

Developing a Chatbot using Machine Learning

K. Jwala, G.N.V.G Sirisha, G.V. Padma Raju

Abstract: In recent years, the development of chatbot has become trendier and so far several conversational chatbots were designed which replaces the traditional chatbots. A chatbot is a computer program which is used to interact with humans and fulfill their needs. Chatbot gives the response for the user query and sometimes they are capable of executing tasks also. Early development of chatbots became so difficult whereas recent chatbots development is much easier because of the wide availability of development platforms and source code. A chatbot can be developed using either Natural Language Processing (NLP) or Deep Learning. When compared to traditional chatbots, bots designed using Deep Learning requires huge amount of data to train. The aim of this paper is to present, in what different ways the chatbot can be developed and their classifications. This paper also makes a discussion about the metrics for accessing the performance of bots. This helps in designing more effective bots.

Index Terms: Chatbots, Deep Learning, Natural Language Processing (NLP), Word Embedding.

I. INTRODUCTION

Now-a-days, human interaction with digital devices has become common which led to the development of a chatbot. Chatbots help humans to converse with computers. Initial chatbots were developed just for the entertainment purpose only.

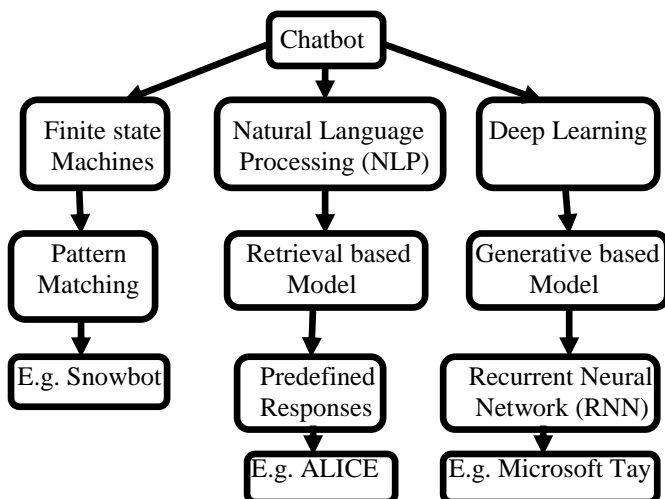


Fig.1: Flow chart of Chatbot

A chatbot can be developed in many ways and the bot developed using Deep Learning requires Neural Networks in order to learn the input sequence. Some bots like ELIZA [1], ALICE [2] take only text as input whereas bots like Siri,

Google Assistant, Amazon's Alexa accepts voice also as input.

A. Natural Language Processing (NLP): It is a branch of Artificial Intelligence (AI) that allows interaction between computer and human languages [3]. NLP can be used not only for text translation but for recognizing speech also.

The successful NLP systems that were developed in early 1960's are SHRDLU which works based on restricted vocabularies and ELIZA which simulates conversation through pattern matching and works based on substitution methodology also falls under this category.

In 1980's most of the NLP's were designed based on some set of hand-written rules. Later they were augmented with Machine Learning (ML) algorithms for language processing.

B. Recurrent Neural Network (RNN): It is an extension of general feed forward network [4] in which the network not only consider the current input, but also takes the previous output to generate a response.

Moreover RNN's have memory which can be used to remember the input sequence. Like every other neural network it has an input layer, output layer and some hidden layers [5].

C. Long Short-Term Memory (LSTM): The main drawback with RNN is they cannot remember the input for a long sequence. This problem can be solved by LSTM's [6] which is an extension of RNN and can remember long sequences of data.

II. CLASSIFICATION OF CHATBOTS

There are two classes of chatbot in regard to their purpose of designing and the information they are expected to provide [7]. They are:

A. Conversational chatbots: A conversational chatbot is designed either for fun purpose or to fulfill a task i.e., a conversational chatbot can be either a Chit-Chat bot or a task-oriented bot.

Chit-Chat bots do not try to reach any target they are focused on general conversation where as task-oriented chatbots are designed for doing a specific task like placing an order, scheduling an event.

B. Domain based chatbots: Chatbots classified based on domains are of two types namely, open domain bots and closed domain bots.

Open domain bots are also known as horizontal chatbots that are designed to answer any question. These bots are perfect, versatile. Siri from

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Apple, Cortana from Microsoft, Alexa from Amazon and Google Assistant come under this category. Closed-domain chatbots are also known as vertical chatbots that are designed for a specific area of interest like providing route for the new visitors.

III. ARCHITECTURAL MODELS OF CHATBOTS

A chatbot can be designed in two ways: Response to a user can either be generated from scratch using machine learning models or choose a relevant response from a repository of predefined responses [8]. Basically a chatbot can be of either Generative model or Retrieval based model.

A. **Generative models:** These models can build bots that can perform human style conversations. Such bots require millions of examples to train in order to get decent quality of conversation. Microsoft Tay [9] comes under this category.

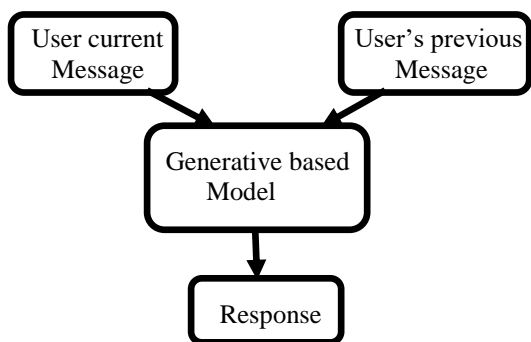


Fig.2: Generative based model

B. **Retrieval based models:** These models are very easy to build and also provide more predictable results. API'S are available for developing retrieval based models. They are easy to build when compared to generative models.

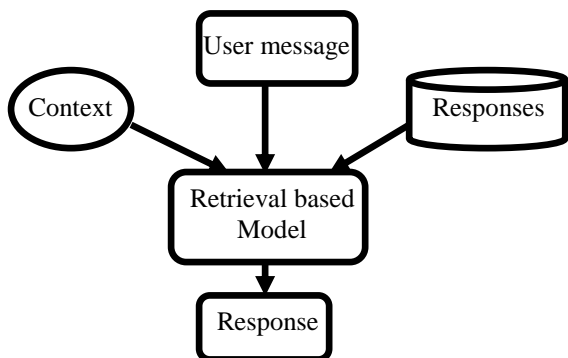


Fig.3: Retrieval based model

IV. EVOLUTION OF CHATBOTS

So far several chatbots were developed for the purpose of entertainment and to complete a goal. The following are some of the publicly known and popular chatbots developed.

A. **ELIZA:** Eliza is the pioneering chat bot built in 1966 at MIT. It works through pattern matching. It takes user's input and searches for a relevant answer in a script by pattern matching.

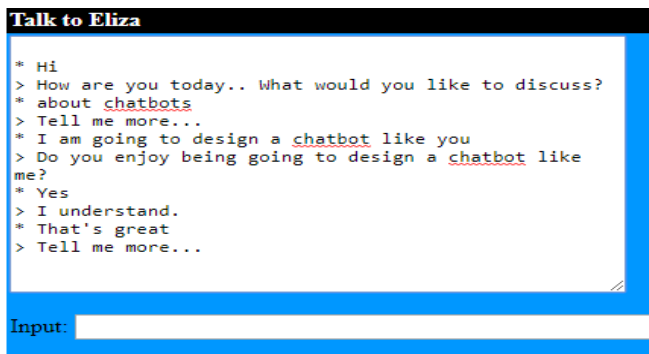


Fig.4: Eliza chatbot.

B. **ALICE:** It was developed in 2009. It allows users to build customized chatbots. It uses an Artificial Intelligence Markup Language (AIML) [10] which is a derivative of extensive markup language (XML).

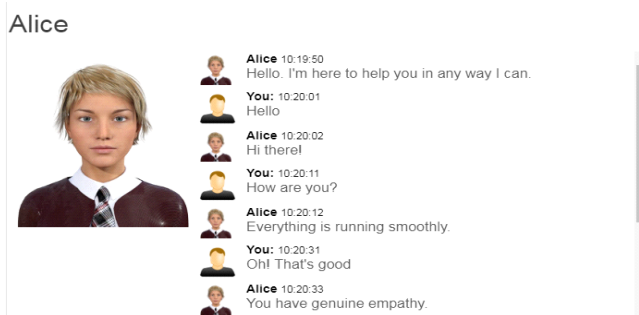


Fig.5: Alice chatbot.

C. **Jabberwacky:** It is an entertainment chat bot. [11]. It mimics human conversation and does nothing else.

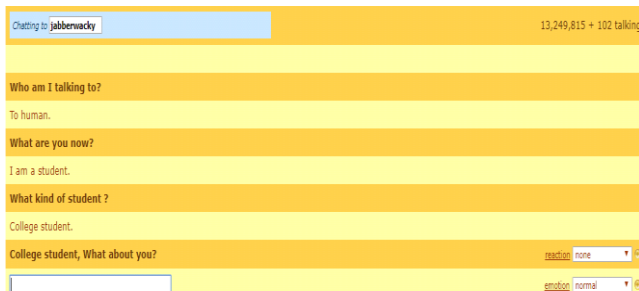


Fig.6: Jabberwacky chatbot

V. OTHER POPULAR CHATBOTS

The above chat bots are popularly known and in addition to them there are several chatbots that were developed and some of them were stated below. Colby developed Parry in 1975. It is the first bot that passed Turing test. It is a rule-based bot. Microsoft's Tay which was launched in 2016 tried to learn about the nuances of human conversation by interacting and monitoring with real people online. Neuralconvo [12], a modern chatbot created in 2016 by JulienChaumond and Clement Delangue was trained using Deep Learning. In addition to these there are several goal oriented chat bots like MedWhat [12] which makes medical diagnoses faster, easier and more



transparent for both patients and physicians.

VI. METRICS USED FOR EVALUATING CHATBOTS

A metric is a quantifiable measure that is used to assess the a business process [13]. In context of Chatbot, a metric is measure that evaluates the performance of a bot. There are several metrics that helps in designing an effective chatbot and some of them are discussed below.

A. Bleu Score: BiLingual Evaluation Understudy (BLEU) score [14] is a method that is used to compare a generated sequence of words with reference sequence.

BLEU score was proposed by Kishore Papineni in 2002 and was initially developed for translation task only. The advantages of BLEU score are:

- It is easy to calculate and inexpensive
- It is language independent
- It correlates highly with human evaluation

BLEU score works by counting matching n-grams of user text to n-grams of reference text. The higher the BLEU score, the more intelligent the chatbot.

B. Turing Test: Turing test [15] was developed by Alan Turing in 1950, which is used to test the ability of machine that exhibits intelligent behavior equivalent to human.

If the tester is unable to distinguish the answers provided by human and machine, then we say that the machine has passed the turing test.

C. Scalability: A chatbot is said to be more scalable if it accepts huge no. of users and additional modules. A good chatbot is capable of working in any environment.

D. Interoperability: Interoperability is the ability of a system to exchange and make use of information. An interoperable chatbot should support multiple channels and users are allowed to switch quickly between channels.

E. Speed: Regarding speed, the response rate measurement of a chatbot plays an important role. Quality chatbots should be able to deliver responses quickly.

METRICS	ELIZA	PARRY	JABBER WACKY	ALICE
Scalability	Not scalable	Not scalable	Not scalable	Not scalable
Turing test	Not passed	Passed	Passed	Passed
Interoperability	Low	Low	High	High
Speed	Low	Low	Average	High

Table.1: Evaluation metrics of different chatbots.

VII. DATASETS

Data plays a crucial role in the design of any application. Chatbot should be trained with sentence/question, response pairs. There are many datasets available for the design of chatbots. I found two data sources that fit for the development of this bot: rdany-chat [16] and chatterbot-corpus-master [17].

VIII. DATA PREPROCESSING

In order to design any application, the first thing we need is data, which should be preprocessed in order to obtain a particular format a machine is able to understand. Since computers cannot make more sense than humans, we need to provide representations for the words in data which can be done by word embedding [18].

A. Word Embeddings: Word embedding is the numerical representation of a text. Since all Machine Learning and Deep Learning algorithms are incapable of reading the plaintext, we require word embedding.

Mapping of a word to a vector is done using dictionary and this vector is represented in one-hot encoded form which means 1 stands for the existence of word and 0 everywhere else.

Let us consider an example sentence="Red wine is of color red". The vector representation of "color" for the above sentence is [0, 0, 0, 0, 1].

B. Categories of Word Embeddings: There are two broad categories of word embeddings which are:

1. Embeddings based on frequency
2. Embeddings based on prediction

1. Embeddings Based on Frequency

There are three popular embeddings based on frequency which are:

1. Count Vector
2. TF_IDF Vector
3. Co-Occurrence Vector

2. Embeddings Based on Prediction:

Word2vec combines two models called CBOW (Continuous bag of words) and Skip-gram. These are shallow neural networks. For each word(s) in the vocabulary of training corpus, they learn weights that show the association between the word(s) and other words in the training corpus. These weights act as word vector representations.

IX. CONCLUSION

This paper has discussed different approaches for designing chatbots with examples. In addition to this a comparison has been made between several chatbots so far developed which was represented in the form of a table. From the above survey it can be concluded that there will be an anonymous growth in the design of chatbots which will lead the internet now a days. Development of good general purpose chatbots requires knowledge bases which are comprehensive.

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