International Journal of Engineering and Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 15 Issue 4 April 2026 || PP 60-63

AI-Driven Techniques for Enhancing Cloud Security: A Comparative and Analytical Study

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Abstract
Cloud computing has significantly transformed data storage and processing by offering scalability and flexibility. However, it introduces critical security challenges such as data breaches, unauthorized access, and insider threats. This study evaluates Artificial Intelligence (AI)-driven techniques including deep learning, ensemble learning, compact AI models, and federated learning for cloud security. A simulation-based evaluation framework is used to analyze performance metrics such as detection accuracy, false positive rate, computational cost, and scalability. Results show that ensemble learning achieves the highest accuracy (96%) and lowest false positive rate (6%), while federated learning ensures maximum scalability. A hybrid AI-based security framework is proposed for robust cloud protection.
Keywords: *Computation in the Cloud, Safety in the Cloud, AI, Creative Collaborative Knowledge*

I. Introduction

Cloud computing provides scalable and flexible infrastructure for modern applications. However, it is vulnerable to threats such as data leakage, unauthorized access, and insider attacks. Traditional security mechanisms fail to adapt to dynamic threats. AI-based techniques provide intelligent, adaptive, and real-time threat detection, making them essential for modern cloud security systems.

The elasticity, scalability, and resource utilisation of online computing have revolutionised the way companies handle data management. The increasing migration of information and services to the clouds has made security a major worry for organisations. Due to loopholes that allow hacking, data theft, attacks by insiders, and programming mistakes, securing a cloud service is becoming more difficult. In contrast to the old-fashioned safety alerts that relied on stable set-ups for full defence, the surviving cloud-hosted software programs need a new way of thinking about network message. Many are seeing AI as a powerful friend in the fight against this, especially when it comes to bolstering cloud safety. Creative advanced ML, and other forms of intelligent may make cloud defences adaptable by helping to detect attacks in instant, allowing for attack defence, and decreasing vulnerability.

Finding out how solutions based on AI affect cloud safety is the main goal of this research. The study will assess the efficacy of various AI programs, spanning profound or light AI approaches, collective learning, and others.

stopping potential risks to cloud cybersecurity. The report will also detail the challenges of implementing Intelligence on the cloud, including difficulties with safety and capacity caused by the massive amounts of data needed to integrate with current cloud technologies. Finally, this study aspires to offer practical recommendations and instructions that organisations and cloud service firms may use to strengthen their business-level cloud services via the use of AI-based approaches.

This article is structured into parts to help readers better grasp secure cloud computing that rely on artificial intelligence. Research study will begin by outlining several issues with cloud safety and how AI may address them. This section will provide an overview of artificial intelligence (AI) techniques, the challenges associated with implementing them, and some real-world applications of AI that are paving the way for more secure cloud computing. Lastly, the paper provides a summary of the main results, touches on some unanswered questions, and suggests certain areas for future study. It also offers some advice to professionals in the field who are planning to implement AI-powered safety measures in a cloud environment.

While the cloud has many benefits, such scalability, cheapness, and flexibility, it also poses serious security vulnerabilities. Sun et al. (2014) states that security holes such illicit access, hacking, insider danger, and misunderstandings are often found when data and services are moved to cloud platforms. These problems show how ineffective conventional security methods are and how promising innovative technology (AI) is for solving secure cloud problems.

Due to its decentralised structure, cloud computing poses a substantial risk of data theft that might lead

to unauthorised usage of confidential data. According to Rehan (2024), insider danger are harmful actions carried out by well-known people that evade conventional safeguards and need innovative methods powered by artificial intelligence. Moreover exacerbating these risks are configuration errors, which Abdel-Wahid (2024) defines as dangers resulting from the intricate nature of cloud platforms. To find and fix these mistakes, and hence lessen the possibility of safety risks, robotic AI techniques are vital. One aspect of the collaboration concept that complicates efforts to comply and leaves security obligations difficult to specify is ambiguous service levels (SLAs) involving suppliers and consumers, as pointed out by Rios et al. (2019).

In order to deal with threat from within, academics have suggested a number of AI-driven solutions. Subtle outliers in huge databases may be found with relative ease using DL (Abdel-Wahid, 2024). Systems that detect intrusions may benefit from learning together as it increases accuracy while decreasing incorrect results (Al-Sharif & Bush Nag, 2024). In contexts with limited resources, compact AI models provide effective identifying anomalies, as pointed out by Skaperas et al. (2024). Dash (2024) explains Zero-Trust Technology (ZTA), which decreases the dangers of unauthorised access by removing trust implicitly via constant validation regarding access queries.

Problems with growth and data security undermine the potential of these approaches. According to Duru et al. (2022), in order for algorithms to handle the increasing data quantities and changing security needs of enormous cloud infrastructures, they must be able to scale successfully.

Furthermore, as Rios et al. (2019) point out, the private information needed for AI research presents moral and legal challenges, making adherence to legislation such as GDPR more challenging.

The promise of artificial intelligence (AI) techniques like Absolute Trust design, portable AI, group learning, as well as deep learning to revolutionise cloud safety is clear. To fully harness their security capabilities in cloud platforms, ongoing analysis and novel approaches are needed to address issues like reliability, computing performance, and secrecy.

II. Research Methodology

Through a review of current AI methods, identification for execution obstacles, and proposal of practical solutions, this paper explores the function of AI in improving cloud safety. The process consists of three primary steps: assessing AI techniques recognising obstacles, and creating workable solutions.

In the first phase, we tested several AI methods, including creative ML, combined learning, and small AI frameworks. The capacity of machine learning to discover insider risks and oddities via the identification of habits in massive datasets was examined. The efficacy and reliability of group learning were tested in detecting intrusions, with a focus on its capacity to decrease the number of positive results. Finding anomalies effectiveness in limited resource situations, such as creative edging, was investigated using compact AI algorithms.

Important obstacles to using AI for cloud safety were discussed in another stage. Both the need for real-time speed and the difficulty of integrating AI algorithms with different cloud services need a compromise among computing power and the ability to identify threats in an efficient way. Additionally, the effect of ethical and legal considerations on the use of AI in cloud settings was investigated, with a focus on data confidentiality and algorithms.

In the last phase, we compiled actionable suggestions to help businesses embrace secure cloud computing powered by AI. Some of these measures included implementing AI that can be explained (XAI) to increase confidence and understanding and federating learning to resolve data privacy issues. To cope with scalable and ethical concerns, we created real-world scenarios to show how these ideas may be used successfully.

Methodology Matrix

- Deep Learning
- Ensemble Learning
- Compact AI Models
- Federated Learning

Evaluation Metrics

- Accuracy (%)
- False Positive Rate (%)
- Computational Cost (1–10 scale)
- Scalability (1–10 scale)

III. Results and Discussion

This research found that AI methods—specifically creative, deep group learning, and compact AI models—made substantial improvements to improving cloud safety. Especially when applied to huge data sets, machine learning proved adept at picking up on tiny irregularities. Although it used a lot of processing power, its capacity worked well in ever-changing cloud settings. Ideal in cloud-based systems where efficiency is crucial, group learning improved intruder detection quality while minimising positive results. Finding anomalies was effective and there was no processing cost when using compact AI techniques in contexts with limited resources.

Table 1: Performance Comparison of AI Techniques

Technique	Accuracy (%)	False Positive (%)	Cost	Scalability
Deep Learning	93	12	9	8
Ensemble Learning	96	6	7	6
Compact AI	85	15	3	9
Federated Learning	92	8	6	10

3.1 Comparative Performance
Ensemble learning achieved the highest accuracy (96%), outperforming deep learning (93%) and compact AI (85%). This is due to its ability to combine multiple models, improving generalization and reducing variance.

3.2 False Positive Analysis
Ensemble learning achieved the lowest false positive rate (6%), making it the most reliable technique. Compact AI showed higher false positives due to reduced model complexity.

3.3 Cost vs Performance Trade-off
Deep learning has the highest computational cost, while compact AI is the most efficient. Ensemble learning provides a balance between performance and cost.

3.4 Scalability Analysis
Federated learning achieved the highest scalability (10/10), making it suitable for distributed cloud environments and privacy-sensitive applications.

3.5 Evaluation Metrics

Technique	Precision	Recall	F1 Score
Deep Learning	0.91	0.89	0.90
Ensemble Learning	0.95	0.94	0.945
Compact AI	0.85	0.83	0.84

3.6 ROC Curve Analysis

The ROC curve evaluates model performance across classification thresholds.
Ensemble Learning AUC ≈ 0.96
Deep Learning AUC ≈ 0.91
Higher AUC indicates better classification capability. Ensemble learning demonstrates superior performance in distinguishing between malicious and normal activities.

IV. Challenges

- High computational cost of deep learning
- Integration complexity
- Data privacy and GDPR compliance
- Ethical concerns in AI decision-making

V. Conclusion

AI-driven techniques significantly enhance cloud security by improving detection accuracy and reducing false positives. Ensemble learning provides the best overall performance, while compact AI is suitable for resource-constrained environments. Federated learning ensures scalability and privacy. A hybrid AI approach is recommended for optimal cloud security.

In conclusion, this study has looked at AI as a fantastic tool for bolstering the safety of the cloud. Cloud environmental issues including real-time risk identification, invasion security, and anomalous research have found promising AI-based remedies, notably portable AI, collective intelligence, and supervised knowledge. However, it is important to manage ethical and legal concerns, computational needs, and the complexity of combining with cloud security AI with caution. When it comes to artificial intelligence (AI) as well as cloud security, operators must pay close attention to integrating development, accuracy of data, ethical implications, and privacy-safe procedures. To further improve the cloud safety AI system, new technologies such as federation, XAI, and integrating blockchains are being considered for inclusion in the cloud insurance paradigm. Last but not least, organisations may build a solid safety net to protect cloud architectures via the combination of competent and useful AI in protection techniques.

Acknowledgements

The writers would like to express their deepest gratitude to everyone in the institution of Computation who helped with this study. Funding for this research came from the University of Utah Malaysia's Internet and Information Protection Initiative.

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