An AI-based Cognitive Chatbot for VMware Troubleshooting

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***Abstract*— All businesses need a faster and more efficient way of accessing the correct information to take quality decisions. The amount of information available inside an enterprise is humongous and needs to be contextualised and filtered before providing the same to the users. Automated conversational agents or intelligent chatbots have become ubiquitous solutions to tackle this need. This paper aims to design and implement a 24/7 interactive, AI-based chat system that can quickly respond to end-user queries and recommend the required information. Here, the authors showcase how with IBM Watson Assistant, a cognitive agent can process documents about VMware-related issues. IBM Watson's cognitive intelligence combines machine learning and artificial intelligence to drive natural language understanding and human-like conversations. The chatbot offers an interactive platform with the IBM Watson chatbot to handle queries related to VMware Snapshots and storage and recommend solutions without human intervention, thus saving time and resources.

The data used in this paper is extracted from VMware's 'Knowledge Base articles. These articles are further embedded into IBM Watson conversational chatbot dialogue workflows, with precisely articulated intents and entities that are further processed to create interactive dialogues.

The prototype is shared with customer service agents to evaluate the performance based on the accuracy and reliability of the chatbot. Necessary enhancement is done depending on the feedback provided. The ease of accessibility and availability of chatbot makes it a popular and reliable source of information to get the necessary details promptly. During the conversational workflow of the chatbot, the end-user can indicate the most common errors as a sub-option. After selecting the appropriate issue category, the necessary recommendations and solutions are suggested based on the choice of the query. This cognitive chatbot assists customers who need assistance in troubleshooting VMware-related issues on VMware snapshots and storage.

Keywords—Artificial Intelligence, Machine Learning, Natural Language Understanding, Cognitive Intelligence, VMware Snapshot, Chatbot, IBM Watson

I. INTRODUCTION

Any business unit worldwide is challenged by the need for accessibility, availability, and reliability of the correct information at the right time. To address the huge demand and supply gap for human resources in customer service, many companies have proposed automated customer service chatbots [1] that are intelligent, fast, and can substitute human functions. However, Artificial Intelligence (AI) and Natural Language Processing (NLP) technologies still need to be improved to replace humans completely [1].

In this paper, the authors propose building a chatbot to address the issue of retrieving relevant, reliable, and efficient troubleshooting techniques for a specific client, VMWare.

VMware is an organization that offers virtualization software that enables users to deploy multiple servers, known as Virtual Machines, on a single host. This is a critical component of VMware's business model [2]. Snapshots offer quicker ways to maintain a virtual machine's memory state and represent the point-in-time state of devices. Datastores are the mounted

storage locations on Elastic Sky X, (ESXi) hosts that offer the required platform for storing the data and Snapshot files for Virtual Machine [3].

The purpose is to build a chatbot to help service engineers solve customer queries related to VMware snapshots and storage. The sample data used are related to VMware snapshot and storage domains. The conversational system intends to enable end users to deal effectively and independently with fundamental and current challenges associated with VMware-specific related queries and issues. The interactions with the chatbot and the agents had to be user-friendly and accessible 24/7 to respond to a user question and assist in identifying and resolving problems.

The authors designed the chatbots with IBM's Watson Assistance Tool, which works on Natural Language Understanding (NLU) and Cognitive Systems that are essential for the chatbot's ability to understand and act on the user's input accordingly [4].

II. LITERATURE REVIEW

This section examines the extant literature on the nature of chatbots deployed in different business fields, the technologies used, and the outcomes.

A research paper presented by Amin Kuhail and the team illustrated the implementation of chatbots to help institutions to design and evaluate educational chatbots to improve students' learning paths [5]. According to Folstad's study, when chatbots are equipped with multiple pragmatic attributes, that can lead to favorable or unfavorable user experiences while, at the same time, accentuating the potential risks associated [6]. In the paper by Vanessa et al., the chatbot is built to investigate and compare the influence of the interaction methods, clicking vs writing chatbot-driven conversations [7]. A study by Calvaresi states the importance of configuring and deploying personalized chatbots to support users in multi-topic and multi-campaign behavioral change programs [8].

The research work by Martin Hasal stresses chatbot security measures and challenges, further emphasizing security threats and necessary steps to safeguard user data, queries, and conversation history [9]. A very comprehensive work by Taejin Kim [10] showed how ineffective it is to construct a functional and reliable information repository using a generic knowledge base. Instead, a substantial body of knowledge documentation and an encoder that is finely calibrated offered a more persuasive approach and values to the construction of the COVID-19 database using Bidirectional Encoder Representation Transformer (BERT) pre-trained language model.

These research articles narrate various subjects and domains; therefore, getting a proper response from the chatbot to specific queries is challenging. All the pieces emphasized the importance of providing customers with a range of options for a particular category of problem, thus enabling the end users to make better choices and perform effective decision-making. The study by Vanessa et al. [7] cited that click-driven chatbot flow provides more accurate responses and recommendations than write-driven chatbot conversations. Therefore, the proposed chatbot is designed to make short conversational dialogues to respond as quickly as possible and be click-driven. Our proposed work has been limited to two major VMware concepts to demonstrate a business-driven application of a chatbot service effectively. The security features are well addressed in the IBM Watson environment. It is integrated with self-embedded security and scalability features that control data ownership and isolation and offer data protection by performing internal and external penetration testing with critical auditing [11].

III. METHODOLOGY

The context of this paper is to create a chatbot that is enhanced with artificial intelligence, natural language understanding and cognitive programming with machine learning to provide effective human-computer interaction (HCI), focusing on VMware-related issues.

Pre-defined logical concepts and proper workflow blueprints are created to establish practical, interactive discussions for chatbots, as shown in Fig. 1. The informal talks are organized using grouped flowcharts that determine the chatbot's response to the questions posed by the end users. Many documents and VMware knowledge Base (KB) articles are researched to gain a thorough understanding of VMware Snapshots [3] and VMware Storage concepts [12].

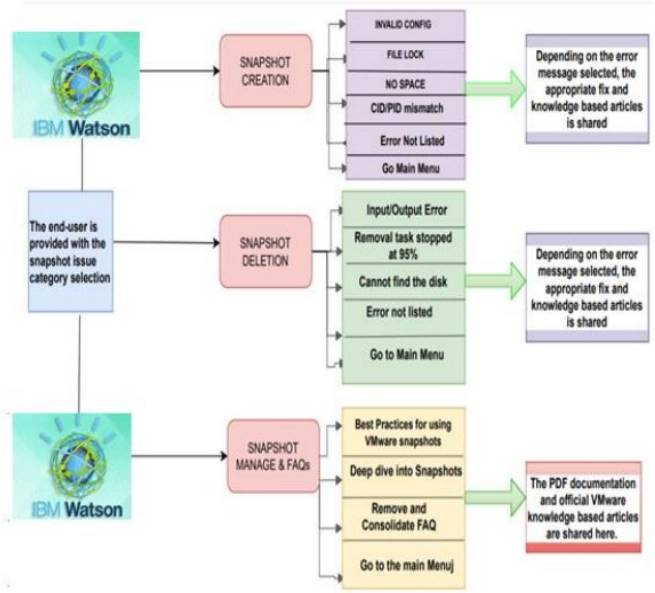

Fig. 1. Basic Technique of Snapshot Troubleshooting

A firm knowledge of storage and snapshot workflow, as well as their underlying conceptual ideas, is certainly required while designing the conversational system. The fundamentals of the snapshot [13] are depicted in Fig. 2.

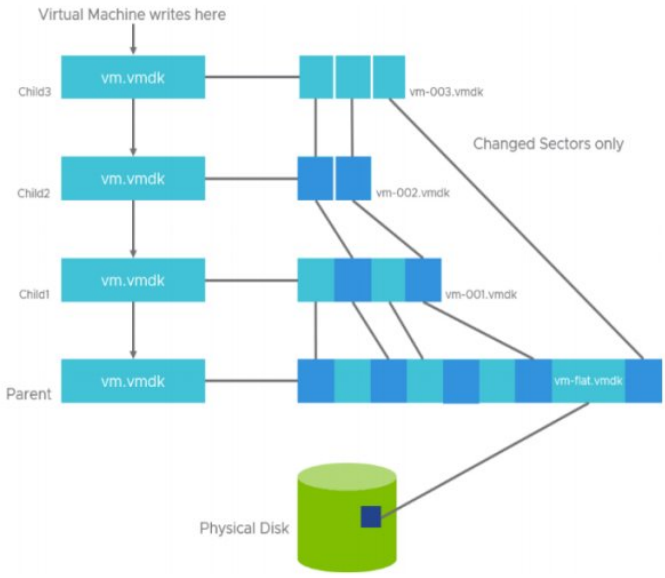

Fig. 2. Snapshot Disk Structure [3]

Watson is based on natural language processing (NLP) models, deep learning, and machine learning algorithms to enhance the interactive sessions and support the end-users with various queries [14]. It uses natural language understanding (NLU) algorithms, Intent classification, entity recognition, irrelevance detection, and a spellcheck [11].

Here the design of the chatbot is limited to the concepts, workarounds and troubleshooting steps defined in VMware knowledge-based articles.

IV. PROPOSED AI-BASED COGNITIVE CHATBOT

This section outlines the steps required to comprehend the workflow of the Storage issue and Snapshot troubleshooting scenarios, along with conceptual features and operation of the IBM Watson chatbot. The technique and procedure utilized to link the chatbot with the troubleshooting conversation for VMware snapshots and datastores are based on the repository of VMware Knowledge-Base articles [15] and VMware documentation [16]. The knowledge base is thus limited to Snapshot issues and Storage troubleshooting and is derived from well-known VMware knowledge base articles.

The entire interactive chat workflow is depicted in Fig. 3.

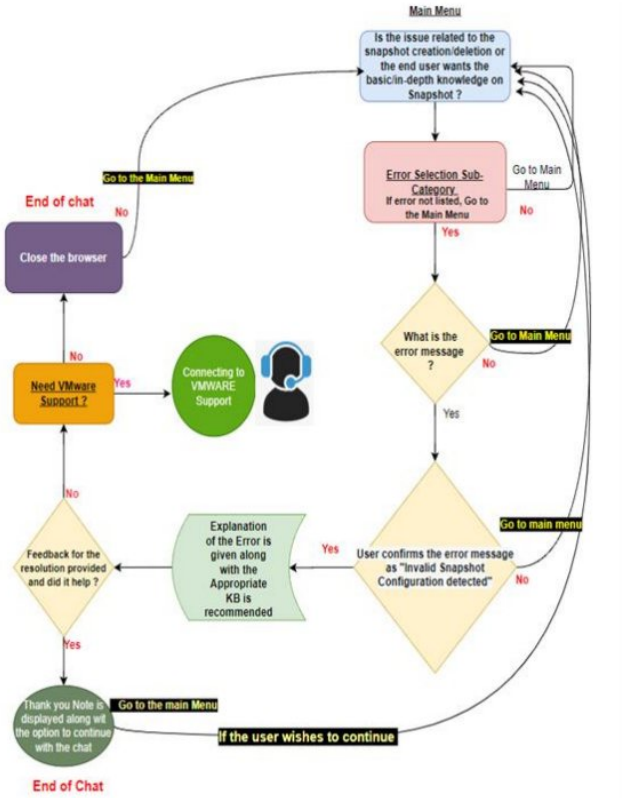

Fig. 3. Framework of Chatbot Interactive Workflow

The above framework defines the workflow of the chatbot starting with "Main Menu" that provides the error category selection. The chatbot suggests further recommendations depending on the error category selected. An effective feedback option is provided to the end-users at the end of the chat interaction. The chatbot design relies on the essential elements

to build a fully-fledged and functional chatbot with parameters such as Intents, Dialogs, and Entities defined in IBM Watson Assistant [17].

a) *Intents (prefixed with #):* An intent is a collection of possible expressions that a user might use to convey a particular objective or notion [17]. This paper defines multiple intents by extracting the keywords used in VMware Knowledge Base, such as #Snapshot_Creation, #Snapshot_Deletion, #Datastore_Mount, #Datastore_UnMount etc.

b) *Entities (prefixed with @):* A component of the user's input known as an entity can be used to deliver a different response to a specific intent [17]. The entities' responses are recorded by deriving the tags and information provided from the Knowledge Base such as @Mount_Process, @No_Space_Left, @Nfs_Mount, @Nfs_Unmount etc.

c) *Dialog* (*represented by nodes*): A dialogue skill integrates entities and intents into a workflow node, using natural language processing and machine learning techniques to interpret end-user queries and provide an appropriate response [17].

Fig. 5. shows the architecture of IBM Watson.

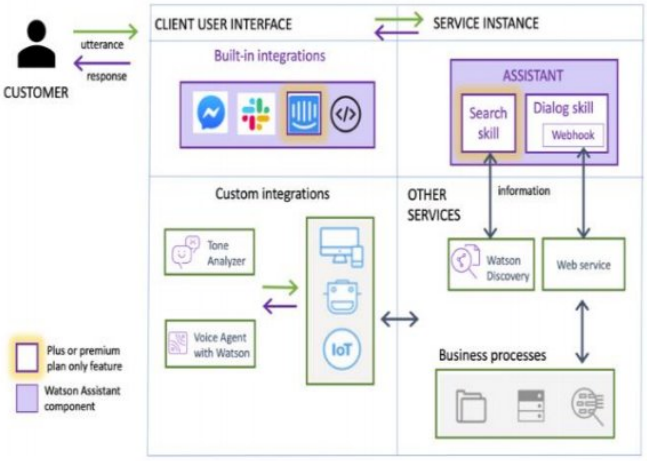

Fig. 5. IBM Watson Architecture [18]

V. IMPLEMENTATION AND RESULTS

The data used are documents with conceptual explanations per the VMware Knowledge Base, where more than twenty articles are reviewed. The vital information regarding VMware Snapshot and Datastores are extracted and processed to create, define, and design the Intents and Entity structural dialogues. IBM Watson Assistant workflow builds customised live chatbots into any device, application, or channel [18]. An individual can interact with a chatbot via integration points, and the chatbot processes their inputs to the dialogue skill layer that directs the flow of the conversation and responds to the user's query. When the dialogue skill cannot provide an answer, the search skill is invoked, which searches the company Knowledge Base configured to find appropriate responses [18].

The first step in implementing a chatbot is to plan its objectives, processes, and business requirement. Next, the infrastructure and resources utilized to develop and design the chatbot; at this point, an effective chatbot application platform is very crucial. This chatbot is built on the IBM Watson Assistant chatbot [19]. Designing and implementing a chatbot includes the workflow of defining intents and entities to help NLU processing and designing structural dialogue nodes for the ease of conversational workflow to make the user sessions more interactive [20]. The intents and entities defined for this paper can be accessed via the GitHub link [21].

Before the Watson chatbot assistant goes live, IBM Watson offers a "preview" capability feature that allows users to test conversational dialogues and interaction responses. In this option, a user can test the skills added to the assistant by entering text into the chat window and initiating a preliminary interactive session with the chatbot [22].

After building and testing the Watson Assistant preview, the chatbot is ready for deployment. Depending on users' preferences, various deployment modes are available in IBM Watson. To properly deploy a chatbot, it is integrated with an interface adapter that enables the assistant to communicate through a channel accessed by the end user [23]. In most cases, an assistant is deployed using one of these integrations.

a) *Web chat integration* allows adding a safe and customisable widget to the website that can be modified per users' preference. Further customisation can match the customer's branding and website layout [24].

b) *Phone integration*: The phone integration enables the assistant to converse with customers, using the IBM Watson Text to Speech and Speech to Text services [25].

The chatbot's evaluation is based on the end users' feedback, who are initially given access to the prototype demo version of the chatbot. After a month's use, the results were obtained. Every participant's feedback is recorded and worked upon to improve the interactive user sessions and provide easy conversation and accurate responses. Based on the feedback, further enhancements are incorporated as listed.

a) Included the "Error, not Listed" option for unknown queries.
b) Added a "Go-To-Main-Menu" option to ensure the end users can navigate to and fro anytime.
c) Provided options to toggle through various error categories.
d) Enabled fuzzy match to round up and auto-correct the most relevant words, errors, and sentences.

End users have provided positive feedback after using the chatbot, especially on the ease of usage and clear, interactive, defined dialogues. The click-driven chatbot flows further ensured that accurate recommendations were provided to the end-users with issues related to Snapshot/Storage troubleshooting. With pre-defined intents and entities implemented in the chatbot, the precision towards getting an appropriate response to a query about Snapshot/Storage is approximately 80%. The preliminary tests with various workflows helped improve a chatbot's functioning to provide the correct answer per the queries. The usage of Watson Assistant is very convenient as it has self-designed and integrated NLU-based algorithms and AI services [20].

VI. CONCLUSION

The chatbot is built on an IBM cloud-based platform that is easily scalable, secure, and capable of ingesting, analysing, and referencing updated documents. With each new intent, entity, and dialogue box created/modified, IBM Watson automatically trains and self-learns to update more sophisticated machine learning models. Because of these improvements and features included, the accuracy of Watson Assistant is significantly improved. Future updates will add more "Error categories," enabling customers to communicate with the chatbot and inquire about a broader range of VMware-related issues and concerns.

In the future, to further enhance the chatbot capability, we want to equip the chatbot to detect an image as input data and deliver the user response by decoding the image using the AI-powered IBM Watson tool. Emojis, emoticons, and GIFs may also be included as choices to enhance interactions and provide human-like conversations. NLP techniques and algorithms can also improve IBM Watson's Text-to-Speech and Speech-to-Text mechanisms, enabling chatbots to offer interactive sessions utilising both text and voice-based [27].

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