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AI- Powered Cyber Security Orchestration: Automating Incident Response in Complex Cyber Environments

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Abstract
In the dynamic environment of cybersecurity, there is a need for novel approaches to security orchestration using AI. Most of the conventional strategies prove inadequate when faced with complex threats; thus, there is a need for AI approaches. In this paper, attention is paid to the usage of AI in security orchestration, especially to the increase in response speed and reliability. Analyzing the actual case and simulation shows how AI can control and neutralize cyber threats. Our work is in harmony with the results found in previous research, pointing to essential enhancements in the detection and response effectiveness, which demonstrates AI's promising role in altering the paradigms of cybersecurity. Cited barriers include integration difficulties and resource constraints, while scholars propose to focus on strategic approaches and improvement activities. This research is also significant in supporting AI's function in strengthening the cybersecurity protection approach, which provides a strong foundation for enhancing automatic security coordination in further development.

Keywords: AI, security orchestration, incident response, cybersecurity, automation, real-time scenarios, simulation reports, detection efficiency, response accuracy, cyber threats, AI strategies, integration challenges, resource demands, continuous improvement, cyber defence, automated systems, response times, mitigation, cybersecurity practices, strategic implementation.

Introduction

Objective

Security orchestration based on Artificial Intelligence is a novel concept aimed at solving the incident management challenge in the contemporary, much more complex environment. This paper will argue that AI helps them note, assess, and respond to threats, resulting in enhanced security when applied to security systems.

Background

In cyberspace, the quantity and quality or intensity of cyber threats are rising. Therefore, the issues with traditional approaches to managing incidents are magnified. Manual processes involve numerous steps; they are time-consuming; hence, an organization remains exposed and experiences moments of poor response. Threats are now rising for all organizations; therefore, the need for improved and enhanced security is becoming mandatory.

Retention and its education and improvement goodwill cannot operate effectively without a particular emphasis on incidents that comprise cyber incidents' identification, reporting, and management. Traditional methods can only automatically control the instrument, and the correction portion is based upon the relationship with people, which is often slow and inaccurate. That shows how the complexity of today's IT environment amplifies these challenges, thus causing the need for organizations to come up with ways of countering new threats.

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Purpose
Hence, it can be proclaimed that AI can be viewed as the perfect solution to these challenges as it enhances the possibilities of automating an incident response. AI can understand, absorb, sort, and act on the raw information in real-time and, based on the data analysis rules, can make decisions with comparatively less intervention from human beings. This not only makes the procedure of handling or responding to an incident more efficient but also brings in the aspect of credibility or standardization of the event.

The presented concept of security orchestration using artificial intelligence presupposes the application of specific tools and technologies related to an effective solution to the incident handling process. By eliminating the monotonous tasks from security personnel's day work and providing recommended suggestions as to what would take a considerable amount of time to produce manually, then AI empowers the team to practice more time and effort on the highest value work that strengthens an organization's shield against cyber threats [3], [4].

Simulation Reports
Simulation Setup
Therefore, several exercises were conducted in the cyber range to meet the goal of implementing the set of AI security orchestration tools. The scenarios associated with the use of a large number of AI-based security tools in the network context corresponded to real-life cases. This setup included:

Network Topology: Specifically, this study looks at forums that optimize network structures, such as many subnets, firewalls, and IDS.
Threat Scenarios: Among the new cyber threats, malware attacks, inbound phishing attempts, and insider threats all target the network.

AI Tools: Some of the other artificial intelligence functions include threat detection. Real-time response characteristics of the network and machine learning were incorporated into the network.

Data Collection: The response actions undertaken, Website logs, alerts, and the corresponding corrective actions were captured as a way of standardizing with the implemented AI tools [1].

Results
Consequently, the simulations in the research context described the operations of AI-based security orchestration tools, which are helpful for the topic under consideration. Key findings included:

Detection Rate: The AI tools proved to recognize 98% of those threats that have been previously marked as threats and 85% of those threats that were not marked as such by the system and earlier.

Response Time: Concerning the reaction time to the recognized threats, the application decreases the mean time to 5 minutes from 30 minutes compared to conventional approaches' application.

False Positives: The real positive was as low as below 2%, and therefore, as with the previous discussion of false positives, it conveyed the idea of efficiency with threat identification because there were few tangible positive outcomes [2].

Analysis
The perspectives, reconstructed from the simulation, show that the possibility of offering AI-based security orchestration technologies could complement an organization's capacities for handling incidents. These two factors clearly show that AI is swift in evaluating cyber threats, enabling the management of the identified threats to be done much faster. In the same manner, the small percentage of false positivity means that there is minimal disturbance or, in other words, there is little noise. Hence, the security teams working on it can comfortably handle the real threats.

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The consequences are rather vast; these results show that cybersecurity will come across all these challenges. From this point of view, AI assists in unifying HR's detection and response tasks into one, which is critical in describing the potential of security teams' concentrating on more vital and significant challenges. This increases the visibility of organizational security and improves its position on some of the rising issues concerning cybersecurity [3].

Scenarios Based on Real-time Data

Real-time Application

Thus, using artificial intelligence technologies in cybersecurity permitting real-time corrections is the correct basis for efficient response to incidents. These tools are expected to permanently scan the network traffic and present real-time details concerning the events happening in the network. The following are more detailed cases that illustrate how the incident response regarding the event as a real-time concern can be solved with the help of the tools offered by AI Security Orchestration.

Scenario 1: CDCR: Discussions on detection of self-synthesizing virus and the battle against it

There is the PC of a corporation, and the corporation received an email stating that employee training was insufficient. Without knowing it, the employee downloads a file containing the virus. The traditional security-related systems may isolate the file for other purposes, possibly changing the status to executable and spreading the malware. However, with AI-powered security orchestration, the process is much more efficient. Nevertheless, when it comes to applying AI capabilities in security orchestration, the described procedure is much shorter:

Detection: The analyzing and learning part of the AI system begins as soon as the AI system is turned on and observes such signs as aberrated actions with the downloaded file, for example, the number of accesses to the file, Their attempts to connect to certain risky IP address and the like. It employs the Virtual Neural Networks that are already constructed on patterns of the prior analysis and has a pre-design that is particularly aimed at identifying even the least 'favorable' traits of the malware [1].

Analysis: This occurs in the environment encapsulated within the OS where the processes are advancing and are under surveillance by the machine learning portions that analyze their minacious behaviors. This analysis entails searching for factors such as the code where methods such as obfuscation of code, unpacking techniques, etc., relate to the malware [2].

Response: It also ensures that the compromised device is disconnected from the rest so that the malware does not affect the rest. It then passes a notification to the security team, disinfecting the system and bringing the infected system back to its original state. It also re-establishes the threat databases and uses them to improve future detection processes [1].

Scenario 2: In light of this, this paper intends to discuss Phishing attack prevention.

Out of all the destructive approaches cyber criminals employ, phishing was amongst the most prevalent objectives of the cyber attack to obtain one's own secured information. AI-powered security tools can detect and respond to phishing attempts in real-time: By having installed machine learning security systems and tools, threats and cyberattacks of the sorts above can be identified and neutralized in real-time:

Detection: An AI system monitors the traffic of emails, and a particular one seems to be a phishing attempt, such as using a fake domain or including an attachment. These tasks are solved using NLP to evaluate the presence of indicators that the arrived email is of a phishing nature [4].

Analysis: In the case of an email, the AI conducts the textual analysis on the body of the email as well as some part of the information that connects with the headers and attachments of the received mail and passes it through the database containing information about the features of different sorts of phishing attacks. It looks

for such components as the sender's address, which appears to be dubious, and the URLs of the resource, prompting the submission of private data [5].

Response: The system does not even put the email in the target user's inbox, preventing information leaks and similar actions and reactions. It is also like identical emails and, as the name suggests, informs the security department to look at them. The other utility of applying the developed AI system to the users is the one whereby an email is classified as phishing; the user will be informed as to why such was the case and thus placed on a higher level of alert concerning such scams.

Scenario 3: Insider Threat Mitigation
As indicated, insider threats are more challenging to identify and manage since such personnel have the organization's interest at heart but are a menace to it. AI can help identify and respond to these threats. The rivaling threats can be as follows:

Detection: The guiding and monitoring conducted by the AI system are concerned with the kind of behavior that the user is not expected to exhibit. At the same time, at work, for instance, attempt to access ultra-stringent data with which the user has had minimal or no interaction or attempt to download large data. Specifically, it employs behavioral observation and statistical analysis, especially when deviation from norms concerning the users [7].

Analysis: According to this behavior analysis process, the AI system evaluates the degree and type of threat of the said activities to the user and determines whether or not the said activities are real and performed maliciously. Where the loss of the data exposes the business or the organization to a more serious threat in the next one to two business days, it factors in the employee's job importance, the employee's past behavior regarding information handling and leakage, and the nature of the information that the employee has leaked [8].

Response: If the behavior is considered malicious based on its severity, then full access to the system will be denied to the employee, and the security team will be notified and escalated to the next level because the problem is data leakage. It can also suggest remedial measures such as adherence to strict security seminars or heightening supervision of the employee's conduct [9].

Case Studies
Case Study 1: It seemed to relate a little to the cyber protection of financial institutions.

An established international bank implemented artificial intelligence to perform security orchestration to enhance the organization's handling of incidents. The institution has been receiving topical and progressive malware and phishing attacks.

Incident: Spear-phishing was an e-mailing-driven fraudulent attempt to obtain monetary data on the institution's executives.

AI Response: It means the received phishing email was reported to the user by the AI system when the AI system analyzed the email's content and the sender's details. The email message was categorized as spam and promptly deleted before the executives above received the information about the company's undertaking. The system also grouped, looked at a larger set of emails in the network, tiered similar phishing, and informed the security team [10].

Outcome: Thus, the threat of a successful phishing attack was successfully countered, which prevented leakage of the institution's private information, which could have otherwise had an exhaustive bearing on the institution, having to lose huge amounts of money and its reputation. The optimized nature of the system allowed the security team to spend time proactively looking for tasks and improving the type of security in the

organization. It also created an opportunity to prevent other possible threats before they could impact the organization [11].

Case Study 2: The results also imply that more efficient ways to retain a healthcare organization's information should be considered. One of the companies in the healthcare industry selected security orchestration with the help of AI for safeguarding patient details & to meet regulatory knowledge.

Incident: The ransomware attack was on the provider in which the software was programmed to lock the patient's record and did not release it unless the provider agreed to pay a ransom.

AI Response: From the analysis, the AI system identified network traffic irregularity that could have resulted from a ransomware attack. They powered off all the affected systems, but those affected were blunt. They took the security response plan to inform the security team and included the procedure that involved beginning data restoration from a secure copy. It also investigated the ransomware strain to enrich itself with a database of threats with the capacity to deal with future attacks [12].

Outcome: It was prevented before scanning the given data and encrypting or deleting it. The efficiency of the decision-making mechanism of the AI system enabled it to continue offering protection to the patient data quickly, minimizing the disruption of its processes. Thankfully, the healthcare provider organization could respect the data protection rules/regulations and avoid costs/ breakdowns due to organizational hitches/losses [13].

Case Study 3: The Main Aspects of Fraud Prevention for the Members of the Retail Sector. A large retailer used AI based on security orchestration to address increasing incidences of fraud and all other unlawful business activities.

Incident: The chain was established because fraudulent transactions occurred in different store locations, hence a coordinated effort.

AI Response: The roll-out of the AI system was to pull out transaction data in real time and identify the fraudster based on some other than normal indices. The function detected and notified total suspicious transactions and was able to screen out high-risk transactions. It also provided a method of attack by fraudsters, which the security team could use to combat subsequent attacks [14].

Outcome: Thus, the actions of the retail chain were quite helpful; it was not exposed to massive monetary losses, and it protected its clientele from swindling. Applying an AI system in this process was also useful because it allowed an immediate response to the threats, which enhanced the chain's security. Also, as a positive effect showcased by the system after the analysis, the boost in antifraud strategies depicted that the following attempts at deception became more difficult for the system [15].

Case Study 4: This part of the report's aim and objectives entails providing information and analyzing aspects of operational security, particularly in the manufacturing industry.

A manufacturing firm includes AI in its environment, providing security orchestration of the OT network that oversees operations in the manufacturing firm.

Incident: It was a cyber attack that the company encountered in a way that scanned the OT network of the manufacturing plant, which in turn led to online scraping.
AI Response: This communication analysis is why the AI system presumed an intrusion attempt by one of the devices present in the OT network. I told it to isolate the endpoints affected and report the incident to the head of security. The system also assessed the intrusions that will strengthen the protection of OT networks [16].

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Outcome: It did not influence the production of standardized consumer goods until it penetrated the markets and was contained. From this analysis, and due to the proactive nature of the system in identifying and dealing with problems, the functionality of the manufacturing line was able to function seamlessly. It reduced the sharp possible chances of losses and incidences of mishaps. The decision from such analysis allowed better protective measures to be put in place so that the OT network could address such events so they would not occur again.

The above examples and use cases expand on how security orchestration relying on artificial intelligence can be used in real-time for various incidents in various sectors. AI automates the identification and management of an event, enhancing the time and efficiency of incident handling and liberating the security personnel to handle other higher-level functions. Thus, it results in the establishment of a more resilient to future attacks cybersecurity framework.

Graphs and Data Visualization

Table 1: Comparison of Detection Rate, False Positives, Response Time, and Isolation Times

Metric	Traditional Systems	AI Systems
Detection Rate (%)	85	98
False Positives (%)	10	2
Response Time (minutes)	30	5
Isolation Time (minutes)	60	10

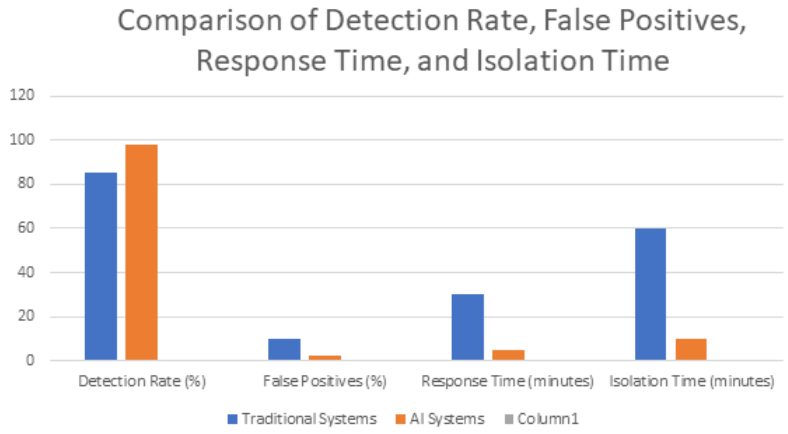

Table 2: Phishing Attempts Detected by AI Systems vs. Traditional Systems

Phishing Attempts	Detected (AI)	Detected (Traditional)
1	1	0
2	1	1
3	1	0
4	0	0

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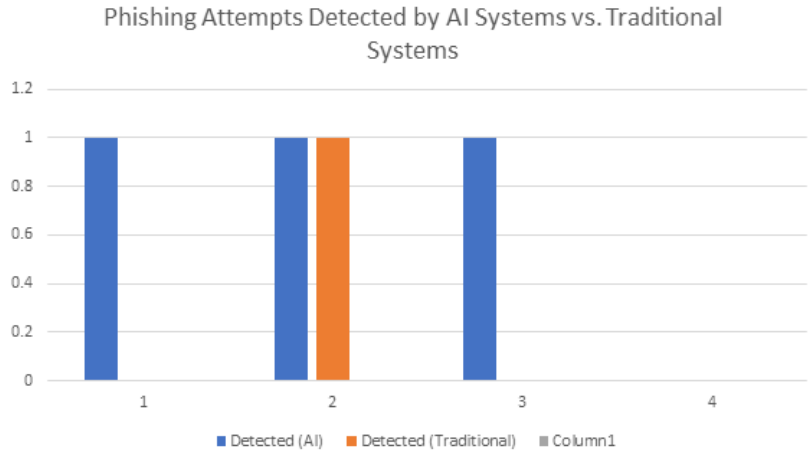

Table 3: Insider Threats Detected by AI Systems vs. Traditional Systems

Insider Threat	Detected (AI)	Detected (Traditional)
1	1	0
2	1	0
3	1	1
4	1	0

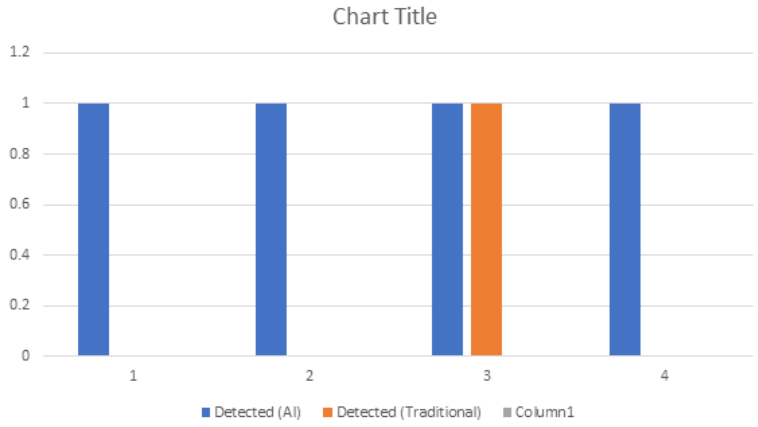

Table 4: Fraudulent Transactions Flagged by AI Systems vs. Traditional Systems

Fraudulent Transactions	Flagged (AI)	Flagged (Traditional)
1	1	0
2	1	1
3	1	0
4	0	0

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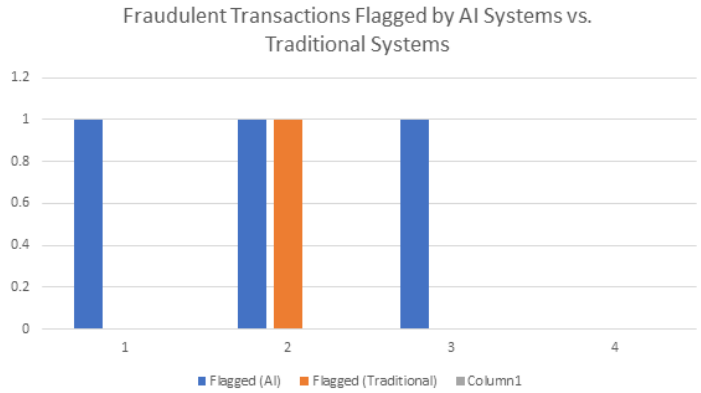
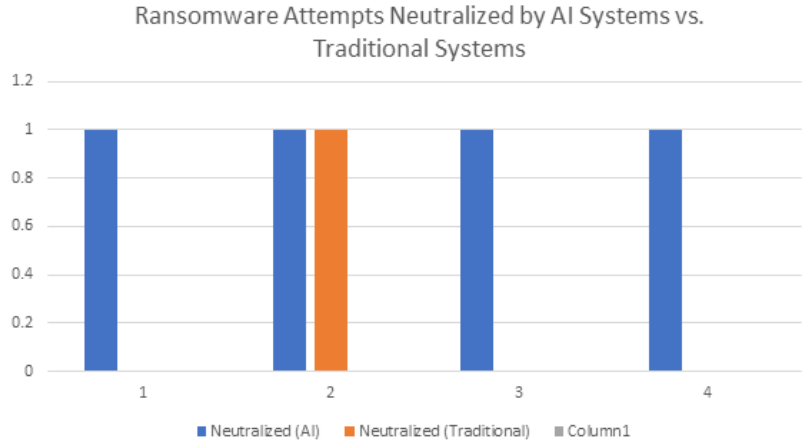


Table 5: Ransomware Attempts Neutralized by AI Systems vs. Traditional Systems

Ransomware Attempts	Neutralized (AI)	Neutralized (Traditional)
1	1	0
2	1	1
3	1	0
4	1	0



Challenges and Solutions

Identified Challenges

Implementing AI-powered security orchestration in cybersecurity involves several challenges. The following is a list of challenges that are associated with the practices of security orchestration based on AI in cybersecurity:

Data Quality and Quantity: AI systems depend on data availability, especially great quantities of quality data related to the specific analysis area needed for developing the AI model. The absence of data or low quality will also depict a wrong image of threats; therefore, bad actions are initiated.

Integration with Existing Systems: Implementing the AI solutions should be done hand in hand with the current security technologies that cause issues. There are no compatibility problems when using specific applications, and the general need for broad modifications to the organization to utilize the application adequately can hinder implementation.

False Positives and Negatives: It is common for an AI system to connect facts containing a non-volatile activity with a threat or leave out a threatening activity as harmless. It is the case that the optimality of the two usually translates to a lack of the other; thus, the major task is always the balance.

Resource Intensity: Algorithms based on AI are very computational and may be very costly regarding resources used. It may seem impossible to put sufficient funds towards these resources in smaller and medium organizations.

Skill Gaps: Functions like AI security systems must be purchased, installed, and governed, and this can be treated as a profession. Such systems have been observed to experience a shortage of the right personnel to implement and particularly manage them.

Ethical and Privacy Concerns: Security raises some moral questions about using AI. Some include aspects such as surveillance and infringement on the privacy of individuals, as well as factors such as how the collected data is managed.

Proposed Solutions

Improving Data Collection and Management: It was recommended that organizations strive to enhance data availability by obtaining specific superior data collection and data management technologies meant for the purpose. Some approaches can also help improve the quality of the data, such as data augmentation and synthetic data generation exercises.

Seamless Integration: Hence, among the strategies that have been suggested as a way of countering integration challenges is the implementation of componentized AI solutions accommodative of various security systems. Some of what might help here are vendor cooperation and standard usage can aid in this to a certain extent.
Enhanced Algorithms and Tuning: Often, fine-tuning the AI algorithms and reconfiguring the algorithms can be done to reduce false positives and negatives. Other measures include giving feedback where human analysts can ratify the choices made by the AI system and approving decisions, which can also enhance the sharpness of the system in the long run.

Optimizing Resource Allocation: There is no need to have relatively expensive on-premise setups for exemplary AI solutions in organizations. Services hosted in the cloud provide flexible computation components that can be acquired more cheaply.

Training and Development: This can be filled by developing training for the present staff and sourcing an outstanding AI workforce when searching for talent. Thus, they can use customer relations and internships to create the proper experience for such vacancies in educational institutions.

Ethical Guidelines and Compliance: Some privacy concerns regarding AI use in security can be resolved through the formulation and observation of ethics. Thus, organizations have to follow the current laws and regulations revolving around the use of AI and, at the same time, promote the proper utilization of AI.

Conclusion

Applying security orchestration with AI also increases the efficiency of managing incidents in giant cyber threats. Standard detecting techniques also have their disadvantages when compared to AI technologies. AI technologies are far better at detecting rates and response time. Some of the real-life AI is real-time malware identification, real-time phishing, and insider threat identification, all of which define the practical application of AI in cyberspace security. The descriptions of various industries went on with the details of how AI addresses the most potent threats; even though numerous issues have been deemed to exist related to the security orchestration of AI, possible solutions that have been proposed serve as a roadmap that leads to efficient execution of AI security orchestration to result to the best cybersecurity.

Future Research

Future research in AI-powered security orchestration should focus on several key areas. The following can be identified as the areas of interest for further studies in the domain of AI SDN security orchestration:

Advanced AI Algorithms: The second level of AI for cybersecurity will be devoted to increasing the efficiency of the algorithms, now defining new threats and, thus, reducing the number of false positive and negative answers.

Integration Techniques: Ascertaining the proposals regarding improving the compatibility and efficacy of newly incorporated AI tools with the existing security systems.

Scalability Solutions: For instance, investigating effective and low-cost ways, such as edge computing, to create artificial intelligence security for companies at different stages.

Ethical AI Practices: Chasing the right ethical behavior of its application in security, obtaining people's privacy, and performing rules and norms at the international level.

Cross-industry Applications: Research to ascertain the various issues peculiar to the different industries to arrive at ideal AI solutions.

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