Automated Healthcare System Using AI Based Chatbot

Akshay Mendon, Megharani Patil, Yash Gupta, Vatsal Kadakia, and Harsh Doshi

Abstract Medical care is vital to having a decent existence. Be that as it may, it is undeniably challenging to get an appointment with a specialist for each medical issue and due to the current global pandemic in the form of Coronavirus, the healthcare industry is under immense pressure to meet the ends of patients' needs. Doctors and nurses are working relentlessly to treat and help the patients in the best possible way and still, they face problems in terms of time management, technical resources, healthcare infrastructure, support staff as well as healthcare personnel. To resolve this problem, we have made a chatbot utilizing Artificial Intelligence (AI) that can analyze the illness and give fundamental insights regarding the infection by looking at the data of a patient who was previously counselled at a health specialist This will also assist in lessening the medical services costs. The chatbot is a product application intended to recreate discussions with human clients through intuitive and customized content. It is in many cases portrayed as the most moving and promising articulations of communication among people and machines utilizing Artificial Intelligence and Natural Language Processing (NLP). The chatbot stores the information in the data set to recognize the sentence and pursue an inquiry choice and answer the corresponding inquiry. Through this paper, we aim to create a fully functional chatbot that will help the patients/users to know about the disease by simply entering the symptoms they possess. Additionally, they can also get information about certain medicine by simply typing the name of the medicine. Another additional feature is the ability of the bot to answer general questions regarding healthcare and wellbeing.

Keywords Chatbot · Artificial intelligence · Disease prediction · Healthcare

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1 Introduction

Starting with a simple yet powerful quote: "Health is Wealth" which in itself is quite self-explanatory stating that without proper and regular management of one's health everything falls apart. It is tragic to know how a single virus can fail some of the best healthcare services around the globe. There are a ton of large-scale health institutions like Hospitals to small-scale clinics but most patients find it difficult to choose and find the best suitable for them. Computers give us data; they draw in us and help us with plenty of habits [1]. Chatbots, otherwise called jabber robots, savvy bots, conversational specialists, computerized associates, or scholarly specialists, are great representations of AI frameworks that have advanced from ML. The Oxford word reference characterizes a chatbot as a PC program that can discuss with an individual, as a rule over the web [2]. They can likewise be actual elements intended to communicate with people or different robots socially. Foreordained reactions are then created by examining client input, on text or spoken ground, and getting to important information [3]. Chatbots are possibly alluded to as the most encouraging and high-level type of human–machine collaborations. At last, these virtual specialists are engaged in super worldwide areas like medical care, banking, schooling, horticulture, and so forth [4]. In India, the Aarogya Setu, a versatile application has evolved to make consciousness of COVID-19 with the equal association of a chatbot. Notwithstanding, these bots are filling in as clinical advisors of Covid, and not a single one of them features the issues concerning far-off patients about the pandemic [5]. Similarly, the German government fostered a battle COVID courier bot [6], and the Bangladesh-based SAJIDA Foundation fostered a nCOV-19 data bot with a side effect checker and clarifications of preventive measures [7]. The users can gain information about other various diseases and small problems right from a small wound to cancer from our Chatbot.

We are now doing more than ever in the field of Artificial Intelligence in various sectors of our society. Right now the healthcare sector is in the utmost need of it. According to IBM, "Artificial intelligence leverages computers and machines to mimic the problem-solving and decision-making capabilities of the human mind." One of the reliable and helpful applications of AI is a chatbot [8]. One of the reliable and helpful applications of AI is a chatbot. A chatbot is a conversational specialist who reenacts ongoing connections with patients/clients. It is a program that conducts a conversation via auditory or textual methods. This proposed chatbot is based on a textual method. The dataset which is going to be used will be proficient in answering most of the queries of the users/patients. Dataset is the JSON file with keys such as intention—What patient is expecting answers from the chatbot, responses, and tags (specific disease). After that, data pre-processing will be carried out using Natural Language Processing (NLP) which provides data for fitting it into different machine learning (ML) predefined algorithms. The proposed model will be integrated into a website to make the website more useful for users. Other than this, the fundamental proverb behind the readiness of this proposed framework is to help and rouse the impending youthful cluster of engineers who are intrigued to bring a plunge into the

fields of AI, Machine Learning and NLP. The entire working and use of technology is shared in detail in the following segments to help them understand the basics of the same.

2 Motivation

Issues with the availability of health care as well as mental health care collected broad consideration during the COVID-19 pandemic when admittance to care turned out to be more troublesome. Notwithstanding average boundaries to treatment, limitations, and lockdowns established to alleviate the spread of COVID-19 made inescapable disturbances to close and personal consideration [9]. If we talk about mental health care, the limitations and lockdown have made a powerful coincidence where a generally wrecked framework has fewer assets and more noteworthy interest, causing an expansion in the neglected need for psychological wellness administrations around the world. As anyone might expect, research proposes the neglected requirement for psychotherapy and guidance, notwithstanding the disturbance of conventional administrations, has expanded during the COVID-19 pandemic [10]. Chatbots have been around for a really long time. Nonetheless, the genuine buzz around this innovation didn't begin until the spring of 2016. Explanations behind the unexpected recharged interest in chatbots remember major advances for Artificial Intelligence (AI) and a significant utilization shift from online informal organizations to portable informing applications like Facebook Messenger, Telegram, Slack, Kik, and Viber [11]. As we all know that Artificial Intelligence (AI) is at the very forefront of changing various parts of our lives by adjusting the manner in which we dissect data and further developing dynamic through critical thinking, thinking, and learning. Machine Learning (ML) is a subset of AI that further develops its exhibition in view of the information given to a conventional calculation as a matter of fact as opposed to characterizing rules in customary methodologies [12]. Progressions in ML have given benefits as far as exactness, direction, speedy handling, cost-viability, and treatment of mind boggling information [13].

With digitization of medical care and developing impact of AI, analysts recognized chatbot's capability to work on patients' openness to medication, reinforce doctor patient correspondence, and help in dealing with the constant requests for different related administrations. Chatbots could have been effectively utilized in wellbeing schooling and training, frequently combined with different capabilities, for example, side effect checker, online emergency, intelligent live criticism, etc. [14]. Given these adequate advantages, it isn't business as usual that chatbots have quickly developed throughout recent many years and coordinated themselves into various fields, like amusement, travel, gaming, advanced mechanics, and security. Chatbots have been demonstrated to be especially relevant in different medical care parts that normally include eye to eye communications. With their capacity for complex exchange the board and conversational adaptability, joining of chatbot innovation into clinical

practice might lessen costs, refine work process efficiencies, and work on tolerant results [15].

3 Literature Review

The literature review focuses on articles from conference proceedings, peer-reviewed journals as well as existing chatbots. The inception of the idea of chatbots is attributed to Alan Turing in 1950 when he questioned, "Can machines think?" [16]. The first models of chatbots were intended to clear the Turing test. Turing test is a test in which an individual aimlessly asks questions to the bot as well as to a human and if the interrogator fails to distinguish between the answers from the human and bot, it is said to pass the test. In the mid-1960s, ELIZA was one of the first know chatbots developed at MIT Artificial Intelligence Library as a natural language processing program [17]. Using 'pattern matching' and replacement methodology it more or less mimicked how humans converse. The early users felt like they were conversing with somebody who grasped their feedback. ELIZA breezed through the Turing test and so did chatbots like Alice and Mitsuku which were influenced by Joseph Weizenbaum's ELIZA program [18]. The program of Alice uses similar pattern matching but works on XML schema which is known as artificial intelligence markup language (AIML) which gives the protocol to converse [19]. A resumed interest in artificial intelligence and machine learning has promoted the development and use of chatbots in different fields [20] and some of the articles are discussed below. They build a text-to-text medical diagnosis bot that helps patients into a discussion about their issues and gives a solution for their diagnosis based on their symptoms and their records. But their algorithm accuracy and diagnosis accuracy were very low.

Agrawal et al. [21] built a text-to-text medical diagnosis bot that helps patients to discuss their issues and gives a solution for their diagnosis based on their symptoms and their records. But their algorithm accuracy and diagnosis accuracy were very low. Bali et al. [22] developed "Diabot" a medical chatbot using ensemble learning which is a meta-algorithm that combines a bundle of weaker models and averages them to produce a single accurate model but the accuracy was lower than the random forest model and thus the ensemble model provided less accuracy.

Ghosh et al. [23] built a chatbot to handle complex question-answering tasks, they employed a linked medical knowledge graph (developed internally) to explore the associations between all the potential medical entities recognized by the user input. The selected entities were then ranked by their strength of association with user-selected entities. The ranking of entities was also facilitated by a frequent occurrence of entities attached to the originally extracted entities. Finally, they used this mechanism to select the top-ranked symptom that is sent back using a natural language template response to the user. But this procedure took a very long time to identify the question of the user.

Rarhi et al. [24] presented a design for a virtual doctor that provides diagnoses and remedies based on the symptoms provided to the system. The chatbot they proposed

was extracting the disease from the symptoms provided by the user and based upon the criticalness of the disease the chatbot identifies whether it is a major or minor disease if the disease is major then the algorithm will propose the patient book an appointment with a doctor from the database but this chatbot can only handle the user-specified symptoms if it is present in the database. Divya et al. [25] built a bot that predicts the disease based upon symptoms provided by the patient and provides some information about the disease before consulting the doctor. It's a text-to-text-based algorithmic process which means it's a text-to-text classification model.

Kumar et al. [26] proposed a system that is based on symptom mapping and the chatbot finds out the solution to the patient's diseases by providing them the way to cure and drugs to consume by scanning their symptoms and if the disease is major it redirects to a page where you can have an appointment with the doctor. There is a database of all doctors according to their qualifications from where the data will be fetched and will be sent to users according to their profiles. There are 3 modules of this chatbot: a collection of users' symptoms, matching with the chatbot database, and curing it. In order to achieve an accurate diagnosis finite graph is used. The string searching algorithm is used to extract symptoms however most of the time the user needs to say exact symptoms in order to get the desired diagnosis otherwise the conversation will go into a loop and start the conversation all over again. The dataset and mapping are accurate but simple and small at the same time. Datasets trained are well and the use of NLP is pinpoint.

4 Methodology

The general layout for the development of any chatbot is relatively very straightforward. There are 4 fundamental stages for all types of chatbots. Processing the input, understanding the input, generating a response and selection of a response are the 4 stages [1]. The architecture used for the development of the chatbot is illustrated in Fig. 1. The user has to first make a request in text format which is processed and interpreted by the chatbot. After the request is processed, the chatbot will store this information or it will request for more information for clarity of the user's request. Once the chatbot understands the request, the data concerned to the request is recovered from the data set [2]. Our proposed chatbot would predict diseases when the user enters symptoms. The user has to enter symptoms one by one followed by comma and the chatbot will predict the most accurate disease affiliated to those symptoms. Secondly, if the user wants to get information about a particular drug then simply providing the name of the medicine would yield the user it's full name, price in Indian Rupees, side effects as well as what exactly is the drug used for. Thirdly, the user can also ask general question answers relating to health concerns as well. For example, the user can ask "How do you treat bruises? "and get answered with the most appropriate answer by the chatbot.

The flow chart illustrated in Fig. 2 explains the methodology for the detection of symptoms and prediction of diseases. The flow of the work can be broken down

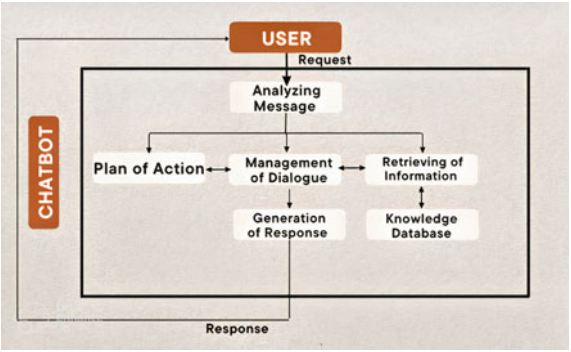

Fig. 1 General chatbot architecture

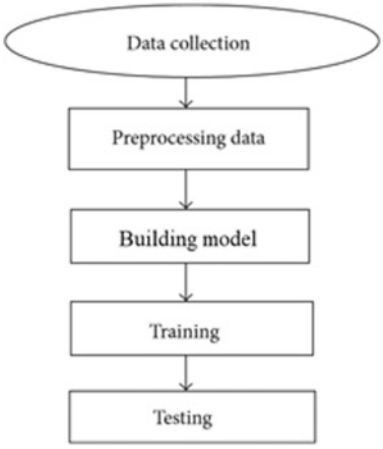

Fig. 2 Flowchart to build a model using machine learning

into 3 stages. Getting the appropriate dataset, pre-processing of text using natural language processing and feeding the data to machine language model for training and testing are the three essential stages that would be further elaborated in the later section.

4.1 Data Collection

The major purpose of datasets related to healthcare is to identify the data elements to be collected for each patient and to provide uniform definitions for common terms. There are different datasets used for this paper for different functions of the chatbot. The datasets were solely prepared and extracted from different website where they conducted different surveys and interviews with health professionals as well as patients. First dataset involves questions and answers type of conversation between the chatbot and the user which helps to know what the user wants and

Table 1 Description of intent, tag and response

Keyname	Description
Intent	Queries asked by the user
Tag	Corresponding disease with respect to Intent
Response	Answers provided by the chatbot

how the user wants to solve it. The dataset is the json file with different keys such as INTENT-Which are different ways of asking questions to chatbot or in simple words the intention of patient; RESPONSE-Which stores the responses of particular questions asked by the patient related to particular disease; TAG-Tag represents the disease name as shown in Table 1. The dataset contains 80 different tags thus capable of answering questions of 80 different diseases. This dataset is used for answering basic queries of patient's related to common/basic remedies of a disease and detailed information of parameters used in various health tests such as blood test, urine test, vitamin test, etc. The dataset contains 10–12 questions of a particular tag thus giving the model sufficient amount of data to correctly predict the intention of users.

The second dataset is an open source dataset which can be acquired on Kaggle website name as Disease Symptom Prediction. This dataset is used to detect disease based on the symptoms provided by the user. The symptoms are marked as binary values i.e. 0 and 1. If a bunch of symptoms map to a particular disease then it is marked as 1 else it is marked as 0. This dataset has 132 parameters on which 42 different types of diseases can be predicted. Since different users can have different symptoms for a particular disease, hence we have different rows for the same prognosis to reduce the incorrectness in predicting the disease. Thirdly, for the function to display information about drugs we used a dataset available on Kaggle that was made by scraping drug list from Drugs.com.

4.2 Pre-processing the Data Using NLP

For a data or text in our case to be predictable and analyzable for different task we need to pre-process it. Preprocessing text is a method to transform text so that it can be in an efficient format ready to be used with a machine learning model for better accuracy. To preprocess the data, we have used techniques like lower casing the text, tokenization, removing stop-words and lemmatization (Fig. 3).

Lower Casing the sentences

One of the simplest and most efficient way of text preprocessing is to convert all the text to lowercase. Words like "Pain" and "pain" mean the same but are represented as different words in the vector space which results in increase in dimension, hence lowercasing the data is important. Table 2 illustrates an example of solving sparsity issue through lowercasing, where same word with different meaning are mapped to single lowercased word.

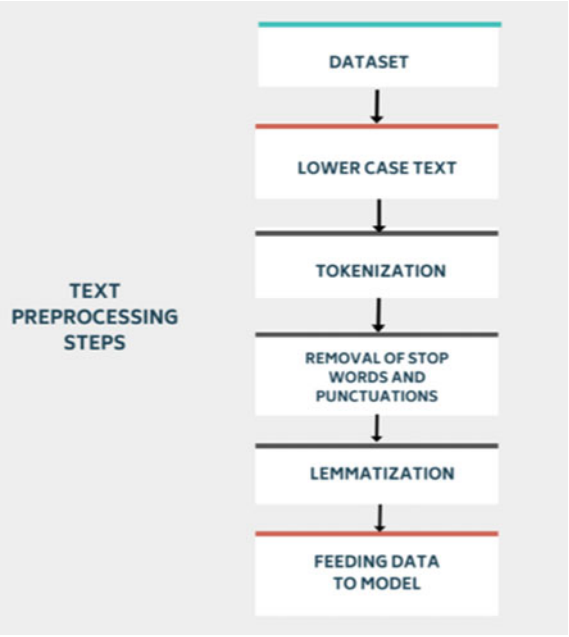

Fig. 3 Process of pre-processing

Table 2 Example of lower casing a word

Raw word	Lowercased word
Fever FeVeR FEVER	fever

Tokenization

Tokenization refers to breaking a sentence into single words whenever a white space or a punctuation is encountered. This step is very essential as it provides list of words to be dealt with for the next steps involved in text preprocessing. For example if input sentence is "I am having a stomach pain", then the sentence is tokenized as "I", "am", "having", "a", "stomach", "pain".

Removal of Stop-words and Punctuations

In NLP, stop words are generally called as "useless" data that is they are not useful for the model. A stop word is a commonly used word (such as "the", "a", "an", "in") which are not at all useful for classification model and can create a noise which will effectively decrease the accuracy model. Hence all the stop words are removed from our data. For removal of punctuations Regular Expression (Regex) are used that identify punctuations and remove them. Punctuations makes the text noisy and provides no efficiency hence it's essential to eliminate them.

Table 3 Example of lemmatization

Original word	Lemmatized word
Itching Itchy Itches	Itch
Sting Stingers Stings	Sting

Lemmatization

Doing things properly with the use of vocabulary through grouping different inflected forms of words to its base root mode with same meaning is known as lemmatization. Lemmatization extracts the correct lemma of each word. Lemmatization is a slower process but it is useful for analysis. It's a dictionary based approach and produces a better accuracy if used. Lemmatization transforms the word without chopping the letters that gives the word a definition. Table 3 shows an example of the words 'Itching', 'Itchy' and 'Itches' mapped to its lemma 'itch'.

4.3 Machine Learning Model

Naïve Bayes algorithm

Naïve Bayes model is a fast and simple classification algorithm used for a very high dimensional dataset. The classifier is based upon Bayesian classification method, which can be shown by Eq. 1 below.

$$P(A|B) = P(B|A) * P(A)/P(B) \quad (1)$$

For prediction, the algorithm uses likelihood probability. In simple term likelihood is known as reverse probability. Each word from the question asked by the user are considered as features and tag and with respect to those tags, questions are considered as labels. Now every input word is compared with all words there in the dataset and based on above Bayesian formula the different labels are associated with input question. The labels having the highest probability are considered and in this way, the algorithm works. For example, let's say if the user asked a question as "What do I do if I am having mild fever?", so now every word will form a feature vector space. Every word will be compared with different words in the bag and based upon that the class labels are assigned with certain probabilistic measure. Class labels assigned are 'mild fever' with probability of 95.67% and an—other class label is assigned as 'cough' with 92.78%, then class label with highest probability is considered that is "mild fever".

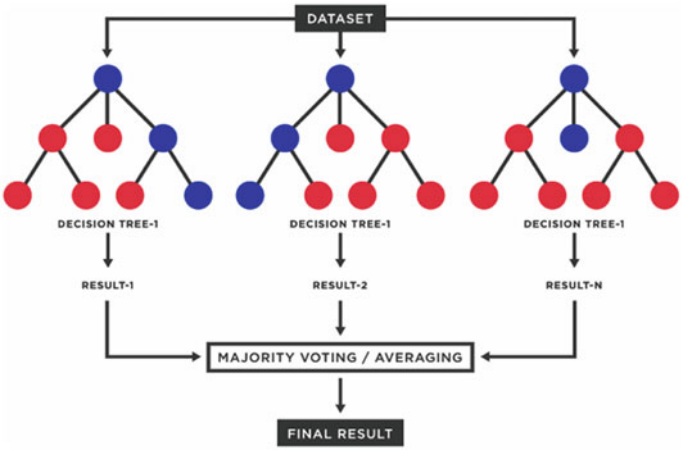

Fig. 4 Process of random forest classifier

Random Forest Classifier

Random forest classifier algorithm is a supervised learning algorithm which is used for classification as well as regression. As a name suggest it is a forest where there are trees which carries correct labels within them. So now random forest classifier algorithm selects the best tree from forest based on voting. Generally, it is considered that if there are more trees in the forest than the accuracy of the algorithm increases, which is indeed true in real life. The main advantage of using random forest classifier is saving the model from overfitting, because it itself takes the average of the prediction. As given in Fig. 4, random subsets are decision tree which consist of root node, leaf node, leaves and correct prediction of each decision tree is stored on its leaf and after through majority voting correct labels are predicted.

5 Evaluation Metrics

To build an effective machine learning model, certain evaluation metrics are used. Evaluating helps to get the useful insights whether the labels are correctly or incorrectly predicted. There are various metrics for evaluating a model such as mean squared error (MSE), Area under Curve (AOC) and confusion matrix. In our case, we would be evaluating our model on the basis of confusion matrix which is the metric used most for classification problems. In confusion matrix, the correct and incorrect predicted labels are segregated or broken with each class. Confusion matrix also gives the type of error the model is making. Figure 5 is an example of confusion matrix that uses terms like True Positive (TP), True Negative (TN), False Positive (FP) and False Negative (FN). TP and TN refers to the model accurately predicting and classifying whereas, FP and FN refers to the model inaccurately predicting and

Fig. 5 Example of confusion matrix

Table 4 Formulae of evaluation metrics

Metric	Formula
Accuracy	(TP + TN)/(TP + FP + FN + TN)
Recall	TP/(TP + FN)
Precision	TP/(TP + FP)
F1 score	$\frac{TP}{TP+\frac{1}{2}(FP+FN)}$

placing the data in wrong classes. Using these terms from the confusion matrix we can calculate the accuracy, precision, recall and F1 score that would be the evaluation metric for our model.

Accuracy is the metric which gives us the ratio of correct predictions (TP and TN) to the number of classes (TP, TN, FP, FN). But we know that, accuracy is not the best option to evaluate a model if the dataset is unbalanced. Hence, we have to use precision and recall as well. Precision is fraction of correct positive predictions (TP) out of all the positive patterns in the class (TP and FP). It is called as positive predictive value. Recall is the true positive rate and gives the fraction of positive labels that are predicted positively. Preferably, the best case of a model would be if the precision and recall having value as one which also implies that FP and FN should be zero. Hence, we would be also using the metric F1 score that uses both precision as well as recall to evaluate the result. Table 4 illustrates the formulae of all the evaluation metrics using confusion matrix terms.

6 Results and Discussion

The dataset used for disease prediction is divided into 70% of the training dataset and 30% of the testing dataset. As discussed in the section Evaluation Metrics, we used confusion matrix to evaluate our classification model and evaluated the metrics like accuracy, precision, recall and F1 scores.

From Table 5 we can conclude that the Random Forest Classification model is a better model for our chatbot with accuracy of 86% and an F1 score of 82% as compared to Naïve Bayes. With this inference we proceeded with the development of our chatbot with Random Forest algorithm as the model to be used.

Table 5 Results of classification models

Algorithm	Accuracy (%)	Precision (%)	Recall (%)	F1-score (%)
Naïve Bayes	52	52	80	65
Random Forest	86	84	88	82

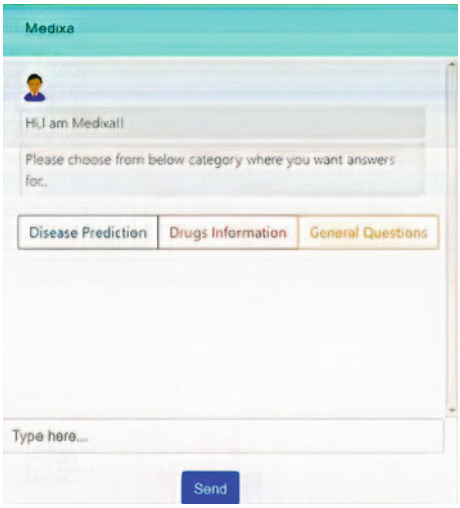

Fig. 6 User Interface of our chatbot

We were successful in creating the chatbot with the planned architecture and modeling as discussed in Methodology section. The program of our chatbot can be integrated with websites that are built for healthcare concerns in order to make the website more useful and give all round support to users. Figure 6 illustrates beginning of the conversation with the chatbot where the user would get to choose the type of conversation from three choices namely.

- Disease prediction.
- Drugs information.
- General question.

Figure 7 illustrates the conversation of the user and chatbot concerning information of medicine 'Adaferin Gel' when the user clicks on Drug information section it provides the user with the medicine's full name, price in Indian Rupees, side effects and the usage of the medicine.

Chatbot accurately predicts the infection Impetigo in Fig. 8 when the user enters a list of symptoms. General questions concerning health was also successfully answered by the chatbot and it has been illustrated in Fig. 9.

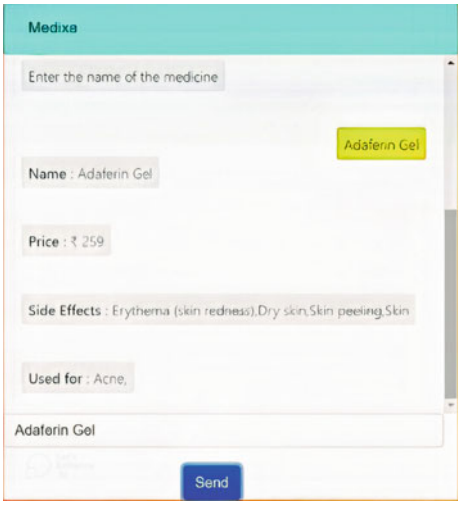

Fig. 7 Chatbot describing about a medicine

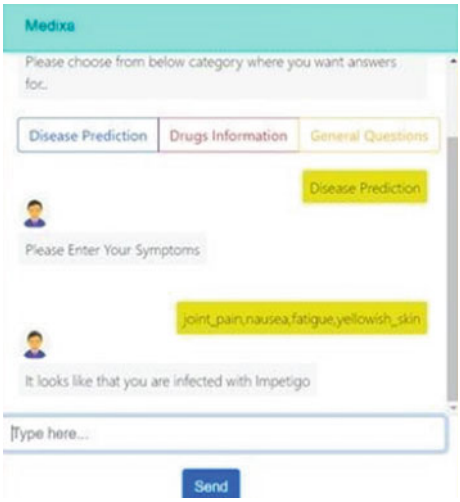

Fig. 8 The chatbot predicting a disease

7 Conclusion

Many individuals are utilizing various sorts of chatbots that work in the field of fashion, medical care, and so on and are helpful for business as expressed by mindtree.org, a web-based website that stays aware of the number and kinds of chatbots all over the planet and has revealed around 1400 chatbots presently underway. A central justification for the spike in fame is the expansion of man-made consciousness to visit applications giving an efficient and compelling response to questions. Chatbots are modified to satisfy the expectation of inquiries posed by the client while

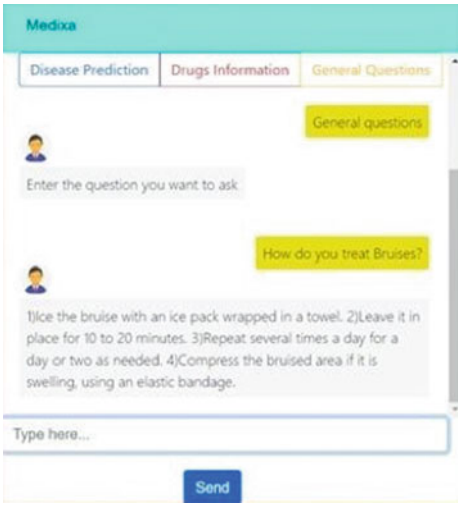

Fig. 9 The chatbot answering general questions

at the same time noting them rapidly. Likewise, chatbot joining in any site or portable application gives the client a remunerating experience and saves a great deal of time.

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