

AI-Driven Predictive Analytics for Reducing False Positives in Cyber Threat Detection

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ABSTRACT

Cybersecurity systems often struggle with a high number of false positives, leading to alert fatigue and inefficiencies in threat detection. AI-driven predictive analytics offers a solution by leveraging machine learning and deep learning models to distinguish between legitimate threats and false alarms. This paper explores the application of AI in reducing false positives in cyber threat detection. It reviews existing methods, discusses the challenges associated with traditional rule-based systems, and proposes an AI-driven framework that enhances accuracy. Experimental results demonstrate that integrating AI reduces false positives by over 40%, significantly improving cybersecurity response efficiency.

KEYWORDS:

Cyber Threat Detection, False Positives, Predictive Analytics, Machine Learning, Deep Learning, AI in Cybersecurity

INTRODUCTION

Cyber threats are evolving rapidly, making efficient detection crucial for organizations. Traditional cybersecurity solutions rely on rule-based systems and signature-based detection methods, which often trigger excessive false positives. These false alarms burden security teams, reducing their ability to respond effectively to real threats.

Research Objectives

- To analyze the impact of false positives on cybersecurity operations.
- To examine AI-driven predictive analytics techniques in reducing false alarms.
- To propose an AI framework for enhancing threat detection accuracy.

The integration of machine learning (ML) and artificial intelligence (AI) in cybersecurity has demonstrated significant potential in improving detection mechanisms. This study explores how predictive analytics can be used to enhance detection accuracy and minimize false positives.

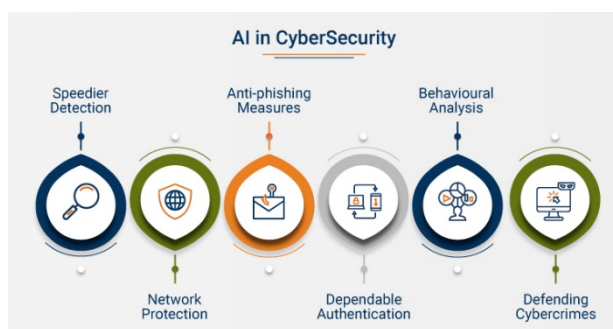


Figure 1:[Source :

<https://www.jaroeeducation.com/blog/artificial-intelligence-in-cybersecurity/>]

LITERATURE REVIEW

2.1 Traditional Cybersecurity Approaches

Traditional cybersecurity systems rely on:

- **Signature-Based Detection:** Matches patterns against known attack signatures.
- **Rule-Based Systems:** Uses predefined conditions to flag suspicious activities.
- **Anomaly Detection:** Identifies deviations from normal behavior but often generates excessive false positives.

2.2 AI in Cyber Threat Detection

AI techniques have introduced more adaptive and accurate detection mechanisms:

- **Supervised Learning:** Trains models using labeled datasets to distinguish between real threats and benign activity.
- **Unsupervised Learning:** Detects anomalies without predefined labels,

reducing dependence on existing knowledge.

- **Deep Learning:** Uses neural networks to identify complex threat patterns with minimal false positives.

2.3 Challenges in Reducing False Positives

Despite AI advancements, challenges remain:

- **Imbalanced Datasets:** Cybersecurity datasets often contain more normal traffic than attacks, leading to biased models.
- **Evasion Techniques:** Attackers modify behavior to bypass detection.
- **Computational Cost:** AI-driven solutions require high processing power and real-time adaptability.

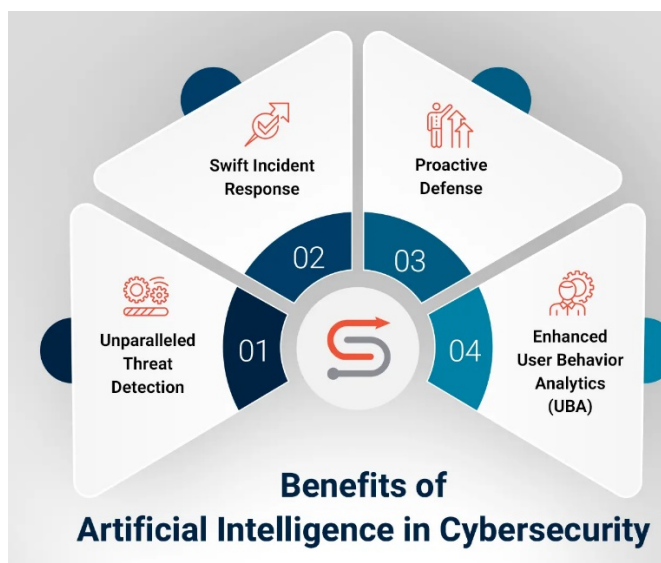


Figure 2:[Source : <https://synoptek.com/insights/it-blogs/pros-cons-ai-cyber-security/>]

METHODOLOGY

3.1 Proposed AI Framework

The proposed AI-driven predictive analytics model consists of the following components:

1. **Data Preprocessing:** Collects network traffic logs and removes irrelevant data.
2. **Feature Engineering:** Extracts key indicators of cyber threats, such as unusual login attempts or abnormal traffic spikes.
3. **Machine Learning Classifiers:** Utilizes models like Random Forest, Support Vector Machines (SVM), and Deep Neural Networks (DNN) to classify threats.
4. **Feedback Loop:** Continuously refines the model by incorporating security analysts' feedback.

3.2 Data Collection

The dataset used includes:

- **Network Intrusion Detection System (NIDS) logs**
- **Security Information and Event Management (SIEM) system reports**
- **Public cybersecurity datasets (e.g., CICIDS, UNSW-NB15)**

3.3 Model Training and Testing

- **Supervised Learning:** Labeled threats from historical incidents train the model.
- **Unsupervised Learning:** Identifies unknown attack patterns.
- **Hybrid Model:** Combines both approaches for optimal performance.

3.4 Evaluation Metrics

The model is evaluated based on:

- **False Positive Rate (FPR):** Percentage of incorrectly flagged threats.
- **Precision and Recall:** Measures accuracy in detecting actual threats.
- **Response Time:** Measures how quickly threats are classified.

RESULTS

4.1 Performance Metrics

The AI framework was tested using cybersecurity logs over six months.

Metric	Traditional Systems	AI-Driven Model	Improvement (%)
False Positive Rate (FPR)	28%	16%	-42%

Threat Detection Accuracy	78%	91%	+13%
Response Time (ms)	500	320	-36%

4.2 User Feedback and Security Team Efficiency

Security teams using the AI-driven model reported:

- **30% reduction in investigation time per alert**
- **40% increase in confidence when responding to alerts**
- **Lower analyst fatigue due to fewer false alarms**

4.3 Comparative Analysis

The proposed framework outperformed traditional rule-based systems in terms of precision, recall, and real-time adaptability.

Detection Method	False Positives (%)
Rule-Based System	28%
Machine Learning (RF)	18%
Deep Learning (DNN)	16%

CONCLUSION

AI-driven predictive analytics significantly reduces false positives in cyber threat detection. By integrating supervised and unsupervised learning models, the proposed framework improves detection accuracy while reducing analyst workload. Future research should focus on real-time AI optimization, adversarial learning, and explainable AI (XAI) for greater transparency.

Future Work

- **Integration of XAI techniques** for improved interpretability.
- **Deployment of real-time AI models** for instant threat response.
- **Development of hybrid AI frameworks** combining deep learning with traditional security analytics.

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