Survey of Various AI Chatbots Based on Technology Used

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Abstract—**Artificial Intelligence is the ability to make machines intelligent. The development in AI made machines capable to initiate the simulation of natural intelligence and are able to take decisions where humans do better. Natural Language Processing, Machine Learning are some of the major branches of AI. A Chatbot is an AI software uses Natural Language Processing Techniques to simulate a chat between a system and a user. Natural Language Processing help Chatbots to understand natural language more clearly and generate an intelligent response. Since the introduction of first Chatbot ELIZA in 1966, different versions with variety of technology and approach have been developed. In this paper, we describe the generic work flow of Chatbots and represents their comparison on the basis of technology/approach used with some significant parameters. To make natural language conversation more efficient, a Chatbot must analyze and understand the user input correctly for a relevant response. They are currently being used in various important domains like science, education, health care etc. Chatbots have a potential to improve human interaction with machines.**

Keywords—CHATBOTS; AI; ML; NLP; Deep Learning; QA Systems.

I. INTRODUCTION

Today there is an epoch of Artificial Intelligence. The science behind human thinking and acting developed by psychologists and philosophers, welcomed by technological experts with robust sophistication developed the science of Artificial Intelligence[1]. Natural Language conversational entities powered by AI, called Chatbots are the main focus of this study. The term 'Chatbot' was coined by Michael Mauldin in 1994 comprises of two terms 'Chat' and 'robot'[2]. Chatbot is a software entity developed to mimic the natural conversation with human partner. Chatbots are powered by AI uses Natural Language Processing to understand natural language. They are very much popular these days because of various success stories and controversies created, including Amazon's ALEXA, Apple's SIRI and Microsoft's TAY. Today most of the Chatbots are accessed via messaging apps such as FB Messenger or WeChat, via virtual assistants such as GOOGLE ASSISTANT, etc. It has a future to automate customer services and reduce human efforts.

The biggest challenge that the majority of existing Chatbots have is to understand human inputs and its responses with emotions. By making Chatbots empathize with people's emotion, can make the users feel more understood and satisfied. Pattern Matching and Parsing algorithms are the common techniques used and these approaches however not able to simulate a satisfactory natural conversation. Due to some drawbacks in scripted responses, developers and researchers kept on adding new functionality and approaches in the existing ways, converging mostly to the use of Semantic Nets and Machine Learning to remember facts from conversation and identify user intents[3]. This not only improved the efficiency of Chatbots but also developed variations in work flow, technical approaches and multiple solutions to the same problem.

The objective of this paper is to make a survey of Chatbot technologies and approaches from the fundamental model to the latest Generative model of Chatbots, so that it becomes easier for developers to understand the infrastructure and select a technology for further development of Chatbot systems.

This paper will be structured as follows: Section II illustrates the Architecture of Chatbot Systems. Section III offers the analysis of AI Bots which is followed by sub-section A discusses about History of Chatbots and sub-section B which provides survey of various Chatbots based on their implementation techniques. Section IV discusses about the Techniques and Approach opted to develop Chatbots. Section V represents the Comparison of Chatbots and Section VI will conclude the overall paper.

II. CHATBOT-SYSTEM ARCHITECTURE

It is important to understand the architecture of Chatbot before development. The correct architecture depends upon specific domain of Chatbot but the basic communication flow remains same. Fig. 1 explains the fundamental work flow of Chatbot. Chatbot takes input from user. The mode of communication can be text, voice based or both. The set of instructions or a query is then passed to Natural Language Processing Component in a form of text. It uses context information to classify intents and entities from the input. By remembering facts from previous conversation it becomes easier to find out the accurate intent of user input. Response Generator uses different algorithms, processes predefined database and calls an external APIs also if required to process user request. It perform all possible set of calculations to generate domain specific response. The result of these calculations is a set of responses which is further passed to Response Selector. Response Selector uses ML plus AI algorithms to select response. The selected response is further optimized by Message Generator which uses some placeholders to generate output which would work better for the user.
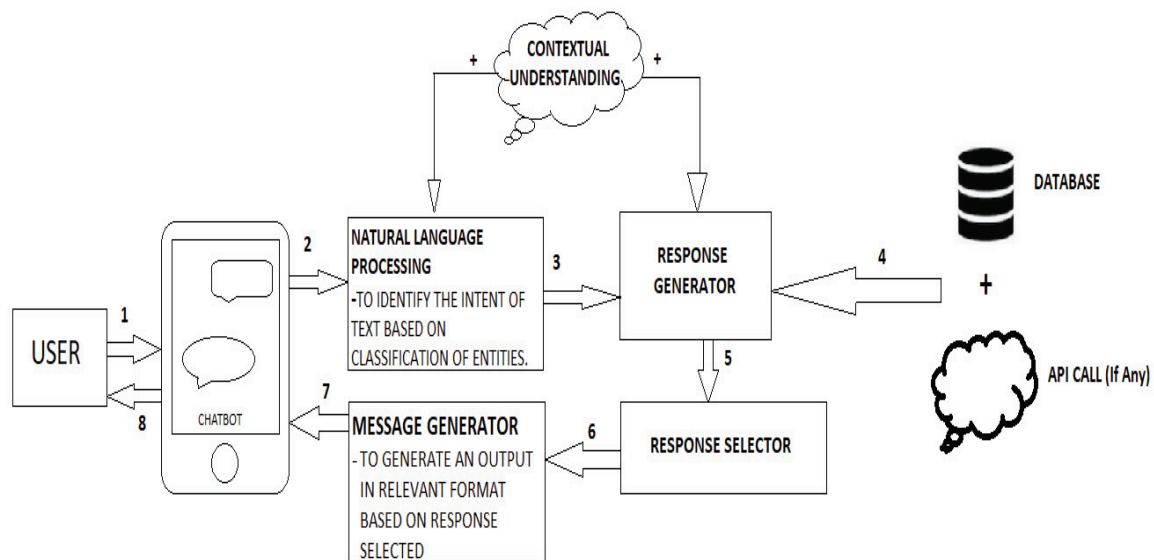
Fig. 1. System Architecture Of Chatbots

III. ANALYSIS OF AI BOTS

A. History Of Chatbots

In 1950, Alan Turing published his paper "Computing Machinery and Intelligence" which considers the question "Can Machines think?" and introduced Turing Test for estimation and evaluation of intelligence simulated by machines. Turing Test is the method of estimation in AI to check whether a computer is capable enough to think like human being or not[4].

ELIZA is considered to be the first entity in a world of Chatbots developed by Joseph Weizenbaum in 1966 at MIT AI Laboratory. Weizenbaum developed ELIZA to simulate the behaviour of Rogerian Psychotherapist(a psychotherapy developed by psychologist Carl Rogers). ELIZA is the first program capable of attempting the Turing Test[5]. After ELIZA Kenneth Colby in 1972 created PARRY, a program identified as ELIZA with attitude. It simulate a person with paranoid schizophrenia and used same approach with more advancement to that used by Weizenbaum[6]. It was tested using Turing Test with some variations in 1970s and correctly identified nearly 48 percent of the time. However, the first Chatbots were based on identifying keywords from the user inputs and applying rules to transform keywords in resulting comments. If the keywords are not found, they reply by returning a generic output from previous conversation. These Chatbots used pattern matching and parsing methodology that gave interrogators an illusion of natural conversation and intelligence. With minimal contextual understanding, these rudimentary models passed the Turing Test which raised arguments on it. This causes slight changes as an improvement in Turing Test.

B. Survey Of Chatbots And Their Implementation Techniques

ELIZA is an early NLP Chatbot created by Joseph Weizenbaum at MIT AI Laboratory. Weizenbaum developed ELIZA to study the conversation between man and machine[5]. It uses pattern matching and some sort of parsing but has no built-in module/functionality for contextualizing-events. By using these methodologies it is able to create an illusion of understanding and convinced most of the users for being able to pass Turing Test. However, the development of ELIZA is not considered to be a failure. It is a great source of motivation and knowledge for innovators focused on AI and NLP.

After ELIZA which simulated Rogerian therapist, PARRY attempted to figure out a person with paranoid schizophrenia. It was developed by Kenneth Colby in 1972. It uses the same approach used in ELIZA but it is much more advance than ELIZA. It used complex system of assumptions ,attributions and emotional responses to mimic the behaviour of paranoid individuals for health care analysis. In 1970, PARRY undergone evaluation by a group of psychiatrists and able to qualify with no identification by 52 % of time[6].

JABBERWACKY is a Chatbot created by Rollo Carpenter in 1982. It is considered to use an AI technique called contextual pattern matching. It simulate natural human chat in interesting, entertaining and humorous manner and the first Chatbot to accept voice inputs[7]. Whereas all the previous Chatbots had relied on static database, JABBERWACKY collects tokens or group of keywords from the set of previous and current conversations and dynamically grow its own content by adding them in database. Rollo developed JABBERWACKY with the purpose to create AI that is able to pass Turing Test. However, it is a two time Loebner Prize Winner(2005 and 2006). The new version of JABBERWACKY came in 2008 and now it is popular by name CLEVERBOT.

Inspired by Weizenbaum's ELIZA, Richard Wallace developed A.L.I.C.E stands for Artificial Linguistic Internet Computer Entity or simply ALICEBOT in 1995. ALICE is a natural language processing Chatbot based on heuristic pattern matching technique to evaluate response[8]. The program uses an XML dialect called Artificial Intelligence Markup Language popular as AIML which allows a wider bank of more sophisticated responses. It is one of the highly

1075

efficient programs of its type and secured Loebner Prize three times(2000, 2001, 2004). But it is based on predefined set of responses to generate output. However, it is not able to pass Turing Test due to some drawbacks.

SMARTERCHILD is an intelligent Chatbot developed by ActiveBuddy. It was released in June 2001 by using AIM platform which is now discontinued. SMARTERCHILD is a Chatbot designed to provide quick access to news, weather, stock information, movie listings, and transit schedules. It has an add on functionality to be used as personal assistant, calculator and translator[9]. This type of bot completely changed the scenario of interaction with machines. It also initiated the era of having virtual assistants.

Later on, in 2006 IBM introduced WATSON. WATSON is a QA computer system developed using IBM's DeepQA software and Apace UIMA framework implementation. It is implemented on the SUSE Linux Enterprise Server 11 OS and Apache Hadoop framework to provide distributed computing. WATSON has an ability to run hundreds of language analysis algorithms on same time and shows high level of linguistic intelligence[10]. It can access enormous databases of knowledge and can access 200 million pages of data in short while making it the ideal QA system. WATSON participated in Jeopardy competition and won in 2011. WATSON 'S capabilities have been extended in recent years. Therefore, IBM WATSON is also considered as the brain or information store for many conversational entities. It is used in health care, as teaching assistant, in weather forecasting, fashion, advertisements,etc.

SIRI is a virtual assistant released in 2011 by Apple Inc. It is available on many platforms including Apple Inc's iOS, watchOS, iPadOS and tvOS operating systems. The assistant uses ASR(Automatic Speech Recognition) and advance machine learning algorithms to translate human speech into text, answer questions, make recommendations and perform actions[11]. It validates a wide horizon of user inputs including performing system actions, checking knowledge base, scheduling events and reminders for curriculum, controlling device settings, searching Internet etc. It has a functionality to forward the user input unable to answer to a more generalized QA services. SIRI is released to support many natural languages, praised for its voice recognition and contextual knowledge.

MITSUKU is an AI Chatbot created from AIML(Artificial Intelligence Markup Language) by Steve Worswick in 2012. It is considered to be an advance intelligent system rectified the major drawbacks seen in most of the Chatbots. To simulate a natural chat it remembers the facts from conversation and avoid answering the same questions again and again[12]. It is built using A.L.I.C.E. AIML files with many integration based on conversations. It has been taken 9 or 10 years to develop a record breaking five time Loebner Prize winner(in 2013, 2016, 2017, 2018, 2019).

CORTANA is a virtual assistant developed by Microsoft in 2014 and made available in 2015 for Windows. Currently it is available in English, German, French and 6 more language editions for Android, Windows, iOS and Xbox OS like popular Operating Systems. Windows 10, Windows 10 Mobile, Microsoft Band, Amazon ALEXA etc are the platforms to access CORTANA[14]. The NLP functionality of CORTANA are accessed from Tellme Networks owned by Microsoft in 2007 and are integrated with a Semantic search Database called Satori[13]. It consists of a speech enabled channel operates on voice inputs and outputs. It can set reminders, recognize natural voices and can answer questions using information and web results from the Bing search engine.

After few months of release of CORTANA, Amazon introduced its new iteration of virtual assistant that is ALEXA. ALEXA uses NLP algorithms for accurate voice interactions. It is capable of setting alarms, playing music playlist, setting up reminders, providing news, playing audio books and streaming pod casts[15]. It can interact with Smart Devices and used as hub to implement Home Automation. AMAZON had done business of 100 million ALEXA - enabled smart devices in the entire world, reported by AMAZON'S team in Jan. 2019 .

The another noteworthy AI Chatbot that came into existence is TAY. Microsoft Corporation released TAY via Twitter on March 2016. It was designed to mimic the 19 year old American girl and made public as Twitter bot. To make TAY learn from interaction with public is a major approach to expand knowledge base of developers focused on AI. But Microsoft also shut down the service only after 16 hours of its launch because of posting offensive tweets related to racism ,feminism etc[16]. Just like human kids it learns and mimics what it is hearing and easily get exploited. The problem is that Microsoft dropped this little kid among a bunch of crazy thugs and trolls with a very little protection and had not given it the understanding of moral values. However, TAY was replaced by ZO, an English language Chatbot developed by Microsoft. It was the English version of Microsoft's other successful Chatbots XIAOICE (China) and RINNA (Japan). But due to some controversial reports, it was shut down on multiple platforms.

Looking forward, Google developed AI enabled GOOGLE ASSISTANT in 2016. GOOGLE ASSISTANT is an extension of GOOGLE NOW, programmed in C++ and unveiled in May 2016[17]. It supports both voice and text based interaction. It is able to access APIs using internet, set reminders, schedule events and alarms, etc. GOOGLE ASSISTANT facilitates the action of smart home control. It is operative with a large store of devices, so that you can control home appliances with your voice. But it does not work without Internet .It also suffers from maximum battery usage and heat up your mobile phone.

Instead of humans learning how the machine interacts, it is the machine that needs to learn and adapt to us. Working on this conceptual philosophy, Samsung released voice powered digital assistant named BIXBY in 2017[18]. Using Deep learning concepts in a core of user interface, Samsung introduced intelligent interface in BIXBY. Completeness, Context Awareness, Cognitive Tolerance are the three major properties of BIXBY. It is expected that it will change the experience of interaction with Smart-phones.

The comparison between Chatbots of different timeline surveyed above is represented in Table 1.

IV. TECHNIQUES AND APPROACH TO DEVELOP CHATBOTS

1) Rule Based Conversation: It is a very basic technique used in most of the Chatbots. It consists of predefined

hierarchy of rules that are used to transform user input into an output. The set of rules can be simple or complex breaks down the input into sequence of tokens to identify pattern[19]. The decomposition of text into set of words is significant to understand the grammatical structure of an input[20]. The classified set of keywords or patterns are used to generate output. The first Chatbot ELIZA is based on this approach. However, these Chatbots are not able to answer patterns that don't match predefined script.

2) Deep Learning: In this method, Chatbots are created using Machine Learning Algorithms. A Deep Learning Chatbot learns everything from its data and conversation with human[21]. It is trained to develop its own opinion on text and can be more effective by using more and more data. RETRIEVAL BASED and GENERATIVE are two major types of bots that can be created using Deep Learning. Retrieval Based Bots uses heuristics and semantic net to estimate the most accurate response from the predefined repositories but Generative model is an advance form doesn't use any type of repository. Generative Chatbots can build a response they have never seen before. Generative models generate mistakes and difficult to be trained. On other hand, Retrieval based Chatbots also returns incorrect outputs because they are totally based on retrieval of data[22].

3) Ensemble Methods[23]: The modern Chatbots like Alexa nowadays, designed to communicate like a virtual family member. They have been built using Ensemble Methods which inherits the functionality of Rule Based, Retrieval Based and Generative methods to process user request. The Chatbots built using this approach are capable enough to simulate conversation on unspecified subjects.

4) Domain Specific Chatbot: The approach to develop Domain Specific Chatbot improves the efficiency of Chatbots. Such Chatbots are used in variety of domains including Education, Health care etc. This approach allows Chatbot to implement the above mentioned techniques and methods for a particular domain. It helps Chatbots to extend the coverage area in a particular subject.

5) Chatbot Builders: Chatbot Builders are the tools to create Chatbots without coding. There are ready made solutions and predefined scenarios that can be used to develop Chatbots in limited time period. It simply works on drag and drop approach. There are various AI Bot builders available including Mobile Monkey, Botsify, Chatfuel, SnatchBot etc to develop Chatbots in limited time and cost.

V. COMPARISON OF CHATBOTS

Table 1 shows the timeline of Chatbots from beginning. It represents the comparison of Chatbots on the basis of some significant parameters and gives them a sort of feedback on technologies used. From the comparison table it is found that the development and improvement of Chatbots is not grown at an expected rate. It is observed that there are multiple solutions and approach to the same problem. The latest Chatbots are nowadays based on Generative approach. Generative Models are more prompt to research these days. However, developers are showing keen interest in Python as a platform to build Chatbots because of the presence of AIML, simplicity and versatility. Python is an open source programming language with great community, reduces code and provide lots of predefined libraries to implement AI conversational entities.

VI. CONCLUSION

In this paper, we have covered a number of significant papers and reference material related to Chatbots and their implementation techniques. They are programmed to simulate natural conversation like human being but remains short of being able to pass Turing Test. A comparison has been made to identify the most efficient technical approach for simulation of natural conversation. From the survey above, it is found that the Generative Models based on Deep Learning can be very effective for building Chatbots. These type of Chatbots are also not being able to pass Turing Test but a proper training using huge amount of quality data and combination with Retrieval Based approach can yield better results. IBM WATSON is a computer system with enormous database can be used as a teaching assistant for Generative Chatbots.

Currently Chatbots have limited linguistic intelligence. So, there is a great scope for removing such language barriers in future Chatbots by making it capable to understand multiple languages or dialects.To simulate a natural conversation with user the current Chatbots need to learn emotions to identify actually the entire possibilities of user input.

TABLE I.   COMPARISON OF CHATBOTS

YEAR OF RELEASE	CHATBOTS	DEVELOPED BY	PROGRAMMING/PLATFORM USED	TECHNICAL DESCRIPTION/WORKFLOW	CONTEXTUAL-UNDERSTANDING	MODE OF INTERACTION	TYPE
1966	ELIZA- [5]	Joseph Weizenbaum	MAD-Slip	User input is analyzed according to the set of decomposition rules to identify keywords. Responses are generated by reassembly rules and pattern matching techniques.	No	Text	RULE BASED
1972	PARRY - [6]	Kenneth Colby	Assembly Language, M-Lisp	User input is analyzed to identify tokens. Complex system of assumptions, attributions and emotions is used to generate responses to mimic the behaviour of paranoid individuals.	No	Text	RULE BASED
1982	JABBERWACKY - [7]	Rollo Carpenter	Computer Programming (not known)	Natural Language Processing and Contextual Pattern Matching is used to analyze user input and generate responses. It learns by associations, collect phrases used in	Yes	Text	RULE BASED

				inputs and store it in dynamic database.			
1995	ALICE - [8]	Richard Wallace	JAVA, AIML	Natural Language Processing Chatbot simulate conversation with human being using AIML based heuristic pattern matching techniques.	No	Text	RETRIEVAL BASED
2001	SMARTERCHILD - [9]	ActiveBuddy Inc.	C++, Adobe Flash(by assumption)	Based on Natural Language Chat Functionality includes wide range of database applications(eg.Sports, Weather, Movies)	Yes	Text	RETRIEVAL BASED
2006	WATSON - [10]	IBM	JAVA, C++, Prolog, Apache UIMA -SUSE Linux Enterprise Server 11	High Level Linguistic Intelligence system runs hundreds of algorithms simultaneously to analyse natural language. Served with complex database can quickly access 200 million pages of data.	Yes	Text	RETRIEVAL BASED
2011	SIRI - [11]	Apple Inc.	Objective C	On receiving request, SIRI translates and breaks down the code to analyze particular patterns, keywords and phrases. The set of data then runs into an algorithm and tested with number of combinations of sentences to identify the exact meaning of input. Then it begins to assess what task needs to be carried out and complete the sentence into a response.	Yes	Text + Voice	RETRIEVAL BASED + GENERATIVE
2012	MITSUKU - [12]	Steve Worswick	AIML	It is developed with AIML technology. It takes user input, identifies the subject in input and queries related to it and returns response. It has an ability to maintain reasons with specific objects.	Yes	Text	RETRIEVAL BASED + GENERATIVE
2014	CORTANA - [14]	Microsoft	C#, C, C++	CORTANA uses information from Bing Search Engine(weather, sports, traffic, etc) to replicate natural conversation. It takes input, analyze and perform actions based on pattern matching and information from search engine.	Yes	Voice	RETRIEVAL BASED
2014	ALEXA - [15]	Amazon	Node.js, JAVA, PYTHON	ALEXA takes input, breaks down the order to analyze the task and carry out the corresponding functions. Calls API if required and replies back by performing actions.	Yes	Voice	RULE BASED+ RETRIEVAL BASED + GENERATIVE
2016	TAY - [16]	Microsoft Research, Bing	Python, Java, Node.js	It was designed to learn from its surroundings. Based on the interactions made with people, it made its own opinion. But the trolls on social media caused very offensive impact on it.	Yes	Text	RULE BASED + GENERATIVE
2016	GOOGLE ASSISTANT - [17]	Google	C++	It uses Smart speaker technology to accept input, NLP to analyze text, invokes Actions SDK to fulfill request. Actions SDK generates response corresponding to your reuest.	Yes	Voice + Text	RETRIEVAL BASED + GENERATIVE
2017	BIXBY - [18]	Samsung	Samsung Development Kit	BIXBY is divided in 3-subparts BIXBY voice, BIXBY Vision, BIXBY Home. BIXBY voice consists of the use of smart speaker to call service by voice. BIXBY Vision is an augmented reality camera used for to carry out image processing tasks. BIXBY Home consists of the list of menus on which BIXBY can interact with.	Yes	Voice + Text	RETRIEVAL BASED + GENERATIVE

1078

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