**An AI based Chatbot for VMware Snapshot and Storage Troubleshooting**

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*Abstract:* Chatbots have emerged as intelligent interactive platforms that facilitate user access to essential information through interactive dialogue. In the context of the widespread culture of remote work, businesses worldwide face the challenge of ensuring information accessibility, reachability, and ease of communication. Consequently, more users are turning to chatbot virtual assistants to streamline tasks in both business-to-business (B2B) and business-to-consumer (B2C) environments. Chatbots have demonstrated their effectiveness in various domains, including e-learning, sales, customer support, and information retrieval. In this paper, we focus on their application to troubleshoot VMware-related issues concerning Snapshots and Datastores. VMware's virtualization technology enables the deployment of multiple servers, known as Virtual Machines, on a single host, making it a fundamental component of the company's business model. Snapshots represent the point-in-time state of Virtual Machines and provide quicker ways to maintain their memory state. Datastores, on the other hand, serve as mounted storage locations on ESXi hosts, facilitating the storage of data and Snapshot files for Virtual Machines.

The primary objective of this research is to create a 24/7 interactive, solution-based system capable of promptly responding to end-user inquiries and providing immediate fixes for Snapshot and Datastore-related issues. The IBM Watson Assistant chatbot powers the system, offering users a selection of issue categories followed by a sub-option of the most common errors and their respective solutions.

Keywords: Chatbot, IBM Watson Assistant, VMware, Virtualization, Snapshots, Datastores, Troubleshooting, Interactive Dialogue, Issue Resolution.

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# Introduction

Since 1998, VMware has been a prominent player in cloud computing and virtualization, offering a range of products like Network Virtualization NSX, Virtual Machine, vRealize, and more. Meanwhile, chatbots have emerged as powerful tools in various domains, including digital virtualization and cloud computing support services. With the use of Natural Language Understanding (NLU) platforms, chatbots have expanded their applications to include healthcare services as well. However, while some companies have proposed automated customer service chatbots to address manpower demands, complete substitution of human functions by artificial intelligence (AI) and natural language processing (NLP) technologies is still limited.

This research paper aims to bridge the gap between human support and AI-driven assistance by developing an AI-based chatbot tailored explicitly for VMware Snapshot and Storage troubleshooting. As the adoption of virtualization technology continues to grow, efficient management of critical components like snapshots and storage becomes increasingly vital for seamless operations and data integrity in modern data centers and cloud environments. The proposed chatbot will leverage state-of-the-art NLP techniques and advanced machine learning algorithms to provide dynamic, real-time assistance and personalized troubleshooting guidance to end-users and administrators.

Key Objectives: The primary objectives of this research article are as follows:

* **Enhancing Troubleshooting Efficiency:** By integrating AI capabilities, the chatbot seeks to streamline the troubleshooting process, reducing the time required for issue identification and resolution. It aims to empower administrators with a powerful tool that can rapidly diagnose and address VMware Snapshot and Storage-related problems.
* **Personalized User Support:** The chatbot aims to provide personalized and user-centric support, tailoring responses to the specific needs and knowledge levels of individual users. Through context-awareness and learning from user interactions, the chatbot strives to deliver more accurate and customized troubleshooting assistance.
* **Seamless Integration with VMware Ecosystem:** This research explores methods to seamlessly integrate the AI-based chatbot into the VMware ecosystem, ensuring compatibility with existing management interfaces and protocols. The goal is to create a chatbot that can seamlessly interact with VMware environments, retrieving and manipulating data to offer real-time solutions.
* **Performance Evaluation and User Feedback:** To validate the effectiveness of the AI-powered chatbot, this research aims to conduct rigorous performance evaluations, comparing its performance against traditional support methods. User feedback will be collected and analyzed to assess user satisfaction and identify areas for further improvement.

# Materials and Methodology

In this section, we will discuss various studies performed on the usage of chatbots in different business domains that in turn helped to build, enhance and optimize the chatbot created for this project.

According to Folstad's research study [1], chatbots with pragmatic attributes can lead to both favorable and unfavorable user experiences while also highlighting potential risks. Calversi's research [5] emphasizes the importance of personalized chatbot configuration and deployment to support users in multi-topic and multi-campaign behavioral change programs. Martin Hasal's work [6] emphasizes comprehensive insights into chatbot security measures and challenges. In Giancarlo's research [7], a micro-service architecture was designed to provide tourists with accessibility through a conversational agent based on the Seq2Seq model. The assessment framework showed that using GRU cells resulted in better outcomes in terms of accuracy and loss compared to LSTM. Guido Tascini's research [3] highlighted the need for chatbots to adequately describe complexity, interpret human language commands, and learn from interactions. Taejin Kim's research [9] demonstrated the ineffectiveness of constructing a fully functional and reliable information repository using a generic knowledge base. Instead, a substantial body of knowledge documentation and a finely calibrated encoder provided a more persuasive approach to constructing the COVID-19 database using the BERT pre-trained language model.

This section presents the precise steps required to understand the workflow of the Storage issue and Snapshot troubleshooting scenarios, along with the conceptual features and operation of the IBM Watson chatbot. The technique used to link the chatbot with the troubleshooting conversation for VMware snapshots and datastores is based on data point elements and their comprehension in the repository of VMware Knowledge-Base articles and documentation.

Diagram

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**Figure 1:** Basic Workflow of Snapshot Troubleshooting Chatbot

Pre-defined logical concepts and proper work process blueprints helped in the establishment of communicative discussions for chatbots. The discussion nodes were organized using grouped flowcharts, which determined the chatbot's responses to the questions posed by the users. To gain a thorough understanding of VMware Snapshots [8] and VMware Storage concepts [9] many documents and VMware KB articles were analysed. The entirety of the policies for mastering Watson Assistance was geared and gauged on the chatbot at its expert level, including the organized description of Entities and Intents and familiarisation with the Dialog boxes, as well as the appropriate relevant circumstances related to the queries and records created in Entities and Intents of Watson Assistance.

Along with the chat-theoretical bot's creation and viability, examination and verification of the Watson Chatbot integrated procedures for Snapshot troubleshooting and Datastore structural layout is very important. These processes rely on the essential elements to build a fully-fledged and functional chatbot and its accompanying parameters such as Intents, Dialogs, and Entities.

The vast majority of knowledge about Snapshot issues and Storage troubleshooting is derived from well-known VMware knowledge base articles [10].

Having a firm knowledge of storage and snapshot workflow, as well as their underlying conceptual ideas, is certainly required. The fundamentals of snapshot [11] can be understood in Figure 2 [12].

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**Figure 2:** Snapshot Disks Hierarchical Structure [12]

The ESXi Hypervisor uses a storage area called the Datastore to house all of the data, configurations, installation, and virtual machine-related files. The VMware storage architecture is shown in Figure 3.

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**Figure 3:** Storage Architecture [13]

A high-performance clustered file system called VMFS offers the Data stores reliable and effective storage virtualization.

ESXi supports various types of Datastores, each with specific characteristics and storage protocols. The commonly used Datastore types include:

* VMFS (Virtual Machine File System): A clustered file system optimized for VM storage, specifically designed for shared storage environments.
* NFS (Network File System): Allows ESXi hosts to access VM data over the network, commonly used for shared storage scenarios.
* vSAN (Virtual SAN): VMware's software-defined storage solution that uses local disks from multiple hosts to create a shared storage pool.
* iSCSI (Internet Small Computer System Interface): Provides block-level access to storage devices over TCP/IP networks.

The entire interactive chat workflow is depicted in Figure 4.

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**Figure 4:** The Chatbot interactive workflow

The project's next significant focus was on comprehending Watson Asistan's architectural design and conceptual operation. To begin building the bot, one must have an IBM Cloud account [14]. IBM Watson Assistant can be used to build customized branded live chatbots into any device, application, or channel [15]. An individual can interact with a chatbot via integration points, and the assistant will process their inputs to the dialogue skill layer which directs the flow of the conversation and responds to the user’s query. When the dialogue skill is unable to provide an answer, the search skill is invoked, which searches the company knowledge bases that are configured for the purpose to find pertinent responses [16].

This interactive workflow, the IBM Watson Assistant chatbot ensures seamless communication with users, offering personalized and accurate responses. The combination of dialogue and search skills empowers the chatbot to handle a wide range of user inquiries, enhancing the overall user experience and providing valuable support to users seeking information or assistance.

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**Figure 5:** IBM Watson Architecture [16]

Additional components of Watson Assistant include these 3 key building blocks.

1. **Intents (prefixed with #):-** An intent is a collection of possible expressions that a user might use to convey a particular objective or notion [17].
2. **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 [18].
3. **Dialog Box:-** A dialogue is made up of nodes that define steps in the conversation that are chained in a tree structure to create an interactive conversation with the user [17].

The first step in creating a chatbot is to plan its objectives, processes, and business requirement. Next comes the infrastructure and resources utilized to develop and design the chatbot, hence, at this point, an effective chatbot application platform is very crucial and this project is designed on the IBM Watson Assistant chatbot [19]. Creating 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 [17]. The intents and entities defined for this project can be accessed via the GitHub link [20].

# Results

Prior to the Watson chatbot assistant going live, IBM Watson offers a "Preview" capability feature that allows users to test the conversational dialogues and interaction responses.

In this option, a user can test the skills that are added to the assistant by entering text into the chat window and initiating a preliminary interactive session with the chatbot [21].

After building and testing the Watson Assitant, 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 [22].

In most cases, an assistant is deployed using one of these integrations.

* **Web chat integration**: This allows adding a safe and incredibly customizable widget to the website that can be modified per users’ preference and further customizable towards the theming to match per customer’s branding and website layout [22].
* **Phone integration**: The phone integration enables the assistant to converse with customers on the phone, using the IBM Watson Text to Speech and Speech to Text services [22].

# Discussion

With comparatively tiny data sets, IBM Watson Assistant employs machine learning and deep learning approaches to learn how to correctly respond to user questions. The Watson Assistant's artificial intelligence is built to recognize all possible combinations of intent as per real-world conversations. Watson Assistant has a new and improved intent detection algorithm, which is more accurate than commercial and open-source solutions in a recently published benchmark [23].

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**Figure 6:** IBM Watson’s improved intent detection algorithm [23]

To further enhance and optimize the Chabot created in this project, analysis is performed on a detailed conversation evaluation, chat dialogue functionality, and interactive responses to the “Issue & Error Selections” made by the end-users. The evaluation of the chatbot is performed depending on the end users’ feedback who were given access to the prototype demo version of the chatbot. And, after a month’s use, every participant’s feedback was recorded and worked upon to further improve the user interactive sessions and the ease of conversation dialogues to provide an accurate response. Based on the feedback, further enhancements were included as listed.

1. Included the Error not Listed option for unknown queries
2. Added “Go-To-Main-Menu” option to ensure the end users can navigate to and for at any given point in time
3. Provided options to toggle through various error categories

Enabled fuzzy match to round up and auto-correct the most relevant words, errors, and sentences

# Conclusion

This research article presents an AI-based chatbot as a significant advancement in VMware Snapshot and Storage troubleshooting. By harnessing the power of AI, the chatbot aims to improve virtualization support, minimize downtime, and enhance the overall user experience. Through systematic experimentation and user feedback, this study sheds light on the effectiveness of AI-based chatbots in complex virtualized environments, paving the way for more intelligent and efficient support systems in enterprise IT. The study covered the use of the IBM Watson assistant chatbot to troubleshoot VMware concepts like snapshots and datastores. Users provided positive feedback, praising the ease of engaging in profound and clear interactive dialogues, leading to quick resolutions and responses. Utilizing Watson Assistant proved advantageous due to its self-designed and integrated NLU-based algorithms and AI services [24]. Additionally, being built on an IBM cloud-based platform ensures scalability, security, and the ability to ingest, analyze, and reference updated documents. Watson's automatic training and self-learning capabilities contribute to an accuracy rate of 79% in the most recent model [23].

Future updates are expected to expand the chatbot's "Error categories," allowing customers to inquire about a wider range of VMware-related issues. Plans include incorporating image recognition, enabling the chatbot to respond to user input by decoding images using IBM Watson's AI-powered tool. Emojis, emoticons, and gifs may be included to enhance the creativity and human-like interactions. Additionally, NLP techniques and algorithms will be employed to implement IBM Watson's Text-to-Speech and Speech-to-Text mechanisms, enabling interactive sessions using both text and voice [25]. These enhancements will further elevate the chatbot's capabilities and user experience.

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