



A SURVEY OF VARIOUS CHATBOT IMPLEMENTATION TECHNIQUES

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Abstract:

Today is the era of intelligence in machines. With the advances in Artificial Intelligence, machines have started to impersonate different human traits today. Artificial intelligence conversational entities, also called chatbots, are an excellent example of such machines. Chatbots are computer programs capable to carry out near - natural conversation with people. In this work, we describe the evolution of chatbots from a rudimentary model to an advanced intelligent system. Chatbots are currently gaining a lot of popularity especially in business sector as they have the potential to automate customer service and reduce human efforts. For a chatbot to perfectly emulate a human dialogue, it must analyze the input given by a user correctly and formulate a relevant and appropriate response.

Keywords: Chatbots, OCR, Information Repository, Knowledge Base, AIML, LSA

Introduction

With the growth in World Wide Web, it becomes difficult for any user to access the required information quickly and in a simple way. In order to increase and improve the ease of user interaction with any system, human and artifact collaboration is necessary. A chatbot can be considered as a question-answer system where experts provide knowledge for solicitation of user. A chatbot is a software designed to simulate an intelligent conversation with a human partner. This survey paper aims to present an overview of the existing approaches of implementing a chatbot system. The crux of this paper is to prepare a comprehensive comparison of chatbot systems right from the first chatbot ELIZA to one of the latest chatbots like Alexa. We have studied the design and implementation of several chatbots and developed a detailed survey of those systems.

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History of Chatbots

The history of chatbots can be traced way back to 1950, when Alan Turing published his paper “Computing Machinery and Intelligence”. This paper is widely regarded as one of the basic foundations of Artificial Intelligence and the Turing Test he proposed in this paper can be considered as a benchmark for evaluating the intelligence of a computer system [8]. The fame of his proposed test drew a lot of attention to Joseph Weizenbaum’s program ELIZA developed in 1966 at the MIT AI Laboratory. ELIZA simulated a simple, text based conversation between a human user and the computer posing as a Rogerian psychotherapist. Weizenbaum’s main intention in creating ELIZA was to exhibit the superficiality of human-computer interaction. However, he did not anticipate how a lot of people easily attributed human-like feelings to the program.

However, the first chatbots were not actually intelligent, but were programs that had a collection of predefined set responses corresponding to specific inputs. They were rudimentary and used pattern matching and string processing to keep conversation moving between the computer and human. They merely created an illusion of intelligence of the computer, but the reality was that the programs had minimal to none contextual understanding.

Survey of Chatbots:

ELIZA is also considered to be one of the first programs capable of passing the Turing test [1]. At first ELIZA examined the text inputted by the user and checked for certain keywords. Then it applied values to them, and transformed the input into a response. The script that ELIZA ran determined the keywords, set the values of keywords, and set the rules of transformation for the output.

PARRY was written in 1972 by psychiatrist Kenneth Colby, at Stanford University. PARRY attempted to simulate a person with paranoid schizophrenia. It embodied a conversational strategy, and as such was a much more serious and advanced program than ELIZA. It was described as "ELIZA with attitude". PARRY was tested in the early 1970s using a variation of the Turing Test. A group of experienced psychiatrists analysed a combination of real patients and computers running PARRY through teleprinters. The psychiatrists were able to make the correct identification only 48 percent of the time.

Jabberwacky is one of the earliest attempt at designing an AI through human interaction [2]. It was mainly a form of entertainment. It aimed to move from a text based system to wholly voice operated system.

ALICE (Artificial Linguistic Internet Computer Entity) created by Richard Wallace in 1995, is an open source natural language processing chatbot program that converses with a human by evaluating user input using certain heuristical pattern matching rules. ALICE is based in XML knowledge bases. It matches the user input against predefined set of responses. As it has a predefined set off responses, it cannot answer all the queries adequately. It is possible for ALICEbots to expand their knowledge bases through an XML dialect AIML [13]. Using this, An ALICE bot can be designed to be an expert in any domain specific information.

Watson, built by IBM is a question answering (QA) computing system designed to apply advanced natural language processing, information retrieval, knowledge representation, automated reasoning, and machine learning technologies to the field of open domain question answering.

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Watson uses IBM's DeepQA software and the Apache UIMA (Unstructured Information Management Architecture) framework. It runs on the SUSE Linux Enterprise Server 11 operating system using Apache Hadoop framework to provide distributed computing [3] [4]. It participated in the Jeopardy! Competition and won in 2011 [5].

Siri uses ASR (Automatic speech recognition) to translate human speech (which includes short utterances of commands, dictations or questions) into text. Using natural language processing (part of speech tagging, noun-phrase chunking, dependency and constituent parsing) it translates transcribed text into "parsed text". Using question & intent analysis it analyzes parsed text, and detects user commands and actions. ("Schedule a meeting", "Set my alarm"). Third party web services like OpenTable, WolframAlpha are interfaced using data mashup technologies. They perform actions like search operations, and question answering. Speech that SIRI has identified as a question, but it cannot directly answer, is forwarded to more general question-answering services such as WolframAlpha.

Alexa is a voice service inhabiting the Amazon Echo device. Alexa uses natural language processing algorithms for voice interaction. She uses these algorithms to receive, recognize and respond to voice commands. She is capable of music playback, making to-do lists, setting alarms, streaming podcasts, playing audiobooks, and providing weather, traffic, and other real time information. Alexa can also control several smart devices using itself as a home automation hub.

Mitsuku uses a programming language called AIML to understand and respond to people. Her intelligence includes the ability to reason with specific objects. She is a two-time Loebner Prize winner in 2013 and 2016 as well as the 2015 runner-up.

Chatbot	Year	Description	Creator	Open Source / Proprietary	Technology / Approach	Self-learning	Inquisitive	Type
Eliza	1964	a simulation of a Rogerian psychotherapist, rephrasing her response with a few grammar rules	Joseph Weizenbaum	Open Source	MAD-Slip	no	no	text
Parry	1972	PARRY attempted to simulate the behavior of a person with paranoid schizophrenia	Kenneth Colby	Proprietary	complex system of assumptions, attributions, and "emotional responses" triggered by shifting weights assigned to verbal inputs	no	no	text
Jabberwacky	1982	Chatbot with stated aim to "simulate natural human chat in an interesting, entertaining and humorous manner"	Robin Carpenter	Proprietary	contextual pattern matching, learns by association, storing replies to inputs in a database	yes	no	text
ALICE	1995	a natural language processing chatbot—a program that engages in a conversation with a human by applying some heuristical pattern matching rules to the human's input	Richard Wallace	Open Source	AIML	no	yes	text
Watson	2006	A question answering system that won the Jeopardy! Contest,	IBM	Proprietary	Watson uses IBM's DeepQA software and the	yes	yes	text

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		defeating the best human players in February 2011.			Apache UIMA (Unstructured Information Management Architecture)			
Mitsuku	2012	Mitsuku claims to be an 18-year-old female chatbot from Leeds.	Steve Worswick	Proprietary	AIML	yes	yes	text
Siri	2011	Computer program that works as an intelligent personal assistant, part of Apple Inc.'s operating systems. The feature uses a natural language user interface to answer questions,	Apple	Proprietary	Java, Javascript, Objective C, NLP, TTS, STT	yes	yes	text + voice
Alexa	2015	An intelligent personal assistant developed by Amazon Lab126, capable of voice interaction, music playback, making-to-do lists, setting alarms, streaming podcasts, playing audiobooks, and providing weather, traffic, and other real time information	Amazon	Proprietary	NLP, TTS, STT, Python, Java, Node.js	yes	yes	voice
Tay	2016	An artificial intelligence chatterbot that caused controversy on Twitter by releasing inflammatory tweets and was taken offline shortly after.	Microsoft	Proprietary	Python, Java, Node.js	yes	yes	text

Approaches:

The following figure shows a generic flow of working of a chatbot. Once the user has entered the query, the chatbot sends it to the machine learning NLP (Natural Language Processing) Engine. The NLP returns the entities in the phrase which are then used to find the relevant data. This data is given back to the chatbot and it is converted to an appropriate response to be given to the user.

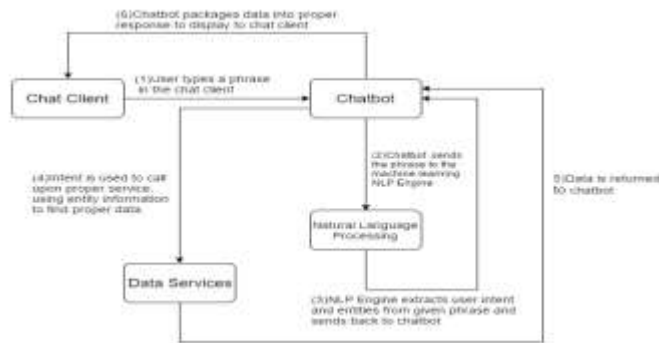


Figure: 1. Generic Chatbot Workflow

One of the approaches of implementing a chatbot is a domain specific chatbot. The hypothesis that a domain specific chatbot yields better efficiency than a generic chatbot can be proved using this approach. Such a chatbot can be used in a variety of domains which include education, Help

desks, e-commerce and so on. In the proposed system the user input is given to the semantic mapper, which maps the input to semantic elements. These elements are given to conflict mediator in order to resolve conflicts by having further conversation with user, and are passed to the topic navigator. If there are no conflicts then the elements are directly given to topic navigator which finds the appropriate answer in the information repository. This answer is given to the response generator for generating a natural language response to be given to the user. Three kinds of chatbot namely Basebot(contains conversational knowledge), Domainbot(contains domain related faqs), Repbot(hybrid) were used to test the efficiency of the proposed system. It was found that a hybrid chatbot yielded best response satisfaction rate and least topic switching rate. According to the results, conversational knowledge Basebot combined with topic specific knowledge should be adopted for future applications [9].

Another approach of implementing a chatbot is the smart answering OCR based chatbot. This approach uses the Optical Character Recognition technology(OCR), Overgenerating transformations and ranking algorithm and Artificial Intelligence Markup Language(AIML). OCR technology is a mechanism of converting a scanned document, images of hand written text into machine encoded text. Overgenerating transformations and ranking algorithm generates logically equivalent questions from source sentences. AIML is an XML dialect for creating natural language software agents. The proposed system has three phases Plain text extraction, Question Generation and Question and Answers. Plain text is extracted from pdf documents or images using OCR technology. Questions are generated from the extracted text via the overgenerating transformations and ranking algorithms. The question-answer pairs that are generated are stored as the chatbot knowledge using AIML. A pattern matching algorithm is used to match the user input to the data stored in AIML. The corresponding responses are given to the user. This approach provides an efficient way of converting documents into the chatbot knowledge. This system can be used in call center services and educational field for answering frequently asked questions [10].

An application of chatbots lies in the field of E-business and e-commerce. The main problem that almost every e-business model currently faces is that of quality customer service in the least amount of time. As a solution to this problem, a solution is proposed by Thomas N T that consists of a chatbot system to generate immediate responses, which is a combination of AIML and LSA [1]. Template based questions and greetings are answered by using AIML and other general questions are answered by using LSA. The user query is first passed to the AIML block, which checks if the query is template based. If yes, then a pattern based answer is generated as response. Otherwise, the query is routed to the LSA block where trained data is required to match the user query with expected output. The FAQs in any particular e-business domain is used for training the model. The FAQ is made using online data from the internet. The FAQ corpus passes through a series of steps beginning with tokenization where tokens are formed. Then stop word removal is performed by using Porter stemmer algorithm. After this, a word-document matrix is generated and then SVD is computed. Cosine similarity is used to evaluate result with minimum distance from user query and this result is generated as the response. User queries are stored in HBase and AIML database is updated to improve answers to template based questions. The model achieved 0.97 precision and LSA based questions gave correct responses [11].

When the user provides insufficient information to answer his query successfully, the chatbot needs to be inquisitive, that is it must proactively ask the user questions in order to mimic a more natural human interaction. This approach details the implementation of such an inquisitive chatbot which recognizes missing data from a query and probes the user to obtain the same in order to answer his query. In the existing chatbots, the chat engine uses pattern-matching algorithms to search the knowledge base for. ALICE engine uses AIML as a knowledge base to stores a set of predefined queries and its variants. In order to make these hard-coded answers dynamic, we

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implement a hybrid knowledge base model, involving AIML and another additional database. In this model, more permanent answers are stored in the AIML, while the frequently changing answers are stored in the database. In order to achieve such a proposed system, an additional knowledge base engine (KB engine) is implemented in the current system. This KB engine interfaces with a database for fetching factual data for responding to certain queries. The Knowledge Base Engine is designed to integrate the database functionality with the AIML and to analyze missing information from a query at the primary level in order to evaluate the query and come up with a response. The KB engine works with a two phase evaluation methodology which constitutes identifying the missed data field, obtaining the data from the user, and processing the retrieved answer for the formation of right answers expected by the user [12].

Applications:

With the rapid advancement of technology, chatbots have become increasingly important in various domains such as scientific, educational, commercial and educational. Chatbots can be implemented as intelligent personal assistants (also called virtual assistants) on mobile devices, as artificial tutors in the educational field as they can provide instant and personalized feedback to learners, and also in social networking domain for providing personalized marketing to customers.

Chatbots are a big step forward in enhancing human computer interactions. Some of the most notable applications of chatbots are as financial advisors [Credit Score Coach], providing free legal aid [DoNotPay], personalized stylist, and providing personal concierge services, offering preliminary medical advice, and many more [7]. However the widest application of chatbots is in the field of e-commerce for automating customer service. Chatbots help to improve customer relations as well as drastically reduce human efforts.

Future Scope:

Currently chatbots have limited language support. They do not support multiple languages, dialects and do not understand colloquial usage. Hence there is a great scope for removing such language barriers in future chatbots. Also, AIML templates could be improved to include more variations for the same input. Intelligent personal assistants integrate various chatbot services into one single platform and pave the way for a truly intelligent self-learning artificial entity.

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