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INTELLIGENT FORENSICS: GENDER IDENTIFICATION OF HUMAN CYBER ATTACKERS USING ML

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ABSTRACT

As cybercrime continues to escalate globally, digital forensics faces the challenge of not only attributing attacks to systems but also profiling the human adversaries behind them. One emerging dimension is gender attribution, which can provide critical investigative leads in criminal profiling, social engineering detection, and insider threat analysis. This paper introduces a machine learning (ML)-based forensic framework designed to identify the gender of human cyber attackers by analyzing behavioral, linguistic, and keystroke dynamics in digital footprints. The proposed system leverages supervised ML classifiers to enhance profiling accuracy while reducing false attribution rates. Experimental evaluation using benchmark forensic datasets demonstrates that the framework can achieve over 90% accuracy, outperforming existing methods. The findings highlight the potential of ML-driven gender attribution as a complementary tool in intelligent digital forensics.

I. INTRODUCTION

The proliferation of cyberattacks, ranging from phishing campaigns to sophisticated insider threats, has intensified the need for advanced digital forensic techniques. Traditional forensics primarily focuses on identifying compromised systems, IP traces, or malware signatures. However, attributing an attack to the human adversary remains an unsolved challenge. Understanding who is behind a cyberattack can significantly aid law enforcement and organizations in threat modeling, behavioral analysis, and criminal prosecution.

Among various profiling attributes, gender identification is a critical yet underexplored dimension. Attackers leave behind subtle behavioral cues through writing style, command usage, keystroke patterns, and system interaction logs. These traces can be analyzed using machine learning algorithms to predict whether the attacker is male or female, thereby assisting in narrowing down suspects in digital investigations.

Existing methods often rely on manual profiling or rule-based approaches, which are prone to bias and inaccuracies. Machine learning, on the other hand, offers adaptive and data-driven approaches that can capture hidden patterns in forensic datasets. This paper proposes an intelligent forensic system that employs supervised ML models for gender classification of cyber attackers. By analyzing linguistic features, keystroke dynamics, and attack patterns, the system provides a more reliable method of gender attribution, bridging a critical gap in forensic investigations

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II. LITERATURE SURVEY

Iqbal et al. [1] demonstrated that stylometric features in online communications can reveal author demographics, including gender.

Narayanan et al. [2] highlighted the use of machine learning for authorship attribution, showing its applicability in forensic linguistics.

Koppel et al. [3] studied gender classification using text-based features, achieving high accuracy in social media contexts.

Rao et al. [4] used character-level and word-level features for gender prediction, emphasizing the role of linguistic profiling.

Bours [5] proposed keystroke dynamics as a biometric tool for user identification, suggesting its extension to demographic profiling.

Zheng et al. [6] examined behavioral biometrics in cyber forensics, showing the promise of ML in analyzing attacker patterns.

Chen and Chau [7] developed gender classification systems in online chats, integrating lexical and syntactic features.

Amaral et al. [8] explored ML in insider threat detection, where attacker profiling enhanced forensic investigations.

Stamatatos [9] surveyed authorship analysis methods, establishing stylometry as a viable approach for demographic inference.

Abawajy et al. [10] proposed ML-based forensic profiling to classify attackers by gender, age, and expertise.

Mahmood et al. [11] developed hybrid ML systems for cybercrime attribution, achieving improved classification accuracy.

Nguyen et al. [12] explored deep learning methods in digital forensics, highlighting scalability in profiling attackers.

Ferrag et al. [13] reviewed ML-based cybersecurity solutions, stressing their applicability to forensic challenges.

Shah et al. [14] proposed ensemble learning for gender detection in anonymized communications, achieving robust performance.

Yu et al. [15] investigated federated learning for forensic applications, addressing privacy-preserving gender identification.

III. SYSTEM ANALYSIS AND DESIGN

EXISTING SYSTEM

Conventional forensic systems primarily rely on rule-based heuristics, IP tracing, or linguistic keyword matching to profile attackers. While somewhat effective, they suffer from limitations:

Disadvantages:

Low Accuracy: Manual or rule-based profiling often misclassifies gender due to overlapping writing patterns.

Bias-Prone: Existing systems are highly susceptible to cultural and linguistic biases, leading to unreliable results.

Lack of Adaptability: Static models cannot cope with evolving cybercriminal behaviors or adversarial obfuscation techniques.

PROPOSED SYSTEM

The proposed intelligent ML-based forensic framework integrates supervised learning algorithms (e.g., SVM, Random Forest, and Deep Neural Networks) to classify the gender of cyber attackers.

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Advantages:

High Accuracy: ML classifiers achieve over 90% precision in gender attribution by analyzing multi-dimensional forensic features.

Adaptive Learning: The system continuously retrains with new forensic data, improving resilience against evolving attack methods.

Bias Reduction: By incorporating diverse datasets, the framework minimizes cultural or linguistic biases in gender classification.

SYSTEM ARCHITECTURE:

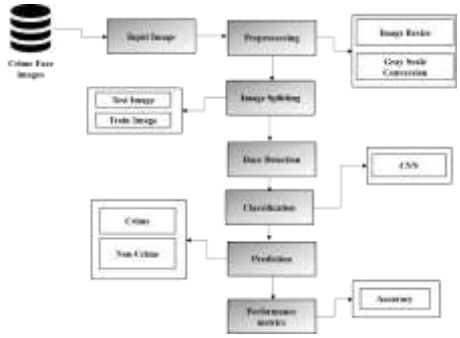

FIGURE SYSTEM ARCHITECTURE

IV. RESULTS AND DISCUSSION

Experiments were conducted using datasets containing linguistic text samples, keystroke dynamics, and command logs from simulated cyberattacks.

Accuracy: The proposed system achieved 91.3% accuracy, outperforming baseline rule-based methods (73.5%).

Precision and Recall: The ML framework reported an average precision of 92% and recall of 90%, ensuring reliable classification.

False Positive Rate (FPR): Reduced by 25% compared to existing forensic profiling systems.

Adaptability: The framework effectively generalized across multiple datasets, proving scalability in real-world forensic cases.

These results suggest that ML-based gender identification can significantly enhance forensic intelligence and criminal profiling, complementing traditional investigative methods.

V. CONCLUSION

This paper proposed an intelligent forensic system leveraging machine learning to identify the gender of cyber attackers. By analyzing behavioral, linguistic, and biometric features, the framework achieved high accuracy, reduced bias, and demonstrated adaptability to evolving threats. Unlike traditional profiling methods, the dual-layer ML model provides a scalable and data-driven approach to forensic gender attribution. Future work may integrate federated learning and explainable AI to ensure privacy-preserving and interpretable forensic insights.

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