Survey on Chatbot Classification and Technologies

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Abstract - *Wanting to reach out to as many people as possible has always been a primary goal of mass production. Virtual agent chat-bots communicate with many people individually. Chat-bots can answer business questions, help make orders, teach a language or play music. Online businesses have implemented simple answering chat-bots that answer commonly asked questions and connect a real human customerservice agent when a specific or complicated question is asked. Online businesses have also implemented high level NLP systems that automatemany configuration tasks after processing a sentence in natural language. In this survey paper we will see chatbot evolution and their different type of technologies used and compare them to understand the techniques, current best chatbots and their limitations to give an idea for someone to improve certain areas in a chatbot to make them more human like.*

Key Words: Chatbots, NLP, Deep Learning, RNN, CNN.

1. INTRODUCTION

The idea of a chatbot comes from the imitation game or the Turing test which was created by Alan Turing in 1950. This game aimed to imitate human behavior. In 1966 the first chatbot called ELIZA was developed. This system used keyword matching and minimal context identification.

This bot lacked the ability to maintain realistic human conversations. In the 1980s, the ALICE or Artificial Linguistic Internet Computer Entity chatbot was created. This bot was considered to be significant due to the use of the Artificial Intelligence Markup Language AIML. The idea behind AIML was to declare the pattern-matching rules which connect user-submitted words and phrases. The Jabberwack chatbot was built to simulate natural human language to learn from previous conversations and then the contextual patterns were used to select the most relevant response. Additionally, commercial chatbots called Lingubots were developed to customize the template to analyze the word structure and grammar of the user's input.

1.1. Uses of Chatbots

Recently, the importance of chatbots in the public sector has taken place. For example, chatbot was used for political purposes to inspire public opinion and intervene in any discussion in social media about politics. Another chatbot has been proposed as a digital channel of communicationbetween citizens and the government.

In the education sector, a chatbot has been used to enhance critical thinking and support learners in learning a new language as the user can learn from the chatbot through their conversations. An educational bot combining an intelligent tutoring system and learner modeling was designed to support learners. Another chatbot was proposed for medical students for educational purposes. In the health care sector, Your.MD chatbot was developed to provide relevant health information for patients.

Shawar and Atwell developed an algorithm for retraining a chatbot in a specific domain about a specific topic in any language. Their algorithm was applied on two different languages, Arabic and Afrikaans, using the different corpus, the Quran to compute frequently asked questions and the corpus of Spoken Afrikaans, respectively. In the past few years, chatbots have been increasingly used by several organizations to increase the response time to customers in answering their questions and also reduce operational costs.

Chatbot applications have been used in both the private sector, including the virtual assistants that are powered by voice (e.g. Siri, Alexa, Google now, Cortana) and public sector gaming agencies, telecommunications, banking (implementing transactions), tourism (booking hotel and travel tickets), media (news provision), retail, stock market and insurance companies. Additionally, governments have used chatbots on social media platforms such as Twitter as a new form of political communication.

1.2 Simple Working of Chatbots

We can broadly divide the working of chatbots into 4 stages.

1. Input from a user: Input can be in any form, basically in text, but if input is in voice, then it need to convert into text. Basically a series of words as a query or just a normal phrase.

2. Analyze Users query: Chatbot with respect to the technology involved in it tries to analyze and interpret the users phrases.

3. Identify intent and entities: After analyzing the sentence, it breaks it down the phrase into words and use its knowledge base to identify keywords and intents to match the query.

4. Compose reply: After identifying the entities, it needs to compose a reply that is appropriate to the users query and give as output.

2. CHATBOT CLASSIFICATION ANDTYPES

There has been a number of classifications of chatbots. We can classify the chatbots based on various factors like the technology used in them, the various domains they are being used, or based on their architecture. We can classify chatbots based on technology like AI chatbots, ML based deep learning chatbots, use of NLP or NER in chatbots, etc. We can classify chatbots based on their functionality for a certain domain like Hospital managing chatbots, Shopping orientated Chatbots, customer service chatbots, etc. We can classify them based on architecture used like a complex CNN or a rule based one.

We can mainly classify the chatbots based on the technology used in them or the way the processing of data happens in them. A simple way of classification on chatbots into mainly 2 types , task oriented and non-task oriented. Again task oriented can be classified into 2 types, Supervised approach and Unsupervised approach. Further there are two types in non-task oriented, Retrieval-based chatbots and Generation- based chatbots[2].

There is another broad classification of these Conversational Agents. This classification is more like based on their architecture. We can classify them mainly into 4 types, 1.Interact Mode, 2.Knowledge Domain, 3.based on Goals, 4.Design Approach [3].Interact Mode chatbots are the ones which we use on daily based like Apples "siri". They can be Text-Based or Voice-Based. There Architecture mainly is complex AI. They continuously develop themselves by machine learning algorithms by observing user interaction. There is a lot of research is going on them to improve the chatbot responses.

Knowledge Domain based chatbots are more like mainly focuses on retrieving appropriate responses from a database on a particular domain or area where it has some knowledge about by searching and matching the keywords in users questions. These can be Open Domain or Closed Domain. Open Domain is chatbots are the ones which have no restrictions on area of expertise or domain knowledge. They are not restricted to only one type of domain. Instead they can be know about a lot of domains. Due to this feature, the conversation with these bots is more realistic and natural. Where as closed domain chatbots knowledge is limited to a certain extent. They can only answer to the questions if they belong to their domain knowledge.

The chatbots based on their Design Approach are of three types, Rule-Based, Retrieval based and Generative Based. Rule Based chatbots responses are all pre-defined, so the developers can control the chatbot conversation levels[7]. It used a tree like structure to answer the user queries with multiple follow-up questions to match and give best response possible. Retrieval based chatbots are like similar to Rule-based with closed domain knowledge and use of neural networks making them advanced chatbots. They mainly do three steps, intent classification, entity recognition, and response selection. They can be implemented with techniques like multi layer perceptron or sentence similarity, etc[8]. Generative based chatbots are advanced bots which can generate response by combinations of language rather than just selecting pre-defined responses. These are build by seq2seq models used for machine translation. Deep learning techniques can be used to refine these chatbots[9].

Now a days, AI and natural language processing(NLP) is being used to create advanced chatbots that talk like a real human. Googles "ok google" and Amazons "alexa" are present advanced chatbots. But they also have some limitations like understanding the intent or users tone and mood in conversations. Yes they do a fine work in giving responses and setting up tasks like alarm but they might not good at understanding human tone and give suggestions at certain moments. Chatbots with NLP technology is used to analyse a text and interpret it to improve their ability to give responses[6]. They can recognize the sentence structure and determine what the user is saying instead of just giving some pre-programmed response. These are often referred as AI virtual agents or assistants. They can replace human agents over repetitive and time consuming communication.

From above, we can now say that they are mainly two types of chatbots, one with intelligence i.e., use of AI and NLP technology in chatbots and another with pre-programmed responses. NLP based are more realistic and more human like because of its deep learning abilities to

give responses in a conversation. Pre-programmed responses chatbots are more like a structured tree like flow or in programming terms nested if-else flow control to give best matched response.

3. AI TECHNIQUES USED IN CHATBOTS

To design a chatbot, developer must be aware of techniques like parsing, pattern matching, AIML, chat script, SQL and relational database, Markov chain and language tricks [5]. Out of these, the AIML is the one which gives chatbot some intelligence making them more human like. With Time many techniques of AI and ML are being applied to chatbots to make them more advance andto make human like conversations. NLP, NLU and NER are the main technologies that helps chatbots to analyse the text or user queries. While NLP used to interpret the texts, NER is used to identify and classify the keywords in users word.

NER (Named Entity Recognition) system processes the sentence to identify and classify the keywords into pre-defined categories or entities. These Entities can be anything like dates, names, locations, Employee IDs, etc. The main component in a chatbot is Natural Language Understanding (NLU) unit. But they take a lot of time to build them from scratch. So integrating various NER modules into knowledge base of chatbots can help to build NLU units faster and more efficient [4].

Augmentation capacities in chatbots make them give more than one appropriate response. We need to augment them with certain predictive analysis features, giving them the ability to understand users mood. It gives ability to ask users when they don't understand a question and to give another response when a user does not understand a response by rephrasing an answer. It also enables them some problem solving ability in chatbots.

Deep learning recurrent networks make chatbots more advance. Seq2Seq is a advanced model of chatbots also known as Encoder-Decoder Model. It contains encoder and decoder for machine translation. It uses recurrent neural networks to process series of text or words in a sentence and trains the model. It is the best model for conversational chatbots. It not only takes current input into account but also the neighboringwords also to generate responses by taking sequence of words as input. It generates a series of words as its output which it uses again as an inputin next step. This takes two inputs at a time, one is from its previous production and other is from the user [1].

4. EFFECT OF TECHNOLOGIES ON CHATBOT PERFORMANCE

There has been a number of advanced technologies came into use in chatbots to make the advanced. From Eliza, which worked on words matching over pre-defined responses to current Alexa, which is advanced by use of deep learning and NLTK techniques, there has been a number of methods involved.

4.1 Words Matching Over Scripted Responses

Eliza is created using this technique. It is naturally pre-programmed hardcoded responses in the database and the machine will match the words of user input over them. But it has some drawbacks like, identification of key words, transformation of responses, discovery of minimal context, generation of responses for non matched key words[10].

4.2 Artificial Intelligence MarkupLanguage(AIML)

Richard Wallace developed AIML in 1995 which is the forming foundation for A.L.I.C.E chatbot. The techniques used in developing various A.L.I.C.E prototypes didn't involved complex machine learning techniques and sophisticated natural language processing. A software is developed to convert readable text(corpus) into AIML format. It works by generating AIML knowledge Base Automatically. The limitation for this is lack of manual development of its knowledge [11].

4.3. Deep Learning Methods

Deep learning is mainly about giving a machine an artificial brain which consists of artificial neural networks to process the data like human brains. The methods like multi-layer perceptron, sentence matching and seq2seq are models to develop chatbots using deep learning. The techniques like Beam Search Decoding makes the searching of answers for questions easy thus increasing the performance of chatbot. It uses a breadth-first Search to build its state-space tree. It works in a greedy approach [12]. Limitations for this type of chatbots are depends upon the algorithm used to develop them. But some common limitations like not recognizing voice correctly might be a huge problem to solve to increase the efficiency and usage of chatbot.

4.4.Effect of NLP on Performance of Chatbots

Natural Language Processing(NLP) gives machine the ability to identify patterns of words and interpret them appropriately, giving the chatbot the ability to have conversations with humans more effectively. It is like an extra layer on top of the deep learning recurrent model architecture. But limitations like Grammatical Errors, Semantics and accuracy have to be improved by tuning the model more. Use of techniques like Feedback Mechanism

and Policy Learning in Agent for Dialogue Management can manage the real context of the user saying. The Question and answer System makes a chatbot to identify frequently asked questions and give replies immediately. It can be done by Manual Training or Automated Training [13].

5. PERFORMANCE METRICS FORCHATBOT

We can analyze and measure the performance of a chatbot by various metrics. Some basic metrics are Speed, Interoperability, turing testand scalability. We can also use traditional R- squared and RMSE factors to evaluate responses. Some Key performance indicators are:

1. **Bounce rate:** volume of sessions where the chatbot was opened but not used

2. **Satisfaction rate:** average grade given when evaluating the chatbot's answers (to balance out with the evaluation rate).

3. **Evaluation rate:** percentage of user sessions that have given an evaluation of the chatbot's answers at least once.

4. **Average chat time:** allows you to evaluate your users' interest for your chatbot.

5. **Average number of interactions:** used to evaluate the Customer Effort Score on the chatbot and must be correlated to the satisfaction rate. If the latter is very low, the bot may be engaging the users in too many branches and steps to meet their needs. In this case, a resolution can be to correct the decision trees or knowledge base architecture.

6. **Goal completion rate:** in case your bot contains targeted actions like CTAs, a form or some cross-selling, that is the rate of users who have reached that specific action through the chatbot.

7. **Non-response rate:** the amount of times the chatbot has failed to push some content following a user question (due to lack of content or misunderstanding).

Use of these KPI's doesn't measure performance of a chatbot completely, but they are sufficient to improve at various limitations of chatbots. Further metrics can be vary depending upon on which domain the chatbot is being used like health-care, shopping or customer service. For domain specific metrics we need to consider metrics like:

Health-care: correct diagnosis, correct prescriptions for diseases, etc.

Shopping: level of accurate suggestions and conversion rate of sales, etc.

Customer Service: Level of answering customers queries and accessibility, etc.

6. CHATBOT EVOLUTION

To test a chatbot, turing test is used. If it passes then chatbot is cable of having a real human conversation.

In 1966 first chatbot has been introduced into the world, created by Joseph Weizenbaum called **ELIZA**. It uses pattern matching and substitution methodology.

PARRY another chatbot built in 1972 by a psychiatrist. This program is used to simulate adisease.

JABBERWACKY was created by Rollo Carpenterin 1988. It used an AI technique called contextual pattern matching. In 1992 a full voice operated chatbot was developed called **Dr.Sbaitso** by creative labs.

A.L.I.C.E(Artificial Linguistic Internet Computer Entity) is a universal language processing chatbot that uses heuristic pattern matching to carry conversations developed by Richard Wallace in 1995.

SIRI developed by Apple as voice assistant for iOSusers in 2010. It uses natural language UI and also can perform various tasks. Command to activate is "Hey Siri".

GOOGLE ASSISTANT was launched in 2012 by Google it is similar to Siri but for android users. It can make calls search the internet for answers. Command to activate is "Ok Google".

CORTANA introduced by Microsoft in 2014 and integrated with windows 10. It uses voice recognition and various algorithms to give answers. Search box can also be used to chat with Cortana. Command to activate is "Hey Cortana".

ALEXA is a personal assistant developed by Amazon and introduced in 2014. It is built into devices like Amazon Echo and Echo Dot. Command to activate is "Alexa" followed by any command.

7.CHATBOT COMPARISIONS

To check chatbot performance we have taken 4 popular chatbots to check their performance. SIRI, GOOGLE ASSISTANT, CORTANA, ALEXA. These chabots are popularly used all over the world. These chatbot are subjected to different commands and their response is recorded. These chatbots learn overtime based on their usage to giverelevant answers to the user. Test Results may waryfrom user to user.

Commands:

1. Sing a song for me, will you?

2. Could you suggest me any good restaurant.

3. What are your hobbies?

4. I would like to drink wine. What does it taste like?

5. Can you fill my resume using a good template?

6. Switch of lights for me in the living room.

Table-1: Results of queries

	Ok Google	Siri	Cortana	Alexa
Q. 1	Custom lyrics everyday with goodtune.	Custom lyrics buthas no tune.	Lyrics from songfound online.	Singing randomsong
Q. 2	Finds by looking through the browser	Is able to lookup nearby restaurants rating and Directions	Is able lookup restaurants through bing.	Suggested Restaurant.
Q. 3	It is able answer with some hobbies	Cannot answer	It is able to answer	Responded with hobbies
Q. 4	Searches for keywords like wineand taste	Searches for keywords like wineand taste	Searches for keywords like wineand taste	Suggested different types of wines and their tastes
Q. 5	Suggests a template from internet	Suggests a template from internet	Unable to answer the question	Suggested webpages
Q. 6	Can perform IoT tasks	Can perform IoT Tasks	Cannot perform IoT tasks	Switched off the lights.

Table-2: Chatbot Performance Table

	Ok Google	Siri	Cortana	Alexa
Relevance(6)	3	3	1.5	4
Accessibility(3)	3	3	1	2
Level of Understanding (6)	4.5	4	2.5	5
Question Framing(6)	3.5	2.5	2	4
Total(21)	14	12.5	7	15

8. CHATBOT APPLICATIONS

8.1. Health Care Domain

Before you go to the doctor, majority of us google the symptoms .In fact 89% of patients google their health symptoms before scheduling an appointment this isn't good idea and results are bad.

Luckily chatbots realize the problem by opening up a app, diagnose yourself by chatting with AI driven health companion

1. **Babylon-**It is designed around a doctor's brain, using Artificial Intelligence (AI).

2. **Elomia**-is an AI powered therapist. It understand, listen and support. The company trained the AI through observations of past therapies

3. **Yuper**- it offers personality assessments, mood-tracking, emotional tests,8 of 10 users reported an improved mood after just one conversation.

8.2.Customer Service

We live in a world of instant messaging and communication, where customers want instant help and support. If you don't provide quick and appropriate customer support you lose customer loyalty and if you try to do everything with customer service they end up answering the same questions and wasting money on agents. So deploying a chatbot is more efficient.

1. Zoho desk-Best for service teams looking for a tool that learns fast from the knowledge base

2. Intercom-Best for teams that want to create targeted messages for different customer segments

3. IBM Watson Assistant-Best for customer service teams that want to reduce costs

8.3. Personal Assistants

A person requires a personal assistant in his/her busy life to remind or follow their work routines to achieve their daily goals.

1.Siri

2.Alexa

3.Cortana

4.Google

5.Bixby

9. CONCLUSION

We presented the past works, evolution of chatbots, classification of them and the technologies emergence and their effects on chatbot efficiency. Their has been a number of improvements to make the chatbot more human like. At present Deep learning Recurrent Models are leading and dominating the technology used in chatbots. We can classify the chatbots mainly into two types, one with intelligence i.e., which can process the data and generates its own responses, another is with no intelligence i.e., pre-defined knowledge base models. Not all chatbots require that advanced technology. It depends on usage of chatbot, we can choose from pre-defined responses model to recurrent models. The metrics used to measure the efficiency also depends on the domain the chatbot is being used. From the comparisons of chatbots, we can conclude that every chatbot has their own limitations and ALEXA, OkGoogle are leading chatbots. The success of those chatbots is may be because of their analysis of user interaction and continues learning process.

10. FUTURE WORKS AND IMPROVEMENTS

One can really try to tune a chatbot more to enhance its ability to have a conversation with humans. We can develop a human mimicking chatbot that can chat on behalf of a person with different people and different tone in the conversations depending upon the relationship of those peoples. It can be made my analysis of user conversations with different people to identify patterns and level of tone with different people. If we can achieve a chatbot that can actually mimic a human, then we can use that technology to integrate it with humanoid robots also.

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