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A Review on the Determinants of a suitable Chatbot Framework- Empirical evidence from implementation of RASA and IBM Watson Assistant Frameworks

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Abstract - *The rapid emergence and evolution of AI chatbots has been phenomenal. There are countless frameworks out there that are trying to catch up to each other in order to be the best. From modest start-ups to significant partnerships, these conversational professionals are utilized in a variety of industries. On the market, there are a variety of code-based and interface-based chatbot development solutions. However, they lack the adaptability and agility required to create sincere conversations. Chatbots are currently developed utilizing rule-based techniques, rudimentary machine learning algorithms, or retrieval-based techniques, however the results are not adequate. It can be difficult to decide which one is most suited to your requirements. The purpose of this paper is to look into the factors that influence the choice of a chatbot platform between RASA and IBM Watson Assistant. This paper presents a survey of these frameworks for researchers in identifying the areas of development and methodology. This study offers a critical examination of these frameworks, with current tactics thoroughly examined and analyzed. 30 publications from well-known digital databases were analyzed using a systematic review approach. In this paper, an extensive comparative analysis is carried out using evaluation models for chatbot performance. This survey concludes with curiosity to know why would we prefer one over the other and what are the future aspects of each. The data is collected from several resources including 50 respondents from 2 MNC's dealing with chatbot providing services.*

Key Words: ***Chatbots, RASA, Machine learning, Deep Learning, IBM Watson Assistant***

1.INTRODUCTION

A chatbot is an artificial intelligence software. It can communicate with a customer in natural language via informative applications, websites, and a variety of applications. It can have a simulated interaction with the user in such a way that they don't feel like they are talking to the machine directly. They are designed to help organizations maintain track of their client interactions. It's ubiquitous on popular chat apps like Facebook Messenger, Telegram, Rocket Chat, and Google Hangouts Chat, among others. Despite the fact that chatbots appear to be a relatively new concept, 75 percent of web customers use courier stages, according to research from the Global Online Index. It is a piece of correspondence programming that mimics written or voice communication with humans.

The chatbot established in the past maintains a rudimentary conversational stream with customers in the form of a simple solicitation and response stream. As research progressed, chatbots have been able to recognize the customers' settings and the flow of interactions and respond appropriately. According to Fortune Business Insights, the chatbot market will reach $721 million in 2022. This number may project to reach 3 billion dollars by the end of the decade, based on its current compound annual growth rate (CAGR) of roughly 22%. Smaller firms are currently using chatbots in large numbers. Adding a third-party customer care bot powered by one of the popular chatbot builders is fairly simple. Larger companies, on the other hand, tend to take a more strategic approach. This pushes them to create their own in-house solution, which prolongs the development process. Conversational bots, according to 61 percent of executives, boost staff productivity by automatically following up on scheduled tasks. (According to Accenture, 2018). Chatbots are expected to provide consumers with 24-hour service (64 percent) and rapid responses (55 percent). (2018, Drift). Chatbots or comparable technology will automate 29% of customer service activities in the United States. (Tableau). During the COVID-19 epidemic, AI-powered chatbots played a crucial role in handling patient demands. The World Health Organization estimates that 4.2 billion people might potentially be reached by the WHO Health Alert Messenger App and other related communication channels. 2020 (World Health Organization)

1.1 Chatbot Usage and Engagement Statistics

AI advancements enhance chatbots' ability to mimic human agents in conversation. Contrasting with human-human conversations, human-chatbot communication is distinguished by noticeable variances in both content and quality. A human–

chatbot conversation can last a long time. It's common for people to speak in brief sentences with few words or even in poor language (Hill, Randolph Ford, & Farreras, 2015). While chatbots are less capable of linguistic interpretation than humans, the fundamental difference between them and humans is how they detect empathy. However, breakthroughs have been made, and chatbots are becoming increasingly sensitive to their users' emotions. (2018) (Fernandes). Artificial intelligence and other technologies are being used by businesses to help them make quicker, more informed choices, increase efficiency, and provide more customized and relevant experiences for both consumers and staff. Conversational bots, like Apple's Siri, Google Assistant, and Amazon's Alexa, are intelligent virtual assistants that enable third parties to create "skills" or original conversational interactions by utilizing the AI, NLP, and ML APIs/services offered by these platform providers. The concept of utilizing human language to communicate with machines emerged in the early 1950s. However, at the time, no one could fathom computers that could react or operate like humans. The last few decades, however, have seen a significant change in the situation. Even though people still have irrational expectations about AI, it can be said that we have advanced in our ability to interact with robots. In a number of industries, including healthcare, business, education, and finance, AI technology is currently used to provide virtual assistance (Tidio). With 1.4 billion people regularly utilizing chatbots, its use has spread to a wide range of industries (Acquire). The fact that chatbots can respond to the majority of questions that customers may ask them is one of the factors contributing to this technology's increasing popularity, per data from the chatbot industry. It is nevertheless vital to have some knowledgeable customer support personnel on standby for more complex inquiries. However, a chatbot service reduces costs and improves response times for common issues. This allows customer service workers to focus on harder tasks and get a bigger picture (IBM).

1.2 Technologies and Conversational Bot Frameworks

To create a chatbot based on natural language understanding, a variety of technologies and platforms are available (NLU). Around the same time that the idea of a chatbot became popular, Alan Turing put up the Turing Test("Can computers think?"). (Turing, 2009, pp. 23–65). In order to serve as a psychoanalyst and respond to customer questions, Eliza, the first known chatbot, was created in 1966. (Weizenbaum, 1966). It used pattern matching algorithms and a template-based response system to react to the user's query (Brandtzaeg & Flstad, 2017, pp. 377–392). A Chatbot dubbed PARRY was created in 1972 in addition to ELIZA. (Colby and colleagues, 1971). A prize-winning chatbot named ALICE was created in 1995. The annual Turing Test award, the Loebner Prize, was conferred to it. It was the first chatbot that was widely recognized as a "human Computer". (Wallace, 2009, pp. 181–210). It used pattern-matching and Artificial Intelligence Markup Language (AIML) to define its core operations (Marietto et al., 2013). Current Chatbots developed as technology advanced include SmarterChild (Moln'ar & Szuts, 2018), Siri, Amazon Alexia, IBM Watson, Cortana, and Google Assistant (Reis et al., 2018). The development of chatbots has significantly increased since 2016, leading to the creation of a wide range of conversational systems for use in industry. The Scopus findings on Chatbot development history are shown in Fig. 1, which was modified from (Adamopoulou & Moussiades, 2020).

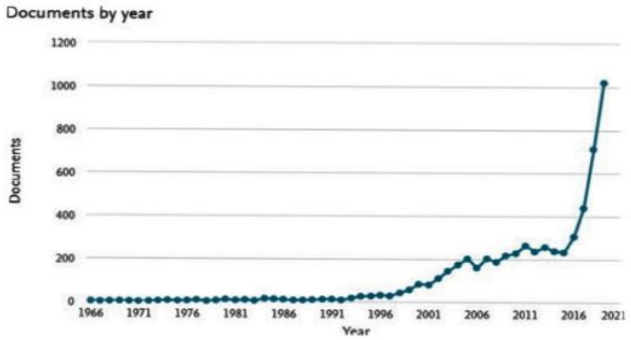

Chart -1- Shows the timeline when people searched Scopus using the phrases "chatbot," "conversation agent," or "conversational interface" (Adamopoulou & Moussiades, 2020). (CW Okonkwo and A. Ade-Ibijola)

Chatbots manage fictitious interactions and lack morals and independence (Murtarelli et al., 2021). A thorough investigation of the various Chatbot platforms, as well as the level of innovation and application of already-existing Chatbots, is recommended by Adamopoulou and Moussiades (2020). Hence the study aims to critically analyze two big chatbot frameworks- RASA and IBM Watson. With the endless chatbot and AI helpers on the market, it is tough to determine which is better and compatible with the platform on which it will be implemented. Although many reviews have been done on the design, trends and applications of the chatbots, their primary focus has been to add to the body of knowledge on the various chatbots designs and

its approaches. This research, on the other hand, proposes to be focused on two frameworks, showing the on-the-ground reality of their implementations pointing researchers into potential fields of future research.

This study contributes to the existing body of knowledge on chatbot frameworks in the following ways (specific to RASA and IBM Watson).

- It offers structured and current information about prior research and their application areas.
- It addresses the primary obstacles related with the deployment of Chatbot systems.
- It outlines the key issues with the usage of Chatbot platform and help in the identification of critical areas that require enhancement.

Given the depth and breadth of prior research on chatbot platforms, the following research questions have been addressed using a systematic literature review (SLR) (RQ).

RQ1 - What is the current research status or profile of the two chatbot frameworks?

RQ2 – What are their main advantages?

RQ3 - According to the literature, what are the hurdles observed during implementation

The remainder of the paper is structured as follows: The two Chatbot frameworks are explained in Section 2, the research methodologies are covered in Section 3, and the results of the search are discussed in Section 4. Section 3 also covers the results of the study's ramifications. Section 4 of the report concludes with suggestions for additional research.

2. Overview of RASA and IBM Watson ChatBot Platform

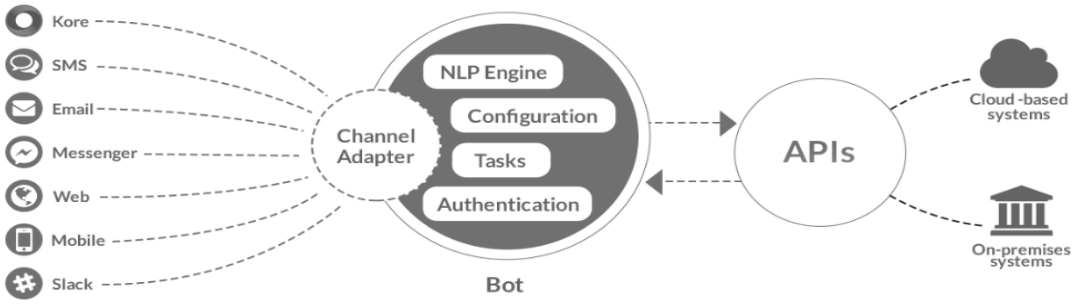

Fig -1: General Architecture of a ChatBot

The illustration (Fig 1) above depicts what happens within a chatbot. Despite the fact that practically every chatbot has these features, they can be categorized into various distinct categories.

A chatbot can be categorized as a personalized bot, a customer support bot, or a functional bot. Each of these category bots can respond to one of two deep learning models that can be used to decide the chatbot's design structure. The first one is the Generative model. Generative models are intelligent Bots that are used seldom but are meant to create complicated algorithms. These bots converse in a human-like manner. Figure 2 shows an example of Microsoft Tay (Deshpande et al., 2017)

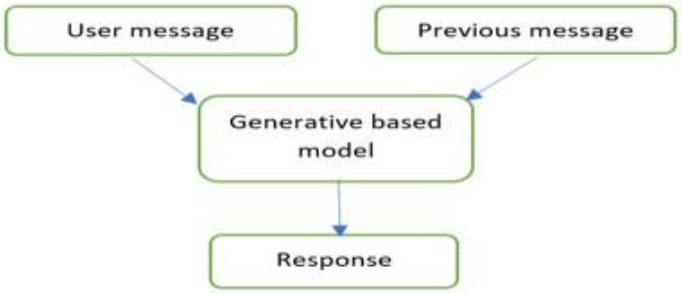

Fig 2: Generative model

The Retrieval-based Model is the second. These are simple to construct utilizing pre-built APIs and established user conversational context. (See Illustration 4) (Deshpande and colleagues, 2017). This model is simple to implement. Its drawback is that the user's inquiry may not always fit into the existing question and answer database.

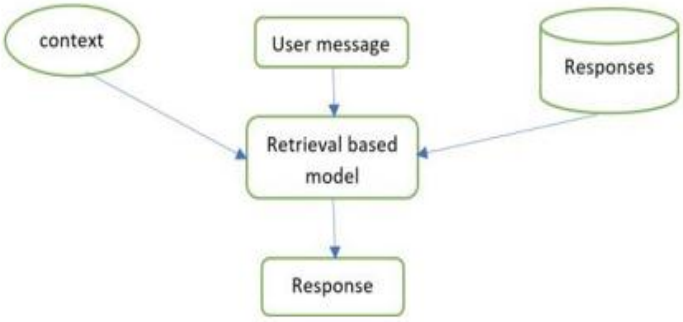

Fig 3: Retrieval-based Model

One of the most popular Artificial Intelligence chatbot platforms used by developers is Watson, which uses a retrieval-based paradigm. It offers a variety of tools for creating bots. In terms of capability, integration, and scalability, IBM Watson holds its own against other significant rivals in the hunt for an AI chatbot framework. It also includes machine learning capabilities. To develop sophisticated AI chatbots for internal usage, large organizations are using IBM Watson. It has considerably enhanced reasoning, pattern recognition, computational linguistics, and artificial intelligence. Additionally, it offers developers enhanced cognitive capacities. More than 10 different languages are currently supported by Watson, and it also has a built-in translator. It contains a tone analyzer that can help with interpreting and identifying positive and negative responses from users and customers. Its Technology stack and approach pretty much includes NLP, IBM's Deep-QA software and Apache UIMA. In 2011, IBM unveiled Watson as a chatbot (Watson Assistant |IBM Cloud, 2020). On the game show "Jeopardy," where participants had to guess the questions that associated with answers they were given, Watson was able to understand real human language well enough to overcome two previous champions. Years later, Watson aided companies in creating better virtual assistants. Watson Health was developed to help medical professionals with disease diagnosis (Eleni Adamopoulou & Lefteris Moussiades., 2020).

On the other hand, RASA is an open-source implementation of the Dual Intent and Entity Transformer (DIET) paradigm for natural language processing (NLP), implements the DIET model. In order to boost efficiency, DIET employs a sequence model that considers word order. It is also available in a smaller, more compact form with a plug-and-play, modular design. For instance, DIET can be used for both intent categorization and entity extraction, or it can be used for a particular task, such as entity extraction alone. This can be done by disabling intent categorization. Before DIET, Rasa's NLU pipeline utilized a bag of words model with just one feature vector for each user communication. Currently, RASA consists of two modules: Rasa Core and Rasa NLU. Rasa NLU analyses user input, categorizes intent, and extracts entities. Rasa core accepts the user's input and uses several pipelines to provide a response. Rasa is a powerful and time-saving tool for creating complicated chatbots that works right out of the box. In terms of development, it is clear and adaptable (Indiaai). Rasa is a chatbot structure to consider for more aggressive roles, with an upgraded NLU motor capable of manipulating important AI associations via text or speech. Rasa is also free and open source, unlike many other bot systems. It's quite robust and is commonly used by designers to create chatbots and context-aware coworkers. Inside the chatbot, one can design, interact, and execute, making it and the data it links

safer. Furthermore, it gives better control and freedom when running the chatbot. In terms of components, combinations, and general adaptability, it ranks with the other major chatbots, such as Amazon Lex, Dialog Stream, and Microsoft Bot Framework.

3. Review Of Literature

Designing a chatbot's objectives, procedures, and user requirements is the first step in creating one. The chatbot functionalities are evaluated locally after being built using a programming language or a chatbot application framework. The chatbot is subsequently made accessible to the public on a website or in a data center, and it is linked to one or more channels to send and receive messages. (Eleni Adamopoulou & Lefteris Moussiades., 2020). The services a chatbot should provide to users and the category it falls under dictate the algorithms or platforms utilized to build them (Nimavat & Champaneria, 2017). The benefits of making the proper decision include connectivity, efficiency, quick and easy production tweaks, and less labor for the designer. It's important to remember that a chatbot is considered more effective if a user may use it directly without downloading and installing anything. Computer languages like Python and Java, as well as a paid or free chatbot creation platform, can be used to create a chatbot (Nayyar, 2019). RASA (Rasa, 2019), Botkit: Building Blocks for Building Bots (2019), and Chatterbot are all open-source platforms. Some NLU cloud platforms (Braun et al., 2017) fueled by machine learning include Google DialogFlow (Dialogflow, 2019), Facebook wit.ai (Wit.ai., 2019), Microsoft LUIS (LUIS (Language Understanding) - Cognitive Services - Microsoft Azure, 2019), and IBM Watson Conversation (IBM Watson Conversation, 2019).

The Rasa NLU and core were first presented under an open-source license by Bocklisch, T. et al. in a paper. The objective of this study was to create a communication system for non-expert technology enthusiasts based on machine learning and language understanding. The bundle they created was small and included everything they needed to progress. 244 versions of Rasa had been produced with a total of 18023 contributions, thanks to the efforts of 344 contributors. Rasa's API integrates principles from scikit-learn [1] (consistent APIs with various backend implementations) and Keras [2], and both of these libraries are (optional) components of a Rasa application. The technique to dialogue management used by Rasa Core is most similar to [3], however it differs from the majority of previous research systems. End-to-end learning, as in [4] or [5,] in which natural language understanding, state monitoring, dialog management, and answer production are all learned collaboratively from discussion transcripts, is not currently enabled. Rasa's language understanding and dialogue management are entirely distinct. Rasa NLU and Core can be used separately, and learned conversation models can be applied to different languages. Rasa's architecture is intended to be modular. This makes integrating with other systems straightforward. For instance, Rasa Core can be used as a dialogue manager in conjunction with NLU services other than Rasa NLU. Despite the fact that the code was built in Python, both services may offer HTTP APIs, making it possible for programs written in other programming languages to easily access them. In an experiment by Anran Jiao[6], the RASA NLU approach outperforms the NN method in terms of accuracy. Additionally, the RASA NLU method excels at extracting all entities while analyzing a single word as a whole. However, it was discovered that the NN approach has superior fidelity when classifying things from segmented words. He integrated the RASA NLU with neural network techniques to create an entity extraction system that can recognize intentions and the entities that go along with them. He also created a practical framework to put the RASA NLU notion into practice. Lacerda[7] used the core of Rasa in his work and proposed a new software stack called Rasa-ptbr-boilerplate for non-specialists who don't know much about the internals of the chatbot and treat chatbots like a blackbox.

To be fair, the experiences of the top three chatbot platforms: Amazon, Google, and IBM are all extremely similar. Rasa was the only chatbot platform that necessitates hands-on Python scripting. Although Rasa's documentation seems the most fun, IBM Watson's appeared to offer the most comprehensive and easy-to-follow resources. The IBM RedguideTM article (2012) illustrates how Watson employs dynamic learning, natural language processing, hypothesis generation, and hypothesis assessment to deliver prompt, accurate responses. It represents a cognitive system in action. With accuracy comparable to that of a human, it can parse human language to identify connections between text parts at rates and scales that are much faster and greater than those that a human alone could achieve. It can handle a high level of accuracy when it comes to knowing the appropriate response to a question. Its pricing starts with the Lite edition, which is cost-free and supports up to 10,000 messages per month. The other fee-based programmes are Standard, Plus, Premium, and Deploy Anywhere. Standard offers an infinite number of texts for $0.0025 each. Although the price of the Plus plan is not disclosed, one can get a free 30-day trial by contacting IBM. The costs of the Premium and Deploy anywhere programmes vary.

3.1 Chatbot Performance Evaluation Models

Evaluation of chatbot performance can be done in a variety of ways. Personal assistants, question-answer bots, and domain-specific bots are some of the different information retrieval (IR) uses for chatbots. The accuracy, precision, recall, and F-score of the chatbot's responses must be measured by the evaluators after they have asked the chatbot questions and made requests (Cahn, 2017). According to the user experience perspective, the bot's goal is probably to increase user satisfaction. Users need to be surveyed (often via questionnaires on websites like Amazon Mechanical Turk), and bots need to be rated based on their

usability and pleasure. To get close to speech, bots should be put to the test by linguists for their ability to put together complete, grammatical, and meaningful utterances. The bot that appears the most convincingly human—that is, one that best passes the Turing Test—is also the most efficient from the perspective of artificial intelligence.

There are many measures that can be used to determine whether a chatbot will be effective, such as the Bleu Score, which compares a created word sequence to a reference sequence. The BLEU score was first developed specifically for translation assignments when it was first introduced by Kishore Papineni in 2002. The BLEU score is determined by counting the instances in which n-grams of user text coincide with n-grams of reference text. The chatbot's intelligence increases with its BLEU score. b) The Turing test is a prominent way of evaluating a machine's capacity to demonstrate intelligent behaviour similar to that of a human. The Turing test indicates that a machine has succeeded if the tester is unable to distinguish between human and computer responses. c) Scalability: If a chatbot accepts a large number of users and new modules, it is said to be more scalable. d) Interoperability, which refers to a system's capacity to share and utilize data. Multiple channels should be supported by an interoperable chatbot, and users should be able to move between channels rapidly. e) Speed: When it comes to speed, a chatbot's response rate measurement is crucial. Chatbots of high quality should be able to respond fast (Pooja Gambhir, 2019).

In relation to IBM Watson Assistant, it can assist in overcoming the high learning curve and annoying language employed by rival virtual agent technologies. Its chatbot design is easy and does not require the need for sophisticated decision trees or scripting. Watson Assistant is found to be very easy to use and very scalable. The CEO of AdMed, Joan Francy states that the interface allows anybody to build a chatbot, while also allowing our developers to fully utilize Watson's capabilities (IBM, 2019). However, building a simple question- answer bot is very easy but establishing a communication with an external API can be a complex process. According to a few respondents, the list of available integrations for the chatbot reveals its major flaw: it can't be used anyplace! Slack is a new addition to their offering, however Microsoft Teams is not supported (which has over 115 million users). Rasa's approach to dialogue management cannot be compared to IBM's. The dialogue management environment in WA is highly strict. The dialogue has elements such as disambiguation, digression, numerous conditioned replies, and a large amount of business logic, resulting in a complicated environment. The Lite plan's metrics are notably light on specifics, making it difficult to even notice where the chatbot's recognition is lacking. In order to make the chatbot user-friendly and useful, one must first identify the shortcomings. IBM has a solution for it, which is called pay for Plus which could go down the expensive road especially for small businesses. Furthermore, if the chatbot requires any third-party API connectors, one must join up for IBM's Cloud Functions service, which, aside from time, costs a lot more money. Nonetheless, IBM Watson is a market-leading AI solution that is acclaimed for helping businesses conduct quick and in-depth research. They can find patterns and insights thanks to its powerful AI and machine learning capabilities

. Through extensive studies of complicated data, meaningful and actionable insights can be gleaned. It may sound mundane in today's bot-building frameworks, but Rasa has claimed to be doing something a little different. According to Rasa Technologies, the architecture enables the creation of contextual chatbots—true AI assistants that do more than repeat FAQ replies. Rasa is more likely to be used for more ambitious applications, such as bots that can comprehend and respond to highly sophisticated statements. That being said, the entrance hurdle is minimal. One can begin using the framework for free, as there is minimal risk in browsing the Rasa documentation to acquire an understanding for it. According to the study [8], RASA is more adaptable than other business softwares due to its scalability and open-source licensing. Jollity chatbot built in Rasa integrated with Telegram helps users cope with depression by giving an unseen friend on whom they can rely, as well as the ability to interact with the bot throughout the day. Various criteria, including intent accuracy, narrative correctness, and confusion matrix, were used to evaluate the system. Experiments showed that the system had a 90% accuracy rate for intent identification and could retrieve pertinent responses (Kanakamedala Deepika, Veeranki Tilekya & Jatroth Mamatha, 2020). According to peerspot, Rasa is placed fourth in Chatbot Development Platforms, whereas IBM Watson Assistant is ranked second. However, the majority of ones selection will be dependent on their previous experience and what they want to accomplish with the bot. The most significant difference between the frameworks is the development ecosystem and assistance that they best enable. Thus, considering the advantages and disadvantages can help in motivating users and establishing acceptable standards that will encourage the growth and application of chatbot technology.

4. Discussion Of Results

The purpose of this study was to conduct a systematic review of the literature on Chatbot technologies (Rasa and IBM Watson Assistant) in order to gain a better understanding of their current status, benefits, obstacles, and future possibilities. Three major research topics were identified in relation to the objectives.

RQ1 investigated the current state and profile of both the frameworks. A total of 30 published research publications were analyzed in order to answer this question. This research also took into account a variety of verified Chatbot Development Platform evaluations in order to uncover the real-world challenges that developers experience during implementation.

According to our findings, It is far too early to determine in the perspective of computing history if IBM Watson Assistant is primitive. In a newly released benchmark (IBM,2020), Watson Assistant's new and enhanced intent recognition algorithm outperformed commercial and open-source competitors. When trained on all training sets and tested on in-scope occurrences, the upgraded version of Watson Assistant achieves an average accuracy of 73.8 percent across all datasets. According to Jio Haptik Technologies (2020), Watson Assistant outperforms Rasa by 9.3 percentage points. According to the study, Watson Assistant competes with pretrained LMs across a wide range of datasets and situations, but trains far faster - an important component in the usability of a commercial conversational AI service. Rasa, on the other hand, allows open-source models to be added in the pipeline, such as Transformer-based (Vaswani et al., 2017) models. Rasa-based chatbots have outperformed any of the other open-source competitors.

RQ2 outlines the benefits of their use in the industry. The review has identified and highlighted numerous advantages gained from the use of these Chatbot frameworks. Some of the advantages of Watson Assistant include the ease of use, does not require any coding knowledge. A high completion and containment rate is achieved through efficient and targeted encounters that include rich media. It is designed for worldwide deployment and is built with IBM security, scalability, and flexibility. RASA, however, falls into the open-source category, which allows for a balance of control over development processes. It takes a flexible approach to Chatbot development in that the NLU pipeline may be tailored to the problem that the CA will address.

RQ3 identifies some of the primary issues that developers confront while implementing these frameworks. Various publications verified chatbot platform evaluation websites, and responses from respondents were used in this research to highlight some of the primary challenges of these frameworks.

5. Conclusion

Chatbots can aid in the implementation of major changes. Customers' interactions with businesses are affected by them. They influence how client support is handled. They influence how leads are produced and how soon clients are helped. Chatbots are one of the most human-like ways for a product to communicate with customers and answer their inquiries. We have analysed the performance of two of the most popular commercial services for developing task-oriented dialogue systems. In practise, systems designed for designing and deploying virtual assistants must address a variety of scenarios and trade-offs. These systems must train the best models in few-shot scenarios, strike a balance between training time and accuracy, and readily adapt to a wide range of domains. In this review it has come to notice that Watson Assistant has outperformed Rasa at many instances however the answer to which framework to prefer lies in the requirement for it. The stated benefits and constraints can be experimentally studied in future works to see how they influence Chatbot development.

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