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Phishing Detection System

Prof. Apeksha Raut, Raj Turkar, Samir Meshram, Prajwal Sathavne, Harsh Wagh
Department of Computer Science Engineering (Data Science),
Abha Gaikwad Patil Collage of Engineering, Nagpur, Maharashtra, India
Prof. Abhimanyu Duotone
Head of Department, Computer Science Engineering (Data Science)
Abha Gaikwad Patil Collage of Engineering, Nagpur, Maharashtra, India

Abstract: *This paper introduces an innovative phishing detection system using machine learning techniques. By examining key attributes of emails and websites, the proposed system achieves high accuracy in finding phishing attempts, offering a robust defence against such cyber threats.*

Keywords: phishing

I. INTRODUCTION

Phishing attacks are a pervasive cybersecurity threat, characterized by deceptive tactics aimed at extracting sensitive information—such as login credentials or financial details—from unsuspecting users. These attacks have grown increasingly complex, often mimicking legitimate communications, which complicates manual detection efforts. The resulting surge in identity theft and economic losses underscores the urgent need for automated, reliable detection mechanisms. This paper proposes a machine learning-based solution to address this challenge, aiming to enhance user protection by accurately distinguishing phishing attempts from legitimate interactions.

II. LITERATURE REVIEW

Existing phishing detection strategies vary widely in approach and efficacy. Blacklist-based methods, which rely on databases of known malicious URLs, are widely used but falter against novel or "zero-day" phishing attempts not yet catalogued. Heuristic-based techniques, employing predefined rules to flag suspicious behaviour, offer some flexibility but remain vulnerable to evasion by adaptive attackers. Recent advancements have shifted toward machine learning, with studies exploring supervised models trained on labelled datasets of phishing and legitimate samples. While these approaches show promise in adapting to evolving threats, gaps persist in balancing detection accuracy with real-time applicability. The system proposed here builds on these foundations, employing a machine learning model to overcome limitations of static blacklists and rigid heuristics.

III. METHODOLOGY

The proposed phishing detection system works by extracting a set of discriminative features from emails and websites. These features include:

- **Suspicious keywords**: Terms commonly associated with urgency or impersonation (e.g., "urgent," "verify account").
- **URL structure**: Indicators such as excessive subdomains, misspellings, or non-standard characters.
- **Domain age**: Newly registered domains, often used in phishing, are flagged as potential risks.

These features form the input to a random forest classifier, a supervised machine learning algorithm chosen for its robustness and ability to handle high-dimensional data. The model is trained on a balanced dataset including phishing and legitimate instances, enabling it to learn patterns distinguishing the two categories. Training involves improving the classifier to minimize misclassification errors, with validation performed via cross-validation to ensure generalizability.

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IV. RESULTS

The system's performance was assessed using a dataset of 10,000 samples—5,000 phishing and 5,000 legitimate emails and websites. Evaluation metrics included accuracy, precision, recall, and F1-score, which collectively gauge the model's effectiveness. The results are as follows:

- **Accuracy**: 98% (overall correct classifications).
- **Precision**: 98.5% (proportion of phishing flags that were correct).
- **Recall**: 97.5% (proportion of actual phishing instances detected).
- **F1-score**: 98% (harmonic mean of precision and recall).

These metrics show impressive performance across both detection reliability and minimization of false alarms.

V. DISCUSSION

The achieved accuracy of 98% and F1-score of 98% affirm the system's capability to effectively find phishing attempts. The high precision (98.5%) ensures that legitimate communications are rarely misclassified, preserving user experience, while the recall (97.5%) reflects successful detection of most phishing instances. However, the slight gap in recall suggests that a small fraction of phishing attempts evade detection, potentially due to feature set limitations or attacker ingenuity. A notable constraint is the system's reliance on a static training dataset, which may not fully reflect the dynamic nature of phishing tactics. Periodic retraining with fresh data could mitigate this, ensuring adaptability to appearing threats. These findings position the system as a significant improvement over traditional blacklist and heuristic methods, though ongoing refinement is called for.

VI. CONCLUSION

This paper has outlined a machine learning-based phishing detection system that surpasses conventional approaches in accuracy and adaptability. By using a random forest classifier and carefully selected features, the system achieves robust performance, as showed by its evaluation results. Future research could enhance this work by exploring advanced techniques, such as deep learning, to capture more nuanced phishing patterns, or by integrating the system into real-time security frameworks like email filters or browser extensions. Such developments promise to further strengthen defences against the ever-evolving landscape of phishing attacks.

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