Volume 9, Issue 5
October 2020

ITEE Journal
Information Technology & Electrical Engineering

ISSN: - 2306-708X

Doctor Chatbot: Heart Disease Prediction System

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ABSTRACT

Chatbots, or conversational interfaces as they are also known, present a new way for individuals to interact with computer systems. A chatbot allows a user to simply ask questions in the same manner that they would address a human. However, chatbots are currently being adopted at a high rate on computer chat platforms. Such bots use artificial intelligence to understand the input given by humans and accordingly respond. Medical/ Health, Agriculture and educational domains are important domains to pay attention to. Nowadays, chatbots can be used anywhere a human can interact with a system anytime. Customer Service, Sales/Marketing/Branding, Human Resources, These are the areas where the fastest adoption is occurring. Other chatbots perform prediction tasks (especially in the medical domain) which is possible today with advancements in AI and Data Mining Techniques. As in today's world, the number of patients daily is increasing rapidly with the change in lifestyle. The queues in hospitals & local doctor's residences are therefore on a rapid increase. Patients with a busy schedule have to spend a lot of time waiting to meet the doctor. Some diseases take a lot of time to cure. Heart Disease is a very common problem worldwide. Every day, many people, young and old, die of a heart attack. The future of healthcare relies on the ability of care providers to collect data remotely, to make accurate diagnoses across distances, to use AI to analyze data to improve both business and health outcomes, and more. The technology at the core of the rise of the chatbot is natural language processing ("NLP"). The tools used for creating chatbots are Dialogflow, Microsoft Bot Framework, Telegram Bot API, etc. Disease prediction can be done using various data mining algorithms along with their respective domain-specific datasets. Both can be integrated to build a conversational system to predict diseases.

Keywords: *Medical Chatbot, Dialogflow, Heart Disease Prediction, python, Support Vector Machine (SVM), ngrok, Machine Learning, Appointment Booking System.*

1. INTRODUCTION

A chatbot is an AI-based software application that performs an automated task that can simulate a conversation (or a chat) with a user in natural language through messaging applications, websites, mobile apps, or through the telephone. A chatbot is often described as one of the most advanced and promising expressions of interaction between humans and machines. Natural language processing (NLP) is the heart of AI-fueled chatbots. The sophisticated NLP algorithms can process the received text: interpret, deduce, and determine what was meant and then specify a series of appropriate actions. The chatbot is used to handle messages and process those using Natural Language Understanding (NLU) services. Just as a human psychologist does.

There are countless cases where a digital personal assistant or a chatbot could help physicians, nurses, patients, or their families. Better organization of patient pathways, medication management, and help in emergencies or with first aid, offering a solution for simpler medical issues: these are all possible situations for chatbots to step in and ease the burden on medical professionals. Most people in this new generation don't pay attention to health. Performing medical check-ups regularly is very much mandatory. This helps in the early detection of diseases such as cancer, AIDS, etc. which can help perform early diagnosis. Detection of disease at a later stage can be very risky and diagnosis at this stage can be very expensive.

Heart Disease is a very common problem worldwide. Every day, many people, young and old, die of a heart attack. Taking care of the Heart is very important and as mentioned above, early detection of such a disease is necessary. However, there are limited doctors available in this field. Some of them charge a reasonable amount of consultation charges which some poor people cannot afford. Hence, there is a need for a platform that can help in the detection of heart disease without the presence of a doctor, free of cost, and user-friendly to use for old as well as young people.

Most Medical Chatbots available are for general purpose i.e. not specific to a certain medical domain like Cardiology (heart), Gastroenterology, etc. Most of these chatbots don't have the feature of booking appointments with related doctors. The objective is to develop a conversational system to predict heart diseases using Dialogflow as front end, SVM algorithm to classify the dataset, and predict whether the user suffers from heart disease or not.

2. LITERATURE SURVEY

Chatbots are computer programs capable of carrying out natural conversations. AI is revolutionizing businesses and chatbots powered by AI are becoming a feasible customer service channel and reduces manpower. Some use sophisticated natural language processing systems, but many simpler ones scan for keywords within the given input, then pull a reply with the most matching keywords/patterns from a database. Chatbots can be classified into many categories such as e-commerce (via chat), analytics, customer support, education,

entertainment, finance, food, games, health (Medical), HR, marketing, news, personal, productivity, shopping, travel, utilities etc. With the increase in data, chatbots can help users to find their requirements. The first-ever chatbot created was called ELIZA. Many Chatbots have been invented till today including Alexa and Siri.

Literature Review or Background was conducted in order to study and obtain knowledge from previous researches and surveys. Some papers were classified based on tools/software's used, algorithms used and their corresponding datasets (if any) used along with the platform. Some Survey papers are also mentioned describing the comparison between various existing chatbots.

Support Vector Machine (SVM) and Artificial Neural Network (ANN) Algorithms were used in predicting heart diseases using Clevenland and Statlog Heart Datasets in MATLAB R2010 where the resulting accuracy, precision and sensitivity are shown in table 1 [1]. Natural Language Understanding, Word Embedding Models, Framework for Emotional Recognition along with Spatial Temporal Context Analysis, Multi-modal Approach is used for defining an Emotional Expression Model to Categorize, Collecting Training Data for Emotion Recognition, Emotion Recognition and Inference, Continuous Emotional Monitoring using data in text, image, video, audio format [2].

SWITCHes Android app makes use of mHealth Intervention Tools and creates a custom medical chatbot algorithm for android under LINE channel for Weight Control and Health Promotion based on energy balance equation [3]. Using AI, Deep Learning and Machine Learning algorithms (with Tensorflow library), accuracy of 98.3% under medical domain can be obtained to deliver personalized healthcare & fitness related assistance [4].

Genetic Algorithm, Decision Trees and Naive Bayes Algorithm was used for comparison using MATLAB R2012a and it is used to develop a prototype which can determine and extract unknown knowledge related to heart disease [5]. MediAssistEdge system used MySQL, AIML, swftools, Red5, HTTP, RTMP and a Single-Supply Biasing Method. The system consists of two subsystems- MediConnect system and DocBot system, which simplifies diagnosis procedure & improves patient doctor connectivity [6]. A chatbot designed for cancer patients, gets the user message through channels like Facebook, WhatsApp etc. The chatbot makes use of Beautiful Soup python library to scrap data from cancer forums and store in local database also uses NLTK available in python for pre-processing of data. Responder takes the fetched data and produces a human like output [7]. VDMS a web-based chatbot is built by using open source php interpreter designed for AIML called program-o. The local knowledge base of VDMS on diabetes is made by using AIML pattern tags. Also makes use of pattern matching algorithm. A test was conducted were a group consisting of 10 participants asked questions to VDMS from which the chatbot could answer 65% of questions which the users were satisfied with [8].

MedBot uses Pattern matching algorithm, Natural Language Understanding (NLU), Dialogflow API and DoctorMe Apps datasets. The chatbot can be easily implemented in online chat systems such as Facebook, Hangout, and Line by using the provided APIs. [9]. WEKA tool And KEEL was used for analysis of Decision tree Algorithm with Cleveland Clinic Foundation (Cleveland Data) for Heart Disease Prediction giving correctly classified Instances of 87.41722% accuracy. Important parameters that were used include ECR, cholesterol, chestpain, fasting sugar, maximum heart rate and many more. A11possible-MV algorithm to fill the missing values in the datasets [10].

AI and machine learning algorithms were compared using MAS (Multi-Agent System) support tool kit to achieve anticipated behaviour, in the dialog manager, and RL (Reinforcement Learning) to facilitate learning. The bot was trained using datasets in the knowledge base using RL [11]. SVM, k-NN, Naive Bayes & Porter Stemming Algorithms along with AIML, Google API, Java & Pascal, MySQL, NLP and certain Heart Diseases datasets were used in building a Heart disease prediction system after distinguishing hyper plane which minimize the error for unseen patterns [12].

The test for diagnosis of heart disease was reduced using feature subset selection which is the process of extracting the relevant data and eliminating the irrelevant data from the given dataset. Genetic algorithm uses genetic search which reduces the number of attributes from the data set for an easy search. Dataset of record 909 with 13 attributes by sellapanetal was used [13]. MedChatbot is an open source AIML based Chatterbean which uses widely available UMLS as the knowledge source to answer the queries. The AIML based chatbot converts natural language queries into SQL queries. The queries are run against the knowledge base and returns results in natural dialog [14].

Farmbot is an agriculture domain based chatbot which uses Natural Language Processing techniques to understand user queries in natural language. The bot is trained by using training dataset based on the dataset a neural network is formed and error is optimized using the gradient descent algorithm. The chatbot makes use of speech synthesis web API to provide voice based responses to the user. The chatbot uses prediction algorithm "ARIMA" to predict the future cost of agriculture products.it gave a mean absolute percentage error of 0.1814% which when tested provided mean absolute percentage error of 0.1814% [15]. A chatbot designed by using Eclipse software in windows operating system where Java programming language was used. To make a chat dialog box, java applets were used. Database of this chatbot was designed by applying two-dimensional string array to the database. The design of this chatbot was very simple, and it answers questions only if they were found in database [16].

Pharmabot is a stand-alone medical chatbot developed by using Visual C# for front-end and MS Access for back-end. The input from user will be analyzed using Left-Right Parsing Algorithm. A group of pharmacy students and pediatricians rated the chatbot on different categories which included user-

Volume 9, Issue 5
October 2020

ITEE Journal
Information Technology & Electrical Engineering

ISSN: - 2306-708X

friendliness, appropriateness, consistency and speed of the chatbot [17]. A survey was taken on various chatbots which divided them into AI-based and Rule-based. System architectures of the chatbots described as 3 main steps: Pre-Processing (NLP), Processing (NLU) and Generation (NLG). They evaluated the chatbot into 3 main categories: Content Evaluation, User Satisfaction, and Functional Evaluation shown in table 2 [18].

A Survey describes artificial intelligence, history of chatbot and applications of chatbots. New approaches have improvement over the pattern matching algorithm with increase in scripts written for it [19]. A comparison survey was conducted on the existing approaches, design and implementation of several chatbot systems from the very first chatbot to the latest ones. There were 3 approaches: Implementation of a domain specific chatbot, Implementation of a smart answering Optical Character Recognition based chatbot and Implementation of an Inquisitive chatbot. The comparison is given in table 3 [20].
Chatbots can be used as a Tool, Channels of Chatbot and Comparisons of Chatbots Based on Features, Programming Name/Apps etc. [21].

Tanagara tool is a data mining suite build around graphical user interface algorithm which is used for classifying the data. Tanagara is a system that contains data clustering, data visualization, Meta supervised learning etc. Algorithm used are decision Tree, clustering, naïve bayes were used. A performance study of 3 data mining algorithms i.e. Naive bayes, Decision tree & k-NN used for analysing datasets of Heart Diseases. They were described based on their accuracy, time taken and other characteristics [22].

A Survey was taken with 100 General Practitioners (GPs) in an online research survey that examined their perceived benefits, challenges, and risks of using chatbots in health care. Almost half of the physicians' perceived health care chatbots to be important for patients, especially for helping patients better manage their own health. These findings suggest that physicians may be comfortable with using chatbots to automate simple logistical tasks but do not believe that chatbots are advanced enough to replace complex decision-making tasks requiring an expert medical opinion [23]. Similarities & Differences with some Influential factors in designs of Chatbots like voice/text, creating new chatbots, using available chatbots, AIML/SQL usage, Matching Technique, Knowledge base and application was examined in a survey which is given in table 4 [24].

3. PROPOSED METHODOLOGY

Based on the Literature Survey conducted in the above Chapter, the classification models such as SVM, Naïve Bayes, kNN and Decision Tree were used to compare their Accuracy using the heart disease dataset which is pre-processed as mentioned above. The implementation of the models and their corresponding outputs are shown below.

Accuracy for training set for SVM = 0.8349056603773585
Accuracy for test set for SVM = 0.9010989010989011
Precision: 0.9038461538461539
Recall: 0.9215686274509803

Accuracy for training set for Naive Bayes = 0.8207547169811321
Accuracy for test set for Naive Bayes = 0.8571428571428571
Precision: 0.88
Recall: 0.8627450980392157

Accuracy for training set for kNN = 0.7547169811320755
Accuracy for test set for kNN = 0.6703296703296703
Precision: 0.7142857142857143
Recall: 0.6862745098039216

Accuracy for training set for Decision Tree = 1.0
Accuracy for test set for Decision Tree = 0.7912087912087912
Precision: 0.8333333333333334
Recall: 0.7843137254901961

As observed from the outputs of the above classification models, the accuracy for SVM algorithm for test sets was 90% which is higher as compared to other algorithms. Thus, This Project will be using SVM classification model.

Dialogflow is a great platform to build chatbots. Using ML and intent matching techniques, it can recognize the given question and answer back accordingly. Chatbots can also be built using AIML which is easy to understand. The Questions and Answers are written and stored in XML format. Support Vector Machine algorithm is used to cluster linear as well as non-linear data from given dataset thus giving more accurate results especially in medical domain. For such an algorithm, Heart Disease Datasets which are publically available can be used. SVM can be implemented using Python Programming Language which has built-in libraries for Machine Learning such as scikit-learn which helps in easy implementation of Support Vector Machine Algorithm. Numpy library can be used to process the multi-dimensional datasets, Matplotlib can be used to report analysis graphs of results. Tools like WEKA and MATLAB can also be used for analysis of data, plotting graphs and also to implement algorithms. WEKA is a data mining tool which can be used for pre-processing, clustering and classification of data. Ngrok can be used to link Dialogflow to the backend operation (SVM) using webhook and python's flask library. Thus, using these tools and technologies, chatbots can be built for various domains like medical, ecommerce, education etc.

The System Working for this Project is as follows:

- User will start interacting with the Chatbot telling his problems (Voice/Text). The Chatbot will prompt some questions where It asks the user whether he is suffering from the asked symptoms or not. This is done with the help of the intents created for this agent in Dialogflow, each consisting of training phrases made up of custom entities such as symptoms.

Volume 9, Issue 5
October 2020

ITEE Journal
Information Technology & Electrical Engineering

ISSN: - 2306-708X

- Furthermore, if the user has report data (related to Heart Disease Dataset), the chatbot requests him to submit that data (using a separate form).
- Once the required data is collected, it is sent via Dialogflow's Fulfillment Webhook feature to the python code (on local machine) using ngrok (with public link) and python's Flask library (using port 5000 on localhost).
- The SVM Algorithm (in python) creates a model using Heart Disease Dataset, and predicts the user's report data (as test case) whether he is suffering from heart disease or not. The other symptoms data can be used to create a report, and provide few basic diagnosis solutions.
- This response is sent back to Dialogflow in the same manner as in step 3. These are called dynamic responses of the intents.
- When user gets its prediction results (and also report), the chatbot asks the user whether he wants to book appointment to related available doctors.
- If user agrees, he supplies date and time with selected doctor and the appointment can be booked.

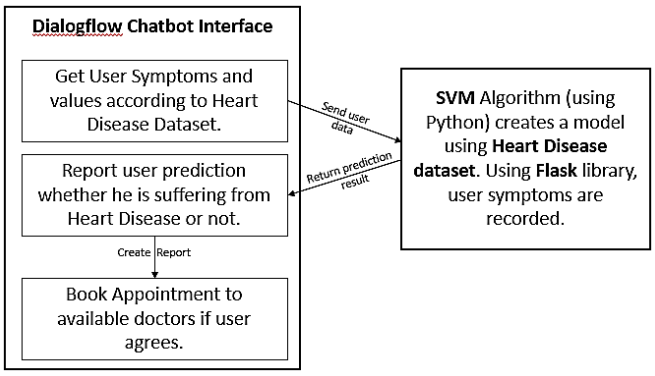

Fig. 1. System Working Model

This Working Model is a Synchronous Model as Client has to wait after submitting the details to the python functions until these function returns back the result back to Dialogflow successfully. Till then, the user cannot chat with the bot! The following Tools & Technologies were used to implement this project:

- SVM Algorithm
- Heart Disease Dataset
- Dialogflow (API.ai)
- ngrok
- Python
- Python Libraries: Flask, pandas, sklearn, smtplib, json.
- Eclipse/Liclipse editor
- HTML, CSS, JS

In Dialogflow, an Agent for the project named 'Doctor_Chatbot' was created, and the intents created & used for this project is shown below.

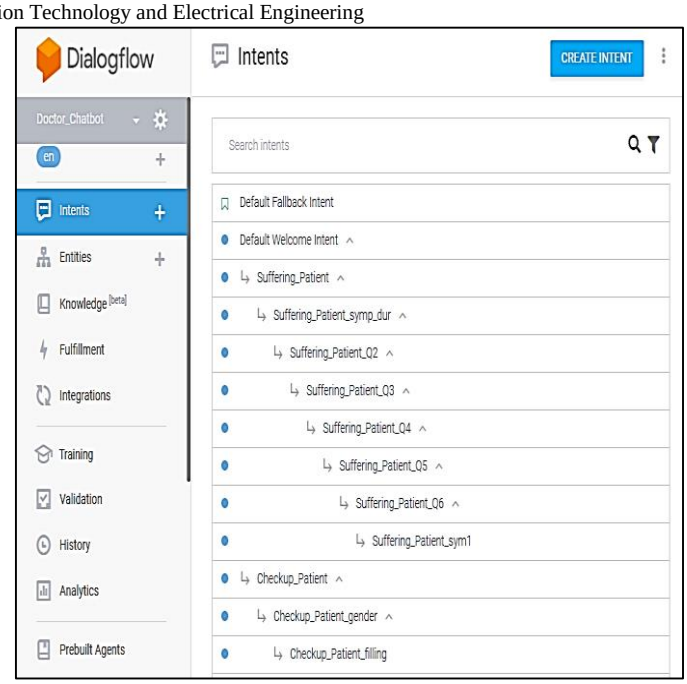

Fig. 2. Dialogflow Intents for Doctor_Chatbot Agent

Training phrases are example phrases for what end-users might type or say, referred to as end-user expressions. The action field is a simple convenience field that assists in executing logic in your service. When an intent is matched at runtime, Dialogflow provides the extracted values from the end-user expression as *parameters*.

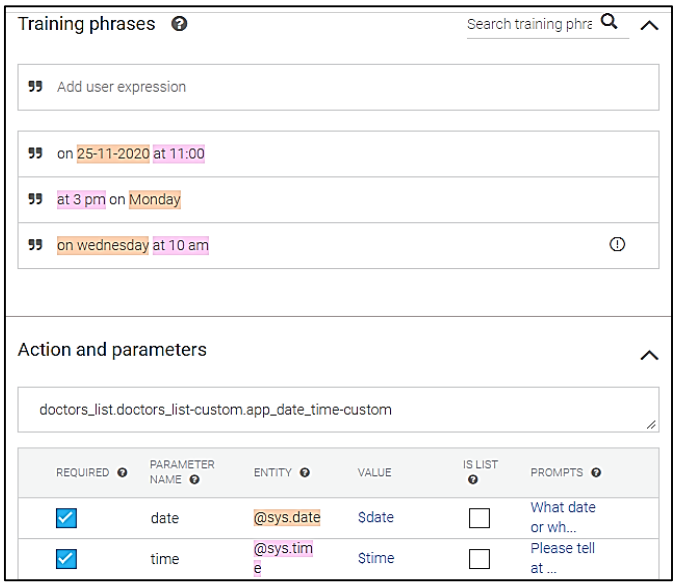

Fig. 3. Examples of Training Phrases and their Action & Parameters

Each intent parameter has a type, called the entity type, which dictates exactly how data from an end-user expression is extracted. Dialogflow provides predefined system entities that can match many common types of data. For example, there are system entities for matching dates, times, colors, email addresses, and so on.

Volume 9, Issue 5
October 2020

ITEE Journal
Information Technology & Electrical Engineering

ISSN: - 2306-708X

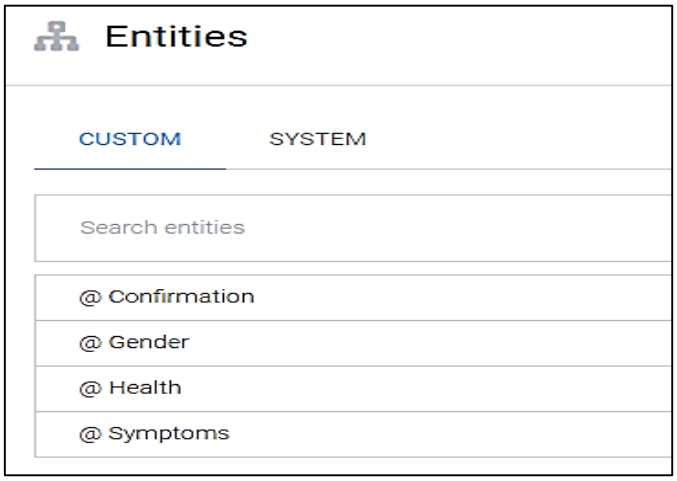

Fig. 4. Dialogflow Entities

Dialogflow integrates with many popular conversation platforms like Google Assistant, Slack, and Facebook Messenger. Dialogflow Web Demo provides a simple text chat user interface for your agent. The Auto Generated code is to be pasted in the Chatbot Html file.

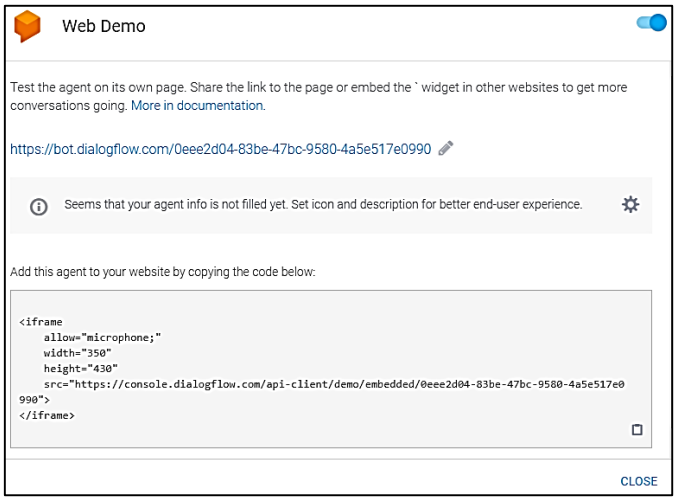

Fig. 5. Web Demo Link Generation in Dialogflow

4. RESULTS

To Execute the Project, first run command prompt, and execute the command: **ngrok http 5000**

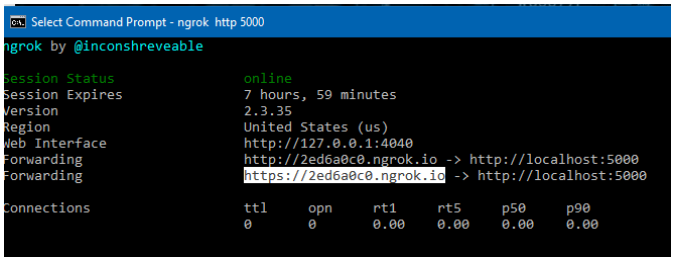

Fig. 6. Executing ngrok command in cmd

Note: open command prompt in the folder where the ngrok file is located. This command supplies a public link for this machine (highlighted in fig. above) on port 5000. Copy that link and paste it in dialogflow -> fulfilment -> Webhook in the URL section. Append /**webhook** to the link as shown in figure below.

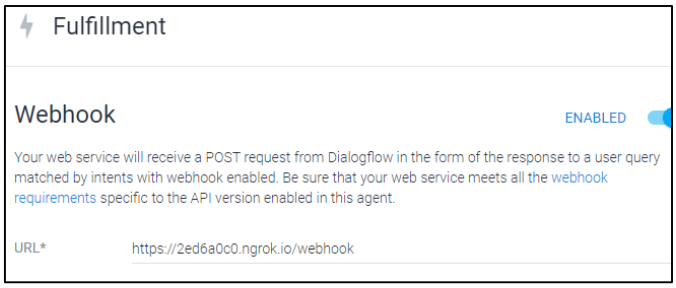

Fig. 7. Dialogflow Fulfilment Webhook URL

This ensures that Dialogflow is connected with our machine via port 5000. Next step is to run the python flask file having @app.route() functions until we get the output in console as shown in figure below.

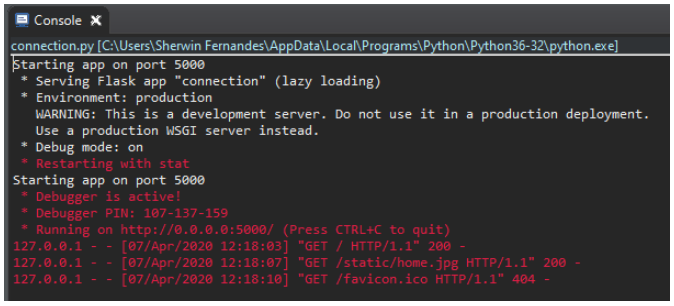

Fig. 8. Execution of python flask file in Eclipse

This ensures that Dialogflow is connected with flask python file. Next step is to execute the chatbot on web. Open a Browser and run the localhost (on port 5000) link for home page using **http://127.0.0.1:5000/** or **http://localhost:5000/**.

Volume 9, Issue 5
October 2020

ITEE Journal
Information Technology & Electrical Engineering

ISSN: - 2306-708X

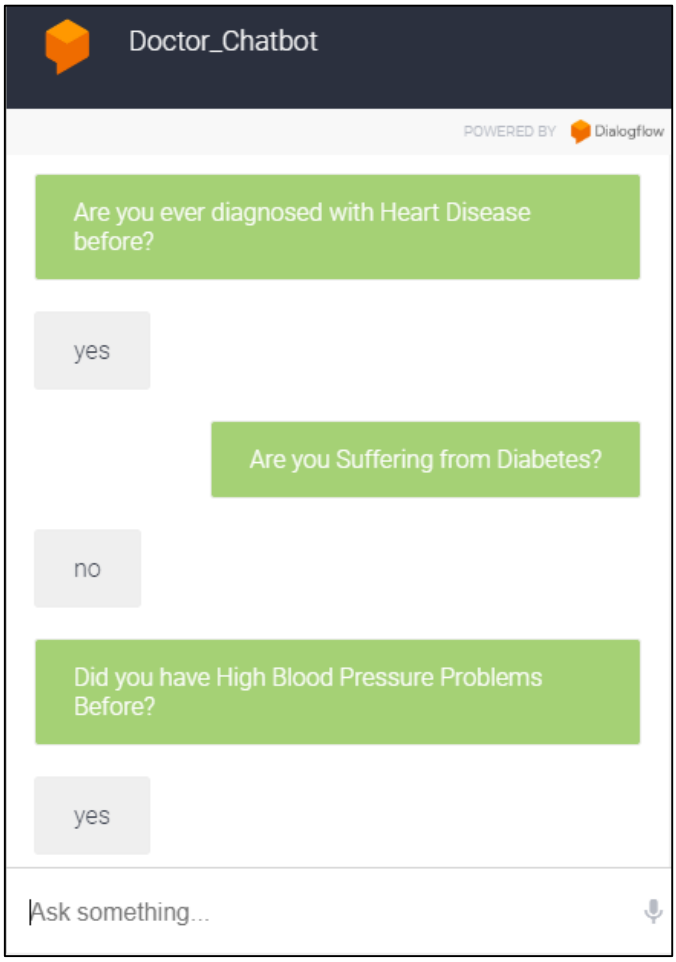

Fig. 9. Chatbot Screenshot 1

Fig. 10. Chatbot Screenshot 2

Volume 9, Issue 5
October 2020

ITEE Journal
Information Technology & Electrical Engineering

ISSN: - 2306-708X

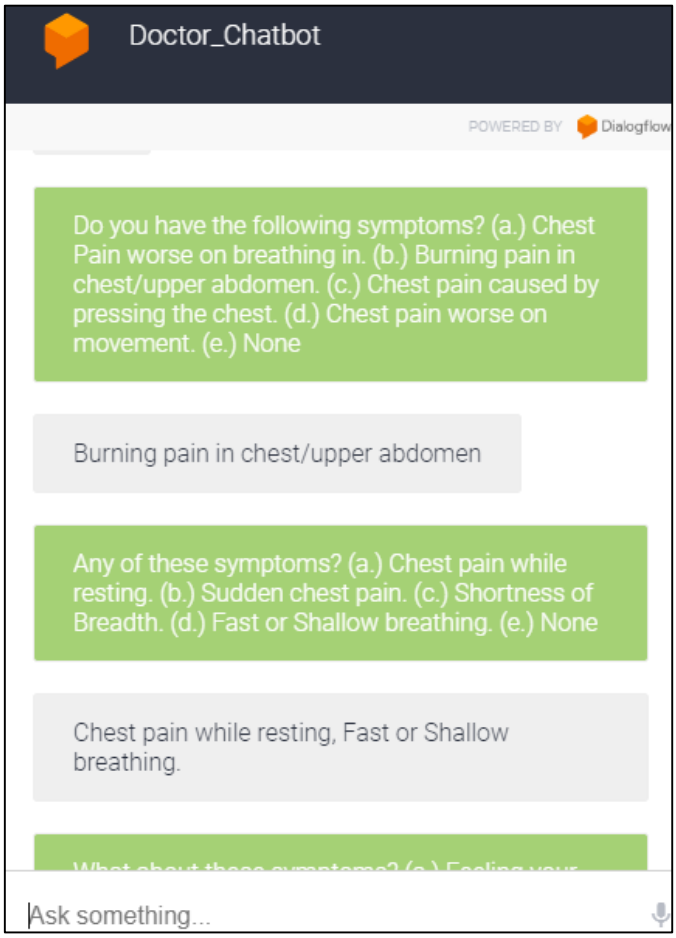

Fig. 11. Chatbot Screenshot 3

The Questions used for chatbot training via intents were:

- How long have you had it?
- Are you ever diagnosed with Heart Disease before?
- Are you diagnosed with Diabetes?
- Are you diagnosed with High Blood Pressure?
- Are you diagnosed with Asthma?
- Are you diagnosed with Chronic Obstructive lung disease?
- Do you smoke or ever smoked?
- Ever had a brain stroke?
- Do you think you are Overweight/Obese?
- Are you diagnosed with Kidney Disease?

- **Do you have the following symptoms?**
- Chest Pain worse on breathing in
- Burning pain in chest/upper abdomen
- Chest pain caused by pressing the chest
- Chest pain worse on movement

- **Any of these symptoms?**
- Chest pain while resting
- Sudden chest pain
- Shortness of Breadth
- Fast or Shallow breathing

- **What about these symptoms?**
- Feeling your heart racing or skipping a beat
- Chest pain spreading to the left arm
- Chest pain spreading on physical effort
- Joint/Abdominal pain

- **What about these symptoms?**
- Chest Tightness
- Unusually Tired
- Anxiety
- Chest pain spreading the Jaw

Dialogflow asks some of these questions frequently, while others may or may not be asked, just like how a Doctor asks. All this inputting information is sent for python flask file and stored there for decision making.

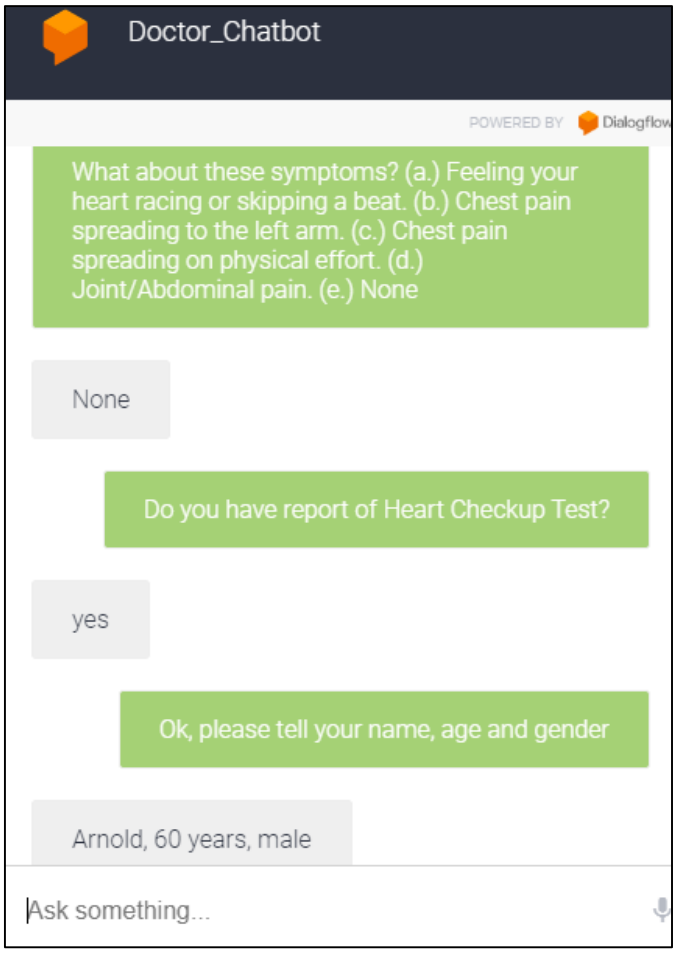

Fig. 12. Chatbot Screenshot 4

When the Bot asks you to fill the report, it is compulsory to enter your name, age and gender, as these parameters are part of the dataset. The input data required to fill in the report are attribute values of the heart disease dataset.

Volume 9, Issue 5
October 2020

ITEE Journal
Information Technology & Electrical Engineering

ISSN: - 2306-708X

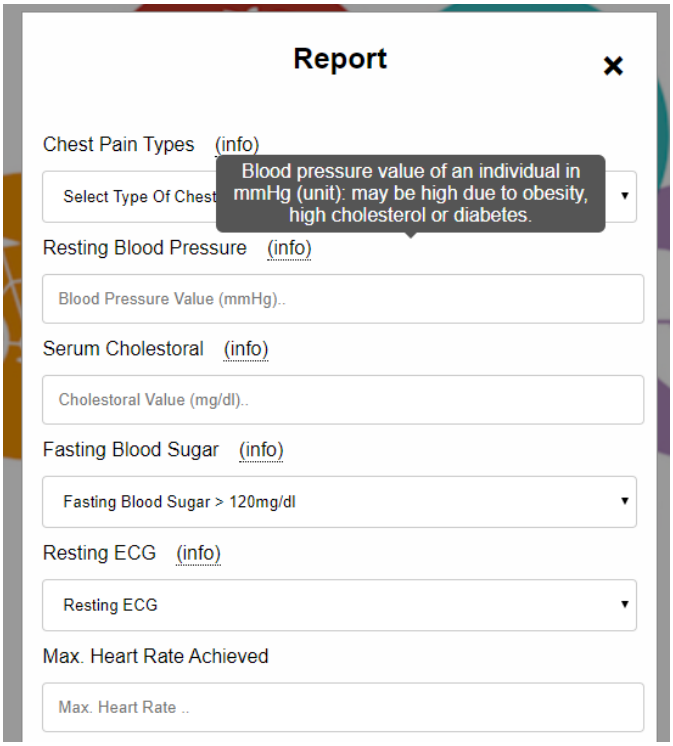

Fig. 13. Dataset Form Screenshot

Then, the bot will give the Summarized report in one message predicting whether the user has heart disease or not, along with the symptoms inputting by the user earlier. The bot may also suggest a basic home remedy plan, and will give disclaimer that the bot has not performed any physical diagnosis to rely on! It thus suggests user to visit the doctor (in case he is suffering), and helps to book any appointment as shown in figure below.

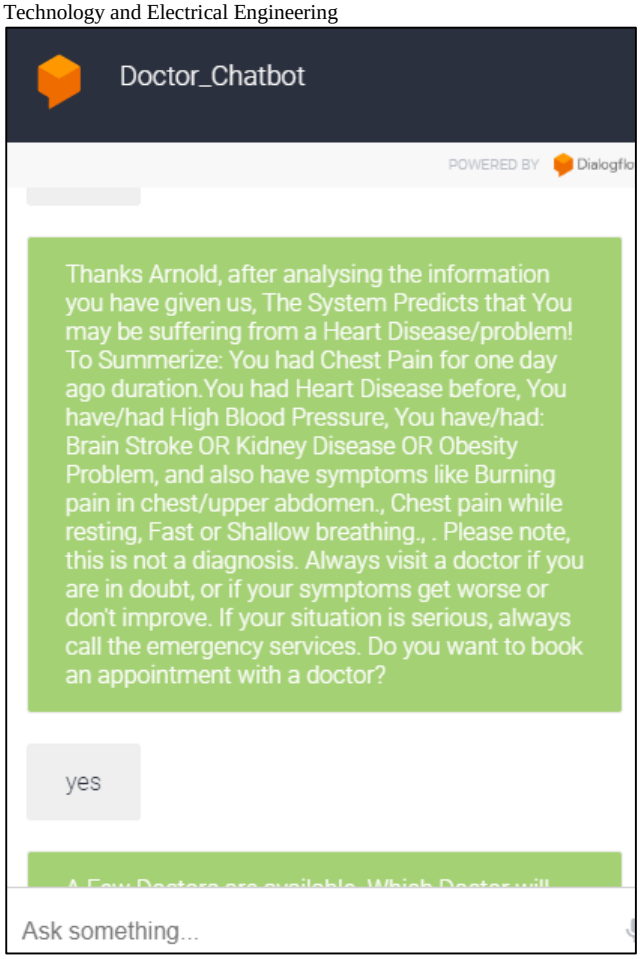

Fig. 14. Chatbot Screenshot 5

The example input provided in the report was [64,1,3,110,211,0,0,144,1,1.8,1,0,2], where result = 1 (Refer Dataset section for input value details). Thus the system predicts that the user (Arnold) may be suffering from a heart disease.

5. CONCLUSION

The main approach of this system is to detect & predict the presence of a Heart Disease with the best possible accuracy and speed which are considered as important characteristics of this project.

From the surveys conducted on various predicting algorithms like KNN, ANN, SVM, I Bayes, Decision tree etc., various tests were conducted on the same dataset to check for accuracy of each algorithm. From the survey point of view, it was found that Support Vector Machine algorithm on a Heart Disease Dataset gives the best possible accuracy in competition with I Bayes, Decision tree, KNN and more. An SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier. SVM is a discriminative classifier formally defined by a separating hyperplane.

Using the Technology above, the objective is to build a System which will be able to get the patient reports, analyse it and conclude whether he/she is suffering from Heart Diseases

or not. The process will be done in a conversational manner using Dialogflow Platform. It also helps to get early diagnosis. The system will also be trained to provide appointment booking facility with related doctors. This healthcare bot system will help hospitals to provide healthcare support online 24 x 7.

Since the project is built to mostly execute on desktop Web Browsers, it is recommended to supply input in text format and not voice so that wrong inputs (like in case of asked symptoms) can be avoided which may lead to error. The Bot also responds with a Disclaimer: "Please note, this is not a diagnosis. Always visit a doctor if you are in doubt, or if your symptoms get worse or don't improve. If your situation is serious, always call the emergency services". This ensures that the user doesn't completely reply on the bots recommendations, which in worst case can lead to death.

6. FUTURE WORK

Since none of the algorithms give 100% accuracy, it can sometimes give wrong output for a chatbot in medical domain, which can lead the user to go under unnecessary medication and cause waste of money & time. Such situation inaccurate results can also occur in the educational and agricultural domain. Thus maintaining such accuracy and user satisfaction is a limitation of this project. The System can also be moved to the cloud platform and can also be converted to multiple platforms such as desktop and mobile applications. Moving this system to the cloud platform and making it available to the public free of cost can increase the users, thus more data can be generated across various domains. Increasing users means that there will be a need for more doctors of various domains. This connects users with various doctors across the world. Since there are more users and more doctors, we can add consultancy services in other medical domains such as Diabetes, Cancer, AIDs etc. Further, online payment services can be added so that the consultancy charges can be paid.

Inorder to run this project in the real world, the dataset is required to as large as possible (size in GBs) inorder to build a model that is reliable to really predict problem presence of the real world, avoiding misconceptions or false results. This dataset which was publically available, cannot be considered as the only attribute for heart diseases. The attributes and their types differs globally, which includes heart images and ECG graphs. So the dataset should be such that it meets all global attributes as an input option. Thus collecting huge amounts of data may require lots of funding & Medical Permissions from Authorities. This can also be considered as future work.

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