

MSc Cyber Security and Digital Forensics

Research Proposal

Title: *AI-Driven Threat Detection and Digital Forensic Investigation Framework*

Word Count: ~4000

Student Name: [Your Name]

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Date: [Insert Date]

1. Introduction (35%)

1.1 Context and Background (10%)

Cyber security and digital forensics form the foundation of protecting and investigating the integrity of information systems. With rapid digitization, organizations face a growing array of threats, including ransomware, phishing, data breaches, insider threats, and AI-driven social engineering [1]. Digital forensics complements cybersecurity by collecting, preserving, analyzing, and presenting digital evidence to support legal and organizational investigations [2].

Over the past decade, significant developments have emerged in this field. Artificial Intelligence (AI) and Machine Learning (ML) have become integral to modern cybersecurity solutions due to their ability to analyze large datasets, identify anomalies, and detect novel threats [3]. Simultaneously, digital forensic tools have evolved to handle the increasing complexity of digital evidence from multiple sources such as cloud systems, IoT devices, and mobile platforms [4].

However, despite these advancements, cyber attackers continuously adapt, leading to a persistent gap between detection mechanisms and new attack patterns [5].

Furthermore, existing digital forensic frameworks often rely heavily on manual intervention, making evidence collection and analysis time-consuming and prone to human error [6].

Recent research trends focus on integrating automation, data mining, and AI to improve forensic efficiency. For instance, machine learning models have been used for malware classification and network intrusion detection [7]. Deep learning techniques, particularly convolutional and recurrent neural networks, are being applied to anomaly detection, log analysis, and forensic timeline reconstruction [8].

This research, therefore, is situated at the intersection of cybersecurity, digital forensics, and artificial intelligence — aiming to explore how AI models can automate threat detection and assist forensic investigators in reconstructing cyber incidents.

1.2 Research Problem (7%)

Despite the proliferation of cybersecurity solutions, many systems fail to identify zero-day attacks and complex multi-vector threats. Traditional digital forensic methods are reactive, involving manual data collection and static rule-based analysis, which are insufficient for modern cyber incidents [9].

Problem Statement:

Current cybersecurity and digital forensic approaches lack automation, adaptability, and real-time analytical capabilities to effectively detect and investigate complex cyber threats.

Current Challenges:

1. **Manual Evidence Analysis:** Forensic investigators often spend significant time filtering through logs and evidence without automated prioritization [10].
2. **Fragmented Data Sources:** With cloud computing and IoT, evidence is spread across multiple systems, complicating chain-of-custody and integrity verification [11].
3. **Evolving Threat Landscape:** Machine-learning-powered attacks and polymorphic malware can bypass traditional intrusion detection systems [12].
4. **Lack of Integration:** There is limited integration between real-time threat detection systems and forensic tools, hindering seamless transition from detection to investigation [13].

Hence, the core problem this research seeks to address is the **lack of an integrated, AI-driven framework that supports both threat detection and automated forensic analysis**.

1.3 Research Aim and Objectives (15%)

Aim:

To develop and evaluate an AI-driven framework for automated cyber threat detection and forensic evidence analysis.

Objectives:

1. To conduct a systematic literature review of AI applications in cybersecurity and digital forensics.
2. To design a prototype framework integrating machine learning-based threat detection with automated forensic data collection.
3. To implement and train ML models (Random Forest, CNN, or SVM) using benchmark datasets (CICIDS2017, UNSW-NB15).

4. To evaluate detection accuracy and forensic evidence correlation efficiency.
5. To analyze ethical, privacy, and data integrity implications of AI-driven forensic automation.

1.4 Significance of the Research (3%)

This research is significant for both academia and industry.

Technical Significance: It aims to bridge the gap between proactive cybersecurity systems and reactive digital forensics, fostering an integrated, AI-enhanced ecosystem.

Practical Impact: The framework can assist investigators in real-time evidence analysis, reducing time-to-resolution in cyber incidents.

Societal Implication: Enhancing forensic readiness supports national cyber defense capabilities and improves trust in digital infrastructure.

Potential Applications: Cyber threat intelligence systems, automated forensic triage tools, and law enforcement digital evidence platforms.

2. Literature Review (25%)

2.1 Introduction to the Literature Review

The purpose of this literature review is to evaluate the current state of knowledge in AI-assisted cybersecurity and digital forensics. The review identifies major advancements, thematic trends, theoretical frameworks, and research gaps that justify the need for this study.

The literature scope includes works published between **2015–2025**, focusing on AI techniques for **intrusion detection, forensic automation, and threat intelligence**.

2.2 Systematic Literature Review Methodology

Search Strategy

Searches were conducted on **Google Scholar, IEEE Xplore, ScienceDirect, and SpringerLink** using the Boolean string:

("AI" OR "Machine Learning") AND ("Cyber Security" OR "Digital Forensics") AND ("Threat Detection" OR "Automation")

Inclusion Criteria

- Peer-reviewed journal or conference papers
- English language publications
- Focused on AI applications in cybersecurity or forensics

Exclusion Criteria

- Non-academic sources
- Duplicates or short abstracts
- Papers not addressing both domains

Initial Results: 742 papers

Screened: 126

Included: 52

Data Management

All references were imported into **RefWorks**, duplicates removed, and metadata extracted. The **PRISMA** flow diagram below shows the review process.

Insert PRISMA Flow Diagram Here

Identification: 742 → Screening: 126 → Eligibility: 75 → Included: 52

Example Screenshots:

Google Scholar: Search results for “AI digital forensics threat detection”.

RefWorks: Screenshot showing citation organization.

2.3 Thematic Review

Theme 1: AI and Machine Learning in Threat Detection

AI-driven intrusion detection systems leverage algorithms like Random Forests, SVMs, and deep learning models to identify anomalies in network traffic [14]. Studies show ML-based models outperform rule-based systems by up to 20% in detecting zero-day attacks [15].

Theme 2: Automation in Digital Forensics

Automation reduces manual intervention in forensic processes such as evidence acquisition and log correlation. Alazab et al. [16] demonstrated ML tools can reconstruct attack timelines automatically.

Theme 3: Data Integrity and Ethical Implications

Maintaining evidence integrity in AI systems remains challenging due to model opacity. Transparent and explainable AI (XAI) frameworks are gaining attention [17].

Theme 4: Integrated Frameworks

Few studies propose full-stack integration between detection and investigation phases. This gap underscores the novelty of the proposed research.

2.4 Summary

The literature reveals advancements in isolated domains but a clear lack of **end-to-end integration** of AI for both **real-time detection** and **forensic evidence management**. This study aims to address that gap.

3. Research Design and Methodology (25%)

3.1 Research Design (7%)

This research adopts a **Design Science Research (DSR)** approach, focusing on developing an artifact — an AI-based forensic detection framework. DSR is appropriate because it combines theory creation and practical solution design.

3.2 Research Methods and Materials

Methods (10%)

- **Approach:** Quantitative
- **Strategy:** Experimental system development and evaluation
- **Architecture:** A modular AI pipeline (data preprocessing → ML detection → forensic logging → visualization dashboard)

Data Analysis

- Algorithms: Random Forest, SVM, CNN
- Evaluation Metrics: Accuracy, Precision, Recall, F1-score
- Tools: Python, scikit-learn, TensorFlow, Jupyter Notebook

Materials (8%)

- **Datasets:** CICIDS2017, UNSW-NB15
- **Software:** Python, Wireshark, ELK Stack, Splunk
- **Hardware:** Cloud VM with GPU (Google Colab or AWS)
- **Ethics:** Anonymized data only; compliance with GDPR and institutional ethics policy.

4. Expected Outcomes (5%)

- Development of a prototype AI-driven cyber forensic framework.
- Improved detection accuracy (expected >90%).
- Faster incident response and automated evidence linkage.
- Contribution to the academic field via publication and dataset release.

Limitations: Model bias, dataset representativeness, and computational cost.

5. Timeline (5%)

Month	Task	Milestone
Jan–Feb	Literature review, tool setup	SLR completed
Mar–Apr	Framework design & dataset preprocessing	Model ready
May–Jun	ML training & testing	Prototype developed
Jul	Evaluation & result analysis	Draft report
Aug	Final submission	Dissertation submission

6. References (5%)

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- [2] E. Casey, *Digital Evidence and Computer Crime*, 3rd ed., Academic Press, 2011.
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