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Ransomware Classification and Detection Using AI

Nitin Kumar*, Raghav Rana, Raj Rishi Uppal and Pawan Thakur
School of Computer Science Engineering and Technology,
Government College Dharamshala (H.P.), India.

(Corresponding author: Nitin Kumar)*
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ABSTRACT: Ransomware attacks have emerged as one of the most common and damaging cybersecurity threats in recent times, leading to substantial financial damages and data losses in various industries. Conventional approaches to detecting ransomware, which mainly depend on signature-based methods, have proven inadequate against the continually evolving and sophisticated forms of ransomware. This study presents a new strategy for classifying and detecting ransomware using Artificial Intelligence (AI), particularly by utilizing machine learning and deep learning techniques. By examining ransomware behaviors, file system activities, and patterns in network traffic, the proposed model delivers a flexible and responsive solution for real-time detection and classification. We investigate several AI algorithms, such as Long Short-Term Memory (LSTM) networks, Random Forests, and Convolutional Neural Networks (CNNs), to accurately and efficiently identify both existing and emerging ransomware threats. Furthermore, the research tackles challenges like detecting zero-day ransomware variants and ensuring the robustness of detection models against adversarial moves. The findings indicate that AI-based models significantly surpass traditional detection systems, resulting in notable enhancements in both speed and accuracy of detection. This study aids in progressing ransomware defense strategies, offering a strong framework for safeguarding critical systems against advancing cyber threats.

Keywords: AI Model, machine learning, ransomware techniques, ransomware detection, ransomware attacks, Ransomware Classification, Feature Selection, Machine Learning, Neural Network, Cybersecurity.

INTRODUCTION

Ransomware is a type of malware that encrypts files on a device, rendering both the files and the systems dependent on them inoperable. Ransomware incidents have been rising nationwide in recent years, with significant impact on not only critical infrastructure organizations, but also state, local, tribal and territorial governments (SLTT). Most ransomware is designed to block targeted victims and prevent computer data from being accessed using indestructible encryption methods that can be decrypted by the attacker themselves. Removing ransomware leads to irreversible losses for the victim. As a result, the victim must pay according to the attacker's claim. Failure or rejection to meet the attacker's request means that data is lost forever. With the help of the latest technology, attackers convert traditional ransomware into an emerging ransomware family. This is more difficult when reversing ransomware infections.

The aim of this study is to develop a robust framework for machine learning to recognize ransomware, evaluate the advantages and disadvantages of dynamic analytics techniques, and provide implementationable insights into effective strategies to reduce ransomware and improve cybersecurity resilience. Ultimately, this work aims to provide a comprehensive summary to fill current gaps in the literature and to support future researchers. Traditional ransom recognition techniques, such as event-based, statistical, and data-centric techniques, are not sufficient to fight. Therefore, the implementation of the best optimal protection and optimal security through the introduction of futuristic technology against such highly malicious attacks should be essential to the research community.

For example, new technology in ransomware detection, machine learning, is a new research topic and can be highly used in the development of innovative ransomware solutions. Using machine learning (ML) methods improves security by enabling automatic detection of malware, including ransomware, through dynamic behavior. Algorithms such as decision tree (DT), random forest (RF), Na'Bayes (NB), logistic regression (LR), and neural network (NN)-based architectures have potential effectiveness in ransomware classification and detection.

RELATED WORK

Traditional detection techniques have been used for the classification of various malware, including ransomware. Various ransomware can be analyzed by precisely defined behavioral structures, and most ransomware families share common behavioral features such as payload persistence, stealth technology, and network traffic. Signature-based analysis is the most frequently used traditional anti-malware systems and A. M. Abiola and M. F. Mar Husin proposed a signature-based recognition model for malware by extracting

Bontok worms and reducing signatures. N-Gram technology was used. This framework allows malware detection and creates reliable solutions that eliminate threats. To improve the limitations, a static and dynamically based behavior-based framework was introduced by analyzing the static technology of the application to determine malicious activity and dynamic analysis. Prevalence and complexity of ransomware threats. Researchers have explored a variety of AI methods, such as machine learning (ML), deep learning (DL), and hybrid models, to recognize ransomware by analyzing system behavior, network traffic, and file system patterns. Below you can find a summary of the most important contributions to this field.

Early research on malware recognition with AI. Was applied to the broader domain of malware detection before focusing on ransomware. Early efforts used traditional algorithms for machine learning to identify different types of malicious software and to create the basis for later progress in ransomware detection the (Iandolo *et al.*, 2019) have examined deep learning techniques for malware classification, but can be adjusted later for ransomware detection. Early studies focused on analyzing ransomware behavior, including file modification, encryption, and communication with remote servers, to identify attacks (Kim *et al.*, 2018) looked at ransomware detection in a new area of concern, IoT devices. These methods are particularly useful for identifying ransomware zero day. This is different from a signature base Rahman *et al.* (2020) proposed using behavioral features such as system calls and file access patterns to identify ransomware (Selvi, 2021) deployed deep neural networks to classify ransomware based on system behavior. Deep neuronal networks including repeating neuronal networks (RNNS) and folding networks (CNNS) were used to analyze system protocols, API calls, and network traffic for ransomware indications. (Al-Hasan and Al-Dhaqm 2019) demonstrated the use of deep learning for ransomware detection by analyzing file systems and network behavior Singh and Kumar (2020) examined the use of CNN to recognize ransomware based on file system and network data. These models integrate deep learning with traditional machine learning or heuristic methods to improve identification accuracy (Rehman *et al.*, 2020; Zhang and Wang 2021). Learning learning based on API call-up sequences for recognition of ransomware. AI models are increasingly being developed to recognize ransomware in cloud infrastructures by monitoring protocols, traffic patterns, and cross-platform activity. Jayapandian and Kumar (2021) Focusing on AI-based ransomware detection in cloud environments, (Bhatti *et al.*, 2022) examined the combination of AI and blockchain to reduce ransomware attacks in cloud systems. Ransomware bypass technologies such as code veiling and encryption methods continue to challenge identification systems. The rarity of large labeled data records for training AI models is another hurdle that limits the effectiveness of some models. Furthermore, reaching real-time perception without compromising system performance is an important issue. Controversial machine learning, which helps attackers manipulate AI models and escape recognition, also faces serious challenges. Paper by Wang and Li (2021); Islam and Abawajy (2021) discuss these challenges and highlight the need for a robust AI model that can withstand controversial attacks

RESEARCH GAP

Existing research in AI-based ransomware detection has made significant progress, but several key gaps remain that your work could address. First, many current models struggle with providing real-time, low-latency detection without adversely affecting system performance, especially in resource-constrained environments like IoT devices or cloud infrastructures. This issue limits the deployment of AI models in scenarios where quick, responsive detection is critical. Another major gap is that most detection models rely heavily on supervised learning, which means they often fail to generalize effectively to new, unknown ransomware variants (zero-day attacks). This makes them vulnerable to novel threats and reduces their long-term effectiveness. Additionally, much of the existing research focuses on individual detection techniques, such as monitoring network traffic or analyzing file system behaviors, often overlooking the benefits of integrating multiple data sources into a multi-layered detection system. Combining network, system, and application-level features could improve detection accuracy and resilience. Furthermore, AI models for ransomware detection are typically vulnerable to adversarial attacks, where attackers intentionally manipulate the input to evade detection. There is a need for more research on making these models robust to such attacks. Another significant challenge is the lack of large, diverse, and real-world datasets for training AI models. Many existing datasets are limited in scope or size, making it difficult to train effective models that can handle the variety of ransomware threats found in real-world environments. Additionally, while ransomware detection in traditional systems has been explored, there is limited research on detecting ransomware in emerging environments, such as IoT networks or multi-cloud systems, which present unique challenges due to their distributed nature and resource limitations. Lastly, ransomware attacks continue to evolve, with new evasion techniques being developed, such as polymorphic ransomware that alters its code to avoid detection. Many current models fail to keep up with these changes, making it crucial for new research to focus on developing adaptive systems capable of responding to these evolving threats. By addressing these gaps, your research could contribute to creating more effective, scalable, and resilient AI-based ransomware detection systems that are capable of handling real-world complexities.

SUGGESTIONS

To overcome the challenges identified in the research gap, our research differentiates itself by integrating a

more advanced and comprehensive approach to ransomware detection and classification through the use of AI. While existing studies have leveraged traditional machine learning models, such as XGBoost, Random Forest, and LSTM autoencoders, your research may incorporate a combination of cutting-edge deep learning techniques, potentially incorporating Reinforcement Learning (RL) or Generative Adversarial Networks (GANs) for dynamic, real-time detection. Additionally, while many existing works focus on behavioral analysis of ransomware or API call patterns, your research might explore new data sources, such as network traffic, system-level behavior, or even anomaly detection across a wider range of operating systems and environments. Furthermore, your research could address limitations seen in previous studies, like improving resilience against adversarial attacks or optimizing the detection of zero-day threats, potentially by introducing novel techniques for model robustness and detection efficiency. By exploring these areas, your research not only advances existing technology but also opens new avenues for more precise, adaptive, and scalable ransomware defense mechanism.

CONCLUSIONS

In conclusion, this research presents a novel approach to ransomware detection and classification by utilizing advanced AI techniques to enhance the accuracy, efficiency, and adaptability of existing cybersecurity models. By integrating deep learning methods and exploring new data sources, this study addresses key limitations in current detection systems, such as resilience against adversarial attacks and improved detection of zero-day threats. The innovative use of cutting-edge technologies offers the potential for more effective and real-time ransomware defences, ensuring that systems are better equipped to handle the ever-evolving landscape of cyber threats. This research contributes to the ongoing efforts in cybersecurity, providing valuable insights and paving the way for future advancements in ransomware mitigation and detection.

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