Design Process

The chatbot design process consist of six steps namely:

1. Scope and requirement: This enables us to know the reason for the chatbot e.g. healthcare delivery, the platform to launch the chatbot and limitations.
2. Identifying the inputs from users: This consist of queries through voice, images, text from devices or intelligent systems
3. Understanding the User Interface elements: This consist of the front-end of the application. It includes Command Line (CL), Graphical User Interface (GUI), Menu-Driven Interface (MDI), Form-Based Interface (FBI) and Natural Language Interface (NLI)

4. Craft first interaction
5. Build conversation
6. Testing: This can be done on mobile device or website to know the functionality.

3.3 Chatbot Architecture

The architecture of chatbot in healthcare aim to respond to user inquiries via text, graphics, and voice, a chatbot's architecture uses a candidate response generator and response selector. In this, user messages are submitted to an intent classification and entity recognition.

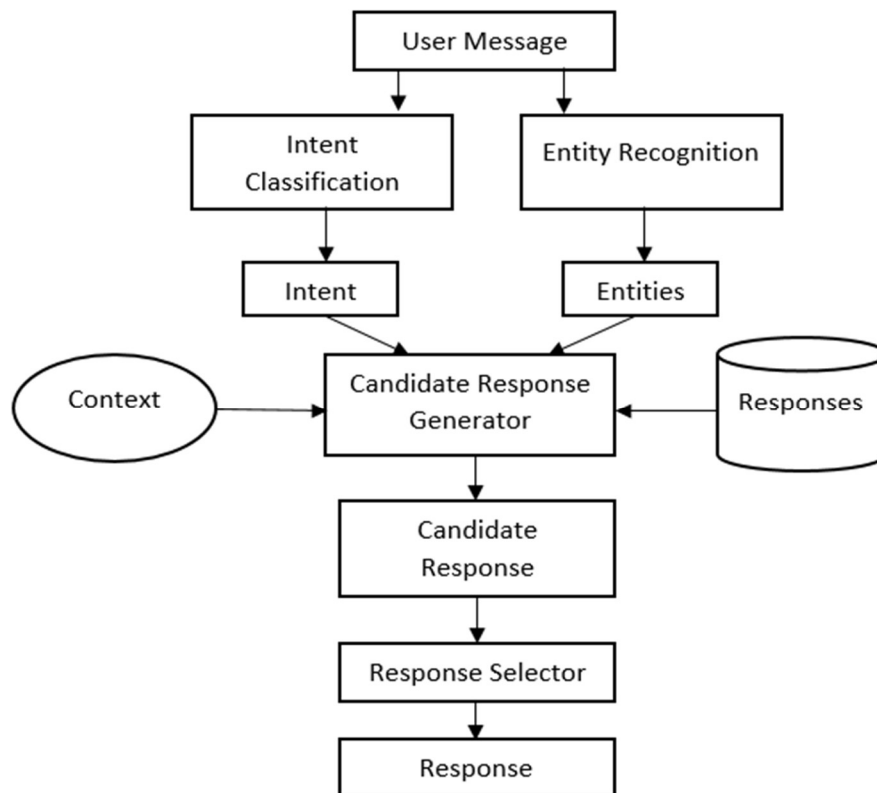


Fig. 1 Architecture of chatbot in healthcare service

- **Intent:** This is user's purpose or intention
- **Entity:** In the chatbot, an entity is used to change an intent. There are three different sorts of entities: system entity, developer entity, and session entity.
- **Candidate Response Generator:** In order to process the user request, the Chatbot's candidate response generator performs calculations utilizing several algorithms. The candidate's response is then the outcome of these calculations.

- **Response Selector:** The chatbot's response selector, chooses words or text to respond to user inquiries, in order to perform better.

Chatbot Challenges

- Nonstandard languages
- Lack of specialization of languages
- In ability to comprehend emotions and opinion of users
- Security

4. CHATBOT IN HEALTHCARE IMPLEMENTATION

4.1 Word Segmentation

Text is divided into more manageable and meaningful parts by the process of segmentation, also known as tokenization. These components could be sentences, clauses, phrases, words, paragraphs, or even letters. The letters are the smallest unit. The division of sentences into words and spaces is known as word segmentation. Sentence tokens are the tokenized units of a sentence. The sentences were divided into independent units of words and punctuation by the tokenizers. The most popular tokenizer divides sentences into words at blank spaces, which is known as the space type tokenizer. Abbreviations, acronyms, dates, numerals in decimal formats, and other terms that cannot be divided at punctuation and blank spaces without losing their meaning must also be taken into account by the tokenizer.

According to Mohammed et al (2015), a method to implement word segmentation is through the use of his proposed algorithm to calculate character spaces in the sentences. All types of gaps between characters are included in the character space. These include gaps between words, punctuation marks and letters. The method is based on the quantity of blank space or characters between each sentence unit. To get the mean average between the characters in the sentence, the character spaces are first determined, and then the gaps are averaged. The sentence that needs to be divided into segments is then subjected to this average gap distance. Points of tokenization are defined as locations where the character space exceeds the average character space. Since there is typically a larger space between words than the average, tokenization occurs in the spaces in between words in sentences.

Naeun Lee et al (2017) stated that Natural Language Toolkit can be used to implement word segmentation. A Python library called Natural Language ToolKit (NLTK) is designed to offer NLP services. It has tokenizers built in. Users must import the package in order to utilize the appropriate tokenizer, which is available as a set of functions. Numerous tokenizers are included in the NLTK, including standard, letter, word, classic, lowercase, N-gram, pattern, keyword, path etc.

The word-punkt tokenizer, which breaks sentences up at blank spaces, is the most often used tokenizer. The NLTK tokenizers' precision, quickness, and efficiency are impressive. Additionally, since the package already performs the algorithms at the backend, there is no need to implement them.

4.2 Natural Language Processing

To simplify the process of chatbot implementation it is essential we refine the architecture of chatbot in healthcare delivery

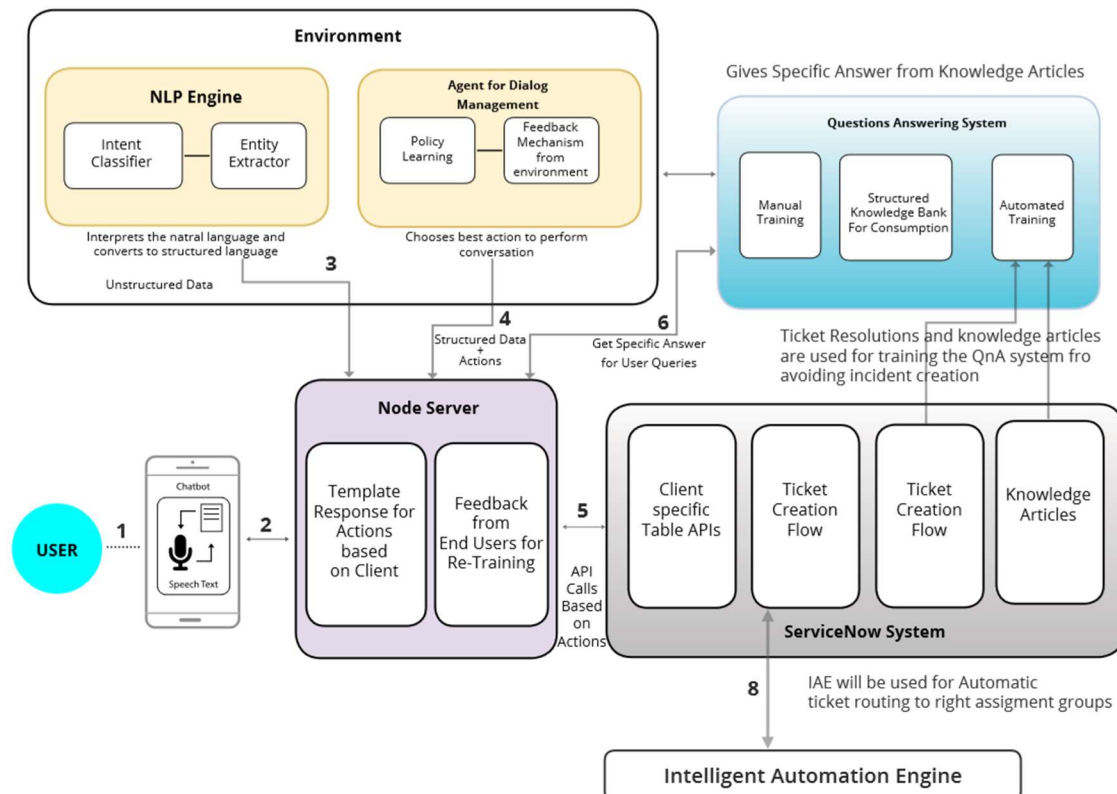


Fig 2: Architecture of a Conversational Chatbot

(<https://blog.vsoftconsulting.com/blog/understanding-the-architecture-of-conversational-chatbot>)

The essential element of conversational chatbot architecture in healthcare:

1. Environment
2. Question and Answer System
3. Plugins/Components
4. Node Server / Traffic Server
5. Front-end Systems

Environment

The Natural Learning Process (NLP) engine's main functions and context interpretation take place here.

NLP Engine

The central element, the NLP Engine, is responsible for interpreting what users say and translating it into structured inputs the system can process further. The chatbot must handle a large number of features because it is domain-specific. Advanced machine learning methods are used in the NLP engine to recognize the user's purpose and then match it to a list of various intents the bot supports.

NLP Engine consists of two parts:

- Intent Classifier: This feature analyzes user input to determine its meaning and tie it to one of the supported chatbot intentions.
- Entity Extractor: This tool extracts important data from the user's query.

Agent for Dialogue Management

It controls the dialogue's actual context. For instance, if the user says, "I have fever," the bot may take the information. The user may then say, "I am feverish," referring to the previous conversation he had previously made. The chatbot must correctly understand this and alter the order, then confirm with the user. We can achieve this thanks to a plugin for dialog management. Dialogue management further has following key plugins:

Feedback Mechanism

The agent periodically asks the user for feedback to determine whether the discussion is going well and whether the user is happy with the bot's response. This encourages the bot to learn from its errors and improve in subsequent discussions.

- Policy Learning: A higher-level framework known as policy learning encourages the bot to follow more pleasant paths throughout conversations in order to increase overall end-user happiness.
- In general, it establishes a network of joyful pathways and directs the discourse toward customer delight.
- The bot then makes an effort to learn from its interactions and mimics the conversation flow with individuals who have similar interests.

Question and Answer System

This is crucial in providing users with frequently asked questions answers. The inquiry is interpreted by the Q&A system, which then provides pertinent knowledge base responses. It consists of the following elements.

- **Manual Training:** During manual training, a domain expert compiles a list of frequently asked questions from users and maps out the solutions. This aids the bot in finding the most crucial questions' solutions rapidly.
- **Automated Training:** With automated training, you provide the bot your company's policy documents and other Q&A-style documents and instruct it to train itself. From these documents, the engine generates a list of questions and responses. The bot can then respond with assurance.

Plugins/Components

Plugins provide intelligent automation APIs and other chatbot solution components for internal enterprise use.

Node Server / Traffic Server

The server that processes user traffic requests and directs them to the proper components. The response from internal components is also forwarded by the traffic server to the front-end systems.

Front-End Systems

Any client-facing platforms can be front-end systems. They may be the actual chatbot user interfaces found on many platforms, like as: Facebook, Skype etc
(<https://blog.vsoftconsulting.com/blog/understanding-the-architecture-of-conversational-chatbot>)

4.3 Machine Language

Chatbots that are scripted have predetermined responses to deliver. They respond to the user's question by selecting a response from a collection of predefined responses that have been categorized. By incorporating Machine Language, chatbots may compute the responses from scratch. It is used to forecast the answers to customer inquiries and to update the system based on previous dialogue or experiences. As fresh information from the user is encountered, it continuously updates the databases. This engine analyzes what the user requests using supervised, unsupervised, or both methodologies. Additionally, it makes use of a model to decipher the user's intent and deliver the proper outcomes. Predictions or any other type of analysis based on the application and evaluation of mathematical models may be the results.

The majority of machine learning models derive their predictions for the test instance on statistical and probabilistic analyses of the instances that occur. The decision engine incorporates methods for information retrieval such as entity extractions, multiple text classifications, etc. in addition to models for predictions. A chatbot system's incorporation of a machine learning layer is also utilized to correlate extracted elements with context-specific inquiries as well as their alternatives, synonyms, and machine-enabled classes.

These machine learning features transform a static and simple Frequently Asked Questions system into an intelligent and more individualized communication process. The machine learning layer expands the services that chatbots offer in a variety of fields. It aims to broaden the system's application and improve the precision of the responses the system gives users. By using what it has learned from its experiences, the system is able to update itself. As a result, the system is less likely to produce incorrect predictions.

A variety of methods, including clustering, Bayesian networks, decision trees, etc., can be utilized by chatbots in the healthcare industry to forecast diseases. The system's brainpower is a decision engine. It incorporates statistical and probabilistic computations, Machine Learning algorithms for forecasting, etc. Additionally, Machine Learning gives the system the ability to draw lessons from its prior dialogues in order to deliver improved results. Algorithm for disease prediction is needed by chatbots in the healthcare industry. Chatbots use numerous methods for making predictions (Bhirud et al, (2019).

5. CONCLUSION

Research in Artificial Intelligence had led to development of chatbot. Chatbot as a feature of Artificial Intelligence has been deployed in healthcare delivery. Chatbot in healthcare is evolving, advancement in Natural Language Processing and Machine Learning has contributed immensely in the accuracy and efficiency of response of chatbot in healthcare. Chatbots in healthcare domain are integrated with messaging app which may be access without the limit of time and location by patients requiring urgent medical attention.

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