

LIST OF FIGURES

Figure 2. 1 Example of a Decision Tree with Attack Classification	17
Figure 2. 2 Logistic Regression.....	17
Figure 2. 3 Naïve Bayes (NB)	18
Figure 3. 1 Research Stages NIDS with ML	20
Figure 3. 2 Differences between previous research model system and current.....	23
Figure 3. 3 NIDS with Machine Learning Flowchart.....	27
Figure 3. 4 Library Code	30
Figure 3. 5 Dataset Info	31
Figure 3. 6 Cleaning Process for duplicates Outliers	31
Figure 3. 7 Data Correlation	32
Figure 3. 8 Oversampling and Feature Selection using Random Forest	33
Figure 3. 9 Feature Selection for Random Forest.....	34
Figure 3. 10 Principal Component Analysis.....	35
Figure 3. 11 Maximum Optimization in each Model using Optuna.....	35
Figure 3. 12 Constraint Function.....	36
Figure 4. 1 Comparison of the number of categories in traffic	36
Figure 4. 2 Heatmap of all features in the UNSW-NB15-dataset	37
Figure 4. 3 Confusion Matrix of KNN UNSW-NB15-dataset	38
Figure 4. 4 Confusion Matrix of Logistic Regression UNSW-NB15-dataset	39
Figure 4. 5 Confusion Matrix of Decision Tree UNSW-NB15-dataset	40
Figure 4. 6 Confusion Matrix of Random Forest UNSW-NB15-dataset	41
Figure 4. 7 Confusion Matrix of XGB UNSW-NB15-dataset	42
Figure 4. 8 Confusion Matrix of Light GBM UNSW-NB15-dataset.....	43
Figure 4. 9 Confusion Matrix of Ada Boost UNSW-NB15-dataset.....	44
Figure 4. 10 Confusion Matrix of Cat Boost UNSW-NB15-dataset.....	45
Figure 4. 11 Confusion Matrix of Extra Trees UNSW-NB15-dataset	46
Figure 4. 12 Comparison of the number of categories in traffic.....	49
Figure 4. 13 Heatmap of all features in the CIC-IDS-2017-dataset	50
Figure 4. 14 Confusion Matrix of KNN CIC-IDS-2017-dataset	51
Figure 4. 15 Confusion Matrix of Logistic Regression CIC-IDS-2017-dataset.....	52
Figure 4. 16 Confusion Matrix of Decision Tree CIC-IDS-2017-dataset	54

Figure 4. 17 Confusion Matrix of Random Forest CIC-IDS-2017-dataset	55
Figure 4. 18 Confusion Matrix of XGB CIC-IDS-2017-dataset	56
Figure 4. 19 Confusion Matrix of Light GBM CIC-IDS-2017-dataset.....	58
Figure 4. 20 Confusion Matrix of Ada Boost CIC-IDS-2017-dataset.....	59
Figure 4. 21 Confusion Matrix of Cat Boost CIC-IDS-2017-dataset.....	60
Figure 4. 22 Confusion Matrix of Extra Trees CIC-IDS-2017-dataset	62
Figure 4. 23 Comparison of the number of categories in traffic	65
Figure 4. 24 Heatmap of all features in the CIC-IDS-2018-dataset	66
Figure 4. 25 Confusion Matrix of KNN CIC-IDS-2018-dataset	67
Figure 4. 26 Confusion Matrix of Logistic Regression CIC-IDS-2018-dataset.....	68
Figure 4. 27 Confusion Matrix of Decision Tree CIC-IDS-2018-dataset	69
Figure 4. 28 Confusion Matrix of Random Forest CIC-IDS-2018-dataset	70
Figure 4. 29 Confusion Matrix of XGB CIC-IDS-2018-dataset	71
Figure 4. 30 Confusion Matrix of Light GBM CIC-IDS-2018-dataset.....	72
Figure 4. 31 Confusion Matrix of Ada Boost CIC-IDS-2018-dataset.....	73
Figure 4. 32 Confusion Matrix of Cat Boost CIC-IDS-2018-dataset.....	74
Figure 4. 33 Confusion Matrix of Extra Trees CIC-IDS-2018-dataset	75
Figure 4. 34 ROC KNN.....	79
Figure 4. 35 ROC Logistic Regression	79
Figure 4. 36 ROC Decision Tree.....	80
Figure 4. 37 ROC Random Forest.....	80
Figure 4. 38 ROC XGBoost	80
Figure 4. 39 ROC Light GBM.....	80
Figure 4. 40 ROC Adaboost	80
Figure 4. 41 ROC Catboost	80
Figure 4. 42 Results of NIDS Traffic Parameters UNSW-NB15.....	81
Figure 4. 43 Results of NIDS Traffic Parameters UNSW-NB15.....	82
Figure 4. 44 Results of NIDS Traffic Parameters UNSW-NB15.....	83