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# Exploring Chatbot Implementation Methodologies used in Customer Support Industry

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***Abstract:*** ***In an IT industry, technical support is a huge sector which requires a lot of manpower and other resources. Although huge organizations have a dedicated group of people working on it, small companies could not afford to have a separate department for managing customer queries. Automation in industry is associated with faster production and cheaper labor costs. By leveraging today's technologies such as Machine learning and Natural Language Processing, the process of handling user's queries such as complaints about a certain product, feedback, customer experience, and clarifications could be automated using intelligent agents (chatbots) that are able to understand the user's query and assist them accordingly. This process of automating user query handling using chatbots has been the main interest of multiple organizations and would result in saving a lot of resources as well as improve overall customer experience.This paper is a comprehensive exploration of how chatbots have evolved over time and what methodologies are being used to implement these chatbots across different organizations.***

***Keywords: automation, chatbot, machine learning, natural language processing.***

## I. INTRODUCTION

The word chat bot simply translates to conversation enabled by a computational element called bot. A Chatbot is a computer program which is capable of having a conversation by taking inputs through either textual or auditory methods. Initially chatbots were simple agents that could only respond only to a set of predefined questions. But, as demand and expectations from the consumers kept increasing, it became obvious that chatbots needed to be much smarter. Organizations worldwide are experimenting and incorporating various artificial intelligence and machine learning techniques to launch chat bot solutions thereby reducing costs and also improve the overall customer experience. It is projected that chat bots will save organizations billions of dollars in the coming decade.

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Chatbots have been around for a decent amount of time, but only recently has deep learning been the go-to approach to the task of creating realistic and effective chatbot interaction. From a high level, the job of a chatbot is to be able to determine the best response for any given message that it receives. This "best" response should either answer the sender's question, or give the sender relevant information, or ask follow-up questions, or continue the conversation in a realistic way.

A chatbot needs to be able to understand the context and the underlying intention of the message received and determine what kind of response message is required. Also, chatbots have to follow correct grammatical of the language while forming the response. Usually, chatbots have a template that they follow on being asked to answer the question or do a certain task. This makes their replies limited as certain functions might not include in their template. But with the improvement in technology, particularly in the field of natural language processing and artificial intelligence, bots are getting intelligent and are fulfilling complex tasks that people want.

## II. HISTORY OF CHATBOTS

ELIZA, a computer program developed in 1964 at MIT Artificial Intelligence Laboratory was one of the earliest known chat bot. ELIZA used a technique called natural language processing to understand the nuances of human language. It was able to recognize key tags (important phrases) and answered some very simple decision tree questions [1]. Development of ELIZA marked the beginning of the first iteration of chat bots. By the late 20th century organizations such as MSN and AOL began implementing this technology in automated telephone systems that used very simple decision trees.

Soon after ELIZA, a much more intelligent bot called PARRY followed. PARRY was developed by psychiatrist Kenneth Colby in the year 1972 [2]. PARRY was able to simulate the behavior of a person with paranoid schizophrenia. By late 1970 more and more bots were developed replacing the older generation bots. Soon, the chatbots became widely used by the masses. Another breakthrough happened in this field when a chatbot called A.L.I.C.E (Artificial Linguistic Internet Computer Entity) was developed. A.L.I.C.E was the most powerful NLP chatbot of its time. It used an XML based Schema called AIML (Artificial Intelligence Markup Language) for specifying conversation template [3].

But unfortunately, it was not able to pass the Turing test (a test conducted to determine whether a computer is capable of thinking like a human being or not). In 1988 Jabberwacky chatter bot created Rollo Carpenter [4] marked the first move away from text chat bots. The Jabberwacky chatbot was able to process and extract words through auditory signals. Later In the year 2001, a chat bot called SmarterChild [5] was developed which used natural language comprehension to act as a personal assistant. SmarterChild was able to understand simple conversations and provided access to recent news, movie timings and local weather.

In 2014 after several years of research, Microsoft developed their Xiaoice chatbot which was based on an emotional computing framework [6]. Xiaoice is a program made possible by applying complex algorithms, big data and cloud computing. Xiaoice can identify the user sentiments and also remember the context across multiple sessions of conversation. Advancements made in fields of artificial intelligence such as natural language processing and deep learning, have given chat bots more power in interpreting natural language and to both understand better, and learn over time.

## III. CLASSIFICATION OF CHATBOT MODELS

### A. Result Based

Result based model have a primary objective to achieve. They are goal oriented and are developed to address a specific task.

Chatbots using conversational model are not focused on providing specific information or to address common routine tasks, they are more focused on the general aspect of the conversation [7]. General aspects include day to day conversations and interaction. The goal of an agent following conversational model is to offer non-repetitive creative answers which keeps the conversation interesting for the person they are chatting with. It is usually developed using a Sequence to Sequence model, usually trained end-to-end on question-answer pairs. An important aspect of agents using conversational model is that they are capable of remembering the previous context and are able to build responses based on the user's previous queries.

Chatbots using task based model are designed for handling specific scenarios such as setting a reminder, scheduling an event, or helping with troubleshooting. Platforms such as Dialog flow by Google, Wit by Facebook and the Bot Framework by Microsoft exist for building task based chat bot from scratch. These bots are designed by specifying a set of intents, entities and the resulting action to be performed if the conversation reaches a defined state. Task based model is widely used as they are goal-oriented chat bots focused on helping users accomplish a certain task. Chat bots using task based model have components such as Natural Language Unit to parse and understand the user's query, Dialog Manager and Dialog Policy to help accomplish the task.

### B. Domain Based

Another classification of chatbots is based on the sort of information they are expected to provide

Chat bots following open domain model [8] are designed to retrieve information for various open-ended general questions such. These agents are developed using algorithms such as PageRank combined with Natural Language Processing. On receiving an open-ended question like "What year was Alan Turing born?", the chat agent parses the question and identifies important key phrases(tags), and then proceeds to search the database for an answer matching those key tags. Personal assistants such as Siri, Cortana, Alexa and Google Assistant are good examples of chatbots using open domain model where they attempt to return an answer for each task they receive.

Closed domain agents are domain specific. They operate on information regarding a specific area of interest. These agents are suitable for narrow scenarios like offering information about a tourist site, providing recommendations for a restaurant. Closed domain agents are relatively easy to implement and perform well in real environments

### C. Response Based

Response based agents have a predefined set of questions and their respective answer. Whenever a same or similar question is asked the agent simply responds with the predefined answer or chooses the answer with the highest predicted priority from a set of answers. A dialog flow manager exists in order to choose the most suitable answer for the query.

Chatbots built using template model generate responses based on predefined templates and patterns. These predefined templates can be defined using Artificial Intelligence Markup Language (AIML). Artificial Intelligence Markup Language is based on XML type schema where the pattern and its response are organized into XML type tags. In combination with Natural Language Processing and rich pattern, AIML can be used to build a smart chat bot. Bots using Template model additionally use a parser to interpret user queries, identify tags and find out which rule matches the user query.

Search based model is a retrieval based model which is reliable and easy to build. Retrieval based bots follow the directed flow defined to find the best response. Initially a database of set question tags and answers are populated into the database. on information. As the bot responds to more and more questions it automatically trains itself to rank the response from a set of predefined responses.

The below Fig 1. summarizes the classification of chatbot models

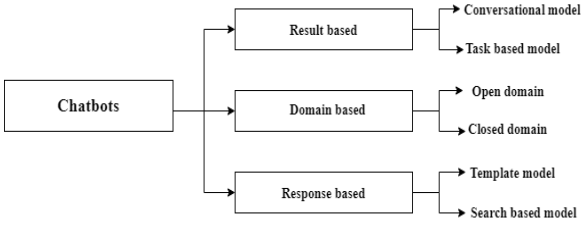


**Fig.1 Classification of chatbot models**

## IV. POPULAR CHATBOT IMPLEMENTATION ALGORITHMS

### A. Decision Tree

Decision tree is a machine learning classification algorithm where a tree-like structure is used to map decisions and their possible consequences. In the late twentieth century major organizations in the telecommunication industry started to implement decision trees in their automated voice-based telephone systems.

The conversation is approached logically in stepwise manner to arrive at the right intent (response or action). The root of the tree would be the customer's initial question. Typically, the goal or action would be at the leaf of the tree structure. Between the root and leaf (intent) lies multiple nodes and branches. Each node represents follow up question (usually a yes/no question) and the branches represent the choices (answer for that question). The major drawback of Decision trees is that it causes over-fitting. To overcome this, more powerful variants of decision trees such as C4.5 and random tree algorithms are used.

### B. Artificial Neural Networks

Artificial Neural Network algorithms by design, try to process information the same way as our brain. Artificial neural networks are a collection of nodes called artificial neurons. The artificial neurons are interconnected and communicate with each other. These neurons are organized into multiple layers starting from input layer which receives external data followed by zero or more in-between hidden layers and an output layer which produces the result. There exist multiple connections between neurons of same or different layers and each connection is assigned a weight that represents its importance. The output is calculated from the input using weighted connections which are calculated from repeated iterations while training the data. Based on the flow of data though the network, Artificial neural networks can be classified into Feed-forward and Feed-back. In Feed-Forward networks the flow of information is unidirectional. Feed-back neural network are recurrent networks where feedback loops are allowed. In Feed-back networks, the signal can travel in both directions.

Sequence to Sequence (Seq2Seq) is a type of recurrent neural network and is one of the most popular network model for designing machine translation and dialogue systems. Seq2Seq model consists of two recurrent neural networks, an encoder and a decoder. Since recurrent neural networks have the problem of vanishing gradient, much more powerful variants such as Long Short Term Memory (LSTM) or Gated Recurrent Units (GRU) are used. The encoder network processes the input sentence (user query) by breaking down the sentence into a hidden feature vector consisting of only the important words. The decoder takes as input the hidden vector generated by the encoder. Along with its own hidden states, current word and the hidden vector generated by encoder, the decoder tries to produce the next hidden vector and finally predicts the next word. Thereby, the Seq2Seq model is able to understand the context of the conversation by taking two inputs (one from the user and the other from the previous output of the model) at each point of time.

### C. Natural Language Processing

Natural Language Processing provides chatbots the ability to read, understand and derive meaning from human languages. Natural language processing is a collective name for a combination of steps to be followed to convert the customer's text or speech into a structured data that could be used to select the related response. Some of the steps include segmentation, tokenization, lemmatization, identifying stop words, dependency parsing, named entity recognition and coreference resolution.

## V. ANALYSIS OF EXISTING CHATBOTS

### A. ELIZA

The ELIZA bot simulated a conversation by using pattern matching technique. Steps followed by ELIZA include identification of keywords, simplifying the context, applying transformation rules and generating appropriate response to the transformation rule. When a user inputs a query, ELIZA starts to examine the query to identify important keywords. These keywords are words which are predefined in ELIZA's script. Each keyword is associated with a predefined number representing its importance. If such words are found, they are put into a stack where words are organized based on rank. The input sentence is then further transformed using decomposition and reassembly rules based on the rule associated with the keywords present in the stack.

The drawback of ELIZA is that it is a simple bot based on per-defined patterns and rules and has no reasoning capacity.

### B. PARRY

PARRY was an enhanced version of ELIZA bot. PARRY was modeled based on the behavior of a person with paranoia. Originally written in LISP programming language, PARRY followed the same pattern matching techniques but had better rules and transformation methods, which made it appear much more like a person than ELIZA.

The drawback of PARRY is that even though PARRY seemed to be an enhanced version of ELIZA, it still was based on per-defined rules and had no intelligence element to it.

### C. Artificial Linguistic Internet Computer Entity

Artificial Linguistic Internet Computer Entity (ALICE) is also a pattern based conversational agent that uses Artificial Intelligence Markup Language for specifying pattern and rules. The Artificial Intelligence Markup Language follows XML like schema where question and its answer are organized into pattern and template tag respectively. When a user provides an input, the ALICE bot does a depth first search on the matching pattern and responds with the pre-defined content specified inside its respective template tag [9]. ALICE is open source and was rewritten in java during 1998.The drawbacks of ALICE were similar to that of ELIZA and PARRY. Due to the lack of an intelligent element, ALICE was not able to pass the Turing test.

### D. Mitsuku

Mitsuku is another pattern-based chat bot implemented using Artificial Intelligence Markup Language [10]. In addition to all the pre-defined Artificial Intelligence Markup Language files, Mitsuku also has the ability to add additional entries based on user generated conversations. Mitsuku also has the additional ability to reason with specific objects. Mitsuku is able to achieve this by using a supervised machine learning algorithm.

The main disadvantage of Mitsuku is that, it is not effective without large amount of training data

### E. Watson

Watson is an Artificial intelligent agent developed at IBM. Watson uses more powerful techniques such as Natural Language Processing and hierarchical machine learning algorithm. Since Watson is based on unsupervised machine learning algorithms, it is able to get better and better over time. Along with machine learning, multiple other technologies such as Hadoop, Unstructured Information Management Architecture are incorporated into Watson. The disadvantage of using Watson is that it does not process structured data directly.

### F. Dialog Flow

Dialog Flow is a technology based on Natural Language conversation. Initially dialog flow was released to third party developers as a Software Development Kit (SDK) [11]. Dialogue flow uses Natural Language Processing to better translate user queries and further uses multilayer neural networks to generate appropriate responses by recognizing intents and context. Dialogue flow also has the capability to take inputs in form of text, audio and pictures. The main disadvantage of dialogue flow is its lack of proper user interface and documentation

### G. Lex

Lex is an agent developed by Amazon for its Amazon Web Service (AWS) [12]. Lex is a service in AWS that helps to build conversational agents (interfaces). It uses Natural Language Understanding (NLU) to identify the Intents and Entities. Lex also uses an automatic speech recognition technique to convert auditory input to vector arrays which can then be passed as an input to deep learning algorithms to generate a response. The main disadvantage of Lex is that, preparation of its data set is very complex and tiresome.

### H. Language Understanding Information Service

Language Understanding Information Service (LUIS) [13] developed by Microsoft is an Artificial Intelligence engine that is based on domain model. LUIS uses a specialized set of Natural Language Processing algorithms that are optimized to work along with big data. LUIS is designed to work with information regarding a specific area of interest. LUIS also has the ability to do sentiment analysis to understand users' emotions and subject.

Table 1. summarizes, the different chatbot models adopted and used across various organizations.

**Table 1. Chatbot comparison**

| CHATBOT NAME | MODEL | TECHNIQUE USED |
|---|---|---|
| ELIZA | Template Based | Identification of keyword and Pattern matching |
| PARRY | Conversational model and Template based model | Pattern matching with transformation rules |
| ALICE | Conversational model and Template based model | Pattern matching using Artificial intelligence markup language |
| MITSUKU | Conversational model and Template based model | Supervised machine learning and Pattern matching |
| Watson | Open domain and conversational model | Natural Language Processing and hierarchical machine learning |
| Dialog Flow | Open domain, conversational model along with search-based model | Deep learning and Natural Language processing |
| Lex | Task based model | Natural language understanding and Deep learning |
| Language Understanding Information Service | Open domain and task oriented | Deep learning, Natural language processing and sentiment analysis |

## VI. CONCLUSION

A chatbot allows even small and medium businesses to automate customer service live chat conversations. Chatbots in the late 20th century followed basic rules and had no reasoning capability. But with help of technologies such as big data, data mining and artificial intelligence, chat bots are getting smarter day by day. From this study, it becomes clear that natural language processing plays a predominant role in designing a chat bot. Many organizations have adopted to handle some of their customer's query using open domain model. It has become obvious that chat bots which provides natural open domain conversations ultimately have the potential to enhance the customer experience and thereby reducing organizations dependency on human resources.

## REFERENCES

1. R. A. Girle, "Eliza and the Automata," Proceedings of the Third Annual Conference of AI, Simulation, and Planning in High Autonomy Systems 'Integrating Perception, Planning and Action'., Perth, Australia, 1992, pp. 287-293.
2. PARRY the AI chatbot [Online], https://phrasee.co/parry-the-a-i-chatterbot-from-1972/ (Accessed 23 January 2020)
3. Chatbot ALICE, ALICEAI Foundation , Virtual Assistant ALICE https://www.chatbots.org/chatbot/a.l.i.c.e(Accessed: 1 January 2020)
4. R. Carpenter. Official Website of Jabberwacky[[Online] http://www.jabberwacky.com/ (Accessed: 23 January 2020)
5. Smarterchild, Colloquis, ,Conversational agent Smarterchild[Online],https://www.chatbots.org/chatterbot/smarterchild(Accessed 25 January 2020)
6. Zhou, Li; Gao, Jianfeng; Li, Di; Shum, Heung-Yeung (21 December 2018). "The Design and Implementation of XiaoIce, an Empathetic Social Chatbot" ,arXiv:1812.08989
7. J. Hill, W. R. Ford, and I. G. Farreras, “Real conversations with artificial intelligence: A comparison between human–human online conversations and human–chatbot conversations,” Computers in Human Behavior, vol. 49, pp. 245–250, 2015.
8. J. Bang, S. Han, K. Lee and G. G. Lee, "Open-domain personalized dialog system using user-interested topics in system responses," 2015 IEEE Workshop on Automatic Speech Recognition and Understanding (ASRU), Scottsdale, AZ, 2015, pp. 771-776.
9. R. Wallace, “The Anatomy of A.L.I.C.E ,Proceedings of International LISP Conference, Springer, 2002
10. Steve Worswick Interview - Loebner 2013 winner [Online] https://aidreams.co.uk/forum/index.php?page=Steve_Worswick_Interview_-_Loebner_2013_winner (Accessed 2nd Feburary 2020)
11. Dialogflow official website [Online] https://dialogflow.com/ (Accessed: 2 Feburary 2020)
12. Amazon Lex official website [Online] https://aws.amazon.com/lex/ https://dialogflow.com/ (Accessed: 4 Feburary 2020)
13. LUIS official website [Online] https://www.luis.ai/ (Accessed: 5 Feburary 2020)

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