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Phishing Website Detector using ML

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Abstract: ***With the proliferation of mobile devices in recent years, there is a tendency to move almost all real-world activities to the cyber world. Although this makes our daily life easier, it violates many security rules due to the anonymous nature of the Internet. Phishing attacks are the easiest way to get sensitive information from innocent users. Phishers aim to obtain sensitive information such as usernames, passwords, and bank account information. Cybersecurity professionals are looking for reliable and consistent detection methods to detect phishing websites. This project deals with machine learning technology to detect phishing URLs by extracting and analyzing various features of legitimate and phishing URLs. Decision trees, random forests, and support vector machine algorithms are used to identify phishing websites in a two-step process of first visualizing and extracting features of URLs using python libraries and then training them into a model using Gradient Classifier Algorithm to predict real-time phishing websites.***
Keywords: cybersecurity, phishing, machine learning, website classification

I. INTRODUCTION

In our daily life, we do a lot of work on digital platforms. In many ways, the use of computers and the Internet make our work and personal lives easier. This allows us to quickly complete our processes and operations in areas such as trade, health, education, communication, banking, aviation, research, engineering, entertainment and public services. We live in a technical world and with more and more advances in technology, we face some serious problems such as external phishing or hackers getting hold of users or customer information by creating fake websites that have a general resemblance to the original website. These attackers can steal bank credentials and various data formats related to users' mail and devices. Since phishing attacks are more successful due to the lack of user awareness, they are more difficult to counter, so it is necessary to develop phishing techniques. Phishing attacks are the easiest way to get sensitive information from innocent users. Phishers aim to obtain sensitive information such as usernames, passwords and bank account information. Everyone is now looking for a reliable and consistent detection method to identify phishing websites.

This project deals with machine learning technology to detect phishing URLs by extracting and analyzing various features of legitimate and phishing URLs. Decision trees, random forests, and support vector machines are algorithms used to identify phishing websites.

The main goal of this paper is to find an effective way to prevent real-time phishing attacks. It shows the basic life cycle of a phishing attack as an entry point when a user clicks on a phishing link and uses technical techniques to detect phishing links and alert users. In addition to commonly used blacklist recognition and matching techniques, this paper provides an in-depth description of machine learning-based URL detection technology. This paper presents state-of-the-art solutions, compares and analyzes the challenges and limitations of each solution, and provides research directions and ideas for future solutions.

The main contributions of this paper are as follows:

- The fishing life cycle to specifically address the problem of phishing.
- Search major databases and information sources for phishing detection websites.
- It is a machine learning-of-the-art based solution for detecting phishing websites.

Researchers and data analysts have been using machine learning for years because of its comparable performance in terms of data accuracy and precision. analysis. In addition, ML-based algorithms are more intuitive due to the simplicity of tracking how data is generated and its inner workings. Made by hand the feature is risky and highly database dependent. So, recently, researchers have focused on database features that extract features based on URL text. Simply put, researchers adapt neural networks to extract rich characters/words from URLs to show valuable information. Our research focuses on data-based features by using neural network-based models that consider domain- and path-based features. Then, we compare our results with previous papers and summarize ideas for better detection systems.

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Statistics from previous work have shown that there is fishing URL is getting more attention lately. However, URL parsing is not an easy search area because most URLs are generated randomly and informative but difficult to research. Therefore, our research focuses on finding phishing URLs to gather as much information as you can find feature-rich information. The presented system works in two phases where we extract different features of URLs and then using these features a web application is developed for the users to detect any URL that they may think is phishing.

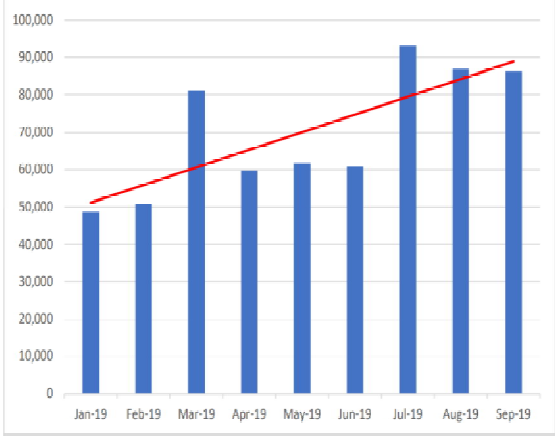

Fig. 1. Number of Phishing Sites **from [1]**

The method of reaching target users in phishing attacks has continuously increased since the last decade.

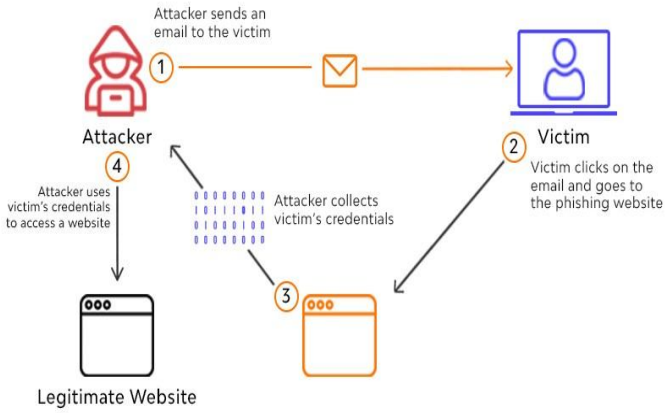

Fig. 2. Life Cycle of a Phishing Attack **from[2]**

Thus, the attacker receives information and/or revenue. Credible email content is crafted in various ways to make the victim believe it. Today, trusted organizations or similar links to these organizations are preferred. The attacker prefers to contact the victim using a secure communication protocol, and the actual URL is changed to something close to the original. At this stage, if the victim knows that the website is fake, he can protect himself from the attack. It is very difficult for the victim to detect the attack itself, because most of these messages give some warning message to the user and the aim is to panic them into entering their confidential information. *Goals and Objectives*

Phishing is a major concern of security researchers today, as it is not difficult to create a fake website that closely resembles a legitimate website. Professionals can identify fake websites, but not all users can identify fake websites and such users can become victims of phishing attacks. The attacker's main goal is to steal bank account documents. Phishing attacks succeed because users lack awareness. Phishing attacks are difficult to mitigate because they exploit user vulnerabilities, but developing phishing techniques is essential. Machine learning technology consists of many algorithms that require past data to determine or predict future data. Author [3] Using this technique, the algorithm will analyze various blacklisted and legitimate URLs and their characteristics to accurately identify phishing websites, including zero-hour websites.

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II. LITERATURE SURVEY

This section discussed some of the techniques based on lists, rules, visual similarity, and machine learning.

A. List-Based Phishing Detection Systems

This system uses two lists to classify phishing and non-phishing websites. These are called whitelists and blacklists. The white list includes websites that are safe and legitimate, while the black list includes websites that are classified as phishing. Researchers use whitelists to identify fishing grounds. In the search, access to the website is only possible if the URL is whitelisted. Another method is blacklisting. In addition to programs such as Google Safe Browsing API and Phish Net, there are also several studies using blacklists in the literature. In a blacklist-based system, the URL is checked against the list, and if it is not on the list, the URL can be accessed. The biggest weakness of this system is that small changes in URLs prevent them from matching in the list. In addition, the latest attacks, known as zero-day attacks, cannot be caught by this defense system.

B. Machine Learning-Based Phishing Detection Systems

In the machine learning-based phishing detection system, the detection of phishing websites is based on the classification of special features using several artificial intelligence techniques. Author [4 & 5] URL attribute, domain name, website attribute or website content, etc. It is created by collecting in different categories like User Security has become popular because of its dynamic structure, especially to detect anomalies on the web page. In the paper written by the author [6], it was observed that a higher level of accuracy could be achieved by reviewing previous studies and using different features. Unlike previous studies, the new study is based on features selected and coded from a larger number of features. 58 features were identified by URL analysis. Accuracy rate and training time of different algorithm models compared with machine learning methods.

III. PROPOSED RESULT AND DISCUSSIONS

In this post, we aim to implement a phishing detection system by analyzing website URLs. URL is a complex string that represents a syntactic and semantic expression for a resource on the Internet. In more detail, the URL structure is shown in Figure 3. In its most basic form: <protocol>: //<hostname><URL> is detailed as follows in its complex form.

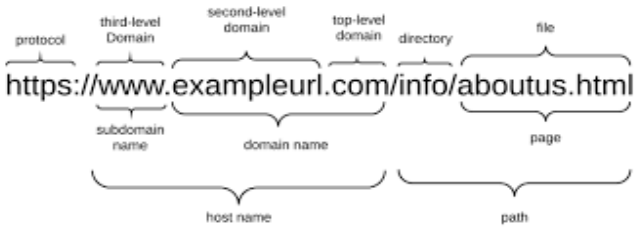


Fig. 3. From [3]

Domain, subdomain, Top Level Domain (TLD), protocol, directory, filename, path, and request fields allow you to create different URLs. These related fields in phishing URLs are different from legitimate fields on web pages. Therefore, the URL plays an important role in detecting phishing attacks, especially for quickly classifying a website. In the literature review by the author [7], it was observed that effective features extracted from URLs improve classification accuracy. In addition, the use of third-party services, site layout, CSS, content, meta data, etc. feature can also improve accuracy. However, these features will increase the classification time of new websites that need to be classified. It is expected that the proposed model, which is only trained with URL derived features, will cluster faster than other models. Given this information, only URL analysis is planned in the study. Therefore, in machine learning, the results of feature classification obtained by different algorithms are compared. In addition, the results of another study with the same database compared to the results of the current study.

C. Datasets

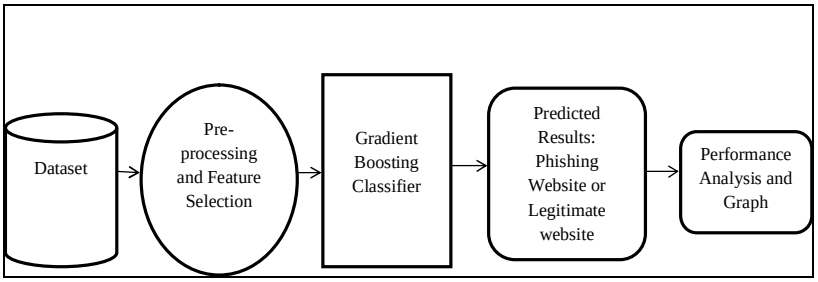
Phistank.com is a site where phishing URLs are found and accessed via API calls. This is an organization whose data is used by companies such as Yahoo Mail, McAfee, APWG, Mozilla, Opera, Kaspersky and Avira. In the literature review, it was observed that the phishing data used in the machine learning method was generally obtained from Phistank.com. Does the classification need the previous website address? It also provides information on positive/negative classification (phishing/non-phishing). However, it does not store website content; so it's a good resource for URL-based analysis.

This article uses open source and accessible databases. We prefer open databases for comparative studies. Three databases are used in this paper, and the researcher named the system Catch Phish [8]. The first of these databases: legitimate sites from the Alexa database and phishing sites from Phish Tank. Second: The legitimate site of public surfing and fishing from Phish Tank. Third: [9] Legitimate sites from regular crawling and Alexa database, Phishing site from Phish Tank. The number of URLs in this database is given in Table I.

TABLE I.

Categories	Dataset-1	Dataset-2	Dataset-3
Phishing	40,666	40,768	40,678
Not Phishing	43,178	42,820	85,809
Total	83,865	82,188	128,07

D. System Design (Diagram)



E. Sytem Study

Feasibility Study

The performance of the project is analyzed at this stage and the business proposal is followed with a general plan for the project and some costs. During system analysis, a feasibility study of the proposed system should be conducted. This is to ensure that the proposed system does not become a burden on the company. A feasibility study requires some understanding of the basic requirements for the system.

Three key considerations involved in the feasibility analysis are:

1) *Economical Feasibility:* This study was conducted to investigate the economic impact of the system on the organization. The amount of funds a company can invest in system research and development is limited. The cost must be correct. Therefore, this advanced system is implemented in the budget and this is achieved because most of the technology used is freely available. He just needs to buy a specific product.
2) *Technical Feasibility:* This study was conducted to check the technical feasibility, i.e. the technical requirements of the system. Any system developed should not place high demands on available technical resources. This will place high demands on available technical resources. This will result in higher demands being placed on the customer. A mature system should have minimal requirements, as only minimal or trivial changes are required to implement the system.
3) *Social Feasibility:* The research aspect is to check the level of acceptance of the system by the users. It involves the process of training users to use the system effectively. The user should not be threatened by the system, but should be treated as a necessity. The level of user acceptance depends solely on the method used to educate and introduce the system to users. His confidence level needs to be raised so that he can make some constructive criticism that is welcomed as an end user of the system.

IV. SYSTEM TESTING

The purpose of testing is to detect errors. Testing is an effort to detect every error or weakness in a work product. It provides a method to verify the functionality of components, subassemblies, assemblies, and/or finished products.

The software system meets the requirements and needs of the users and does not fail without acceptance. There are several types of tests. Each type of test provides specific test requirements.

A. Integration Testing

Software integration testing is an incremental integration test of two or more software applications integrated on one platform to produce failures caused by interface defects.

The purpose of integration testing is to verify the availability of components or software. software components or step-up - enterprise-grade software - for error-free interoperability.

- *Test Results:* All the test cases mentioned above passed successfully. No defects were encountered.

B. Acceptance Testing

User acceptance testing is an important phase of any project and requires significant involvement of end users. It also ensures that the system meets the functional requirements.

V. CONCLUSIONS

In recent years, due to the evolving technologies on networking not only for traditional web applications but also for mobile and social networking tools, phishing attacks have become one of the important threats in cyberspace. Although most security attacks target system vulnerabilities, phishing exploits the vulnerabilities of human end-users. Therefore, the main defense form for the companies is informing the employees about this type of attack. However, security managers can get some additional protection mechanisms that can be executed either as a decision support system for the user or as a prevention mechanism on the servers.

In this paper, we aimed to implement a phishing detection system by using some machine learning algorithms specifically Random Forest Algorithm and RNN. The proposed systems are tested with some recent datasets in the literature and reached results are compared with the newest works in the literature. The comparison results show that the proposed systems enhance the efficiency of phishing detection and reach very good accuracy rates. As future works, firstly, it aims to create a new and huge dataset for URL-based Phishing Detection Systems to create a safe, user-friendly environment that can detect illegitimate activities.

It is possible to report and block a hacker using a phishing website URL and tracing the location of such anonymous hackers as suggested by **Author [10]**. Awareness can be created among users by displaying a certain type of Phishing URLs available or causing more harm to our system like zero-hour phishing websites.

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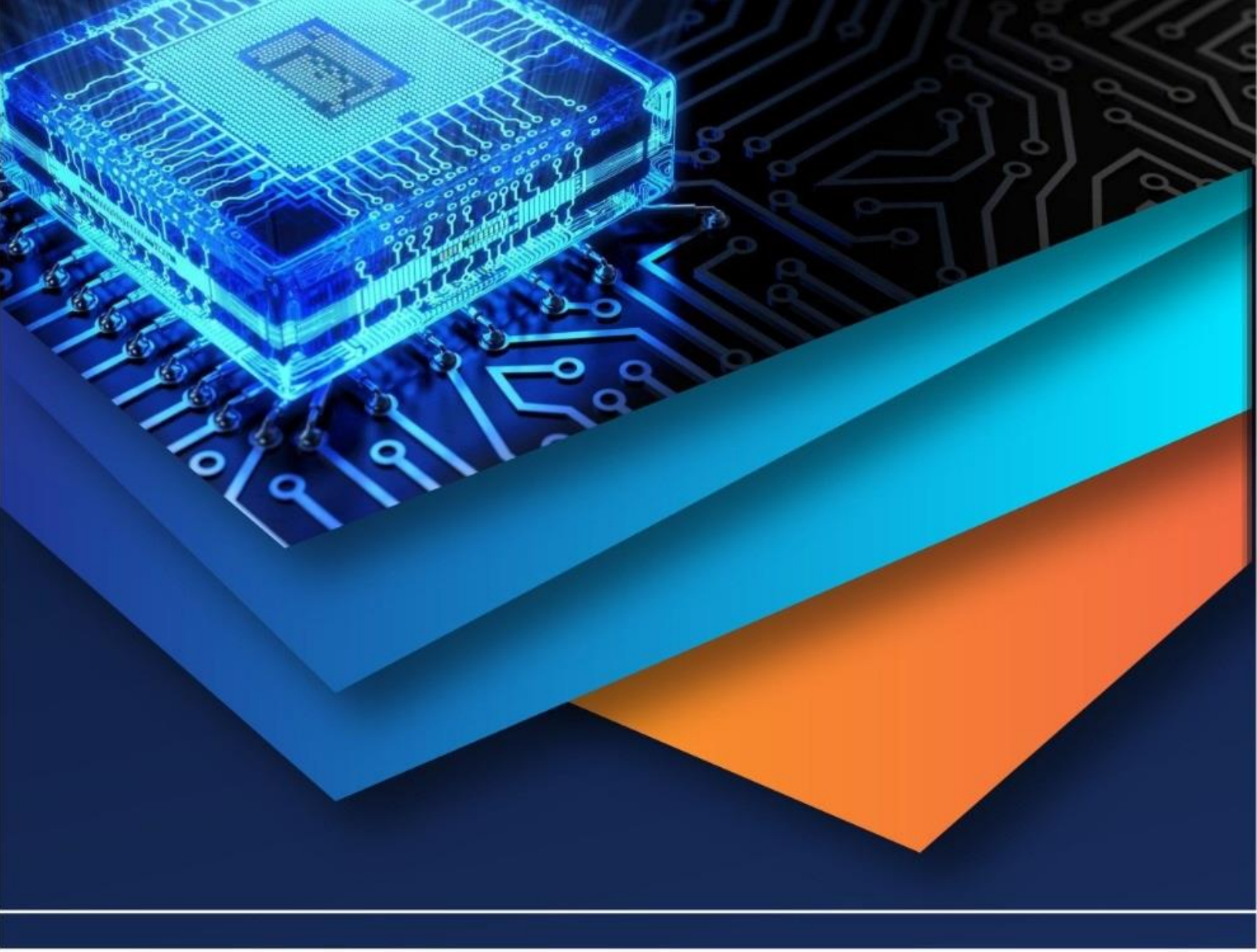

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