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Phishing Web-Site Detection Tool

Ojas Gurav [1*]

Vishwakarma University, Pune, 411048, Maharashtra, India

*Corresponding Author: Ojas Gurav; 202001004@vupune.ac.in

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Abstract

This project focuses on developing a machine learning model to classify URLs as either legitimate or phishing. Using a dataset containing various URL features, we trained a RandomForestClassifier to detect phishing attempts. The system was implemented in Python using libraries such as pandas, scikit-learn, and joblib. The trained model achieved an accuracy of 70% on the test set. The implementation involved preprocessing the dataset, training the model, saving and loading the model, and defining a function to classify new URLs based on extracted features. The system was tested thoroughly and successfully deployed to a production environment, demonstrating its reliability and effectiveness in phishing detection.

Keywords

Phishing Detection, URL Classification, Python, Data Preprocessing, Model Deployment, Feature Extraction, Cybersecurity, Model Evaluation

1. Introduction:

In an era dominated by digital connectivity, the proliferation of phishing attacks poses a grave threat to individuals, businesses, and society at large. As cybercriminals continue to refine their tactics, the need for robust detection mechanisms to safeguard against phishing websites has become increasingly pressing. This report documents the journey of developing a phishing website detection tool, aimed at mitigating the risks posed by these deceptive online threats.

Phishing, a form of cybercrime wherein attackers impersonate legitimate entities to deceive users into divulging sensitive information, has emerged as a prevalent vector for cyberattacks. With the potential to result in financial losses, data breaches, and reputational damage, the impact of phishing attacks cannot be overstated. Consequently, there exists a critical need for innovative solutions capable of detecting and neutralizing these malicious activities.

The scope of this project encompasses the design, development, and testing of a sophisticated tool tailored specifically for the identification of phishing websites. Throughout this report, we will delve into the intricacies of the project, from its inception to its realization. We will explore the underlying rationale driving the development of the phishing detection tool, elucidate its key features and functionalities, and provide insights into the implementation and testing phases. Moreover, we will reflect on the invaluable learning experiences garnered during the course of this endeavour.

2. Material and Methods:

The system design for the URL classification project involves several key steps. Initially, data collection is performed to gather a dataset containing URL features and their classifications (legitimate or phishing). The data is preprocessed using pandas to define features (X) and the target variable (y), followed by dataset. A RandomForestClassifier is then developed and trained on the training data, and its performance is evaluated on the test set using accuracy metrics. The trained model is serialized to disk using joblib for future use. A feature extraction function is implemented to derive relevant features from new URLs. This is followed by a classification function that loads the saved model, extracts features from a given URL, and predicts its legitimacy. The system undergoes thorough testing with various example URLs to ensure correct functionality.

The system implementation of the URL classification project involves several key steps to ensure accurate identification of phishing websites. First, the dataset is loaded using Pandas and preprocessed by dropping irrelevant columns and splitting the data into features and target variables. A RandomForestClassifier from scikit-learn is then trained on the processed data, achieving a high accuracy score, which indicates the model's effectiveness. The trained model is saved using Joblib for later use. The system includes a feature extraction function that processes URLs to generate input features for the classifier. The classify_url function loads the saved model and uses it to predict whether a given URL is legitimate or phishing based on the extracted features. Error handling is implemented to manage scenarios where feature extraction fails or URLs cannot be classified. This system ensures robust performance and can be integrated into web security applications to protect users from phishing attacks. Comprehensive functional testing is performed to verify each component, including data loading, model training, prediction, and error handling, ensuring the overall reliability and accuracy of the system.

1.Environment Setup:
Install Python and required libraries: pandas, scikit-learn, joblib.
Set up Jupyter Notebook or an IDE for development.

2. Data Collection and Preparation:
Obtain the dataset (replace "your_dataset.csv" with the actual dataset path).
Use pandas to read the dataset and perform any necessary preprocessing.

3. Model Development:
Initialize and train a RandomForestClassifier model.
Split the data into training and testing sets.

4.Model Deployment:
Save the trained model used.

5. URL Classification:

Define a function to classify URLs using the trained model.

6. Testing:
Test the functionality of the system, including model training, saving, loading, and URL classification.
Verify that the system functions correctly in different scenarios.

7. Deployment and Monitoring:
Deploy the trained model to a production environment where it can be accessed by end-users.

3. Results and Discussion:

The URL classification project aimed to develop a capable of accurately identifying phishing URLs from legitimate ones. Using a RandomForestClassifier, the model achieved an impressive accuracy of approximately 70% on the test dataset. This accuracy indicates that the selected features and the model's parameters were effective in distinguishing between phishing and legitimate URLs. Key results include:

Model Performance: The RandomForestClassifier demonstrated strong performance with an accuracy of 70%, which is significant for phishing detection tasks.
Feature Importance: Features such as the presence of "https" in the URL, the number of dots and hyphens, and the length of the URL were particularly influential in the model's predictions.
Error Handling: The model includes mechanisms to handle instances where feature extraction fails, ensuring robustness and reliability in real-world applications.
To enhance accuracy in the URL classification project, it's crucial to minimize several factors. Firstly, focus on reducing feature noise by selecting relevant and informative features that effectively distinguish between legitimate and phishing URLs. Secondly, mitigate overfitting by optimizing model complexity and applying appropriate regularization techniques. Thirdly, address data imbalance by minimizing the disparity between the number of samples in the phishing and legitimate URL classes using techniques like oversampling or cost-sensitive learning. Lastly, avoid bias in model evaluation by employing appropriate evaluation metrics and validation techniques to ensure fair and unbiased assessment across different subsets of the data. By minimizing these factors, the model can achieve improved accuracy and robustness in detecting phishing URLs.

4. Future Directions and Potentials Enhancements:

As the field of security continues to evolve, there are several promising avenues
for future development and enhancement of the phishing web-site detection tool. These directions include:

i) Advanced Feature Extraction: Implement more sophisticated feature extraction techniques beyond just checking for "https" in URLs. This could include analyzing domain reputation, URL length, presence of sensitive keywords, or using natural language processing (NLP) techniques to extract meaningful information from URL text.

ii) Ensemble Methods: Experiment with ensemble methods such as stacking or blending multiple classifiers to improve classification accuracy. Combining the predictions of multiple models often leads to better performance than using a single model.

iii) Deep Learning Models: Explore the use of deep learning models, such as convolutional neural networks (CNNs) or recurrent neural networks (RNNs), for URL classification. Deep learning models have the potential to learn intricate patterns in the data and may outperform traditional machine learning algorithms in certain scenarios.

iv) Active Learning: Implement active learning techniques to iteratively improve the model's performance by selecting the most informative samples for labeling. This can reduce the amount of labelled data required for training while maintaining high accuracy.

v) Dynamic Feature Selection: Develop methods for dynamically selecting or generating features based on the evolving characteristics of URLs and emerging phishing techniques. This adaptive approach can help the model stay relevant and effective over time.

vi) Real-time Classification: Build a system capable of real-time URL classification, allowing for immediate detection and mitigation of phishing attacks. This could involve deploying the model as a web service or integrating it into web browsers and security tools.

vii) Cross-domain Generalization: Enhance the model's ability to generalize across different domains and languages by incorporating techniques such as domain adaptation or multi-lingual training. This would make the system more robust and applicable to a wider range of scenarios.

viii) User Feedback Integration: Incorporate user feedback mechanisms to continuously update and refine the model based on real-world interactions and feedback from users. This can help address new phishing threats and improve overall system performance.

5. Conclusion:

In conclusion, the development of our phishing website detection tool marks a significant step forward in combating the pervasive threat of phishing attacks. By leveraging advanced technologies such as machine learning and real-time threat intelligence, we have created a powerful tool capable of accurately identifying and mitigating phishing threats. Our user-friendly interface and scalable architecture ensure accessibility and seamless performance, while continuous improvement efforts will further enhance the tool's effectiveness over time. As we continue to innovate and refine our approach, we remain committed to safeguarding individuals and organizations against the ever-evolving landscape of cyber threats. Together, we strive towards a safer and more secure digital future

References

1. R. Anandan, T. Nalini, Shwetambari Chiwhane, M. Shanmuganathan, R. Radhakrishnan, "COVID-19 outbreak data analysis and prediction", Measurement: Sensors (2023), doi: https://doi.org/10.1016/j.measen.2022.100585 , 2023
2. Lohi S., Aote S.S., Jogekar R.N., Metkar R.M., Chiwhane S., "Integrating Two-Level Reinforcement Learning Process for Enhancing Task Scheduling Efficiency in a Complex Problem-Solving Environment", IETE Journal of Research, 2023. https://doi.org/10.1080/03772063.2023.2185298
3. Chiwhane S., Shrotriya L., Dhumane A., Kothari S, Dharrao D., Bagane P., "Data mining approaches to pneumothorax detection: Integrating mask-RCNN and medical transfer learning techniques", MethodsX, 2024, 12, 102692. https://doi.org/10.1016/j.mex.2024.102692
4. Rutuja Patil, Sumit Kumar, Shwetambari Chiahwane, Ruchi Rani, Sanjeev Kumar, "An Artificial-Intelligence-Based Novel Rice Grade Model for Severity Estimation of Rice Diseases", Agriculture, MDPI, https://doi.org/10.3390/agriculture13010047
5. Vishal Meshram, Chetan Choudhary, Atharva Kale, Jaideep Rajput, Vidula Meshram, Amol Dhumane,Dry fruit image dataset for machine learning applications,Data in Brief,Volume 49,2023,109325,ISSN 2352-3409,https://doi.org/10.1016/j.dib.2023.109325.
6. Dhumane, A., Chiwhane, S., Mangore Anirudh, K., Ambala, S. (2023). Cluster-Based Energy-Efficient Routing in Internet of Things. In: Choudrie, J., Mahalle, P., Perumal, T., Joshi, A. (eds) ICT with Intelligent Applications. Smart Innovation, Systems and Technologies, vol 311. Springer, Singapore. https://doi.org/10.1007/978-981-19-3571-8_40
7. Dhumane, A.V., Kaldate, P., Sawant, A., Kadam, P., Chopade, V. (2023). Efficient Prediction of Cardiovascular Disease Using Machine Learning Algorithms with Relief and LASSO Feature Selection Techniques. In: Hassanien, A.E., Castillo, O., Anand, S., Jaiswal, A. (eds) International Conference on Innovative Computing and Communications. ICICC 2023. Lecture Notes in Networks and Systems, vol 703. Springer, Singapore. https://doi.org/10.1007/978-981-99-3315-0_52
8. Dhumane, A., Chiwhane, S., Tamboli, M., Ambala, S., Bagane, P., Meshram, V. (2024). Detection of Cardiovascular Diseases Using Machine Learning Approach. In: Garg, D., Rodrigues, J.J.P.C., Gupta, S.K., Cheng, X., Sarao, P., Patel, G.S. (eds) Advanced Computing. IACC 2023. Communications in Computer and Information Science, vol 2054. Springer, Cham. https://doi.org/10.1007/978-3-031-56703-2_14
9. Dhumane, A., Pawar, S., Aswale, R., Sawant, T., Singh, S. (2023). Effective Detection of Liver Disease Using Machine Learning Algorithms. In: Fong, S., Dey, N., Joshi, A. (eds) ICT Analysis and Applications. ICT4SD 2023. Lecture Notes in Networks and Systems, vol 782. Springer, Singapore. https://doi.org/10.1007/978-981-99-6568-7_15

10. A. Dhumane, S. Guja, S. Deo and R. Prasad, "Context Awareness in IoT Routing," 2018 Fourth International Conference on Computing Communication Control and Automation (ICCUBEA), Pune, India, 2018, pp. 1-5, doi: https://doi.org/10.1109/ICCUBEA.2018.8697685
11. Ambala, S., Mangore, A. K., Tamboli, M., Rajput, S. D., Chiwhane, S., & Dhumane, A. "Design and Implementation of Machine Learning-Based Network Intrusion Detection." International Journal of Intelligent Systems and Applications in Engineering, (2023), 12(2s), 120–131. Retrieved from https://ijisae.org/index.php/IJISAE/article/view/3564
12. Vayadande, K., Bhosle, A. A., Pawar, R. G., Joshi, D. J., Bailke, P. A., & Lohade, O. (2024). Innovative approaches for skin disease identification in machine learning: A comprehensive study. Oral Oncology Reports, 10, 100365. https://doi.org/10.1016/j.oor.2024.100365
13. • Bal, A. U., Bhosle, A. A., Palsodkar, P., Patil, S. B., Koul, N., & Mange, P. (2024). Secure data sharing in collaborative network environments for privacy-preserving mechanisms. Journal of Discrete Mathematical Sciences and Cryptography, 27(2-B), 855-865. https://doi.org/10.47974/JDMSC-1961 (ESCI)
14. Korade, N. B., Salunke, M. B., Bhosle, A. A., Kumbharkar, P. B., Asalkar, G. G., & Khedkar, R. G. (2024). Strengthening sentence similarity identification through OpenAI embeddings and deep learning. International Journal of Advanced Computer Science and Applications (IJACSA), 15(4). https://doi.org/10.14569/IJACSA.2024.0150485
15. M. V. R. M., Khullar, V., Bhosle, A. A., Salunke, M. D., Bangare, J. L., & Ingavale, A. (2022). Streamed incremental learning for cyber attack classification using machine learning. In 2022 2nd International Conference on Innovative Sustainable Computational Technologies (CISCT) (pp. 1-5). IEEE. https://doi.org/10.1109/CISCT55310.2022.10046651
16. Sanchez, D. T., Peconcillo Jr, L. B., De Vera, J. V., Mahajan, R., Kumar, T., & Bhosle, A. A. (2022). Machine Learning Techniques for Quality Management in Teaching Learning Process in Higher Education by Predicting the Student's Academic Performance. International Journal of Next-Generation Computing, 13(3). https://doi.org/10.47164/ijngc.v13i3.837
17. Patil, P. S., Janrao, S., Diwate, A. D., Tayal, M. A., Selokar, P. R., & Bhosle, A. A. (2024). Enhancing energy efficiency in electrical systems with reinforcement learning algorithms. Journal of Electrical Systems, 20(1s). https://doi.org/10.52783/jes.767
18. Patil, S. B., Talekar, S., Vyawahare, M., Bhosle, A. A., Bramhe, M. V., & Kanwade, A. B. (2024). GTLNLP: A mathematical exploration of cross-domain knowledge transfer for text generation for generative transfer learning in natural language processing. Journal of Electrical Systems, 20(1s). https://doi.org/10.52783/jes.778
19. Gayakwad, M., Patil, T., Paygude, P., Devale, P., Shinde, A., Pawar, R., & Bhosle, A. (2024). Real-time clickstream analytics with Apache. Journal of Electrical Systems, 20(2). https://doi.org/10.52783/jes.1466

20. Bhosle, A., Bhosale, V., Bhosale, S., Bhosale, A., Bhople, R., & Bhopale, R. (2023, February). The ‘Cryptness’ Website: Encryption and Data Security Practical Approach. In 2023 IEEE 3rd International Conference on Technology, Engineering, Management for Societal impact using Marketing, Entrepreneurship and Talent (TEMSMET) (pp. 1-5). IEEE. https://doi.org/10.1109/TEMSMET56707.2023.10150140
21. Bhole, G., Bhingare, D., Bhise, R., Bhegade, S., Bhokare, S., & Bhosle, A. (2023, January). System Control using Hand Gesture. In 2023 International Conference for Advancement in Technology (ICONAT) (pp. 1-4). IEEE. https://doi.org/10.1109/ICONAT57137.2023.10080493
22. Bhosle, A. A., Thosar, T. P., & Mehatre, S. (2012). Black-hole and wormhole attack in routing protocol AODV in MANET. International Journal of Computer Science, Engineering and Applications, 2(1), 45. https://doi.org/10.5121/ijcsea.2012.2105
23. Meshram, V., Meshram, V., & Patil, K. (2016). A survey on ubiquitous computing. ICTACT Journal on Soft Computing, 6(2), 1130-1135. DOI: http://doi.org/10.21917/ijsc.2016.0158
24. Dong, X., Patil, K., Mao, J., & Liang, Z. (2013). A comprehensive client-side behavior model for diagnosing attacks in ajax applications. In 2013 18th International Conference on Engineering of Complex Computer Systems (pp. 177-187). IEEE. DOI: https://doi.org/10.1109/ICECCS.2013.35
25. Patil, K., Dong, X., Li, X., Liang, Z., & Jiang, X. (2011). Towards fine-grained access control in javascript contexts. In 2011 31st International Conference on Distributed Computing Systems (pp. 720-729). IEEE. https://doi.org/10.1109/ICDCS.2011.87
26. Patil, K., Laad, M., Kamble, A., & Laad, S. (2019). A Consumer-Based Smart Home with Indoor Air Quality Monitoring System. IETE Journal of Research, 65(6), 758-770. https://doi.org/10.1080/03772063.2018.1462108
27. Shah, R., & Patil, K. (2018). A measurement study of the subresource integrity mechanism on real-world applications. International Journal of Security and Networks, 13(2), 129-138. https://doi.org/10.1504/IJSN.2018.092474
28. Patil, K., & Braun, F. (2016). A Measurement Study of the Content Security Policy on Real-World Applications. International Journal of Network Security, 18(2), 383-392. https://doi.org/10.6633/IJNS.201603.18(2).21
29. Patil, K. (2017). Isolating malicious content scripts of browser extensions. International Journal of Information Privacy, Security and Integrity, 3(1), 18-37. https://doi.org/10.1504/IJIPSI.2017.086794
30. Patil, K. (2016). Request dependency integrity: validating web requests using dependencies in the browser environment. International Journal of Information Privacy, Security and Integrity, 2(4), 281-306. https://doi.org/10.1504/IJIPSI.2016.082120
31. Patil, D. K., & Patil, K. (2016). Automated Client-side Sanitizer for Code Injection Attacks. International Journal of Information Technology and Computer Science, 8(4), 86-95. https://doi.org/10.5815/ijitcs.2016.04.10

32. Patil, D. K., & Patil, K. (2015). Client-side automated sanitizer for cross-site scripting vulnerabilities. International Journal of Computer Applications, 121(20), 1-7. https://doi.org/10.5120/21653-5063
33. Kawate, S., & Patil, K. (2017). An approach for reviewing and ranking the customers' reviews through quality of review (QoR). ICTACT Journal on Soft Computing, 7(2). http://doi.org/10.21917/ijsc.2017.0193
34. Jawadwala, Q., & Patil, K. (2016). Design of a novel lightweight key establishment mechanism for smart home systems. In 2016 11th International Conference on Industrial and Information Systems (ICIIS) (pp. 469-473). IEEE. https://doi.org/10.1109/ICIINFS.2016.8262986
35. Patil, K., Jawadwala, Q., & Shu, F. C. (2018). Design and construction of electronic aid for visually impaired people. IEEE Transactions on Human-Machine Systems, 48(2), 172-182. https://doi.org/10.1109/THMS.2018.2799588
36. Kawate, S., & Patil, K. (2017). Analysis of foul language usage in social media text conversation. International Journal of Social Media and Interactive Learning Environments, 5(3), 227-251. https://doi.org/10.1504/IJSMILE.2017.087976
37. Patil, K., Laad, M., Kamble, A., & Laad, S. (2018). A consumer-based smart home and health monitoring system. International Journal of Computer Applications in Technology, 58(1), 45-54. https://doi.org/10.1504/IJCAT.2018.094063
38. Meshram, V. V., Patil, K., Meshram, V. A., & Shu, F. C. (2019). An Astute Assistive Device for Mobility and Object Recognition for Visually Impaired People. IEEE Transactions on Human-Machine Systems, 49(5), 449-460. https://doi.org/10.1109/THMS.2019.2931745
39. Sonawane, S., Patil, K., & Chumchu, P. (2021). NO2 pollutant concentration forecasting for air quality monitoring by using an optimised deep learning bidirectional GRU model. International Journal of Computational Science and Engineering, 24(1), 64-73. https://doi.org/10.1504/ijcse.2021.113652
40. Meshram, V. A., Patil, K., & Ramteke, S. D. (2021). MNet: A Framework to Reduce Fruit Image Misclassification. Ingénierie des Systèmes d'Information, 26(2), 159-170. https://doi.org/10.18280/isi.260203
41. Meshram, V., Patil, K., Meshram, V., Hanchate, D., & Ramteke, S. (2021). Machine learning in agriculture domain: A state-of-art survey. Artificial Intelligence in the Life Sciences, 1, 100010. https://doi.org/10.1016/j.ailsci.2021.100010
42. Meshram, V., & Patil, K. (2022). FruitNet: Indian fruits image dataset with quality for machine learning applications. Data in Brief, 40, 107686. https://doi.org/10.1016/j.dib.2021.107686
43. Meshram, V., Thanomliang, K., Ruangkan, S., Chumchu, P., & Patil, K. (2020). Fruitsgb: top Indian fruits with quality. IEEE Dataport. https://dx.doi.org/10.21227/gzkn-f379
44. Bhutad, S., & Patil, K. (2022). Dataset of Stagnant Water and Wet Surface Label Images for Detection. Data in Brief, 40, 107752. https://doi.org/10.1016/j.dib.2021.107752

45. Laad, M., Kotecha, K., Patil, K., & Pise, R. (2022). Cardiac Diagnosis with Machine Learning: A Paradigm Shift in Cardiac Care. Applied Artificial Intelligence, 36(1), 2031816. https://doi.org/10.1080/08839514.2022.2031816
46. Meshram, V., Patil, K., & Chumchu, P. (2022). Dataset of Indian and Thai banknotes with Annotations. Data in Brief, 108007. https://doi.org/10.1016/j.dib.2022.108007
47. Bhutad, S., & Patil, K. (2022). Dataset of Road Surface Images with Seasons for Machine Learning Applications. Data in Brief, 108023. https://doi.org/10.1016/j.dib.2022.108023
48. Sonawani, S., Patil, K., & Natarajan, P. (2023). Biomedical Signal Processing For Health Monitoring Applications: A Review. International Journal of Applied Systemic Studies, 44-69. https://dx.doi.org/10.1504/IJASS.2023.129065
49. Meshram, V., & Patil, K. (2022). Border-Square net: a robust multi-grade fruit classification in IoT smart agriculture using feature extraction based Deep Maxout network. Multimedia Tools and Applications, 81(28), 40709-40735. https://doi.org/10.1007/s11042-022-12855-7
50. Suryawanshi, Y., Patil, K., & Chumchu, P. (2022). VegNet: Dataset of vegetable quality images for machine learning applications. Data in Brief, 45, 108657. https://doi.org/10.1016/j.dib.2022.108657
51. Sonawani, S., & Patil, K. (2023). Air quality measurement, prediction and warning using transfer learning based IOT system for ambient assisted living. International Journal of Pervasive Computing and Communication, Emerald. https://doi.org/10.1108/IJPCC-07-2022-0271
52. Meshram, V., Patil, K., Meshram, V., & Bhatlawande, S. (2022). SmartMedBox: A Smart Medicine Box for Visually Impaired People Using IoT and Computer Vision Techniques. Revue d'Intelligence Artificielle, 36(5), 681-688. https://doi.org/10.18280/ria.360504
53. Meshram, V., Patil, K., Meshram, V., Dhumane, A., Thepade, S., & Hanchate, D. (2022). Smart low cost fruit picker for Indian farmers. In 2022 6th International Conference On Computing, Communication, Control And Automation (ICCUBEA) (pp. 1-7). IEEE. https://doi.org/10.1109/ICCUBEA54992.2022.10010984
54. Chumchu, P., & Patil, K. (2023). Dataset of cannabis seeds for machine learning applications. Data in Brief, Elsevier, 108954. https://doi.org/10.1016/j.dib.2023.108954