Using Machine Learning to predict whether bitcoin transactions are associated with ransomware

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Introduction

- Ransomware in becoming highly publicized and is increasing in frequency
- Machines can be rendered useless when encrypted, locking out the user. This can be problematic if the computers are running critical infrastructure, or something vital to national security.
- The payments sent to the attacker for the decryption key are always in the form of cryptocurrency, Bitcoin in particular.
- I will use machine learning techniques to produce a model that predicts whether particular bitcoin transactions are being used as a ransomware payment

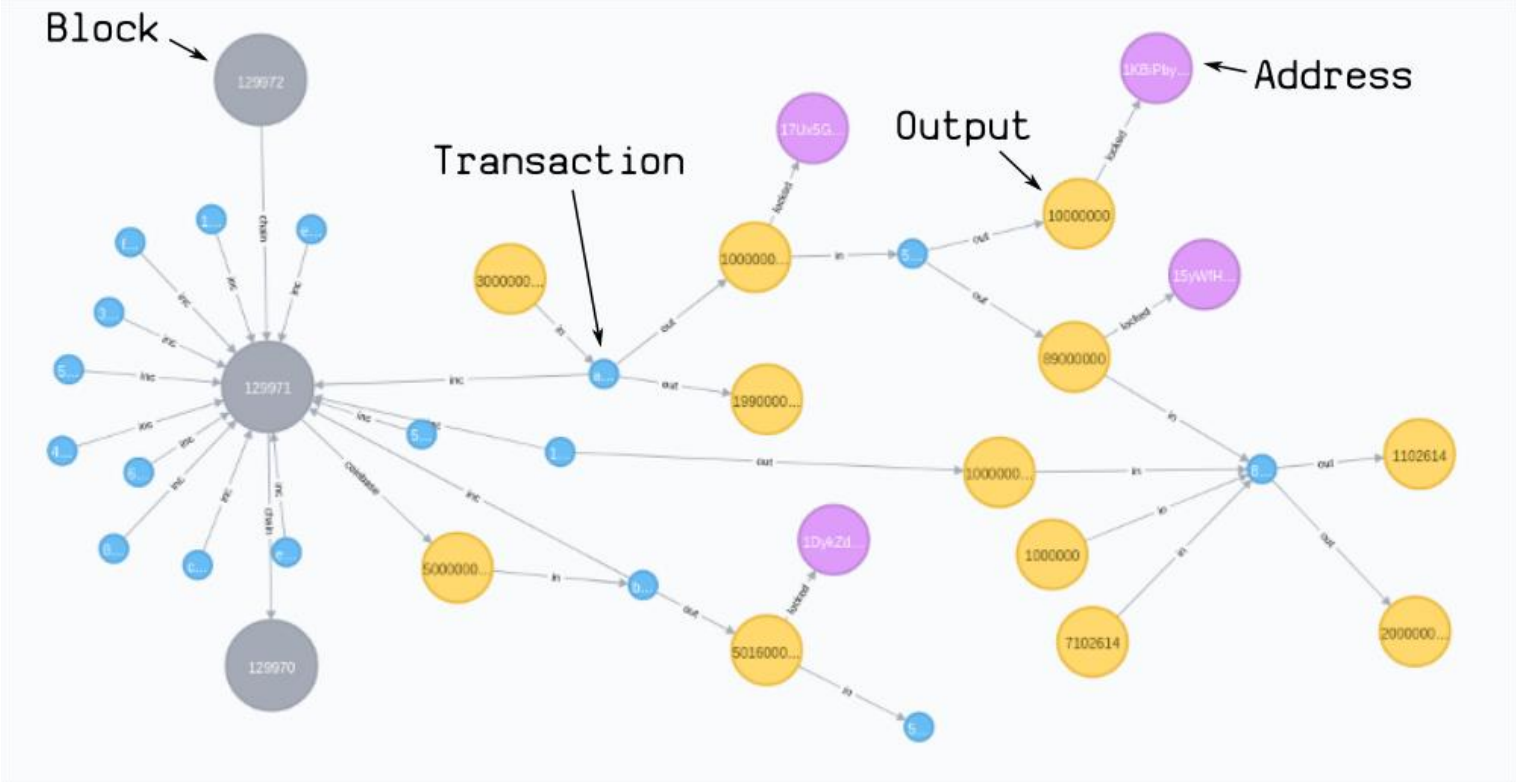


Fig 1: Bitcoin Transaction Graph

Problem Statement

Given a bitcoin payment transaction along with the data pertaining to its node in the bitcoin graph, the goal is to predict if the payment is associated with a ransomware payment. The graph features are designed to quantify specific transaction patterns (Akcora et al., UCI, 2020). These predictors will be used in several classification algorithms in order to classify each transaction as either a ransomware payment, or not.

Data

address: String. Bitcoin address
year: int. Year
day: int. Day of the year. 1 is the first day, 365 is the last
length: int. Length is designed to quantify mixing rounds on Bitcoin, where transactions receive and distribute similar amounts of coins in multiple rounds with newly created addresses to hide the coin origin (Chandrasekharuni, 2021).
weight: float. Weight quantifies the merge behavior (i.e., the transaction has more input addresses than output addresses), where coins in multiple addresses are each passed through a succession of merging transactions and accumulated in a final address (Chandrasekharuni, 2021).
count: int. Similar to weight, the count feature is designed to quantify the merging pattern. However, the count feature represents information on the number of transactions, whereas the weight feature represents information on the amount of transaction (Chandrasekharuni, 2021).
looped: int. Loop is intended to count how many transactions i) split their coins; ii) move these coins in the network by using different paths and finally, and iii) merge them in a single address. Coins at this final address can then be sold and converted to fiat currency (Chandrasekharuni, 2021).
neighbors: int. Indicates the number of neighbors a transaction had (Chandrasekharuni, 2021).

income: int. Income in terms of Satoshi amount where a Satoshi is the smallest unit of a bitcoin, equivalent to 100 millionth of a bitcoin (Chandrasekharuni, 2021).

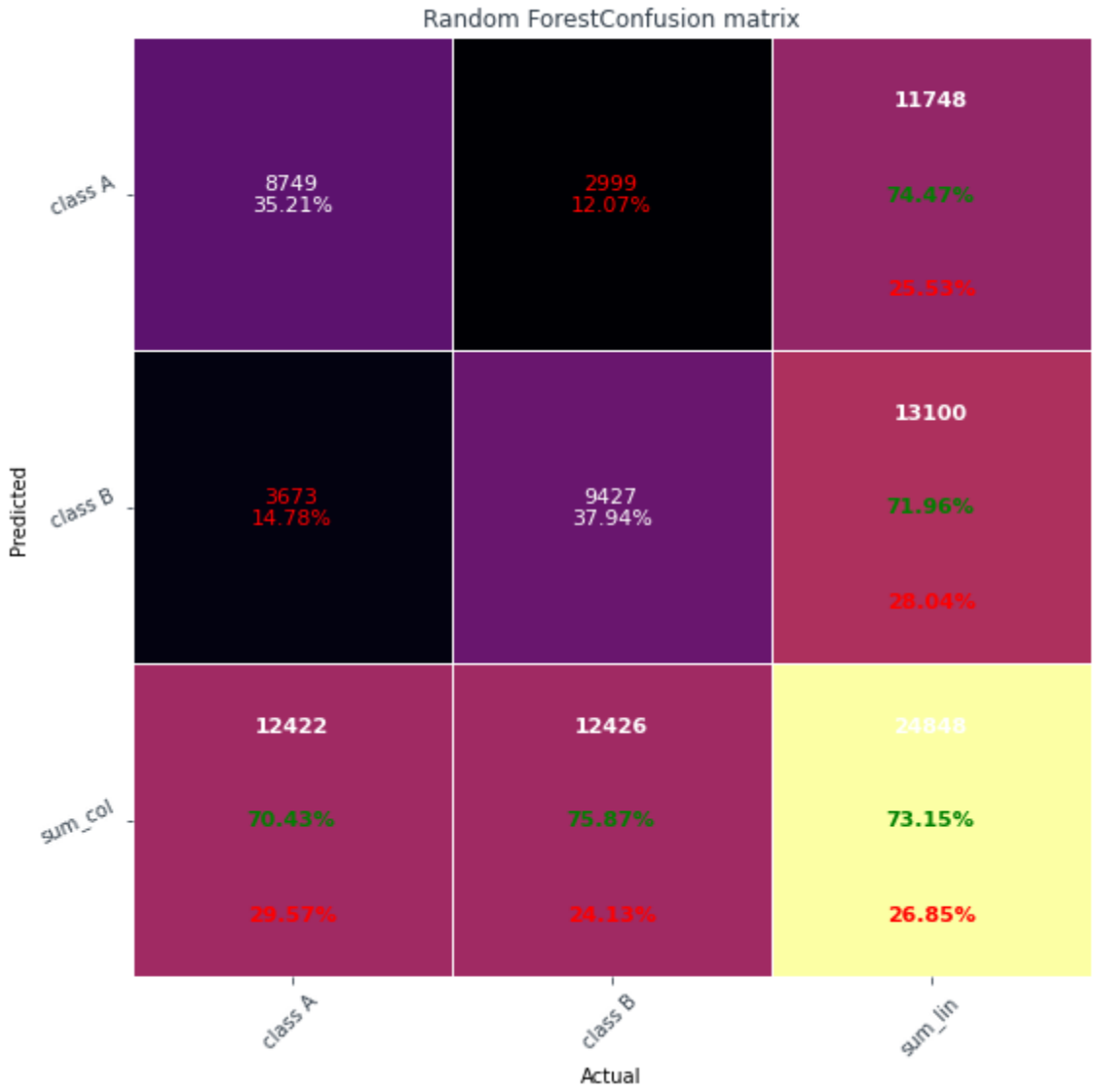
Methods

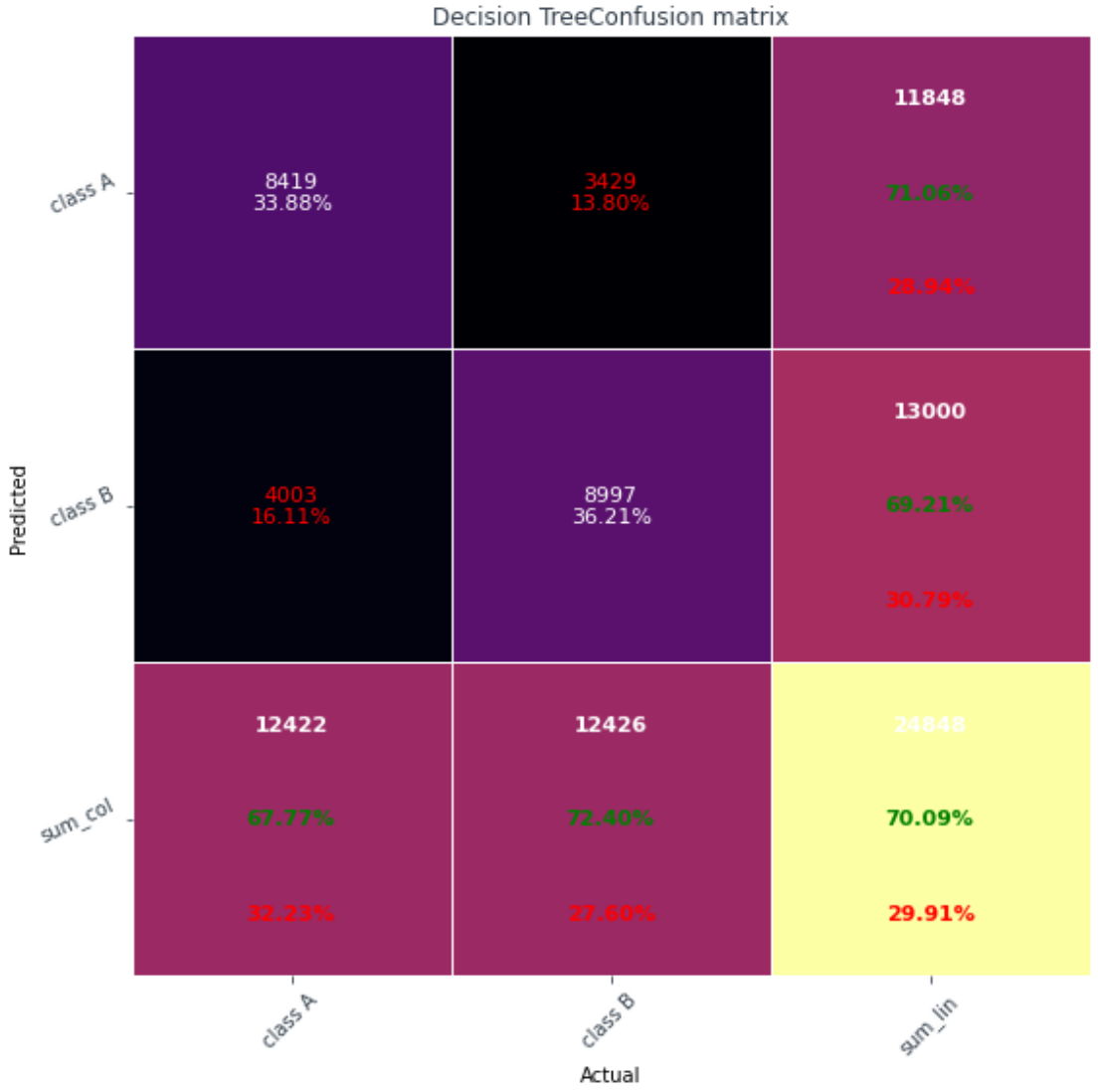
- Python : Scikit-learn, pandas, matplotlib, prettytable
  - DecisionTreeClassifier
  - RandomForestClassifier
  - GaussianNB
  - Support Vector Machine - SVC (polynomial & radial basis function kernel)
- 10-fold cross validation
- accuracy, CV score, F1 score, precision and recall
- Confusion Matrix

Results

Model Name	Accuracy	CV Score	F1-Score	Precision	Recall
Decision Tree	70%	0.70	0.707	0.69	0.72
Random Forest	73%	0.69	0.740	0.72	0.76
Naive Bayes	51%	0.69	0.669	0.50	N/A
SVM (polynomial)	55%	0.53	N/A	N/A	N/A
SVM (RBF)	52%	0.53	N/A	N/A	N/A

Confusion Matrix





Conclusion

- The results show that all of the models performed with an accuracy better than guessing, some significantly better. The Random Forest (50 Decision Trees) performed the best, predicting ransomware bitcoin transactions with an accuracy of 73%, a cross validation score (10-fold) of 0.70, F1 score of 0.74, Precision of 0.72, and a Recall of 0.76. The Random Forest outperformed all other models in every evaluation metric. The Decision Tree was second with an accuracy of 70%. Next was the SVM (polynomial kernel) at 54%, then SVM (rbf) at 52%, and the Naïve Bayes Classifier at 50%, the same as blind guessing. Overall, I think these results are promising and I believed they can be improved with hyperparameter tuning, but still can be applied to the problem of predicting ransomware bitcoin transactions.

References

- Chandrasekharuni, Yogesh (2021). Using AI to detect Bitcoin addresses involved in ransomware transactions. Analytics Vidya. Using AI to detect Bitcoin addresses involved in ransomware transactions | by Yogesh Chandrasekharuni | Analytics Vidhya | Medium

- Al-Haija, Q. A., & Alsulami, A. A. (2021). High Performance Classification Model to Identify Ransomware Payments for Heterogeneous Bitcoin Networks. *Electronics*, *10*(17), 2113. Electronics | Free Full-Text | High Performance Classification Model to Identify Ransomware Payments for Heterogeneous Bitcoin Networks (mdpi.com)

- [Data] UCI Machine Learning Repository. Accessed 2021. UCI Machine Learning Repository: BitcoinHeistRansomwareAddressDataset Data Set

- [Fig 1] Bitcoin Transaction Graph. neo4j-bitcoin.png (1000×521)


The End