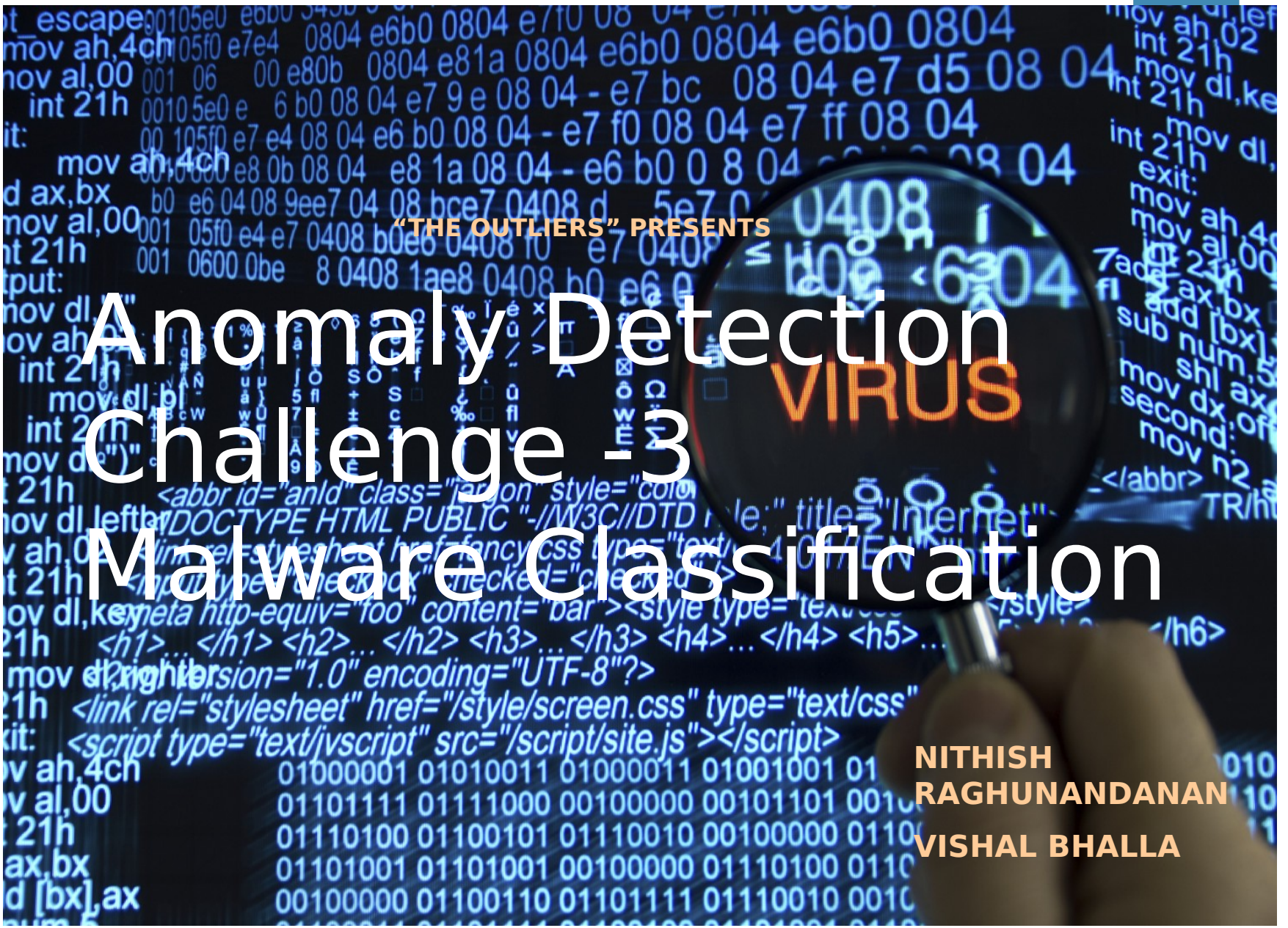


Picture courtesy One's and Zero's IT Solutions

Agenda

- Introduction
- System Pipeline
- Data Preprocessing & Analysis
- Feature Engineering
- Model - Tuning & Evaluation
- Kaggle Results
- Conclusion
- Key Takeaways

Introduction

- Aim: Classify malware into predefined families (0...9) or outlier (10).
- Problem Type: Multi-class Classification
- Samples
  - Training Set: 2056 (1627 after Removal of Missing Training Data)
  - Test Set: 1676
- Number of Features: PE Info(Static Analysis) and VT Info(Antivirus Signatures)
- Classification
  - There are 11 decision classes: 0 to 10.

System Pipeline

- Data Visualization
  - Tabulate & analyse the structure of the data.
- Feature Selection
  - Encoding selected parts of the data as features.
- Evaluation of Models
  - Classification accuracy using K Fold Stratified Cross Validation.

Data Preprocessing

- Removal of Missing Training Samples
  - No Static Analysis and Anti Virus Signatures for 429 samples of the training set
  - Removed the training samples from the training phase

Data Analysis

- PE Info
  - Multiple pe_section, pe_resources, pe_import, pe_timestamp, rich_header sections per sample.
    - Sample File
  - Analysis of Sections
    - Analysis
- VT Info
  - Single Signature for some of the 75 Anti Viruses per sample.
    - Sample File
  - Frequency Analysis for Anti Virus Signatures.
    - Analysis

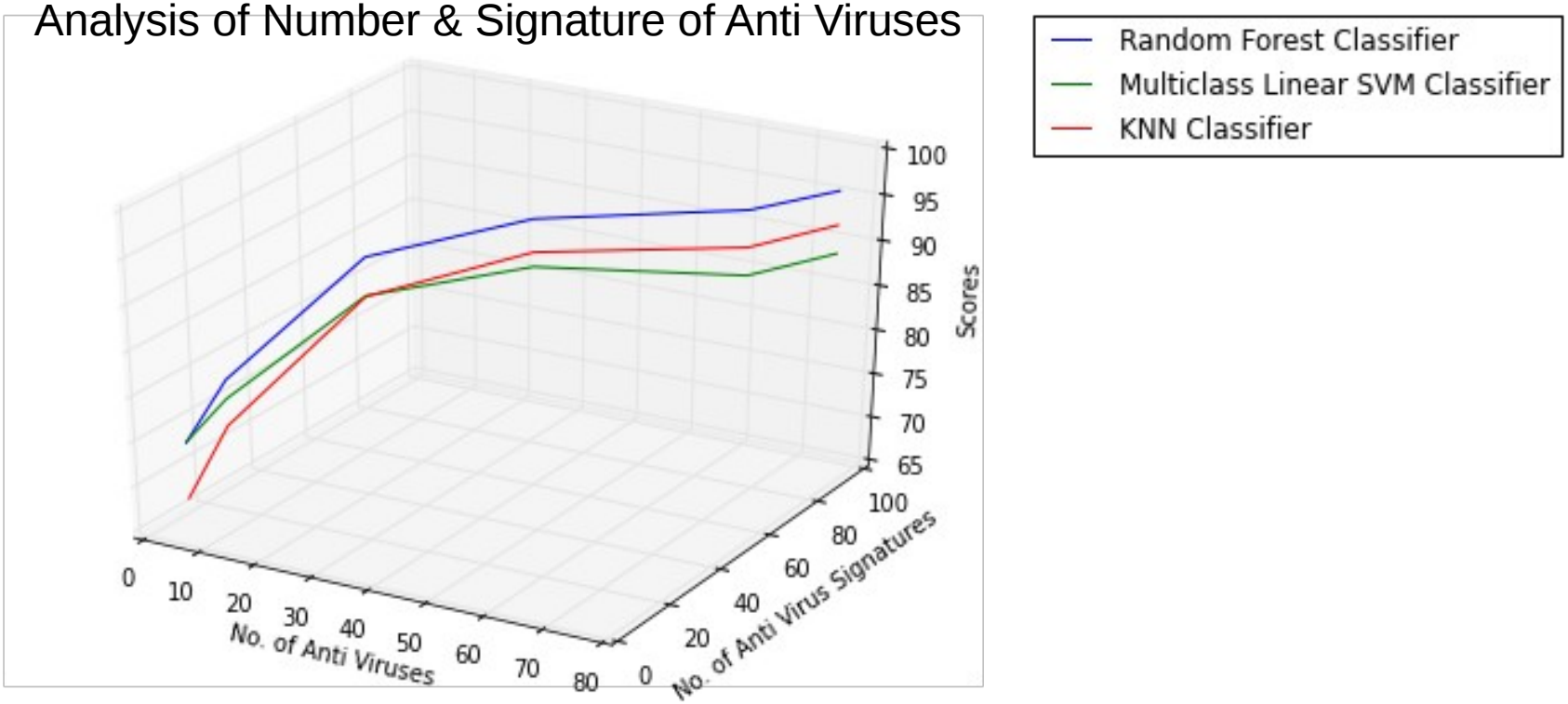
Feature Engineering

- VT Info
  - ✓ Selecting sub set of Anti Viruses with high variance.
  - ✓ Selecting all Anti Viruses.
  - ✓ Reduction of Null Feature Vectors.
- Variance of Anti Virus
  - ✓ Variance = Total No. of Samples / No. of Unique Signatures

Feature Engineering(2)

- Encoding of Features
  - ✓ One Hot Encoding
    - Blow up of features.
    - 75 anti viruses * 203 Signatures on average
  - ✓ Binary Encoding
    - Presence/Absence of Anti virus signature for the sample
  - ✓ Frequency Encoding
    - Variance of Anti virus/ Total Occurences for the sample

Feature Engineering(3)



Feature Engineering(4)

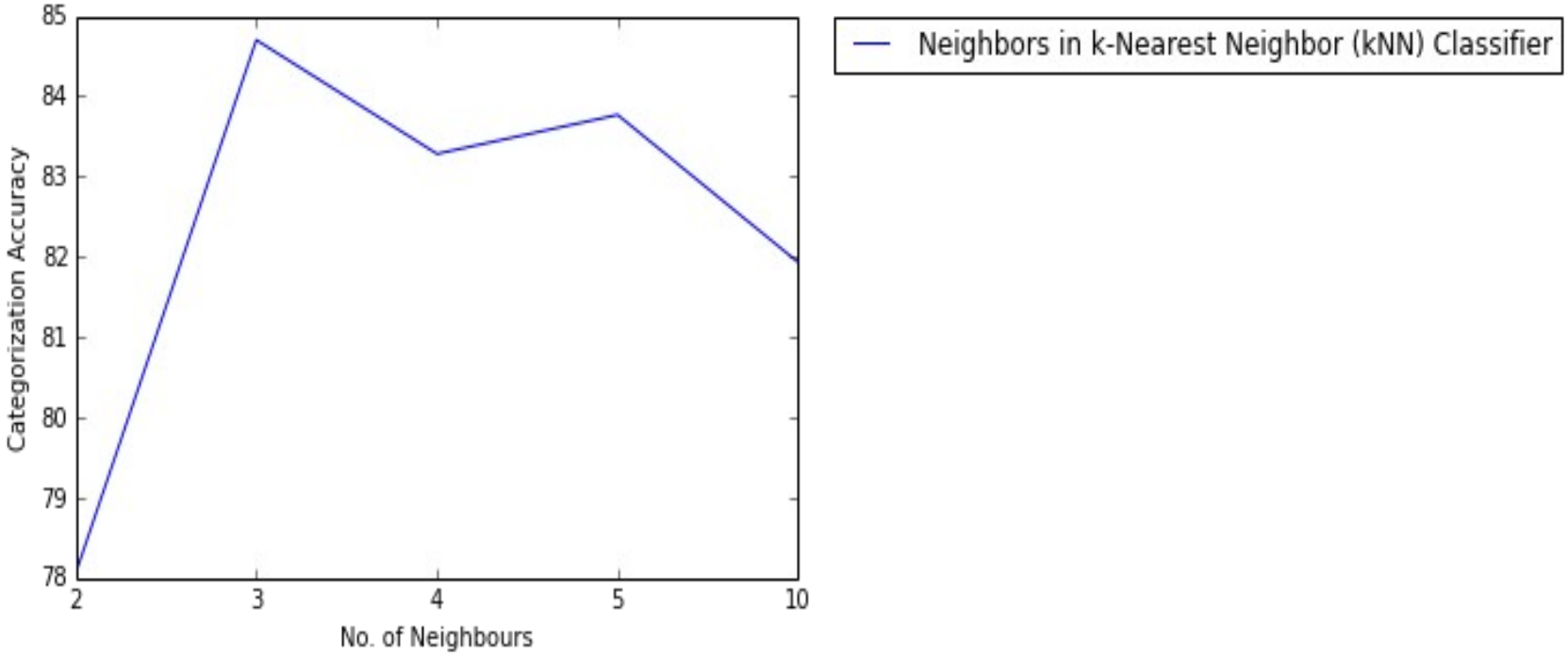
- PE Info
  - ✓ Most of the sections are repeated per sample.
  - ✓ Mean, Median & Mode could be tried on Numerical Features.
  - ✓ Entropy Mean & Median gave best results.
  - ✓ Increasing number of features did not necessarily give better results compared to pure VT Info Encoding.
  - ✓ Selected just Entropy.

Model

- We tried different types of Multi Class Classification Models to fit our data
  - Random Forests
  - Multi Class SVM with Linear Kernel
  - K Nearest Neighbors with 3 Neighbors

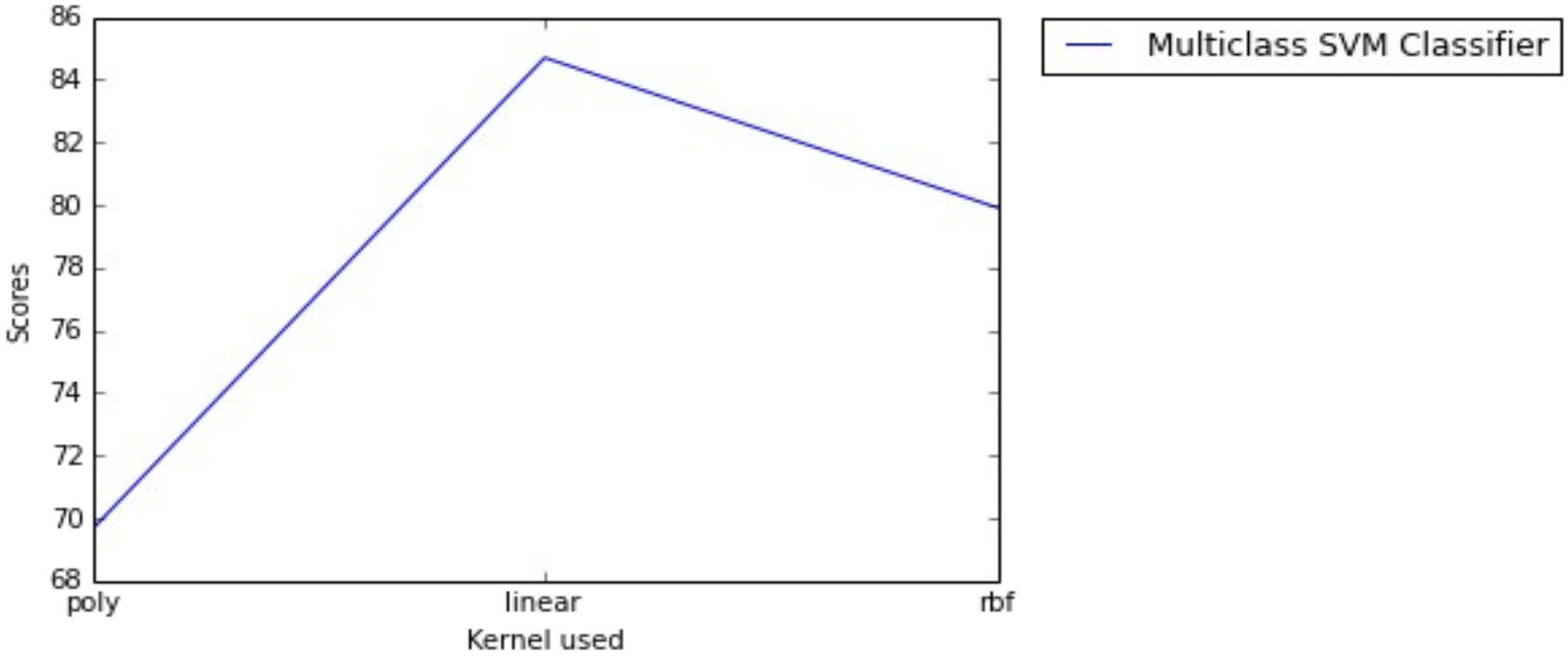
Tuning Model Parameters

K Nearest Neighbors (kNN)



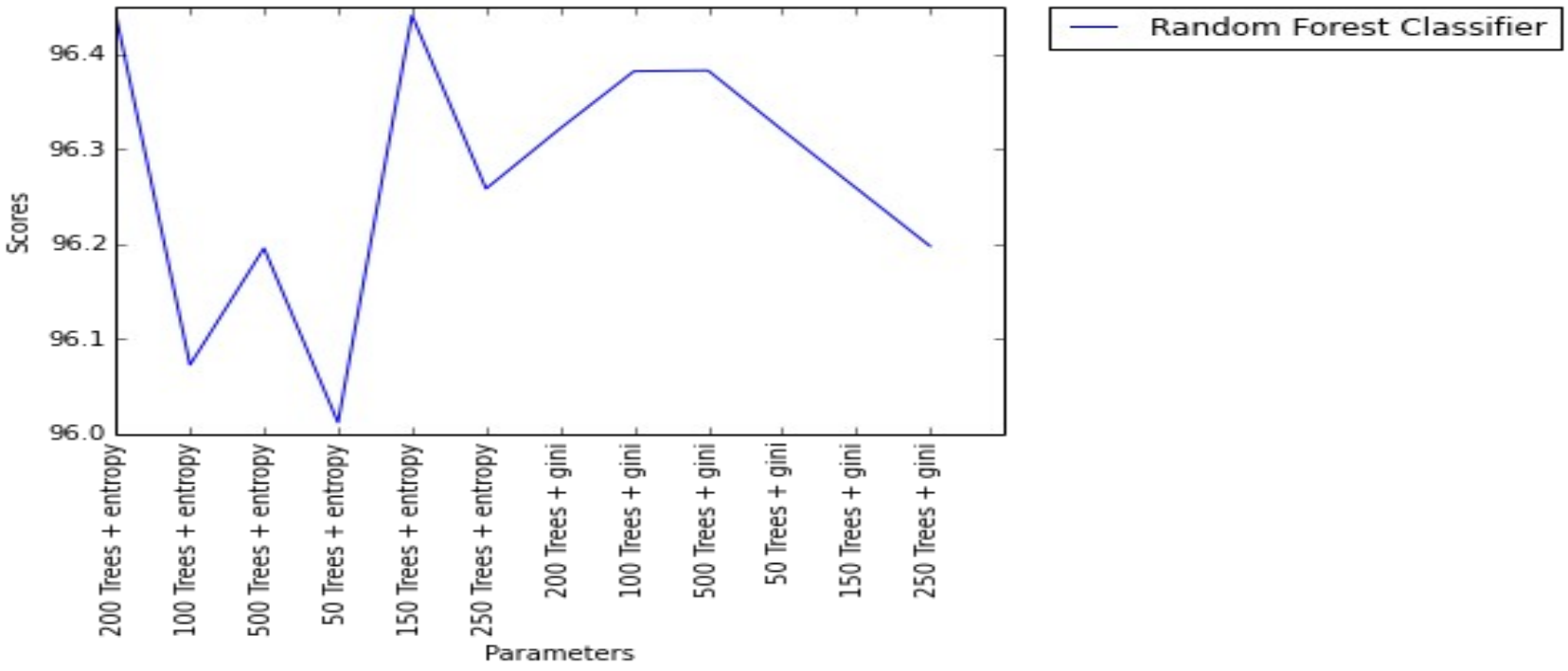
Tuning Model Parameters(2)

Multi Class Support Vector Machines (SVM)



Tuning Model Parameters(3)

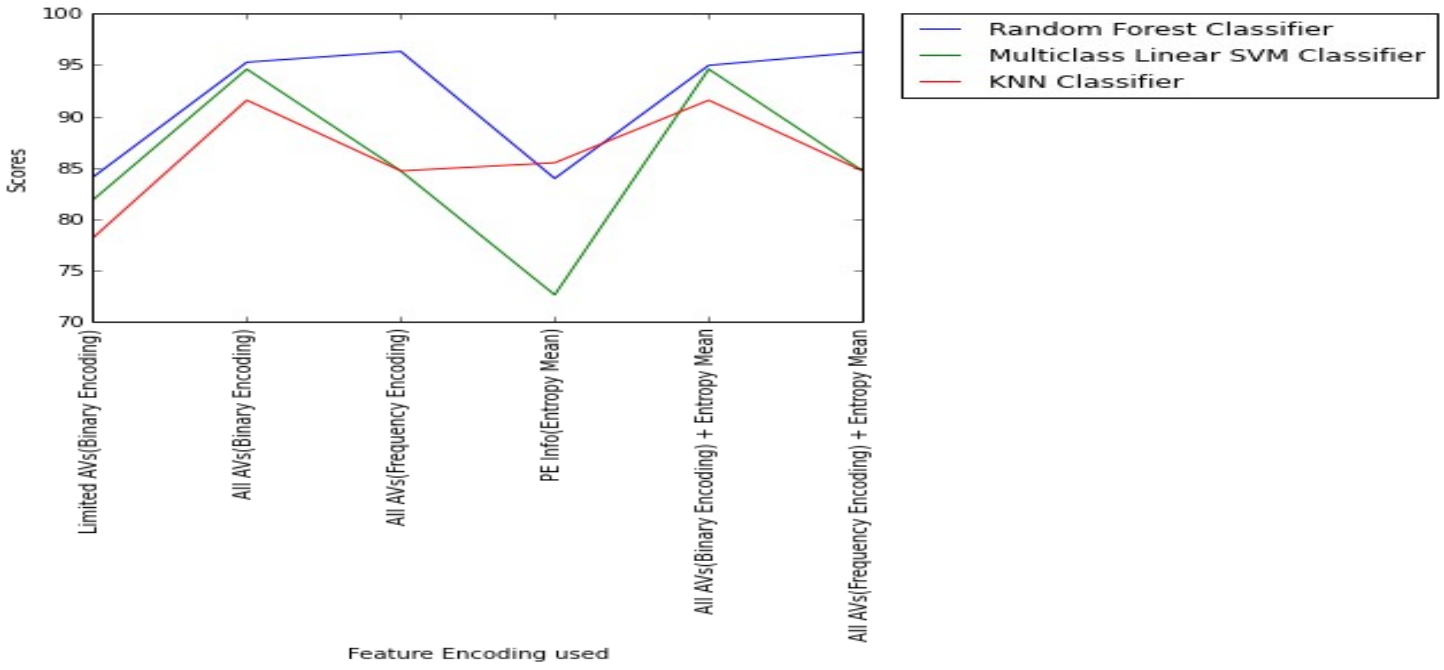
Random Forests (RF)



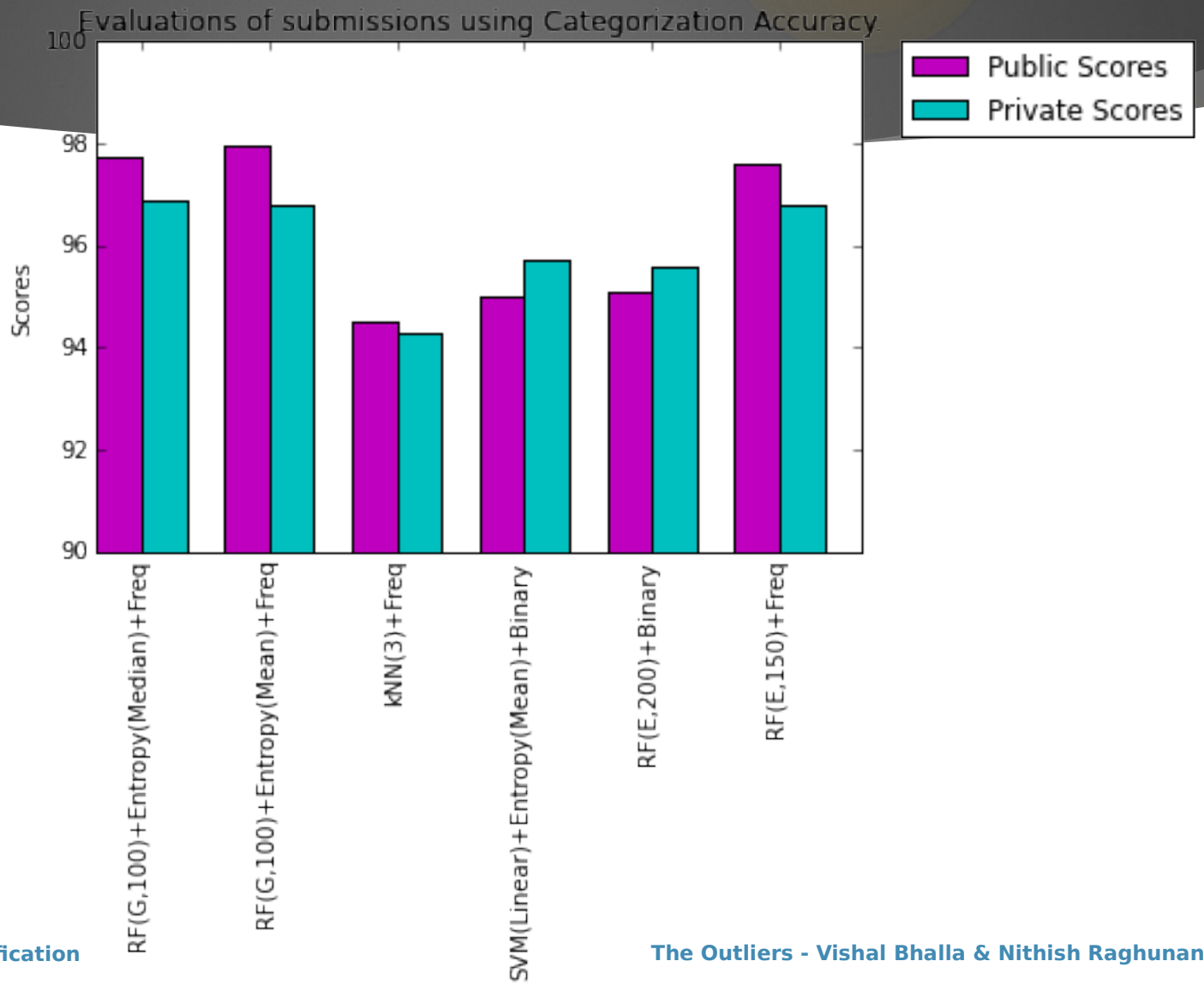
Evaluation of the Models

Criteria

Classification Accuracy on Stratified K-Fold Cross Validation with a split of 4:1.



Kaggle Results



Conclusion

- The best results were observed for Random Forest (100 trees with Gini as a criterion) on Frequency Encoded all Anti Viruses' VT Info data.
- The addition of Entropy Mean/Median from PE Info gives almost the same result as pure Frequency based VT Info encoding on all Anti Viruses.
- KNN & Multi Class SVM worked better on Binary Encoding of VT Info.

Key Takeaways

- Visualization for analysis of data set for feature engineering.
- Inherent structure of our data consisted of mainly categorical features. Random Forest Classifier works well on categorical features.
- Adding more features could result in overfitting.

Questions?

Thank You !