UNIVERSITY OF HASSELT

BACHELOR THESIS: EXPERIMENTS

Machine learning techniques for flow-based network intrusion detection systems: Experiments

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Contents

Chapter 1

Introduction

This document contains all the different results from the experiments that have been done for the thesis. Each chapter contains the results from the algorithm that is being described. Each algorithm has been tested using **3 different feature sets**. Each experiment has been repeated **10 times**.

This document only contains the results from the statistically relevant tests. During the thesis, several small tests were done to quickly verify whether an assumption could be correct. These tests carry no statistical weight and have been omitted.

The tests from the Cegeka and EDM datasets are already completely included in the thesis and have also been omitted from this document.

Chapter 2

Baseline

2.1 All positive classifier

Table 2.1: Random classifier (All positive): Experiment 1.

Multi-class F-score	0.0278101317419
Multi-class Precision	0.107528930091
Multi-class Recall	0.0177871154502
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.2: Random classifier (All positive): Experiment 2.

Multi-class F-score	0.0298600574097
Multi-class Precision	0.113797455271
Multi-class Recall	0.0188397606526
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.3: Random classifier (All positive): Experiment 3.

Multi-class F-score	0.0286524653515
Multi-class Precision	0.110591750253
Multi-class Recall	0.0182659827349
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.4: Random classifier (All positive): Experiment 4.

Multi-class F-score	0.0296288564088
Multi-class Precision	0.113736213431
Multi-class Recall	0.0188699594904
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.5: Random classifier (All negative): Experiment 5.

Multi-class F-score	0.0292004993775
Multi-class Precision	0.113388546809
Multi-class Recall	0.0186154264292
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.6: Random classifier (All negative): Experiment 6.

Multi-class F-score	0.0278965946907
Multi-class Precision	0.107294768998
Multi-class Recall	0.017735346014
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.7: Random classifier (All negative): Experiment 7.

Multi-class F-score	0.0283002741893
Multi-class Precision	0.110069185304
Multi-class Recall	0.0179510519981
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.8: Random classifier (All negative): Experiment 8.

Multi-class F-score	0.0283205353963
Multi-class Precision	0.108264061487
Multi-class Recall	0.0181322450247
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.9: Random classifier (All negative): Experiment 9.

Multi-class F-score	0.0289294882254
Multi-class Precision	0.110422766353
Multi-class Recall	0.0183824639663
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.10: Random classifier (All negative): Experiment 10.

Multi-class F-score	0.0293343900062
Multi-class Precision	0.111170402437
Multi-class Recall	0.0186671958653
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.11: Random classifier (All negative): Experiment 11.

Multi-class F-score	0.0289468910843
Multi-class Precision	0.111420565395
Multi-class Recall	0.0183910922057
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.12: Random classifier (All negative): Experiment 12.

Multi-class F-score	0.0291526082172
Multi-class Precision	0.112434880164
Multi-class Recall	0.0185334581552
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.13: Random classifier (All negative): Experiment 13.

Multi-class F-score	0.0285753343588
Multi-class Precision	0.110114258978
Multi-class Recall	0.0182573544955
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.14: Random classifier (All negative): Experiment 14.

Multi-class F-score	0.0291823789722
Multi-class Precision	0.112169327343
Multi-class Recall	0.0185507146339
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.15: Random classifier (All negative): Experiment 15.

Multi-class F-score	0.0289088150915
Multi-class Precision	0.10982690679
Multi-class Recall	0.0185464005142
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.16: Random classifier (All negative): Experiment 16.

Multi-class F-score	0.0292964220378
Multi-class Precision	0.111933482382
Multi-class Recall	0.0185291440355
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.17: Random classifier (All negative): Experiment 17.

Multi-class F-score	0.0290246359201
Multi-class Precision	0.112269764445
Multi-class Recall	0.018373835727
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.18: Random classifier (All negative): Experiment 18.

Multi-class F-score	0.0279099515037
Multi-class Precision	0.107124091942
Multi-class Recall	0.0177914295698
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.19: Random classifier (All negative): Experiment 19.

Multi-class F-score	0.0284173940105
Multi-class Precision	0.107856212712
Multi-class Recall	0.0182271556578
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.20: Random classifier (All negative): Experiment 20.

Multi-class F-score	0.0279751773331
Multi-class Precision	0.108452504735
Multi-class Recall	0.0178777119635
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797
False negative	83250
False positive	0
True negative	148547
True positive	0
Positive training samples	0
Negative training samples	49638

Table 2.21: Random classifier (All negative): Average.

Multi-class F-score	0.0287661450663
Multi-class Precision	0.110493303766
Multi-class Recall	0.0183162422292
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	231797.0
False negative	83250.0
False positive	0.0
True negative	148547.0
True positive	0.0
Positive training samples	0.0
Negative training samples	49638.0

Table 2.22: Random classifier (All negative): Variance.

Multi-class F-score	3.40907048968e-07
Multi-class Precision	4.50919745538e-06
Multi-class Recall	1.13671033698e-07
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	0.0
False negative	0.0
False positive	0.0
True negative	0.0
True positive	0.0
Positive training samples	0.0
Negative training samples	0.0

2.2 Random classifier

Table 2.23: Random classifier (uniform): Experiment 1.

Multi-class F-score	0.0163342899919
Multi-class Precision	0.120990499706
Multi-class Recall	0.0097542246017
Binary F-score	0.466989190926
Binary Precision	0.360362359514
Binary Recall	0.663231231231
Total amount of samples	231797
False negative	28036
False positive	98004
True negative	50543
True positive	55214
Positive training samples	82159
Negative training samples	49638

Table 2.24: Random classifier (uniform): Experiment 2.

Multi-class F-score	0.0167473851241
Multi-class Precision	0.122541108697
Multi-class Recall	0.00993541762836
Binary F-score	0.464841535142
Binary Precision	0.358818918213
Binary Recall	0.659795795796
Total amount of samples	231797
False negative	28322
False positive	98152
True negative	50395
True positive	54928
Positive training samples	82159
Negative training samples	49638

Table 2.25: Random classifier (uniform): Experiment 3.

Multi-class F-score	0.0165656364523
Multi-class Precision	0.12005166617
Multi-class Recall	0.0098275646363
Binary F-score	0.466666948404
Binary Precision	0.35998226592
Binary Recall	0.663219219219
Total amount of samples	231797
False negative	28037
False positive	98164
True negative	50383
True positive	55213
Positive training samples	82159
Negative training samples	49638

Table 2.26: Random classifier (uniform): Experiment 4.

Multi-class F-score	0.016693391333
Multi-class Precision	0.123864900641
Multi-class Recall	0.00991816114963
Binary F-score	0.464362841844
Binary Precision	0.358209831063
Binary Recall	0.659927927928
Total amount of samples	231797
False negative	28311
False positive	98432
True negative	50115
True positive	54939
Positive training samples	82159
Negative training samples	49638

Table 2.27: Random classifier (uniform): Experiment 5.

Multi-class F-score	0.0162710973894
Multi-class Precision	0.119816777975
Multi-class Recall	0.00964637160964
Binary F-score	0.46410202093
Binary Precision	0.358495876424
Binary Recall	0.65790990991
Total amount of samples	231797
False negative	28479
False positive	98009
True negative	50538
True positive	54771
Positive training samples	82159
Negative training samples	49638

Table 2.28: Random classifier (uniform): Experiment 6.

Multi-class F-score	0.0157567492435
Multi-class Precision	0.114562174747
Multi-class Recall	0.00938321030902
Binary F-score	0.464243288192
Binary Precision	0.358875464074
Binary Recall	0.657201201201
Total amount of samples	231797
False negative	28538
False positive	97742
True negative	50805
True positive	54712
Positive training samples	82159
Negative training samples	49638

Table 2.29: Random classifier (uniform): Experiment 7.

Multi-class F-score	0.0163889036304
Multi-class Precision	0.122262040425
Multi-class Recall	0.00971108340488
Binary F-score	0.465075311983
Binary Precision	0.359147422188
Binary Recall	0.659627627628
Total amount of samples	231797
False negative	28336
False positive	97987
True negative	50560
True positive	54914
Positive training samples	82159
Negative training samples	49638

Table 2.30: Random classifier (uniform): Experiment 8.

Multi-class F-score	0.0160651463272
Multi-class Precision	0.120491325092
Multi-class Recall	0.00952557625854
Binary F-score	0.466065090385
Binary Precision	0.359722848056
Binary Recall	0.66166966967
Total amount of samples	231797
False negative	28166
False positive	98045
True negative	50502
True positive	55084
Positive training samples	82159
Negative training samples	49638

Table 2.31: Random classifier (uniform): Experiment 9.

Multi-class F-score	0.0159673444711
Multi-class Precision	0.116977686286
Multi-class Recall	0.00952989037822
Binary F-score	0.464543391369
Binary Precision	0.358715980278
Binary Recall	0.658942942943
Total amount of samples	231797
False negative	28393
False positive	98069
True negative	50478
True positive	54857
Positive training samples	82159
Negative training samples	49638

Table 2.32: Random classifier (uniform): Experiment 10.

Multi-class F-score	0.0160210785289
Multi-class Precision	0.117916927842
Multi-class Recall	0.0095342044979
Binary F-score	0.464791476099
Binary Precision	0.358940648588
Binary Recall	0.659183183183
Total amount of samples	231797
False negative	28373
False positive	98009
True negative	50538
True positive	54877
Positive training samples	82159
Negative training samples	49638

Table 2.33: Random classifier (uniform): Experiment 11.

Multi-class F-score	0.0166465116909
Multi-class Precision	0.122515220998
Multi-class Recall	0.00988796231185
Binary F-score	0.465763738495
Binary Precision	0.359459671206
Binary Recall	0.661345345345
Total amount of samples	231797
False negative	28193
False positive	98109
True negative	50438
True positive	55057
Positive training samples	82159
Negative training samples	49638

Table 2.34: Random classifier (uniform): Experiment 12.

Multi-class F-score	0.0162632284115
Multi-class Precision	0.11989368021
Multi-class Recall	0.00968951280646
Binary F-score	0.463758798051
Binary Precision	0.357912330413
Binary Recall	0.658498498498
Total amount of samples	231797
False negative	28430
False positive	98346
True negative	50201
True positive	54820
Positive training samples	82159
Negative training samples	49638

Table 2.35: Random classifier (uniform): Experiment 13.

Multi-class F-score	0.0166667311136
Multi-class Precision	0.12710137567
Multi-class Recall	0.0098750199528
Binary F-score	0.46459563239
Binary Precision	0.358515318044
Binary Recall	0.659831831832
Total amount of samples	231797
False negative	28319
False positive	98287
True negative	50260
True positive	54931
Positive training samples	82159
Negative training samples	49638

Table 2.36: Random classifier (uniform): Experiment 14.

Multi-class F-score	0.0168336062636
Multi-class Precision	0.119430439085
Multi-class Recall	0.0100993541763
Binary F-score	0.465721861261
Binary Precision	0.359690673087
Binary Recall	0.660396396396
Total amount of samples	231797
False negative	28272
False positive	97870
True negative	50677
True positive	54978
Positive training samples	82159
Negative training samples	49638

Table 2.37: Random classifier (uniform): Experiment 15.

Multi-class F-score	0.0159650035165
Multi-class Precision	0.123141252832
Multi-class Recall	0.00949537742076
Binary F-score	0.466315762751
Binary Precision	0.359946959998
Binary Recall	0.661921921922
Total amount of samples	231797
False negative	28145
False positive	97987
True negative	50560
True positive	55105
Positive training samples	82159
Negative training samples	49638

Table 2.38: Random classifier (uniform): Experiment 16.

Multi-class F-score	0.0159238348977
Multi-class Precision	0.118760625682
Multi-class Recall	0.00946949270267
Binary F-score	0.465590577868
Binary Precision	0.359637410825
Binary Recall	0.660048048048
Total amount of samples	231797
False negative	28301
False positive	97841
True negative	50706
True positive	54949
Positive training samples	82159
Negative training samples	49638

Table 2.39: Random classifier (uniform): Experiment 17.

Multi-class F-score	0.0159838121441
Multi-class Precision	0.117367743297
Multi-class Recall	0.0095342044979
Binary F-score	0.465213104904
Binary Precision	0.359098302295
Binary Recall	0.660348348348
Total amount of samples	231797
False negative	28276
False positive	98115
True negative	50432
True positive	54974
Positive training samples	82159
Negative training samples	49638

Table 2.40: Random classifier (uniform): Experiment 18.

Multi-class F-score	0.0157756966482
Multi-class Precision	0.117105994008
Multi-class Recall	0.00932281263347
Binary F-score	0.465890942277
Binary Precision	0.359338338808
Binary Recall	0.66227027027
Total amount of samples	231797
False negative	28116
False positive	98298
True negative	50249
True positive	55134
Positive training samples	82159
Negative training samples	49638

Table 2.41: Random classifier (uniform): Experiment 19.

Multi-class F-score	0.01673675601
Multi-class Precision	0.122738311676
Multi-class Recall	0.00997855882518
Binary F-score	0.466664403558
Binary Precision	0.360780505728
Binary Recall	0.660516516517
Total amount of samples	231797
False negative	28262
False positive	97426
True negative	51121
True positive	54988
Positive training samples	82159
Negative training samples	49638

Table 2.42: Random classifier (uniform): Experiment 20.

Multi-class F-score	0.0161412488249
Multi-class Precision	0.123215807827
Multi-class Recall	0.00957303157504
Binary F-score	0.465199884958
Binary Precision	0.359008003342
Binary Recall	0.660600600601
Total amount of samples	231797
False negative	28255
False positive	98191
True negative	50356
True positive	54995
Positive training samples	82159
Negative training samples	49638

Table 2.43: Random classifier (uniform): Average.

Multi-class F-score	0.0162873726006
Multi-class Precision	0.120537277943
Multi-class Recall	0.00968455156883
Binary F-score	0.465319790089
Binary Precision	0.359232956403
Binary Recall	0.660324324324
Total amount of samples	231797.0
False negative	28278.0
False positive	98054.15
True negative	50492.85
True positive	54972.0
Positive training samples	82159.0
Negative training samples	49638.0

Table 2.44: Random classifier (uniform): Variance.

Multi-class F-score	1.17806631371e-07
Multi-class Precision	8.33396600028e-06
Multi-class Recall	4.45846682108e-08
Binary F-score	8.2151409325e-07
Binary Precision	4.99721573097e-07
Binary Recall	2.47545563582e-06
Total amount of samples	0.0
False negative	17156.3
False positive	48798.9275
True negative	48798.9275
True positive	17156.3
Positive training samples	0.0
Negative training samples	0.0

Chapter 3

K-Nearest Neighbors

3.1 Standard feature set

3.1.1 CTU Dataset

Table 3.1: K-Nearest Neighbors with Standard feature set CTU: Experiment 1.

Multi-class F-score	0.615350710589
Multi-class Precision	0.682057180856
Multi-class Recall	0.628087295864
Binary F-score	0.950001701201
Binary Precision	0.920392926013
Binary Recall	0.981578808599
Total amount of samples	195519
False negative	1048
False positive	4830
True negative	133798
True positive	55843
Positive training samples	35363
Negative training samples	49638

Table 3.2: K-Nearest Neighbors with Standard feature set CTU: Experiment 2.

Multi-class F-score	0.615350710589
Multi-class Precision	0.682057180856
Multi-class Recall	0.628087295864
Binary F-score	0.950001701201
Binary Precision	0.920392926013
Binary Recall	0.981578808599
Total amount of samples	195519
False negative	1048
False positive	4830
True negative	133798
True positive	55843
Positive training samples	35363
Negative training samples	49638

Table 3.3: K-Nearest Neighbors with Standard feature set CTU: Experiment 3.

Multi-class F-score	0.615350710589
Multi-class Precision	0.682057180856
Multi-class Recall	0.628087295864
Binary F-score	0.950001701201
Binary Precision	0.920392926013
Binary Recall	0.981578808599
Total amount of samples	195519
False negative	1048
False positive	4830
True negative	133798
True positive	55843
Positive training samples	35363
Negative training samples	49638

Table 3.4: K-Nearest Neighbors with Standard feature set CTU: Experiment 4.

Multi-class F-score	0.615350710589
Multi-class Precision	0.682057180856
Multi-class Recall	0.628087295864
Binary F-score	0.950001701201
Binary Precision	0.920392926013
Binary Recall	0.981578808599
Total amount of samples	195519
False negative	1048
False positive	4830
True negative	133798
True positive	55843
Positive training samples	35363
Negative training samples	49638

Table 3.5: K-Nearest Neighbors with Standard feature set CTU: Experiment 5.

Multi-class F-score	0.615350710589
Multi-class Precision	0.682057180856
Multi-class Recall	0.628087295864
Binary F-score	0.950001701201
Binary Precision	0.920392926013
Binary Recall	0.981578808599
Total amount of samples	195519
False negative	1048
False positive	4830
True negative	133798
True positive	55843
Positive training samples	35363
Negative training samples	49638

Table 3.6: K-Nearest Neighbors with Standard feature set CTU: Experiment 6.

Multi-class F-score	0.615350710589
Multi-class Precision	0.682057180856
Multi-class Recall	0.628087295864
Binary F-score	0.950001701201
Binary Precision	0.920392926013
Binary Recall	0.981578808599
Total amount of samples	195519
False negative	1048
False positive	4830
True negative	133798
True positive	55843
Positive training samples	35363
Negative training samples	49638

Table 3.7: K-Nearest Neighbors with Standard feature set CTU: Experiment 7.

Multi-class F-score	0.615350710589
Multi-class Precision	0.682057180856
Multi-class Recall	0.628087295864
Binary F-score	0.950001701201
Binary Precision	0.920392926013
Binary Recall	0.981578808599
Total amount of samples	195519
False negative	1048
False positive	4830
True negative	133798
True positive	55843
Positive training samples	35363
Negative training samples	49638

Table 3.8: K-Nearest Neighbors with Standard feature set CTU: Experiment 8.

Multi-class F-score	0.615350710589
Multi-class Precision	0.682057180856
Multi-class Recall	0.628087295864
Binary F-score	0.950001701201
Binary Precision	0.920392926013
Binary Recall	0.981578808599
Total amount of samples	195519
False negative	1048
False positive	4830
True negative	133798
True positive	55843
Positive training samples	35363
Negative training samples	49638

Table 3.9: K-Nearest Neighbors with Standard feature set CTU: Experiment 9.

Multi-class F-score	0.615350710589
Multi-class Precision	0.682057180856
Multi-class Recall	0.628087295864
Binary F-score	0.950001701201
Binary Precision	0.920392926013
Binary Recall	0.981578808599
Total amount of samples	195519
False negative	1048
False positive	4830
True negative	133798
True positive	55843
Positive training samples	35363
Negative training samples	49638

Table 3.10: K-Nearest Neighbors with Standard feature set CTU: Experiment 10.

Multi-class F-score	0.615350710589
Multi-class Precision	0.682057180856
Multi-class Recall	0.628087295864
Binary F-score	0.950001701201
Binary Precision	0.920392926013
Binary Recall	0.981578808599
Total amount of samples	195519
False negative	1048
False positive	4830
True negative	133798
True positive	55843
Positive training samples	35363
Negative training samples	49638

Table 3.11: K-Nearest Neighbors with Standard feature set CTU: Average.

Multi-class F-score	0.615350710589
Multi-class Precision	0.682057180856
Multi-class Recall	0.628087295864
Binary F-score	0.950001701201
Binary Precision	0.920392926013
Binary Recall	0.981578808599
Total amount of samples	195519.0
False negative	1048.0
False positive	4830.0
True negative	133798.0
True positive	55843.0
Positive training samples	35363.0
Negative training samples	49638.0

Table 3.12: K-Nearest Neighbors with Standard feature set CTU: Variance.

Multi-class F-score	1.23259516441e-32
Multi-class Precision	0.0
Multi-class Recall	1.23259516441e-32
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	4.93038065763e-32

3.1.2 Cross Dataset

Table 3.13: KNeighborsClassifier with Standard feature set Cross: Experiment 1.

Multi-class F-score	0.757301259892
Multi-class Precision	0.776935222974
Multi-class Recall	0.763047385654
Binary F-score	0.96329980249
Binary Precision	0.954391968763
Binary Recall	0.972375485678
Total amount of samples	246467
False negative	2979
False positive	5011
True negative	133617
True positive	104860
Positive training samples	65363
Negative training samples	49638

Table 3.14: KNeighborsClassifier with Standard feature set Cross: Experiment 2.

Multi-class F-score	0.756976503625
Multi-class Precision	0.776733138807
Multi-class Recall	0.762633537147
Binary F-score	0.96288093225
Binary Precision	0.954347133033
Binary Recall	0.971568727455
Total amount of samples	246467
False negative	3066
False positive	5012
True negative	133616
True positive	104773
Positive training samples	65363
Negative training samples	49638

Table 3.15: KNeighborsClassifier with Standard feature set Cross: Experiment 3.

Multi-class F-score	0.757098782034
Multi-class Precision	0.77683838115
Multi-class Recall	0.762787716003
Binary F-score	0.963065062278
Binary Precision	0.95440472071
Binary Recall	0.971884012278
Total amount of samples	246467
False negative	3032
False positive	5007
True negative	133621
True positive	104807
Positive training samples	65363
Negative training samples	49638

Table 3.16: KNeighborsClassifier with Standard feature set Cross: Experiment 4.

Multi-class F-score	0.757223900281
Multi-class Precision	0.776896025566
Multi-class Recall	0.76293783752
Binary F-score	0.9630500581
Binary Precision	0.954071418171
Binary Recall	0.9721992971
Total amount of samples	246467
False negative	2998
False positive	5047
True negative	133581
True positive	104841
Positive training samples	65363
Negative training samples	49638

Table 3.17: KNeighborsClassifier with Standard feature set Cross: Experiment 5.

Multi-class F-score	0.757306595502
Multi-class Precision	0.776906000755
Multi-class Recall	0.76310418839
Binary F-score	0.96335968325
Binary Precision	0.954446992864
Binary Recall	0.972440397259
Total amount of samples	246467
False negative	2972
False positive	5005
True negative	133623
True positive	104867
Positive training samples	65363
Negative training samples	49638

Table 3.18: KNeighborsClassifier with Standard feature set Cross: Experiment 6.

Multi-class F-score	0.756909155209
Multi-class Precision	0.77671263334
Multi-class Recall	0.762568619734
Binary F-score	0.962896925693
Binary Precision	0.954423299414
Binary Recall	0.97152236204
Total amount of samples	246467
False negative	3071
False positive	5003
True negative	133625
True positive	104768
Positive training samples	65363
Negative training samples	49638

Table 3.19: KNeighborsClassifier with Standard feature set Cross: Experiment 7.

Multi-class F-score	0.757256613301
Multi-class Precision	0.776835341082
Multi-class Recall	0.763043328316
Binary F-score	0.963302499472
Binary Precision	0.95432580742
Binary Recall	0.972449670342
Total amount of samples	246467
False negative	2971
False positive	5019
True negative	133609
True positive	104868
Positive training samples	65363
Negative training samples	49638

Table 3.20: KNeighborsClassifier with Standard feature set Cross: Experiment 8.

Multi-class F-score	0.757116693487
Multi-class Precision	0.77686853057
Multi-class Recall	0.762816117371
Binary F-score	0.96313688012
Binary Precision	0.954518961058
Binary Recall	0.971911831527
Total amount of samples	246467
False negative	3029
False positive	4994
True negative	133634
True positive	104810
Positive training samples	65363
Negative training samples	49638

Table 3.21: KNeighborsClassifier with Standard feature set Cross: Experiment 9.

Multi-class F-score	0.757325030769
Multi-class Precision	0.776849040139
Multi-class Recall	0.763160991127
Binary F-score	0.963338859523
Binary Precision	0.954254312541
Binary Recall	0.97259803967
Total amount of samples	246467
False negative	2955
False positive	5028
True negative	133600
True positive	104884
Positive training samples	65363
Negative training samples	49638

Table 3.22: KNeighborsClassifier with Standard feature set Cross: Experiment 10.

Multi-class F-score	0.756959486591
Multi-class Precision	0.776768852172
Multi-class Recall	0.762584849087
Binary F-score	0.962819316861
Binary Precision	0.954333448722
Binary Recall	0.971457450459
Total amount of samples	246467
False negative	3078
False positive	5013
True negative	133615
True positive	104761
Positive training samples	65363
Negative training samples	49638

Table 3.23: KNeighborsClassifier with Standard feature set Cross: Average.

Multi-class F-score	0.757147402069
Multi-class Precision	0.776834316655
Multi-class Recall	0.762868457035
Binary F-score	0.963115002004
Binary Precision	0.95435180627
Binary Recall	0.972040727381
Total amount of samples	246467.0
False negative	3015.1
False positive	5013.9
True negative	133614.1
True positive	104823.9
Positive training samples	65363.0
Negative training samples	49638.0

Table 3.24: KNeighborsClassifier with Standard feature set Cross: Variance.

Multi-class F-score	2.2293279957e-08
Multi-class Precision	4.98630124675e-09
Multi-class Recall	4.43336317463e-08
Binary F-score	3.76253590802e-08
Binary Precision	1.35682736371e-08
Binary Recall	1.64764710795e-07

3.2 TCP feature set

3.2.1 CTU Dataset

Table 3.25: K-Nearest Neighbors with TCP feature set CTU: Experiment 1.

Multi-class F-score	0.847659233776
Multi-class Precision	0.852770192008
Multi-class Recall	0.84828072975
Binary F-score	0.985744483849
Binary Precision	0.979753780973
Binary Recall	0.991808897717
Total amount of samples	195519
False negative	465.999999982
False positive	1165.99999998
True negative	137462.0
True positive	56425.0
Positive training samples	35363
Negative training samples	49638

Table 3.26: K-Nearest Neighbors with TCP feature set CTU: Experiment 2.

Multi-class F-score	0.847659233776
Multi-class Precision	0.852770192008
Multi-class Recall	0.84828072975
Binary F-score	0.985744483849
Binary Precision	0.979753780973
Binary Recall	0.991808897717
Total amount of samples	195519
False negative	465.999999982
False positive	1165.99999998
True negative	137462.0
True positive	56425.0
Positive training samples	35363
Negative training samples	49638

Table 3.27: K-Nearest Neighbors with TCP feature set CTU: Experiment 3.

Multi-class F-score	0.847659233776
Multi-class Precision	0.852770192008
Multi-class Recall	0.84828072975
Binary F-score	0.985744483849
Binary Precision	0.979753780973
Binary Recall	0.991808897717
Total amount of samples	195519
False negative	465.999999982
False positive	1165.99999998
True negative	137462.0
True positive	56425.0
Positive training samples	35363
Negative training samples	49638

Table 3.28: K-Nearest Neighbors with TCP feature set CTU: Experiment 4.

Multi-class F-score	0.847659233776
Multi-class Precision	0.852770192008
Multi-class Recall	0.84828072975
Binary F-score	0.985744483849
Binary Precision	0.979753780973
Binary Recall	0.991808897717
Total amount of samples	195519
False negative	465.999999982
False positive	1165.99999998
True negative	137462.0
True positive	56425.0
Positive training samples	35363
Negative training samples	49638

Table 3.29: K-Nearest Neighbors with TCP feature set CTU: Experiment 5.

Multi-class F-score	0.847659233776
Multi-class Precision	0.852770192008
Multi-class Recall	0.84828072975
Binary F-score	0.985744483849
Binary Precision	0.979753780973
Binary Recall	0.991808897717
Total amount of samples	195519
False negative	465.999999982
False positive	1165.99999998
True negative	137462.0
True positive	56425.0
Positive training samples	35363
Negative training samples	49638

Table 3.30: K-Nearest Neighbors with TCP feature set CTU: Experiment 6.

Multi-class F-score	0.847659233776
Multi-class Precision	0.852770192008
Multi-class Recall	0.84828072975
Binary F-score	0.985744483849
Binary Precision	0.979753780973
Binary Recall	0.991808897717
Total amount of samples	195519
False negative	465.999999982
False positive	1165.99999998
True negative	137462.0
True positive	56425.0
Positive training samples	35363
Negative training samples	49638

Table 3.31: K-Nearest Neighbors with TCP feature set CTU: Experiment 7.

Multi-class F-score	0.847659233776
Multi-class Precision	0.852770192008
Multi-class Recall	0.84828072975
Binary F-score	0.985744483849
Binary Precision	0.979753780973
Binary Recall	0.991808897717
Total amount of samples	195519
False negative	465.999999982
False positive	1165.99999998
True negative	137462.0
True positive	56425.0
Positive training samples	35363
Negative training samples	49638

Table 3.32: K-Nearest Neighbors with TCP feature set CTU: Experiment 8.

Multi-class F-score	0.847659233776
Multi-class Precision	0.852770192008
Multi-class Recall	0.84828072975
Binary F-score	0.985744483849
Binary Precision	0.979753780973
Binary Recall	0.991808897717
Total amount of samples	195519
False negative	465.999999982
False positive	1165.99999998
True negative	137462.0
True positive	56425.0
Positive training samples	35363
Negative training samples	49638

Table 3.33: K-Nearest Neighbors with TCP feature set CTU: Experiment 9.

Multi-class F-score	0.847659233776
Multi-class Precision	0.852770192008
Multi-class Recall	0.84828072975
Binary F-score	0.985744483849
Binary Precision	0.979753780973
Binary Recall	0.991808897717
Total amount of samples	195519
False negative	465.999999982
False positive	1165.99999998
True negative	137462.0
True positive	56425.0
Positive training samples	35363
Negative training samples	49638

Table 3.34: K-Nearest Neighbors with TCP feature set CTU: Experiment 10.

Multi-class F-score	0.847659233776
Multi-class Precision	0.852770192008
Multi-class Recall	0.84828072975
Binary F-score	0.985744483849
Binary Precision	0.979753780973
Binary Recall	0.991808897717
Total amount of samples	195519
False negative	465.999999982
False positive	1165.99999998
True negative	137462.0
True positive	56425.0
Positive training samples	35363
Negative training samples	49638

Table 3.35: K-Nearest Neighbors with TCP feature set CTU: Average.

Multi-class F-score	0.847659233776
Multi-class Precision	0.852770192008
Multi-class Recall	0.84828072975
Binary F-score	0.985744483849
Binary Precision	0.979753780973
Binary Recall	0.991808897717
Total amount of samples	195519
False negative	466.5
False positive	1169.2
True negative	137458.8
True positive	56424.5
Positive training samples	35363.0
Negative training samples	49638.0

Table 3.36: K-Nearest Neighbors with TCP feature set CTU: Variance.

Multi-class F-score	1.23259516441e-32
Multi-class Precision	1.23259516441e-32
Multi-class Recall	0.0
Binary F-score	1.23259516441e-32
Binary Precision	0.0
Binary Recall	0.0

3.2.2 Cross Dataset

Table 3.37: KNeighborsClassifier with TCP feature set Cross: Experiment 1.

Multi-class F-score	0.879819023217
Multi-class Precision	0.883963152115
Multi-class Recall	0.880304462666
Binary F-score	0.992457713282
Binary Precision	0.989248302485
Binary Recall	0.995688016395
Total amount of samples	246467
False negative	464.99999998
False positive	1166.99999998
True negative	137461.0
True positive	107374.0
Positive training samples	65363
Negative training samples	49638

Table 3.38: KNeighborsClassifier with TCP feature set Cross: Experiment 2.

Multi-class F-score	0.879831863358
Multi-class Precision	0.883991953976
Multi-class Recall	0.880316634681
Binary F-score	0.992453056905
Binary Precision	0.989248203427
Binary Recall	0.995678743312
Total amount of samples	246467
False negative	465.999999977
False positive	1167.00000003
True negative	137461.0
True positive	107373.0
Positive training samples	65363
Negative training samples	49638

Table 3.39: KNeighborsClassifier with TCP feature set Cross: Experiment 3.

Multi-class F-score	0.879836895345
Multi-class Precision	0.88398840731
Multi-class Recall	0.88032069202
Binary F-score	0.992457713282
Binary Precision	0.989248302485
Binary Recall	0.995688016395
Total amount of samples	246467
False negative	464.99999998
False positive	1166.99999998
True negative	137461.0
True positive	107374.0
Positive training samples	65363
Negative training samples	49638

Table 3.40: KNeighborsClassifier with TCP feature set Cross: Experiment 4.

Multi-class F-score	0.879783170371
Multi-class Precision	0.883937201004
Multi-class Recall	0.880280118637
Binary F-score	0.992453056905
Binary Precision	0.989248203427
Binary Recall	0.995678743312
Total amount of samples	246467
False negative	465.999999977
False positive	1167.00000003
True negative	137461.0
True positive	107373.0
Positive training samples	65363
Negative training samples	49638

Table 3.41: KNeighborsClassifier with TCP feature set Cross: Experiment 5.

Multi-class F-score	0.879773420233
Multi-class Precision	0.883914381836
Multi-class Recall	0.88027200396
Binary F-score	0.992457713282
Binary Precision	0.989248302485
Binary Recall	0.995688016395
Total amount of samples	246467
False negative	464.99999998
False positive	1166.99999998
True negative	137461.0
True positive	107374.0
Positive training samples	65363
Negative training samples	49638

Table 3.42: KNeighborsClassifier with TCP feature set Cross: Experiment 6.

Multi-class F-score	0.879731130008
Multi-class Precision	0.883876751129
Multi-class Recall	0.880251717268
Binary F-score	0.992453056905
Binary Precision	0.989248203427
Binary Recall	0.995678743312
Total amount of samples	246467
False negative	465.999999977
False positive	1167.00000003
True negative	137461.0
True positive	107373.0
Positive training samples	65363
Negative training samples	49638

Table 3.43: KNeighborsClassifier with TCP feature set Cross: Experiment 7.

Multi-class F-score	0.879757218189
Multi-class Precision	0.883916505237
Multi-class Recall	0.880259831945
Binary F-score	0.992453056905
Binary Precision	0.989248203427
Binary Recall	0.995678743312
Total amount of samples	246467
False negative	465.999999977
False positive	1167.00000003
True negative	137461.0
True positive	107373.0
Positive training samples	65363
Negative training samples	49638

Table 3.44: KNeighborsClassifier with TCP feature set Cross: Experiment 8.

Multi-class F-score	0.879837524423
Multi-class Precision	0.883975859552
Multi-class Recall	0.880312577343
Binary F-score	0.992453056905
Binary Precision	0.989248203427
Binary Recall	0.995678743312
Total amount of samples	246467
False negative	465.999999977
False positive	1167.00000003
True negative	137461.0
True positive	107373.0
Positive training samples	65363
Negative training samples	49638

Table 3.45: KNeighborsClassifier with TCP feature set Cross: Experiment 9.

Multi-class F-score	0.87977425873
Multi-class Precision	0.883899875911
Multi-class Recall	0.880263889283
Binary F-score	0.992453056905
Binary Precision	0.989248203427
Binary Recall	0.995678743312
Total amount of samples	246467
False negative	465.999999977
False positive	1167.00000003
True negative	137461.0
True positive	107373.0
Positive training samples	65363
Negative training samples	49638

Table 3.46: KNeighborsClassifier with TCP feature set Cross: Experiment 10.

Multi-class F-score	0.879788947099
Multi-class Precision	0.883957671492
Multi-class Recall	0.880284175975
Binary F-score	0.992457713282
Binary Precision	0.989248302485
Binary Recall	0.995688016395
Total amount of samples	246467
False negative	464.99999998
False positive	1166.99999998
True negative	137461.0
True positive	107374.0
Positive training samples	65363
Negative training samples	49638

Table 3.47: KNeighborsClassifier with TCP feature set Cross: Average.

Multi-class F-score	0.879793345097
Multi-class Precision	0.883942175956
Multi-class Recall	0.880286610378
Binary F-score	0.992454919456
Binary Precision	0.98924824305
Binary Recall	0.995682452545
Total amount of samples	246467.0
False negative	474.5
False positive	1172.2
True negative	137455.8
True positive	107364.5
Positive training samples	65363.0
Negative training samples	49638.0

Table 3.48: KNeighborsClassifier with TCP feature set Cross: Variance.

Multi-class F-score	1.20514870248e-09
Multi-class Precision	1.39558357295e-09
Multi-class Recall	5.76828273987e-10
Binary F-score	5.20364413128e-12
Binary Precision	2.35497164587e-15
Binary Recall	2.06376164954e-11

3.3 Country feature set

3.3.1 CTU Dataset

Table 3.49: K-Nearest Neighbors with Country feature set CTU: Experiment 1.

Multi-class F-score	0.614888612093
Multi-class Precision	0.686304857668
Multi-class Recall	0.627790649502
Binary F-score	0.949903890316
Binary Precision	0.920224774649
Binary Recall	0.981561231126
Total amount of samples	195519
False negative	1049
False positive	4841
True negative	133787
True positive	55842
Positive training samples	35363
Negative training samples	49638

Table 3.50: K-Nearest Neighbors with Country feature set CTU: Experiment 2.

Multi-class F-score	0.614888612093
Multi-class Precision	0.686304857668
Multi-class Recall	0.627790649502
Binary F-score	0.949903890316
Binary Precision	0.920224774649
Binary Recall	0.981561231126
Total amount of samples	195519
False negative	1049
False positive	4841
True negative	133787
True positive	55842
Positive training samples	35363
Negative training samples	49638

Table 3.51: K-Nearest Neighbors with Country feature set CTU: Experiment 3.

Multi-class F-score	0.614888612093
Multi-class Precision	0.686304857668
Multi-class Recall	0.627790649502
Binary F-score	0.949903890316
Binary Precision	0.920224774649
Binary Recall	0.981561231126
Total amount of samples	195519
False negative	1049
False positive	4841
True negative	133787
True positive	55842
Positive training samples	35363
Negative training samples	49638

Table 3.52: K-Nearest Neighbors with Country feature set CTU: Experiment 4.

Multi-class F-score	0.614888612093
Multi-class Precision	0.686304857668
Multi-class Recall	0.627790649502
Binary F-score	0.949903890316
Binary Precision	0.920224774649
Binary Recall	0.981561231126
Total amount of samples	195519
False negative	1049
False positive	4841
True negative	133787
True positive	55842
Positive training samples	35363
Negative training samples	49638

Table 3.53: K-Nearest Neighbors with Country feature set CTU: Experiment 5.

Multi-class F-score	0.614888612093
Multi-class Precision	0.686304857668
Multi-class Recall	0.627790649502
Binary F-score	0.949903890316
Binary Precision	0.920224774649
Binary Recall	0.981561231126
Total amount of samples	195519
False negative	1049
False positive	4841
True negative	133787
True positive	55842
Positive training samples	35363
Negative training samples	49638

Table 3.54: K-Nearest Neighbors with Country feature set CTU: Experiment 6.

Multi-class F-score	0.614888612093
Multi-class Precision	0.686304857668
Multi-class Recall	0.627790649502
Binary F-score	0.949903890316
Binary Precision	0.920224774649
Binary Recall	0.981561231126
Total amount of samples	195519
False negative	1049
False positive	4841
True negative	133787
True positive	55842
Positive training samples	35363
Negative training samples	49638

Table 3.55: K-Nearest Neighbors with Country feature set CTU: Experiment 7.

Multi-class F-score	0.614888612093
Multi-class Precision	0.686304857668
Multi-class Recall	0.627790649502
Binary F-score	0.949903890316
Binary Precision	0.920224774649
Binary Recall	0.981561231126
Total amount of samples	195519
False negative	1049
False positive	4841
True negative	133787
True positive	55842
Positive training samples	35363
Negative training samples	49638

Table 3.56: K-Nearest Neighbors with Country feature set CTU: Experiment 8.

Multi-class F-score	0.614888612093
Multi-class Precision	0.686304857668
Multi-class Recall	0.627790649502
Binary F-score	0.949903890316
Binary Precision	0.920224774649
Binary Recall	0.981561231126
Total amount of samples	195519
False negative	1049
False positive	4841
True negative	133787
True positive	55842
Positive training samples	35363
Negative training samples	49638

Table 3.57: K-Nearest Neighbors with Country feature set CTU: Experiment 9.

Multi-class F-score	0.614888612093
Multi-class Precision	0.686304857668
Multi-class Recall	0.627790649502
Binary F-score	0.949903890316
Binary Precision	0.920224774649
Binary Recall	0.981561231126
Total amount of samples	195519
False negative	1049
False positive	4841
True negative	133787
True positive	55842
Positive training samples	35363
Negative training samples	49638

Table 3.58: K-Nearest Neighbors with Country feature set CTU: Experiment 10.

Multi-class F-score	0.614888612093
Multi-class Precision	0.686304857668
Multi-class Recall	0.627790649502
Binary F-score	0.949903890316
Binary Precision	0.920224774649
Binary Recall	0.981561231126
Total amount of samples	195519
False negative	1049
False positive	4841
True negative	133787
True positive	55842
Positive training samples	35363
Negative training samples	49638

Table 3.59: K-Nearest Neighbors with Country feature set CTU: Average.

Multi-class F-score	0.614888612093
Multi-class Precision	0.686304857668
Multi-class Recall	0.627790649502
Binary F-score	0.949903890316
Binary Precision	0.920224774649
Binary Recall	0.981561231126
Total amount of samples	195519.0
False negative	1049.0
False positive	4841.0
True negative	133787.0
True positive	55842.0
Positive training samples	35363.0
Negative training samples	49638.0

Table 3.60: K-Nearest Neighbors with Country feature set CTU: Variance.

Multi-class F-score	1.23259516441e-32
Multi-class Precision	1.23259516441e-32
Multi-class Recall	1.23259516441e-32
Binary F-score	1.23259516441e-32
Binary Precision	4.93038065763e-32
Binary Recall	1.23259516441e-32

3.3.2 Cross Dataset

Table 3.61: KNeighborsClassifier with Country feature set Cross: Experiment 1.

Multi-class F-score	0.760059768354
Multi-class Precision	0.77725130922
Multi-class Recall	0.767952707665
Binary F-score	0.97129245442
Binary Precision	0.954421768707
Binary Recall	0.98877029646
Total amount of samples	246467
False negative	1211
False positive	5092
True negative	133536
True positive	106628
Positive training samples	65363
Negative training samples	49638

Table 3.62: KNeighborsClassifier with Country feature set Cross: Experiment 2.

Multi-class F-score	0.760401772328
Multi-class Precision	0.777426158001
Multi-class Recall	0.767932420973
Binary F-score	0.971555324779
Binary Precision	0.95472204816
Binary Recall	0.988992850453
Total amount of samples	246467
False negative	1187
False positive	5058
True negative	133570
True positive	106652
Positive training samples	65363
Negative training samples	49638

Table 3.63: KNeighborsClassifier with Country feature set Cross: Experiment 3.

Multi-class F-score	0.761939954269
Multi-class Precision	0.779033869408
Multi-class Recall	0.769936746096
Binary F-score	0.971316123919
Binary Precision	0.954562547004
Binary Recall	0.988668292547
Total amount of samples	246467
False negative	1222
False positive	5075
True negative	133553
True positive	106617
Positive training samples	65363
Negative training samples	49638

Table 3.64: KNeighborsClassifier with Country feature set Cross: Experiment 4.

Multi-class F-score	0.762010140216
Multi-class Precision	0.779532749532
Multi-class Recall	0.769965147464
Binary F-score	0.971269314316
Binary Precision	0.95426480063
Binary Recall	0.98889084654
Total amount of samples	246467
False negative	1198
False positive	5111
True negative	133517
True positive	106641
Positive training samples	65363
Negative training samples	49638

Table 3.65: KNeighborsClassifier with Country feature set Cross: Experiment 5.

Multi-class F-score	0.761991102914
Multi-class Precision	0.779063816689
Multi-class Recall	0.769859656668
Binary F-score	0.971483997887
Binary Precision	0.954454754512
Binary Recall	0.989131946698
Total amount of samples	246467
False negative	1172
False positive	5090
True negative	133538
True positive	106667
Positive training samples	65363
Negative training samples	49638

Table 3.66: KNeighborsClassifier with Country feature set Cross: Experiment 6.

Multi-class F-score	0.762357003665
Multi-class Precision	0.778221367471
Multi-class Recall	0.770447970722
Binary F-score	0.971412175671
Binary Precision	0.954497449208
Binary Recall	0.988937211955
Total amount of samples	246467
False negative	1193
False positive	5084
True negative	133544
True positive	106646
Positive training samples	65363
Negative training samples	49638

Table 3.67: KNeighborsClassifier with Country feature set Cross: Experiment 7.

Multi-class F-score	0.760431825805
Multi-class Precision	0.776958545895
Multi-class Recall	0.767944592988
Binary F-score	0.971306229359
Binary Precision	0.954578013359
Binary Recall	0.988631200215
Total amount of samples	246467
False negative	1226
False positive	5073
True negative	133555
True positive	106613
Positive training samples	65363
Negative training samples	49638

Table 3.68: KNeighborsClassifier with Country feature set Cross: Experiment 8.

Multi-class F-score	0.762245266556
Multi-class Precision	0.778303821214
Multi-class Recall	0.769656789753
Binary F-score	0.971414779429
Binary Precision	0.954416107383
Binary Recall	0.989029942785
Total amount of samples	246467
False negative	1183
False positive	5094
True negative	133534
True positive	106656
Positive training samples	65363
Negative training samples	49638

Table 3.69: KNeighborsClassifier with Country feature set Cross: Experiment 9.

Multi-class F-score	0.761893792235
Multi-class Precision	0.779180372416
Multi-class Recall	0.769372776071
Binary F-score	0.971316385236
Binary Precision	0.954554407578
Binary Recall	0.98867756563
Total amount of samples	246467
False negative	1221
False positive	5076
True negative	133552
True positive	106618
Positive training samples	65363
Negative training samples	49638

Table 3.70: KNeighborsClassifier with Country feature set Cross: Experiment 10.

Multi-class F-score	0.762384754857
Multi-class Precision	0.779110772829
Multi-class Recall	0.770180186394
Binary F-score	0.971407751514
Binary Precision	0.954488906391
Binary Recall	0.988937211955
Total amount of samples	246467
False negative	1193
False positive	5085
True negative	133543
True positive	106646
Positive training samples	65363
Negative training samples	49638

Table 3.71: KNeighborsClassifier with Country feature set Cross: Average.

Multi-class F-score	0.76157153812
Multi-class Precision	0.778408278268
Multi-class Recall	0.769324899479
Binary F-score	0.971377453653
Binary Precision	0.954496080293
Binary Recall	0.988866736524
Total amount of samples	246467.0
False negative	1200.6
False positive	5083.8
True negative	133544.2
True positive	106638.4
Positive training samples	65363.0
Negative training samples	49638.0

Table 3.72: KNeighborsClassifier with Country feature set Cross: Variance.

Multi-class F-score	7.29291617112e-07
Multi-class Precision	7.625866973e-07
Multi-class Recall	8.90263983563e-07
Binary F-score	7.79891776623e-09
Binary Precision	1.32763719901e-08
Binary Recall	2.63335986483e-08

3.4 Different k-Values

3.4.1 With k = 3

Table 3.73: KNeighborsClassifier with k=3 Cross: Experiment 1.

Multi-class F-score	0.87836492686
Multi-class Precision	0.883244584442
Multi-class Recall	0.877898461052
Binary F-score	0.992406771515
Binary Precision	0.989211151855
Binary Recall	0.995623104814
Total amount of samples	246467
False negative	471.999999963
False positive	1170.99999996
True negative	137457.0
True positive	107367.0
Positive training samples	65363
Negative training samples	49638

Table 3.74: KNeighborsClassifier with k=3 Cross: Experiment 2.

Multi-class F-score	0.878242949831
Multi-class Precision	0.88317161083
Multi-class Recall	0.877825428962
Binary F-score	0.992406771515
Binary Precision	0.989211151855
Binary Recall	0.995623104814
Total amount of samples	246467
False negative	471.999999963
False positive	1170.99999996
True negative	137457.0
True positive	107367.0
Positive training samples	65363
Negative training samples	49638

Table 3.75: KNeighborsClassifier with k=3 Cross: Experiment 3.

Multi-class F-score	0.87831613932
Multi-class Precision	0.883197652003
Multi-class Recall	0.877866002345
Binary F-score	0.992406771515
Binary Precision	0.989211151855
Binary Recall	0.995623104814
Total amount of samples	246467
False negative	471.999999963
False positive	1170.99999996
True negative	137457.0
True positive	107367.0
Positive training samples	65363
Negative training samples	49638

Table 3.76: KNeighborsClassifier with k=3 Cross: Experiment 4.

Multi-class F-score	0.878351970129
Multi-class Precision	0.883208777672
Multi-class Recall	0.87787817436
Binary F-score	0.992402114837
Binary Precision	0.989211052452
Binary Recall	0.995613831731
Total amount of samples	246467
False negative	472.999999961
False positive	1171.00000002
True negative	137457.0
True positive	107366.0
Positive training samples	65363
Negative training samples	49638

Table 3.77: KNeighborsClassifier with k=3 Cross: Experiment 5.

Multi-class F-score	0.878329818776
Multi-class Precision	0.883200375517
Multi-class Recall	0.877870059683
Binary F-score	0.992402114837
Binary Precision	0.989211052452
Binary Recall	0.995613831731
Total amount of samples	246467
False negative	472.999999961
False positive	1171.00000002
True negative	137457.0
True positive	107366.0
Positive training samples	65363
Negative training samples	49638

Table 3.78: KNeighborsClassifier with k=3 Cross: Experiment 6.

Multi-class F-score	0.878329844732
Multi-class Precision	0.883195078746
Multi-class Recall	0.877874117022
Binary F-score	0.992402114837
Binary Precision	0.989211052452
Binary Recall	0.995613831731
Total amount of samples	246467
False negative	472.999999961
False positive	1171.00000002
True negative	137457.0
True positive	107366.0
Positive training samples	65363
Negative training samples	49638

Table 3.79: KNeighborsClassifier with k=3 Cross: Experiment 7.

Multi-class F-score	0.878299765142
Multi-class Precision	0.883154930916
Multi-class Recall	0.877837600977
Binary F-score	0.992388144547
Binary Precision	0.989210754234
Binary Recall	0.995586012482
Total amount of samples	246467
False negative	475.999999954
False positive	1170.99999997
True negative	137457.0
True positive	107363.0
Positive training samples	65363
Negative training samples	49638

Table 3.80: KNeighborsClassifier with k=3 Cross: Experiment 8.

Multi-class F-score	0.878283777899
Multi-class Precision	0.883129915374
Multi-class Recall	0.877821371624
Binary F-score	0.992406771515
Binary Precision	0.989211151855
Binary Recall	0.995623104814
Total amount of samples	246467
False negative	471.999999963
False positive	1170.99999996
True negative	137457.0
True positive	107367.0
Positive training samples	65363
Negative training samples	49638

Table 3.81: KNeighborsClassifier with k=3 Cross: Experiment 9.

Multi-class F-score	0.878283756613
Multi-class Precision	0.883191877516
Multi-class Recall	0.877845715654
Binary F-score	0.992406771515
Binary Precision	0.989211151855
Binary Recall	0.995623104814
Total amount of samples	246467
False negative	471.999999963
False positive	1170.99999996
True negative	137457.0
True positive	107367.0
Positive training samples	65363
Negative training samples	49638

Table 3.82: KNeighborsClassifier with k=3 Cross: Experiment 10.

Multi-class F-score	0.878328709178
Multi-class Precision	0.883184038235
Multi-class Recall	0.877857887669
Binary F-score	0.992397458117
Binary Precision	0.989210953048
Binary Recall	0.995604558648
Total amount of samples	246467
False negative	473.999999958
False positive	1170.99999998
True negative	137457.0
True positive	107365.0
Positive training samples	65363
Negative training samples	49638

Table 3.83: KNeighborsClassifier with k=3 Cross: Average.

Multi-class F-score	0.878313165848
Multi-class Precision	0.883187884125
Multi-class Recall	0.877857481935
Binary F-score	0.992402580475
Binary Precision	0.989211062391
Binary Recall	0.995614759039
Total amount of samples	246467
False negative	474.5
False positive	1172.2
True negative	137455.8
True positive	107364.5
Positive training samples	65363.0
Negative training samples	49638.0

Table 3.84: KNeighborsClassifier with k=3 Cross: Variance.

Multi-class F-score	1.18293391398e-09
Multi-class Precision	8.69652338643e-10
Multi-class Recall	5.48019784276e-10
Binary F-score	3.23109098581e-11
Binary Precision	1.47231916237e-14
Binary Recall	1.28125202409e-10

3.4.2 With k = 7

Table 3.85: KNeighborsClassifier with k=7 Cross: Experiment 1.

Multi-class F-score	0.880726942835
Multi-class Precision	0.884659635862
Multi-class Recall	0.881939570003
Binary F-score	0.992668269231
Binary Precision	0.989730920622
Binary Recall	0.995623104814
Total amount of samples	246467
False negative	471.999999963
False positive	1114.00000001
True negative	137514.0
True positive	107367.0
Positive training samples	65363
Negative training samples	49638

Table 3.86: KNeighborsClassifier with k=7 Cross: Experiment 2.

Multi-class F-score	0.880774646543
Multi-class Precision	0.884661827724
Multi-class Recall	0.88197202871
Binary F-score	0.992672925883
Binary Precision	0.989731015284
Binary Recall	0.995632377897
Total amount of samples	246467
False negative	470.999999965
False positive	1113.99999996
True negative	137514.0
True positive	107368.0
Positive training samples	65363
Negative training samples	49638

Table 3.87: KNeighborsClassifier with k=7 Cross: Experiment 3.

Multi-class F-score	0.880750048247
Multi-class Precision	0.884627851576
Multi-class Recall	0.88194768468
Binary F-score	0.992672925883
Binary Precision	0.989731015284
Binary Recall	0.995632377897
Total amount of samples	246467
False negative	470.999999965
False positive	1113.99999996
True negative	137514.0
True positive	107368.0
Positive training samples	65363
Negative training samples	49638

Table 3.88: KNeighborsClassifier with k=7 Cross: Experiment 4.

Multi-class F-score	0.88078366869
Multi-class Precision	0.884702918746
Multi-class Recall	0.881984200725
Binary F-score	0.992672925883
Binary Precision	0.989731015284
Binary Recall	0.995632377897
Total amount of samples	246467
False negative	470.999999965
False positive	1113.99999996
True negative	137514.0
True positive	107368.0
Positive training samples	65363
Negative training samples	49638

Table 3.89: KNeighborsClassifier with k=7 Cross: Experiment 5.

Multi-class F-score	0.880764346843
Multi-class Precision	0.884688007445
Multi-class Recall	0.881967971371
Binary F-score	0.992668269231
Binary Precision	0.989730920622
Binary Recall	0.995623104814
Total amount of samples	246467
False negative	471.999999963
False positive	1114.00000001
True negative	137514.0
True positive	107367.0
Positive training samples	65363
Negative training samples	49638

Table 3.90: KNeighborsClassifier with k=7 Cross: Experiment 6.

Multi-class F-score	0.880745423919
Multi-class Precision	0.884654756443
Multi-class Recall	0.881955799357
Binary F-score	0.992668269231
Binary Precision	0.989730920622
Binary Recall	0.995623104814
Total amount of samples	246467
False negative	471.999999963
False positive	1114.00000001
True negative	137514.0
True positive	107367.0
Positive training samples	65363
Negative training samples	49638

Table 3.91: KNeighborsClassifier with k=7 Cross: Experiment 7.

Multi-class F-score	0.880786717402
Multi-class Precision	0.884692146539
Multi-class Recall	0.881980143386
Binary F-score	0.992668201444
Binary Precision	0.989739949668
Binary Recall	0.995613831731
Total amount of samples	246467
False negative	472.999999961
False positive	1112.99999997
True negative	137515.0
True positive	107366.0
Positive training samples	65363
Negative training samples	49638

Table 3.92: KNeighborsClassifier with k=7 Cross: Experiment 8.

Multi-class F-score	0.880744658722
Multi-class Precision	0.884636071522
Multi-class Recall	0.881955799357
Binary F-score	0.99267285814
Binary Precision	0.989740044248
Binary Recall	0.995623104814
Total amount of samples	246467
False negative	471.999999963
False positive	1112.99999998
True negative	137515.0
True positive	107367.0
Positive training samples	65363
Negative training samples	49638

Table 3.93: KNeighborsClassifier with k=7 Cross: Experiment 9.

Multi-class F-score	0.880773845825
Multi-class Precision	0.884672511871
Multi-class Recall	0.881967971371
Binary F-score	0.992668269231
Binary Precision	0.989730920622
Binary Recall	0.995623104814
Total amount of samples	246467
False negative	471.999999963
False positive	1114.00000001
True negative	137514.0
True positive	107367.0
Positive training samples	65363
Negative training samples	49638

Table 3.94: KNeighborsClassifier with k=7 Cross: Experiment 10.

Multi-class F-score	0.880787865327
Multi-class Precision	0.88468509978
Multi-class Recall	0.881976086048
Binary F-score	0.992668269231
Binary Precision	0.989730920622
Binary Recall	0.995623104814
Total amount of samples	246467
False negative	471.999999963
False positive	1114.00000001
True negative	137514.0
True positive	107367.0
Positive training samples	65363
Negative training samples	49638

Table 3.95: KNeighborsClassifier with k=7 Cross: Average.

Multi-class F-score	0.880763816435
Multi-class Precision	0.884668082751
Multi-class Recall	0.881964725501
Binary F-score	0.992670118339
Binary Precision	0.989732764288
Binary Recall	0.99562495943
Total amount of samples	264467.0
False negative	474.5
False positive	1117.4
True negative	137510.6
True positive	107364.5
Positive training samples	65363.0
Negative training samples	49638.0

Table 3.96: KNeighborsClassifier with k=7 Cross: Variance.

Multi-class F-score	3.9696047677e-10
Multi-class Precision	5.430134289e-10
Multi-class Recall	1.90300652034e-10
Binary F-score	5.1923916777e-12
Binary Precision	1.30800065139e-11
Binary Recall	3.09564247437e-11

3.5 Distance metrics

3.5.1 Chebyshev distance

Table 3.97: KNeighborsClassifier with distance chebyshev Cross: Experiment 1.

Multi-class F-score	0.875475860472
Multi-class Precision	0.879596429277
Multi-class Recall	0.876186264287
Binary F-score	0.991224585939
Binary Precision	0.987412008282
Binary Recall	0.995066719832
Total amount of samples	246467
False negative	532.000000037
False positive	1367.99999995
True negative	137260.0
True positive	107307.0
Positive training samples	65363
Negative training samples	49638

Table 3.98: KNeighborsClassifier with distance chebyshev Cross: Experiment 2.

Multi-class F-score	0.875548284014
Multi-class Precision	0.879684722097
Multi-class Recall	0.876218722993
Binary F-score	0.991224666999
Binary Precision	0.987403038361
Binary Recall	0.995075992915
Total amount of samples	246467
False negative	531.000000039
False positive	1369.00000004
True negative	137259.0
True positive	107308.0
Positive training samples	65363
Negative training samples	49638

Table 3.99: KNeighborsClassifier with distance chebyshev Cross: Experiment 3.

Multi-class F-score	0.875418161835
Multi-class Precision	0.879530803911
Multi-class Recall	0.876121346874
Binary F-score	0.991210689427
Binary Precision	0.987402690616
Binary Recall	0.995048173666
Total amount of samples	246467
False negative	534.000000032
False positive	1369.0
True negative	137259.0
True positive	107305.0
Positive training samples	65363
Negative training samples	49638

Table 3.100: KNeighborsClassifier with distance chebyshev Cross: Experiment 4.

Multi-class F-score	0.875512145622
Multi-class Precision	0.87965654636
Multi-class Recall	0.876206550978
Binary F-score	0.991233823217
Binary Precision	0.98742121003
Binary Recall	0.995075992915
Total amount of samples	246467
False negative	531.000000039
False positive	1366.99999999
True negative	137261.0
True positive	107308.0
Positive training samples	65363
Negative training samples	49638

Table 3.101: KNeighborsClassifier with distance chebyshev Cross: Experiment 5.

Multi-class F-score	0.875453220255
Multi-class Precision	0.879616584324
Multi-class Recall	0.87615380558
Binary F-score	0.991215348661
Binary Precision	0.987402806533
Binary Recall	0.995057446749
Total amount of samples	246467
False negative	533.000000035
False positive	1369.00000003
True negative	137259.0
True positive	107306.0
Positive training samples	65363
Negative training samples	49638

Table 3.102: KNeighborsClassifier with distance chebyshev Cross: Experiment 6.

Multi-class F-score	0.8755282898
Multi-class Precision	0.879652048078
Multi-class Recall	0.876218722993
Binary F-score	0.991220088954
Binary Precision	0.987393952778
Binary Recall	0.995075992915
Total amount of samples	246467
False negative	531.000000039
False positive	1369.99999999
True negative	137258.0
True positive	107308.0
Positive training samples	65363
Negative training samples	49638

Table 3.103: KNeighborsClassifier with distance chebyshev Cross: Experiment 7.

Multi-class F-score	0.875569738518
Multi-class Precision	0.87972451488
Multi-class Recall	0.876255239038
Binary F-score	0.991229245087
Binary Precision	0.987412124112
Binary Recall	0.995075992915
Total amount of samples	246467
False negative	531.000000039
False positive	1368.0
True negative	137260.0
True positive	107308.0
Positive training samples	65363
Negative training samples	49638

Table 3.104: KNeighborsClassifier with distance chebyshev Cross: Experiment 8.

Multi-class F-score	0.875450597261
Multi-class Precision	0.879587795146
Multi-class Recall	0.87615380558
Binary F-score	0.991224585939
Binary Precision	0.987412008282
Binary Recall	0.995066719832
Total amount of samples	246467
False negative	532.000000037
False positive	1367.99999995
True negative	137260.0
True positive	107307.0
Positive training samples	65363
Negative training samples	49638

Table 3.105: KNeighborsClassifier with distance chebyshev Cross: Experiment 9.

Multi-class F-score	0.875488118818
Multi-class Precision	0.879611703559
Multi-class Recall	0.876170034934
Binary F-score	0.991219926748
Binary Precision	0.987411892449
Binary Recall	0.995057446749
Total amount of samples	246467
False negative	533.000000035
False positive	1368.0
True negative	137260.0
True positive	107306.0
Positive training samples	65363
Negative training samples	49638

Table 3.106: KNeighborsClassifier with distance chebyshev Cross: Experiment 10.

Multi-class F-score	0.875498751248
Multi-class Precision	0.879661336174
Multi-class Recall	0.87620249364
Binary F-score	0.991220088954
Binary Precision	0.987393952778
Binary Recall	0.995075992915
Total amount of samples	246467
False negative	531.000000039
False positive	1369.99999999
True negative	137258.0
True positive	107308.0
Positive training samples	65363
Negative training samples	49638

Table 3.107: KNeighborsClassifier with distance chebyshev Cross: Average.

Multi-class F-score	0.875494316784
Multi-class Precision	0.879632248381
Multi-class Recall	0.87618869869
Binary F-score	0.991222304993
Binary Precision	0.987406568422
Binary Recall	0.995067647141
Total amount of samples	246467.0
False negative	539.2
False positive	1369.2
True negative	137258.8
True positive	107299.9
Positive training samples	65363.0
Negative training samples	49638.0

Table 3.108: KNeighborsClassifier with distance chebyshev Cross: Variance.

Multi-class F-score	1.98715454894e-09
Multi-class Precision	2.73126485256e-09
Multi-class Recall	1.40651277767e-09
Binary F-score	3.95608516937e-11
Binary Precision	6.92731246614e-11
Binary Recall	9.37291749168e-11

3.5.2 Euclidean distance

Table 3.109: KNeighborsClassifier with distance euclidean Cross: Experiment 1.

Multi-class F-score	0.877199370566
Multi-class Precision	0.881428425138
Multi-class Recall	0.877813256947
Binary F-score	0.99172958038
Binary Precision	0.988277545007
Binary Recall	0.995205816078
Total amount of samples	246467
False negative	516.999999965
False positive	1272.99999996
True negative	137355.0
True positive	107322.0
Positive training samples	65363
Negative training samples	49638

Table 3.110: KNeighborsClassifier with distance euclidean Cross: Experiment 2.

Multi-class F-score	0.877227276323
Multi-class Precision	0.881490037177
Multi-class Recall	0.877837600977
Binary F-score	0.99172958038
Binary Precision	0.988277545007
Binary Recall	0.995205816078
Total amount of samples	246467
False negative	516.999999965
False positive	1272.99999996
True negative	137355.0
True positive	107322.0
Positive training samples	65363
Negative training samples	49638

Table 3.111: KNeighborsClassifier with distance euclidean Cross: Experiment 3.

Multi-class F-score	0.877220745589
Multi-class Precision	0.881451634
Multi-class Recall	0.877821371624
Binary F-score	0.991734238917
Binary Precision	0.988277652952
Binary Recall	0.995215089161
Total amount of samples	246467
False negative	515.999999967
False positive	1273.00000003
True negative	137355.0
True positive	107323.0
Positive training samples	65363
Negative training samples	49638

Table 3.112: KNeighborsClassifier with distance euclidean Cross: Experiment 4.

Multi-class F-score	0.87720782688
Multi-class Precision	0.881447069069
Multi-class Recall	0.877813256947
Binary F-score	0.99172958038
Binary Precision	0.988277545007
Binary Recall	0.995205816078
Total amount of samples	246467
False negative	516.999999965
False positive	1272.99999996
True negative	137355.0
True positive	107322.0
Positive training samples	65363
Negative training samples	49638

Table 3.113: KNeighborsClassifier with distance euclidean Cross: Experiment 5.

Multi-class F-score	0.877218128909
Multi-class Precision	0.88149279044
Multi-class Recall	0.877821371624
Binary F-score	0.991692310536
Binary Precision	0.988276681371
Binary Recall	0.995131631413
Total amount of samples	246467
False negative	525.000000053
False positive	1272.99999997
True negative	137355.0
True positive	107314.0
Positive training samples	65363
Negative training samples	49638

Table 3.114: KNeighborsClassifier with distance euclidean Cross: Experiment 6.

Multi-class F-score	0.877207229506
Multi-class Precision	0.881473630396
Multi-class Recall	0.8778294863
Binary F-score	0.991734238917
Binary Precision	0.988277652952
Binary Recall	0.995215089161
Total amount of samples	246467
False negative	515.999999967
False positive	1273.00000003
True negative	137355.0
True positive	107323.0
Positive training samples	65363
Negative training samples	49638

Table 3.115: KNeighborsClassifier with distance euclidean Cross: Experiment 7.

Multi-class F-score	0.877245080072
Multi-class Precision	0.881483246596
Multi-class Recall	0.877841658315
Binary F-score	0.99172958038
Binary Precision	0.988277545007
Binary Recall	0.995205816078
Total amount of samples	246467
False negative	516.999999965
False positive	1272.99999996
True negative	137355.0
True positive	107322.0
Positive training samples	65363
Negative training samples	49638

Table 3.116: KNeighborsClassifier with distance euclidean Cross: Experiment 8.

Multi-class F-score	0.877222798622
Multi-class Precision	0.881503878181
Multi-class Recall	0.877841658315
Binary F-score	0.99172958038
Binary Precision	0.988277545007
Binary Recall	0.995205816078
Total amount of samples	246467
False negative	516.999999965
False positive	1272.99999996
True negative	137355.0
True positive	107322.0
Positive training samples	65363
Negative training samples	49638

Table 3.117: KNeighborsClassifier with distance euclidean Cross: Experiment 9.

Multi-class F-score	0.877226572004
Multi-class Precision	0.881489336548
Multi-class Recall	0.877841658315
Binary F-score	0.991734238917
Binary Precision	0.988277652952
Binary Recall	0.995215089161
Total amount of samples	246467
False negative	515.999999967
False positive	1273.00000003
True negative	137355.0
True positive	107323.0
Positive training samples	65363
Negative training samples	49638

Table 3.118: KNeighborsClassifier with distance euclidean Cross: Experiment 10.

Multi-class F-score	0.877170423979
Multi-class Precision	0.881430392611
Multi-class Recall	0.877797027594
Binary F-score	0.991720263177
Binary Precision	0.98827732911
Binary Recall	0.995187269912
Total amount of samples	246467
False negative	518.99999996
False positive	1272.99999996
True negative	137355.0
True positive	107320.0
Positive training samples	65363
Negative training samples	49638

Table 3.119: KNeighborsClassifier with distance euclidean Cross: Average.

Multi-class F-score	0.877214545245
Multi-class Precision	0.881469044016
Multi-class Recall	0.877825834696
Binary F-score	0.991726319236
Binary Precision	0.988277469437
Binary Recall	0.99519932492
Total amount of samples	246467.0
False negative	528.4
False positive	1281.4
True negative	137346.6
True positive	107310.6
Positive training samples	65363.0
Negative training samples	49638.0

Table 3.120: KNeighborsClassifier with distance euclidean Cross: Variance.

Multi-class F-score	3.63411755334e-10
Multi-class Precision	6.78239083685e-10
Multi-class Recall	2.08902705391e-10
Binary F-score	1.43460688975e-10
Binary Precision	7.70327667189e-14
Binary Recall	5.68394354314e-10

3.5.3 Canberra distance

Table 3.121: KNeighborsClassifier with distance canberra Cross: Experiment 1.

Multi-class F-score	0.915072024374
Multi-class Precision	0.921624432006
Multi-class Recall	0.91222760045
Binary F-score	0.976833537426
Binary Precision	0.959394448816
Binary Recall	0.994918350504
Total amount of samples	246467
False negative	547.999999999
False positive	4541.00000001
True negative	134087.0
True positive	107291.0
Positive training samples	65363
Negative training samples	49638

Table 3.122: KNeighborsClassifier with distance canberra Cross: Experiment 2.

Multi-class F-score	0.91511408166
Multi-class Precision	0.921663752774
Multi-class Recall	0.912276288509
Binary F-score	0.976889427038
Binary Precision	0.959398805479
Binary Recall	0.9950296275
Total amount of samples	246467
False negative	536.000000028
False positive	4541.00000001
True negative	134087.0
True positive	107303.0
Positive training samples	65363
Negative training samples	49638

Table 3.123: KNeighborsClassifier with distance canberra Cross: Experiment 3.

Multi-class F-score	0.915078445008
Multi-class Precision	0.921625650268
Multi-class Recall	0.912243829803
Binary F-score	0.976853643105
Binary Precision	0.959338399642
Binary Recall	0.995020354417
Total amount of samples	246467
False negative	537.000000025
False positive	4548.00000004
True negative	134080.0
True positive	107302.0
Positive training samples	65363
Negative training samples	49638

Table 3.124: KNeighborsClassifier with distance canberra Cross: Experiment 4.

Multi-class F-score	0.915107671797
Multi-class Precision	0.921658406805
Multi-class Recall	0.912268173833
Binary F-score	0.976880112527
Binary Precision	0.959398079433
Binary Recall	0.995011081334
Total amount of samples	246467
False negative	538.000000023
False positive	4541.00000006
True negative	134087.0
True positive	107301.0
Positive training samples	65363
Negative training samples	49638

Table 3.125: KNeighborsClassifier with distance canberra Cross: Experiment 5.

Multi-class F-score	0.915148803939
Multi-class Precision	0.921693578719
Multi-class Recall	0.912308747216
Binary F-score	0.976926683387
Binary Precision	0.959401709402
Binary Recall	0.995103812164
Total amount of samples	246467
False negative	528.000000046
False positive	4540.99999996
True negative	134087.0
True positive	107311.0
Positive training samples	65363
Negative training samples	49638

Table 3.126: KNeighborsClassifier with distance canberra Cross: Experiment 6.

Multi-class F-score	0.915156227688
Multi-class Precision	0.921700777358
Multi-class Recall	0.912316861892
Binary F-score	0.97693599705
Binary Precision	0.959402435317
Binary Recall	0.99512235833
Total amount of samples	246467
False negative	526.000000051
False positive	4541.00000005
True negative	134087.0
True positive	107313.0
Positive training samples	65363
Negative training samples	49638

Table 3.127: KNeighborsClassifier with distance canberra Cross: Experiment 7.

Multi-class F-score	0.915146894257
Multi-class Precision	0.921688377675
Multi-class Recall	0.912308747216
Binary F-score	0.976926683387
Binary Precision	0.959401709402
Binary Recall	0.995103812164
Total amount of samples	246467
False negative	528.000000046
False positive	4540.99999996
True negative	134087.0
True positive	107311.0
Positive training samples	65363
Negative training samples	49638

Table 3.128: KNeighborsClassifier with distance canberra Cross: Experiment 8.

Multi-class F-score	0.915094855704
Multi-class Precision	0.921646395878
Multi-class Recall	0.912256001818
Binary F-score	0.976866140442
Binary Precision	0.959396990316
Binary Recall	0.994983262085
Total amount of samples	246467
False negative	541.000000016
False positive	4541.00000005
True negative	134087.0
True positive	107298.0
Positive training samples	65363
Negative training samples	49638

Table 3.129: KNeighborsClassifier with distance canberra Cross: Experiment 9.

Multi-class F-score	0.915021700812
Multi-class Precision	0.921580383992
Multi-class Recall	0.912187027067
Binary F-score	0.976788437464
Binary Precision	0.959333309489
Binary Recall	0.994890531255
Total amount of samples	246467
False negative	550.999999992
False positive	4547.99999999
True negative	134080.0
True positive	107288.0
Positive training samples	65363
Negative training samples	49638

Table 3.130: KNeighborsClassifier with distance canberra Cross: Experiment 10.

Multi-class F-score	0.915125950032
Multi-class Precision	0.921672274228
Multi-class Recall	0.912284403186
Binary F-score	0.97689874138
Binary Precision	0.959399531499
Binary Recall	0.995048173666
Total amount of samples	246467
False negative	534.000000032
False positive	4540.99999996
True negative	134087.0
True positive	107305.0
Positive training samples	65363
Negative training samples	49638

Table 3.131: KNeighborsClassifier with distance canberra Cross: Average.

Multi-class F-score	0.915106665527
Multi-class Precision	0.92165540297
Multi-class Recall	0.912267768099
Binary F-score	0.976879940321
Binary Precision	0.95938654188
Binary Recall	0.995023136342
Total amount of samples	246467.0
False negative	539.2
False positive	4540.7
True negative	134087.3
True positive	107299.8
Positive training samples	65363.0
Negative training samples	49638.0

Table 3.132: KNeighborsClassifier with distance canberra Cross: Variance.

Multi-class F-score	1.56331898669e-09
Multi-class Precision	1.25203343079e-09
Multi-class Recall	1.49623064562e-09
Binary F-score	1.93636742777e-09
Binary Precision	6.48800194785e-10
Binary Recall	5.38383820327e-09

Chapter 4

Decision Tree Classifier

4.1 Standard feature set

4.1.1 CTU Dataset

Table 4.1: DecisionTreeClassifier with Standard feature set CTU: Experiment 1.

Multi-class F-score	0.600550604122
Multi-class Precision	0.657768055449
Multi-class Recall	0.601312404421
Binary F-score	0.908264963828
Binary Precision	0.840760804501
Binary Recall	0.987555149321
Total amount of samples	195519
False negative	708
False positive	10641
True negative	127987
True positive	56183
Positive training samples	25195
Negative training samples	24806

Table 4.2: DecisionTreeClassifier with Standard feature set CTU: Experiment 2.

Multi-class F-score	0.599723082938
Multi-class Precision	0.656979098165
Multi-class Recall	0.60028437134
Binary F-score	0.906333688252
Binary Precision	0.837494968769
Binary Recall	0.987502416902
Total amount of samples	195519
False negative	711
False positive	10901
True negative	127727
True positive	56180
Positive training samples	25195
Negative training samples	24806

Table 4.3: DecisionTreeClassifier with Standard feature set CTU: Experiment 3.

Multi-class F-score	0.599966992355
Multi-class Precision	0.656486962224
Multi-class Recall	0.600949268358
Binary F-score	0.907934712346
Binary Precision	0.84019500815
Binary Recall	0.987555149321
Total amount of samples	195519
False negative	708
False positive	10686
True negative	127942
True positive	56183
Positive training samples	25195
Negative training samples	24806

Table 4.4: DecisionTreeClassifier with Standard feature set CTU: Experiment 4.

Multi-class F-score	0.599850550114
Multi-class Precision	0.656920347771
Multi-class Recall	0.600545215554
Binary F-score	0.906686248245
Binary Precision	0.838084582681
Binary Recall	0.987519994375
Total amount of samples	195519
False negative	710
False positive	10854
True negative	127774
True positive	56181
Positive training samples	25195
Negative training samples	24806

Table 4.5: DecisionTreeClassifier with Standard feature set CTU: Experiment 5.

Multi-class F-score	0.599608827077
Multi-class Precision	0.657068251333
Multi-class Recall	0.600330402672
Binary F-score	0.90757388516
Binary Precision	0.839589933648
Binary Recall	0.987537571848
Total amount of samples	195519
False negative	709
False positive	10734
True negative	127894
True positive	56182
Positive training samples	25195
Negative training samples	24806

Table 4.6: DecisionTreeClassifier with Standard feature set CTU: Experiment 6.

Multi-class F-score	0.600791622873
Multi-class Precision	0.657826758729
Multi-class Recall	0.60162439456
Binary F-score	0.907474258025
Binary Precision	0.83939402994
Binary Recall	0.987572726793
Total amount of samples	195519
False negative	707
False positive	10750
True negative	127878
True positive	56184
Positive training samples	25195
Negative training samples	24806

Table 4.7: DecisionTreeClassifier with Standard feature set CTU: Experiment 7.

Multi-class F-score	0.599833298642
Multi-class Precision	0.656600037906
Multi-class Recall	0.60070376792
Binary F-score	0.907686714869
Binary Precision	0.839821209675
Binary Recall	0.98748483943
Total amount of samples	195519
False negative	712
False positive	10715
True negative	127913
True positive	56179
Positive training samples	25195
Negative training samples	24806

Table 4.8: DecisionTreeClassifier with Standard feature set CTU: Experiment 8.

Multi-class F-score	0.600420916922
Multi-class Precision	0.65744375654
Multi-class Recall	0.601092476946
Binary F-score	0.907184033328
Binary Precision	0.838935595144
Binary Recall	0.987519994375
Total amount of samples	195519
False negative	710
False positive	10786
True negative	127842
True positive	56181
Positive training samples	25195
Negative training samples	24806

Table 4.9: DecisionTreeClassifier with Standard feature set CTU: Experiment 9.

Multi-class F-score	0.599721499396
Multi-class Precision	0.656800586978
Multi-class Recall	0.600412236151
Binary F-score	0.907408304666
Binary Precision	0.839281179511
Binary Recall	0.987572726793
Total amount of samples	195519
False negative	707
False positive	10759
True negative	127869
True positive	56184
Positive training samples	25195
Negative training samples	24806

Table 4.10: DecisionTreeClassifier with Standard feature set CTU: Experiment 10.

Multi-class F-score	0.600119012652
Multi-class Precision	0.657045853748
Multi-class Recall	0.600826518139
Binary F-score	0.907100649036
Binary Precision	0.838754945137
Binary Recall	0.987572726793
Total amount of samples	195519
False negative	707
False positive	10801
True negative	127827
True positive	56184
Positive training samples	25195
Negative training samples	24806

Table 4.11: DecisionTreeClassifier with Standard feature set CTU: Average.

Multi-class F-score	0.600058640709
Multi-class Precision	0.657093970884
Multi-class Recall	0.600808105606
Binary F-score	0.907364745776
Binary Precision	0.839231225716
Binary Recall	0.987539329595
Total amount of samples	195519.0
False negative	708.9
False positive	10762.7
True negative	127865.3
True positive	56182.1
Positive training samples	25195.0
Negative training samples	24806.0

Table 4.12: DecisionTreeClassifier with Standard feature set CTU: Variance.

Multi-class F-score	1.44525542814e-07
Multi-class Precision	1.85853892895e-07
Multi-class Recall	1.76098578635e-07
Binary F-score	2.92239071481e-07
Binary Precision	8.41785995193e-07
Binary Recall	8.92916210555e-10

4.1.2 Cross Dataset

Table 4.13: DecisionTreeClassifier with Standard feature set Cross: Experiment 1.

Multi-class F-score	0.751456683266
Multi-class Precision	0.789500071853
Multi-class Recall	0.745856443256
Binary F-score	0.94128452462
Binary Precision	0.894592201544
Binary Recall	0.993119372398
Total amount of samples	246467
False negative	742
False positive	12619
True negative	126009
True positive	107097
Positive training samples	30140
Negative training samples	19861

Table 4.14: DecisionTreeClassifier with Standard feature set Cross: Experiment 2.

Multi-class F-score	0.751175623771
Multi-class Precision	0.789881997219
Multi-class Recall	0.745568372236
Binary F-score	0.941342930085
Binary Precision	0.894569810753
Binary Recall	0.993277014809
Total amount of samples	246467
False negative	725
False positive	12624
True negative	126004
True positive	107114
Positive training samples	30140
Negative training samples	19861

Table 4.15: DecisionTreeClassifier with Standard feature set Cross: Experiment 3.

Multi-class F-score	0.750989198786
Multi-class Precision	0.789976506307
Multi-class Recall	0.745191039774
Binary F-score	0.941139774365
Binary Precision	0.894210460408
Binary Recall	0.993267741726
Total amount of samples	246467
False negative	726
False positive	12672
True negative	125956
True positive	107113
Positive training samples	30140
Negative training samples	19861

Table 4.16: DecisionTreeClassifier with Standard feature set Cross: Experiment 4.

Multi-class F-score	0.750398146373
Multi-class Precision	0.789322974362
Multi-class Recall	0.74457838169
Binary F-score	0.941081886118
Binary Precision	0.894166068358
Binary Recall	0.993193557062
Total amount of samples	246467
False negative	734
False positive	12677
True negative	125951
True positive	107105
Positive training samples	30140
Negative training samples	19861

Table 4.17: DecisionTreeClassifier with Standard feature set Cross: Experiment 5.

Multi-class F-score	0.750557597117
Multi-class Precision	0.788966819949
Multi-class Recall	0.74505714761
Binary F-score	0.941684247539
Binary Precision	0.895096130547
Binary Recall	0.993388291805
Total amount of samples	246467
False negative	713
False positive	12555
True negative	126073
True positive	107126
Positive training samples	30140
Negative training samples	19861

Table 4.18: DecisionTreeClassifier with Standard feature set Cross: Experiment 6.

Multi-class F-score	0.750731991378
Multi-class Precision	0.789012983495
Multi-class Recall	0.745199154451
Binary F-score	0.941428791175
Binary Precision	0.894800160406
Binary Recall	0.993184283979
Total amount of samples	246467
False negative	735
False positive	12592
True negative	126036
True positive	107104
Positive training samples	30140
Negative training samples	19861

Table 4.19: DecisionTreeClassifier with Standard feature set Cross: Experiment 7.

Multi-class F-score	0.751210922617
Multi-class Precision	0.790376519046
Multi-class Recall	0.745576486913
Binary F-score	0.941279348242
Binary Precision	0.894537709847
Binary Recall	0.993175010896
Total amount of samples	246467
False negative	736
False positive	12627
True negative	126001
True positive	107103
Positive training samples	30140
Negative training samples	19861

Table 4.20: DecisionTreeClassifier with Standard feature set Cross: Experiment 8.

Multi-class F-score	0.751183766726
Multi-class Precision	0.789438228138
Multi-class Recall	0.745625174973
Binary F-score	0.94168739945
Binary Precision	0.89517712834
Binary Recall	0.993295560975
Total amount of samples	246467
False negative	723
False positive	12543
True negative	126085
True positive	107116
Positive training samples	30140
Negative training samples	19861

Table 4.21: DecisionTreeClassifier with Standard feature set Cross: Experiment 9.

Multi-class F-score	0.750473561247
Multi-class Precision	0.789039920758
Multi-class Recall	0.744878624725
Binary F-score	0.941773910597
Binary Precision	0.895461614354
Binary Recall	0.993137918564
Total amount of samples	246467
False negative	740
False positive	12503
True negative	126125
True positive	107099
Positive training samples	30140
Negative training samples	19861

Table 4.22: DecisionTreeClassifier with Standard feature set Cross: Experiment 10.

Multi-class F-score	0.750513737741
Multi-class Precision	0.789215825137
Multi-class Recall	0.744886739401
Binary F-score	0.940843734355
Binary Precision	0.893653587846
Binary Recall	0.993295560975
Total amount of samples	246467
False negative	723
False positive	12747
True negative	125881
True positive	107116
Positive training samples	30140
Negative training samples	19861

Table 4.23: DecisionTreeClassifier with Standard feature set Cross: Average.

Multi-class F-score	0.750869122902
Multi-class Precision	0.789473184626
Multi-class Recall	0.745241756503
Binary F-score	0.941354654654
Binary Precision	0.89462648724
Binary Recall	0.993233431319
Total amount of samples	246467.0
False negative	729.7
False positive	12615.9
True negative	126012.1
True positive	107109.3
Positive training samples	30140.0
Negative training samples	19861.0

Table 4.24: DecisionTreeClassifier with Standard feature set Cross: Variance.

Multi-class F-score	1.28985585938e-07
Multi-class Precision	1.98312328034e-07
Multi-class Recall	1.48000735042e-07
Binary F-score	7.92964846173e-08
Binary Precision	2.59523638352e-07
Binary Recall	6.43291704179e-09

4.2 TCP feature set

4.2.1 CTU Dataset

Table 4.25: DecisionTreeClassifier with TCP feature set CTU: Experiment 1.

Multi-class F-score	0.664852721831
Multi-class Precision	0.709460994347
Multi-class Recall	0.673044563444
Binary F-score	0.950852421826
Binary Precision	0.917068073086
Binary Recall	0.987221177339
Total amount of samples	195519
False negative	727.000000007
False positive	5079.00000039
True negative	133549.0
True positive	56164.0
Positive training samples	25195
Negative training samples	24806

Table 4.26: DecisionTreeClassifier with TCP feature set CTU: Experiment 2.

Multi-class F-score	0.66502260591
Multi-class Precision	0.709551737503
Multi-class Recall	0.673474189209
Binary F-score	0.95141998561
Binary Precision	0.917608255503
Binary Recall	0.987818811411
Total amount of samples	195519
False negative	693.000000017
False positive	5046.00000017
True negative	133582.0
True positive	56198.0
Positive training samples	25195
Negative training samples	24806

Table 4.27: DecisionTreeClassifier with TCP feature set CTU: Experiment 3.

Multi-class F-score	0.665331534955
Multi-class Precision	0.709902731669
Multi-class Recall	0.673596939428
Binary F-score	0.951201747997
Binary Precision	0.917809338585
Binary Recall	0.987115712503
Total amount of samples	195519
False negative	732.999999992
False positive	5029.00000033
True negative	133599.0
True positive	56158.0
Positive training samples	25195
Negative training samples	24806

Table 4.28: DecisionTreeClassifier with TCP feature set CTU: Experiment 4.

Multi-class F-score	0.665707088832
Multi-class Precision	0.710513728026
Multi-class Recall	0.674057252748
Binary F-score	0.951557737894
Binary Precision	0.917849385095
Binary Recall	0.987836388884
Total amount of samples	195519
False negative	692.0
False positive	5030.00000035
True negative	133598.0
True positive	56199.0
Positive training samples	25195
Negative training samples	24806

Table 4.29: DecisionTreeClassifier with TCP feature set CTU: Experiment 5.

Multi-class F-score	0.664508568392
Multi-class Precision	0.709257808118
Multi-class Recall	0.672865552708
Binary F-score	0.951093210587
Binary Precision	0.916939944202
Binary Recall	0.987889121302
Total amount of samples	195519
False negative	689.000000008
False positive	5091.00000016
True negative	133537.0
True positive	56202.0
Positive training samples	25195
Negative training samples	24806

Table 4.30: DecisionTreeClassifier with TCP feature set CTU: Experiment 6.

Multi-class F-score	0.664907883302
Multi-class Precision	0.710152429256
Multi-class Recall	0.673090594776
Binary F-score	0.950846596681
Binary Precision	0.917163435627
Binary Recall	0.98709813503
Total amount of samples	195519
False negative	734.000000008
False positive	5072.00000046
True negative	133556.0
True positive	56157.0
Positive training samples	25195
Negative training samples	24806

Table 4.31: DecisionTreeClassifier with TCP feature set CTU: Experiment 7.

Multi-class F-score	0.665000086504
Multi-class Precision	0.709951546627
Multi-class Recall	0.673346324398
Binary F-score	0.951167872085
Binary Precision	0.917776651903
Binary Recall	0.987080557557
Total amount of samples	195519
False negative	735.000000025
False positive	5031.00000021
True negative	133597.0
True positive	56156.0
Positive training samples	25195
Negative training samples	24806

Table 4.32: DecisionTreeClassifier with TCP feature set CTU: Experiment 8.

Multi-class F-score	0.664918454515
Multi-class Precision	0.709943913238
Multi-class Recall	0.673284949289
Binary F-score	0.951146408372
Binary Precision	0.917539245634
Binary Recall	0.987309064703
Total amount of samples	195519
False negative	721.999999982
False positive	5048.00000029
True negative	133580.0
True positive	56169.0
Positive training samples	25195
Negative training samples	24806

Table 4.33: DecisionTreeClassifier with TCP feature set CTU: Experiment 9.

Multi-class F-score	0.664639419081
Multi-class Precision	0.710319278269
Multi-class Recall	0.672845094339
Binary F-score	0.95107618838
Binary Precision	0.917514825767
Binary Recall	0.987186022394
Total amount of samples	195519
False negative	728.999999983
False positive	5049.00000044
True negative	133579.0
True positive	56162.0
Positive training samples	25195
Negative training samples	24806

Table 4.34: DecisionTreeClassifier with TCP feature set CTU: Experiment 10.

Multi-class F-score	0.665780933583
Multi-class Precision	0.71069155127
Multi-class Recall	0.67410328408
Binary F-score	0.950943779692
Binary Precision	0.91748096343
Binary Recall	0.986939937776
Total amount of samples	195519
False negative	742.999999986
False positive	5050.00000001
True negative	133578.0
True positive	56148.0
Positive training samples	25195
Negative training samples	24806

Table 4.35: DecisionTreeClassifier with TCP feature set CTU: Average.

Multi-class F-score	0.665066929691
Multi-class Precision	0.709974571832
Multi-class Recall	0.673370874442
Binary F-score	0.951130594912
Binary Precision	0.917475011883
Binary Recall	0.98734949289
Total amount of samples	195519
False negative	722.5
False positive	5050.6
True negative	133577.4
True positive	56168.5
Positive training samples	25195.0
Negative training samples	24806.0

Table 4.36: DecisionTreeClassifier with TCP feature set CTU: Variance.

Multi-class F-score	1.58381213855e-07
Multi-class Precision	1.91813674992e-07
Multi-class Recall	1.79413454195e-07
Binary F-score	4.70193363196e-08
Binary Precision	9.1539312147e-08
Binary Recall	1.15124397652e-07

4.2.2 Cross Dataset

Table 4.37: DecisionTreeClassifier with TCP feature set Cross: Experiment 1.

Multi-class F-score	0.804074298918
Multi-class Precision	0.830762578285
Multi-class Recall	0.805596692458
Binary F-score	0.971247483815
Binary Precision	0.950165435143
Binary Recall	0.993286287892
Total amount of samples	246467
False negative	724.000000015
False positive	5618.00000002
True negative	133010.0
True positive	107115.0
Positive training samples	30140
Negative training samples	19861

Table 4.38: DecisionTreeClassifier with TCP feature set Cross: Experiment 2.

Multi-class F-score	0.803638357068
Multi-class Precision	0.830210640663
Multi-class Recall	0.805085467831
Binary F-score	0.971677915669
Binary Precision	0.951032186459
Binary Recall	0.993239922477
Total amount of samples	246467
False negative	729.000000003
False positive	5515.00000006
True negative	133113.0
True positive	107110.0
Positive training samples	30140
Negative training samples	19861

Table 4.39: DecisionTreeClassifier with TCP feature set Cross: Experiment 3.

Multi-class F-score	0.804955096221
Multi-class Precision	0.831186777151
Multi-class Recall	0.806935614098
Binary F-score	0.972681162376
Binary Precision	0.951382361808
Binary Recall	0.994955442836
Total amount of samples	246467
False negative	544.000000009
False positive	5483.00000002
True negative	133145.0
True positive	107295.0
Positive training samples	30140
Negative training samples	19861

Table 4.40: DecisionTreeClassifier with TCP feature set Cross: Experiment 4.

Multi-class F-score	0.804199864239
Multi-class Precision	0.830049639495
Multi-class Recall	0.805685953901
Binary F-score	0.971548826894
Binary Precision	0.950827385391
Binary Recall	0.993193557062
Total amount of samples	246467
False negative	733.999999991
False positive	5539.00000002
True negative	133089.0
True positive	107105.0
Positive training samples	30140
Negative training samples	19861

Table 4.41: DecisionTreeClassifier with TCP feature set Cross: Experiment 5.

Multi-class F-score	0.804361653737
Multi-class Precision	0.830825653429
Multi-class Recall	0.805994311612
Binary F-score	0.971149051147
Binary Precision	0.95002793965
Binary Recall	0.993230649394
Total amount of samples	246467
False negative	730.0
False positive	5634.00000004
True negative	132994.0
True positive	107109.0
Positive training samples	30140
Negative training samples	19861

Table 4.42: DecisionTreeClassifier with TCP feature set Cross: Experiment 6.

Multi-class F-score	0.804860765836
Multi-class Precision	0.831329370479
Multi-class Recall	0.806375701412
Binary F-score	0.970919902825
Binary Precision	0.949597936042
Binary Recall	0.993221376311
Total amount of samples	246467
False negative	730.999999998
False positive	5685.00000002
True negative	132943.0
True positive	107108.0
Positive training samples	30140
Negative training samples	19861

Table 4.43: DecisionTreeClassifier with TCP feature set Cross: Experiment 7.

Multi-class F-score	0.804663432405
Multi-class Precision	0.830704034143
Multi-class Recall	0.806042999671
Binary F-score	0.971828941998
Binary Precision	0.950990050679
Binary Recall	0.993601572715
Total amount of samples	246467
False negative	689.999999987
False positive	5521.99999994
True negative	133106.0
True positive	107149.0
Positive training samples	30140
Negative training samples	19861

Table 4.44: DecisionTreeClassifier with TCP feature set Cross: Experiment 8.

Multi-class F-score	0.804502267242
Multi-class Precision	0.830998233308
Multi-class Recall	0.805815788726
Binary F-score	0.97163557885
Binary Precision	0.950602826498
Binary Recall	0.993620118881
Total amount of samples	246467
False negative	687.999999992
False positive	5567.99999997
True negative	133060.0
True positive	107151.0
Positive training samples	30140
Negative training samples	19861

Table 4.45: DecisionTreeClassifier with TCP feature set Cross: Experiment 9.

Multi-class F-score	0.803759498349
Multi-class Precision	0.831152345488
Multi-class Recall	0.804955633006
Binary F-score	0.971655292811
Binary Precision	0.950716973096
Binary Recall	0.993536661134
Total amount of samples	246467
False negative	696.999999971
False positive	5553.99999997
True negative	133074.0
True positive	107142.0
Positive training samples	30140
Negative training samples	19861

Table 4.46: DecisionTreeClassifier with TCP feature set Cross: Experiment 10.

Multi-class F-score	0.803826097192
Multi-class Precision	0.830129376312
Multi-class Recall	0.805332965468
Binary F-score	0.971786919142
Binary Precision	0.950841637311
Binary Recall	0.993675757379
Total amount of samples	246467
False negative	682.000000006
False positive	5539.99999996
True negative	133088.0
True positive	107157.0
Positive training samples	30140
Negative training samples	19861

Table 4.47: DecisionTreeClassifier with TCP feature set Cross: Average.

Multi-class F-score	0.804284133121
Multi-class Precision	0.830734864875
Multi-class Recall	0.805782112818
Binary F-score	0.971613107553
Binary Precision	0.950618473208
Binary Recall	0.993556134608
Total amount of samples	246467
False negative	700.9
False positive	5567.7
True negative	133060.3
True positive	107138.1
Positive training samples	30140.0
Negative training samples	19861.0

Table 4.48: DecisionTreeClassifier with TCP feature set Cross: Variance.

Multi-class F-score	1.93335356128e-07
Multi-class Precision	1.92223698782e-07
Multi-class Recall	3.21088067544e-07
Binary F-score	2.05771459414e-07
Binary Precision	2.59161730669e-07
Binary Recall	2.50118453018e-07

4.3 Country feature set

4.3.1 CTU Dataset

Table 4.49: DecisionTreeClassifier with Country feature set CTU: Experiment 1.

Multi-class F-score	0.599977008976
Multi-class Precision	0.65682599607
Multi-class Recall	0.600662851181
Binary F-score	0.906866187236
Binary Precision	0.838417455153
Binary Recall	0.98748483943
Total amount of samples	195519
False negative	712
False positive	10827
True negative	127801
True positive	56179
Positive training samples	25195
Negative training samples	24806

Table 4.50: DecisionTreeClassifier with Country feature set CTU: Experiment 2.

Multi-class F-score	0.60004990241
Multi-class Precision	0.656948151542
Multi-class Recall	0.600770257622
Binary F-score	0.90740082698
Binary Precision	0.839331869183
Binary Recall	0.98748483943
Total amount of samples	195519
False negative	712
False positive	10754
True negative	127874
True positive	56179
Positive training samples	25195
Negative training samples	24806

Table 4.51: DecisionTreeClassifier with Country feature set CTU: Experiment 3.

Multi-class F-score	0.599917375249
Multi-class Precision	0.656999856449
Multi-class Recall	0.60072422629
Binary F-score	0.907386322343
Binary Precision	0.839243569444
Binary Recall	0.987572726793
Total amount of samples	195519
False negative	707
False positive	10762
True negative	127866
True positive	56184
Positive training samples	25195
Negative training samples	24806

Table 4.52: DecisionTreeClassifier with Country feature set CTU: Experiment 4.

Multi-class F-score	0.598766880772
Multi-class Precision	0.656271404448
Multi-class Recall	0.599527411658
Binary F-score	0.906914614559
Binary Precision	0.838462227263
Binary Recall	0.987537571848
Total amount of samples	195519
False negative	709
False positive	10824
True negative	127804
True positive	56182
Positive training samples	25195
Negative training samples	24806

Table 4.53: DecisionTreeClassifier with Country feature set CTU: Experiment 5.

Multi-class F-score	0.599891242676
Multi-class Precision	0.657164575279
Multi-class Recall	0.600632163626
Binary F-score	0.906573501053
Binary Precision	0.837917250843
Binary Recall	0.98748483943
Total amount of samples	195519
False negative	712
False positive	10867
True negative	127761
True positive	56179
Positive training samples	25195
Negative training samples	24806

Table 4.54: DecisionTreeClassifier with Country feature set CTU: Experiment 6.

Multi-class F-score	0.599938281319
Multi-class Precision	0.657061863905
Multi-class Recall	0.600760028437
Binary F-score	0.906740475941
Binary Precision	0.838151927438
Binary Recall	0.987555149321
Total amount of samples	195519
False negative	708
False positive	10849
True negative	127779
True positive	56183
Positive training samples	25195
Negative training samples	24806

Table 4.55: DecisionTreeClassifier with Country feature set CTU: Experiment 7.

Multi-class F-score	0.600865186318
Multi-class Precision	0.657928901797
Multi-class Recall	0.601629509153
Binary F-score	0.907192856393
Binary Precision	0.838938000239
Binary Recall	0.987537571848
Total amount of samples	195519
False negative	709
False positive	10786
True negative	127842
True positive	56182
Positive training samples	25195
Negative training samples	24806

Table 4.56: DecisionTreeClassifier with Country feature set CTU: Experiment 8.

Multi-class F-score	0.599746659081
Multi-class Precision	0.656946729948
Multi-class Recall	0.60047361126
Binary F-score	0.906212447477
Binary Precision	0.837262674734
Binary Recall	0.987537571848
Total amount of samples	195519
False negative	709
False positive	10920
True negative	127708
True positive	56182
Positive training samples	25195
Negative training samples	24806

Table 4.57: DecisionTreeClassifier with Country feature set CTU: Experiment 9.

Multi-class F-score	0.600335687345
Multi-class Precision	0.657389604878
Multi-class Recall	0.601240800127
Binary F-score	0.909014417242
Binary Precision	0.842109996852
Binary Recall	0.987467261957
Total amount of samples	195519
False negative	713
False positive	10533
True negative	128095
True positive	56178
Positive training samples	25195
Negative training samples	24806

Table 4.58: DecisionTreeClassifier with Country feature set CTU: Experiment 10.

Multi-class F-score	0.599900321173
Multi-class Precision	0.656653704741
Multi-class Recall	0.600729340882
Binary F-score	0.908021174284
Binary Precision	0.840419484172
Binary Recall	0.987449684484
Total amount of samples	195519
False negative	714
False positive	10667
True negative	127961
True positive	56177
Positive training samples	25195
Negative training samples	24806

Table 4.59: DecisionTreeClassifier with Country feature set CTU: Average.

Multi-class F-score	0.599938854532
Multi-class Precision	0.657019078905
Multi-class Recall	0.600715020024
Binary F-score	0.907232282351
Binary Precision	0.839025445532
Binary Recall	0.987511205639
Total amount of samples	195519.0
False negative	710.5
False positive	10778.9
True negative	127849.1
True positive	56180.5
Positive training samples	25195.0
Negative training samples	24806.0

Table 4.60: DecisionTreeClassifier with Country feature set CTU: Variance.

Multi-class F-score	2.44402923375e-07
Multi-class Precision	1.72849786148e-07
Multi-class Recall	2.59638046722e-07
Binary F-score	5.80291324381e-07
Binary Precision	1.73922780861e-06
Binary Recall	1.56028611187e-09

4.3.2 Cross Dataset

Table 4.61: DecisionTreeClassifier with Country feature set Cross: Experiment 1.

Multi-class F-score	0.750514171292
Multi-class Precision	0.78895469205
Multi-class Recall	0.744882682063
Binary F-score	0.941782056354
Binary Precision	0.895295484367
Binary Recall	0.993360472556
Total amount of samples	246467
False negative	716
False positive	12528
True negative	126100
True positive	107123
Positive training samples	30140
Negative training samples	19861

Table 4.62: DecisionTreeClassifier with Country feature set Cross: Experiment 2.

Multi-class F-score	0.750462077799
Multi-class Precision	0.789343029936
Multi-class Recall	0.744785305944
Binary F-score	0.941134608457
Binary Precision	0.894156044708
Binary Recall	0.993323380224
Total amount of samples	246467
False negative	720
False positive	12680
True negative	125948
True positive	107119
Positive training samples	30140
Negative training samples	19861

Table 4.63: DecisionTreeClassifier with Country feature set Cross: Experiment 3.

Multi-class F-score	0.750736467976
Multi-class Precision	0.789479693438
Multi-class Recall	0.745170753083
Binary F-score	0.941742750263
Binary Precision	0.895254571591
Binary Recall	0.993323380224
Total amount of samples	246467
False negative	720
False positive	12533
True negative	126095
True positive	107119
Positive training samples	30140
Negative training samples	19861

Table 4.64: DecisionTreeClassifier with Country feature set Cross: Experiment 4.

Multi-class F-score	0.751086165168
Multi-class Precision	0.789751164854
Multi-class Recall	0.745479110794
Binary F-score	0.941109798047
Binary Precision	0.894171369419
Binary Recall	0.99324919556
Total amount of samples	246467
False negative	728
False positive	12677
True negative	125951
True positive	107111
Positive training samples	30140
Negative training samples	19861

Table 4.65: DecisionTreeClassifier with Country feature set Cross: Experiment 5.

Multi-class F-score	0.750781804033
Multi-class Precision	0.789592753592
Multi-class Recall	0.744976000844
Binary F-score	0.941400311102
Binary Precision	0.894620800241
Binary Recall	0.99334192639
Total amount of samples	246467
False negative	718
False positive	12618
True negative	126010
True positive	107121
Positive training samples	30140
Negative training samples	19861

Table 4.66: DecisionTreeClassifier with Country feature set Cross: Experiment 6.

Multi-class F-score	0.750916646913
Multi-class Precision	0.789199120926
Multi-class Recall	0.745365505321
Binary F-score	0.941574683389
Binary Precision	0.89510898636
Binary Recall	0.993128645481
Total amount of samples	246467
False negative	741
False positive	12550
True negative	126078
True positive	107098
Positive training samples	30140
Negative training samples	19861

Table 4.67: DecisionTreeClassifier with Country feature set Cross: Experiment 7.

Multi-class F-score	0.750618223404
Multi-class Precision	0.789042220241
Multi-class Recall	0.744980058182
Binary F-score	0.941577735192
Binary Precision	0.89500906607
Binary Recall	0.993258468643
Total amount of samples	246467
False negative	727
False positive	12565
True negative	126063
True positive	107112
Positive training samples	30140
Negative training samples	19861

Table 4.68: DecisionTreeClassifier with Country feature set Cross: Experiment 8.

Multi-class F-score	0.751045124812
Multi-class Precision	0.78958356398
Multi-class Recall	0.745292473232
Binary F-score	0.941209032598
Binary Precision	0.894290413338
Binary Recall	0.993323380224
Total amount of samples	246467
False negative	720
False positive	12662
True negative	125966
True positive	107119
Positive training samples	30140
Negative training samples	19861

Table 4.69: DecisionTreeClassifier with Country feature set Cross: Experiment 9.

Multi-class F-score	0.751196086467
Multi-class Precision	0.789576620854
Multi-class Recall	0.745779353828
Binary F-score	0.941414816149
Binary Precision	0.894737281764
Binary Recall	0.993230649394
Total amount of samples	246467
False negative	730
False positive	12601
True negative	126027
True positive	107109
Positive training samples	30140
Negative training samples	19861

Table 4.70: DecisionTreeClassifier with Country feature set Cross: Experiment 10.

Multi-class F-score	0.750223087693
Multi-class Precision	0.788658249746
Multi-class Recall	0.74457838169
Binary F-score	0.940738398848
Binary Precision	0.893433530447
Binary Recall	0.993332653307
Total amount of samples	246467
False negative	719
False positive	12777
True negative	125851
True positive	107120
Positive training samples	30140
Negative training samples	19861

Table 4.71: DecisionTreeClassifier with Country feature set Cross: Average.

Multi-class F-score	0.750757985556
Multi-class Precision	0.789318110962
Multi-class Recall	0.745128962498
Binary F-score	0.94136841904
Binary Precision	0.89460775483
Binary Recall	0.9932872152
Total amount of samples	246467.0
False negative	723.9
False positive	12619.1
True negative	126008.9
True positive	107115.1
Positive training samples	30140.0
Negative training samples	19861.0

Table 4.72: DecisionTreeClassifier with Country feature set Cross: Variance.

Multi-class F-score	8.60942949731e-08
Multi-class Precision	1.08475121707e-07
Multi-class Recall	1.1575103008e-07
Binary F-score	9.44629407473e-08
Binary Precision	3.19455779064e-07
Binary Recall	4.49642069396e-09

Chapter 5

Naive Bayes

5.1 Standard feature set

5.1.1 CTU Dataset

Table 5.1: Gaussian Naive Bayes with Standard feature set CTU: Experiment 1.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56191.2407
False positive	38392.939024
True negative	100235.060976
True positive	699.7593
Positive training samples	3545
Negative training samples	4956

Table 5.2: Gaussian Naive Bayes with Standard feature set CTU: Experiment 2.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56191.2407
False positive	38392.939024
True negative	100235.060976
True positive	699.7593
Positive training samples	3545
Negative training samples	4956

Table 5.3: Gaussian Naive Bayes with Standard feature set CTU: Experiment 3.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56191.2407
False positive	38392.939024
True negative	100235.060976
True positive	699.7593
Positive training samples	3545
Negative training samples	4956

Table 5.4: Gaussian Naive Bayes with Standard feature set CTU: Experiment 4.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56191.2407
False positive	38392.939024
True negative	100235.060976
True positive	699.7593
Positive training samples	3545
Negative training samples	4956

Table 5.5: Gaussian Naive Bayes with Standard feature set CTU: Experiment 5.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56191.2407
False positive	38392.939024
True negative	100235.060976
True positive	699.7593
Positive training samples	3545
Negative training samples	4956

Table 5.6: Gaussian Naive Bayes with Standard feature set CTU: Experiment 6.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56191.2407
False positive	38392.939024
True negative	100235.060976
True positive	699.7593
Positive training samples	3545
Negative training samples	4956

Table 5.7: Gaussian Naive Bayes with Standard feature set CTU: Experiment 7.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56191.2407
False positive	38392.939024
True negative	100235.060976
True positive	699.7593
Positive training samples	3545
Negative training samples	4956

Table 5.8: Gaussian Naive Bayes with Standard feature set CTU: Experiment 8.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56191.2407
False positive	38392.939024
True negative	100235.060976
True positive	699.7593
Positive training samples	3545
Negative training samples	4956

Table 5.9: Gaussian Naive Bayes with Standard feature set CTU: Experiment 9.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56191.2407
False positive	38392.939024
True negative	100235.060976
True positive	699.7593
Positive training samples	3545
Negative training samples	4956

Table 5.10: Gaussian Naive Bayes with Standard feature set CTU: Experiment 10.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56191.2407
False positive	38392.939024
True negative	100235.060976
True positive	699.7593
Positive training samples	3545
Negative training samples	4956

Table 5.11: Gaussian Naive Bayes with Standard feature set CTU: Average.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56191.2407
False positive	38392.939024
True negative	100235.060976
True positive	699.7593
Positive training samples	3545.0
Negative training samples	4956.0

Table 5.12: Gaussian Naive Bayes with Standard feature set CTU: Variance.

Multi-class F-score	3.08148791102e-33
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0
Binary Precision	1.20370621524e-35
Binary Recall	0.0

5.1.2 Cross Dataset

Table 5.13: Gaussian Naive Bayes with Standard feature set Cross: Experiment 1.

Multi-class F-score	0.339831289644
Multi-class Precision	0.31689704817
Multi-class Recall	0.404743839946
Binary F-score	0.499173836505
Binary Precision	0.485123214786
Binary Recall	0.514062630403
Total amount of samples	246467
False negative	52521.0
False positive	58973.9999999
True negative	79654.0000001
True positive	55318.0
Positive training samples	6545
Negative training samples	4956

Table 5.14: Gaussian Naive Bayes with Standard feature set Cross: Experiment 2.

Multi-class F-score	0.340032225539
Multi-class Precision	0.317036056613
Multi-class Recall	0.40490207614
Binary F-score	0.498791856754
Binary Precision	0.48533630438
Binary Recall	0.513014772021
Total amount of samples	246467
False negative	52374.0
False positive	58814.9999999
True negative	79813.0000001
True positive	55465.0
Positive training samples	6545
Negative training samples	4956

Table 5.15: Gaussian Naive Bayes with Standard feature set Cross: Experiment 3.

Multi-class F-score	0.340792161042
Multi-class Precision	0.317864042643
Multi-class Recall	0.405717601139
Binary F-score	0.498762292532
Binary Precision	0.485404855102
Binary Recall	0.512875675776
Total amount of samples	246467
False negative	52503.0
False positive	58977.0000002
True negative	79650.9999998
True positive	55336.0
Positive training samples	6545
Negative training samples	4956

Table 5.16: Gaussian Naive Bayes with Standard feature set Cross: Experiment 4.

Multi-class F-score	0.340275821393
Multi-class Precision	0.317562095309
Multi-class Recall	0.405068427011
Binary F-score	0.499653237501
Binary Precision	0.485706781071
Binary Recall	0.514424280641
Total amount of samples	246467
False negative	52399.0
False positive	58797.0
True negative	79831.0
True positive	55440.0
Positive training samples	6545
Negative training samples	4956

Table 5.17: Gaussian Naive Bayes with Standard feature set Cross: Experiment 5.

Multi-class F-score	0.340750397056
Multi-class Precision	0.317847421142
Multi-class Recall	0.40578657589
Binary F-score	0.499673618958
Binary Precision	0.485563546643
Binary Recall	0.514628288467
Total amount of samples	246467
False negative	52387.0
False positive	58975.9999999
True negative	79652.0000001
True positive	55452.0
Positive training samples	6545
Negative training samples	4956

Table 5.18: Gaussian Naive Bayes with Standard feature set Cross: Experiment 6.

Multi-class F-score	0.339285750089
Multi-class Precision	0.31637019332
Multi-class Recall	0.404293475394
Binary F-score	0.498433461443
Binary Precision	0.483677350688
Binary Recall	0.514118268901
Total amount of samples	246467
False negative	52646.0
False positive	59019.0
True negative	79609.0
True positive	55193.0
Positive training samples	6545
Negative training samples	4956

Table 5.19: Gaussian Naive Bayes with Standard feature set Cross: Experiment 7.

Multi-class F-score	0.345205005794
Multi-class Precision	0.322386700092
Multi-class Recall	0.409458467056
Binary F-score	0.50123401799
Binary Precision	0.491548843761
Binary Recall	0.511308524745
Total amount of samples	246467
False negative	52371.0
False positive	59523.0
True negative	79105.0
True positive	55468.0
Positive training samples	6545
Negative training samples	4956

Table 5.20: Gaussian Naive Bayes with Standard feature set Cross: Experiment 8.

Multi-class F-score	0.338318339305
Multi-class Precision	0.315459222151
Multi-class Recall	0.403246682112
Binary F-score	0.497581631185
Binary Precision	0.482852780807
Binary Recall	0.513237326014
Total amount of samples	246467
False negative	52311.0
False positive	59496.0000001
True negative	79131.9999999
True positive	55528.0
Positive training samples	6545
Negative training samples	4956

Table 5.21: Gaussian Naive Bayes with Standard feature set Cross: Experiment 9.

Multi-class F-score	0.338601785301
Multi-class Precision	0.315780754419
Multi-class Recall	0.403335943554
Binary F-score	0.497478159056
Binary Precision	0.483580077219
Binary Recall	0.512198740715
Total amount of samples	246467
False negative	52411.0
False positive	58744.0000001
True negative	79883.9999999
True positive	55428.0
Positive training samples	6545
Negative training samples	4956

Table 5.22: Gaussian Naive Bayes with Standard feature set Cross: Experiment 10.

Multi-class F-score	0.34028130756
Multi-class Precision	0.317357583018
Multi-class Recall	0.405214491189
Binary F-score	0.499934734369
Binary Precision	0.485743024578
Binary Recall	0.514980665622
Total amount of samples	246467
False negative	52548.0
False positive	57368.0
True negative	81260.0
True positive	55291.0
Positive training samples	6545
Negative training samples	4956

Table 5.23: Gaussian Naive Bayes with Standard feature set Cross: Average.

Multi-class F-score	0.340337408272
Multi-class Precision	0.317456111688
Multi-class Recall	0.405176757943
Binary F-score	0.499071684629
Binary Precision	0.485453677903
Binary Recall	0.51348491733
Total amount of samples	246467
False negative	52474.5
False positive	58695.1
True negative	79932.9
True positive	55364.5
Positive training samples	6545.0
Negative training samples	4956.0

Table 5.24: Gaussian Naive Bayes with Standard feature set Cross: Variance.

Multi-class F-score	3.26221097803e-06
Multi-class Precision	3.31137799822e-06
Multi-class Recall	2.71674280874e-06
Binary F-score	1.14724430627e-06
Binary Precision	5.08666503668e-06
Binary Recall	1.22062988554e-06

5.2 TCP feature set

5.2.1 CTU Dataset

Table 5.25: Gaussian Naive Bayes with TCP feature set CTU: Experiment 1.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.26: Gaussian Naive Bayes with TCP feature set CTU: Experiment 2.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.27: Gaussian Naive Bayes with TCP feature set CTU: Experiment 3.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.28: Gaussian Naive Bayes with TCP feature set CTU: Experiment 4.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.29: Gaussian Naive Bayes with TCP feature set CTU: Experiment 5.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.30: Gaussian Naive Bayes with TCP feature set CTU: Experiment 6.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.31: Gaussian Naive Bayes with TCP feature set CTU: Experiment 7.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.32: Gaussian Naive Bayes with TCP feature set CTU: Experiment 8.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.33: Gaussian Naive Bayes with TCP feature set CTU: Experiment 9.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.34: Gaussian Naive Bayes with TCP feature set CTU: Experiment 10.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.35: Gaussian Naive Bayes with TCP feature set CTU: Average.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545.0
Negative training samples	4956.0

Table 5.36: Gaussian Naive Bayes with TCP feature set CTU: Variance.

Multi-class F-score	3.08148791102e-33
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0
Binary Precision	1.20370621524e-35
Binary Recall	0.0

5.2.2 Cross Dataset

Table 5.37: Gaussian Naive Bayes with TCP feature set Cross: Experiment 1.

Multi-class F-score	0.339236012662
Multi-class Precision	0.316226540158
Multi-class Recall	0.404236672658
Binary F-score	0.49806645628
Binary Precision	0.484005879677
Binary Recall	0.512968406606
Total amount of samples	246467
False negative	52521.0
False positive	58973.9999999
True negative	79654.0000001
True positive	55318.0
Positive training samples	6545
Negative training samples	4956

Table 5.38: Gaussian Naive Bayes with TCP feature set Cross: Experiment 2.

Multi-class F-score	0.340428461519
Multi-class Precision	0.317522980348
Multi-class Recall	0.405441702135
Binary F-score	0.499416979187
Binary Precision	0.485343017151
Binary Recall	0.51433154981
Total amount of samples	246467
False negative	52374.0
False positive	58814.9999999
True negative	79813.0000001
True positive	55465.0
Positive training samples	6545
Negative training samples	4956

Table 5.39: Gaussian Naive Bayes with TCP feature set Cross: Experiment 3.

Multi-class F-score	0.339152128495
Multi-class Precision	0.316168004065
Multi-class Recall	0.404114952509
Binary F-score	0.49818142533
Binary Precision	0.48407442723
Binary Recall	0.513135322101
Total amount of samples	246467
False negative	52503.0
False positive	58977.0000002
True negative	79650.9999998
True positive	55336.0
Positive training samples	6545
Negative training samples	4956

Table 5.40: Gaussian Naive Bayes with TCP feature set Cross: Experiment 4.

Multi-class F-score	0.340449473102
Multi-class Precision	0.31754038202
Multi-class Recall	0.405466046164
Binary F-score	0.499288531854
Binary Precision	0.48530686205
Binary Recall	0.514099722735
Total amount of samples	246467
False negative	52399.0
False positive	58797.0
True negative	79831.0
True positive	55440.0
Positive training samples	6545
Negative training samples	4956

Table 5.41: Gaussian Naive Bayes with TCP feature set Cross: Experiment 5.

Multi-class F-score	0.339145855607
Multi-class Precision	0.316224341508
Multi-class Recall	0.404090608479
Binary F-score	0.498967458057
Binary Precision	0.48460167092
Binary Recall	0.514210999731
Total amount of samples	246467
False negative	52387.0
False positive	58975.9999999
True negative	79652.0000001
True positive	55452.0
Positive training samples	6545
Negative training samples	4956

Table 5.42: Gaussian Naive Bayes with TCP feature set Cross: Experiment 6.

Multi-class F-score	0.339101802592
Multi-class Precision	0.31602696355
Multi-class Recall	0.404114952509
Binary F-score	0.497120030984
Binary Precision	0.483250446538
Binary Recall	0.511809271228
Total amount of samples	246467
False negative	52646.0
False positive	59019.0
True negative	79609.0
True positive	55193.0
Positive training samples	6545
Negative training samples	4956

Table 5.43: Gaussian Naive Bayes with TCP feature set Cross: Experiment 7.

Multi-class F-score	0.337467078615
Multi-class Precision	0.315092655799
Multi-class Recall	0.40198079256
Binary F-score	0.497850379213
Binary Precision	0.482368185336
Binary Recall	0.514359369059
Total amount of samples	246467
False negative	52371.0
False positive	59523.0
True negative	79105.0
True positive	55468.0
Positive training samples	6545
Negative training samples	4956

Table 5.44: Gaussian Naive Bayes with TCP feature set Cross: Experiment 8.

Multi-class F-score	0.338124510272
Multi-class Precision	0.315676559178
Multi-class Recall	0.402743572162
Binary F-score	0.498315108385
Binary Precision	0.482751425789
Binary Recall	0.514915754041
Total amount of samples	246467
False negative	52311.0
False positive	59496.0000001
True negative	79131.9999999
True positive	55528.0
Positive training samples	6545
Negative training samples	4956

Table 5.45: Gaussian Naive Bayes with TCP feature set Cross: Experiment 9.

Multi-class F-score	0.340235706247
Multi-class Precision	0.317439863455
Multi-class Recall	0.405100885717
Binary F-score	0.499326609943
Binary Precision	0.48547805066
Binary Recall	0.513988445739
Total amount of samples	246467
False negative	52411.0
False positive	58744.0000001
True negative	79883.9999999
True positive	55428.0
Positive training samples	6545
Negative training samples	4956

Table 5.46: Gaussian Naive Bayes with TCP feature set Cross: Experiment 10.

Multi-class F-score	0.345258922589
Multi-class Precision	0.322384127836
Multi-class Recall	0.409722194046
Binary F-score	0.50151021778
Binary Precision	0.490781917113
Binary Recall	0.512718033365
Total amount of samples	246467
False negative	52548.0
False positive	57368.0
True negative	81260.0
True positive	55291.0
Positive training samples	6545
Negative training samples	4956

Table 5.47: Gaussian Naive Bayes with TCP feature set Cross: Average.

Multi-class F-score	0.33985999517
Multi-class Precision	0.317030241792
Multi-class Recall	0.404701237894
Binary F-score	0.498804319701
Binary Precision	0.484796188246
Binary Recall	0.513653687441
Total amount of samples	246467
False negative	52452.9
False positive	58882.7
True negative	79745.3
True positive	55386.1
Positive training samples	6545.0
Negative training samples	4956.0

Table 5.48: Gaussian Naive Bayes with TCP feature set Cross: Variance.

Multi-class F-score	4.06734524861e-06
Multi-class Precision	3.79670488202e-06
Multi-class Recall	3.90123662258e-06
Binary F-score	1.3149697161e-06
Binary Precision	5.05026286532e-06
Binary Recall	8.18753579524e-07

5.3 Country feature set

5.3.1 CTU Dataset

Table 5.49: Gaussian Naive Bayes with Country feature set CTU: Experiment 1.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.50: Gaussian Naive Bayes with Country feature set CTU: Experiment 2.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.51: Gaussian Naive Bayes with Country feature set CTU: Experiment 3.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.52: Gaussian Naive Bayes with Country feature set CTU: Experiment 4.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.53: Gaussian Naive Bayes with Country feature set CTU: Experiment 5.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.54: Gaussian Naive Bayes with Country feature set CTU: Experiment 6.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.55: Gaussian Naive Bayes with Country feature set CTU: Experiment 7.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.56: Gaussian Naive Bayes with Country feature set CTU: Experiment 8.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.57: Gaussian Naive Bayes with Country feature set CTU: Experiment 9.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.58: Gaussian Naive Bayes with Country feature set CTU: Experiment 10.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545
Negative training samples	4956

Table 5.59: Gaussian Naive Bayes with Country feature set CTU: Average.

Multi-class F-score	0.325294340964
Multi-class Precision	0.298005512701
Multi-class Recall	0.423171149607
Binary F-score	0.0146735906589
Binary Precision	0.0179846938776
Binary Recall	0.0123921182612
Total amount of samples	195519
False negative	56186.0
False positive	38495.0
True negative	100133.0
True positive	705.0
Positive training samples	3545.0
Negative training samples	4956.0

Table 5.60: Gaussian Naive Bayes with Country feature set CTU: Variance.

Multi-class F-score	3.08148791102e-33
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0
Binary Precision	1.20370621524e-35
Binary Recall	0.0

5.3.2 Cross Dataset

Table 5.61: Gaussian Naive Bayes with Country feature set Cross: Experiment 1.

Multi-class F-score	0.339236012662
Multi-class Precision	0.316226540158
Multi-class Recall	0.404236672658
Binary F-score	0.49806645628
Binary Precision	0.484005879677
Binary Recall	0.512968406606
Total amount of samples	246467
False negative	52521.0
False positive	58973.9999999
True negative	79654.0000001
True positive	55318.0
Positive training samples	6545
Negative training samples	4956

Table 5.62: Gaussian Naive Bayes with Country feature set Cross: Experiment 2.

Multi-class F-score	0.340428461519
Multi-class Precision	0.317522980348
Multi-class Recall	0.405441702135
Binary F-score	0.499416979187
Binary Precision	0.485343017151
Binary Recall	0.51433154981
Total amount of samples	246467
False negative	52374.0
False positive	58814.9999999
True negative	79813.0000001
True positive	55465.0
Positive training samples	6545
Negative training samples	4956

Table 5.63: Gaussian Naive Bayes with Country feature set Cross: Experiment 3.

Multi-class F-score	0.339152128495
Multi-class Precision	0.316168004065
Multi-class Recall	0.404114952509
Binary F-score	0.49818142533
Binary Precision	0.48407442723
Binary Recall	0.513135322101
Total amount of samples	246467
False negative	52503.0
False positive	58977.0000002
True negative	79650.9999998
True positive	55336.0
Positive training samples	6545
Negative training samples	4956

Table 5.64: Gaussian Naive Bayes with Country feature set Cross: Experiment 4.

Multi-class F-score	0.340449473102
Multi-class Precision	0.31754038202
Multi-class Recall	0.405466046164
Binary F-score	0.499288531854
Binary Precision	0.48530686205
Binary Recall	0.514099722735
Total amount of samples	246467
False negative	52399.0
False positive	58797.0
True negative	79831.0
True positive	55440.0
Positive training samples	6545
Negative training samples	4956

Table 5.65: Gaussian Naive Bayes with Country feature set Cross: Experiment 5.

Multi-class F-score	0.339145855607
Multi-class Precision	0.316224341508
Multi-class Recall	0.404090608479
Binary F-score	0.498967458057
Binary Precision	0.48460167092
Binary Recall	0.514210999731
Total amount of samples	246467
False negative	52387.0
False positive	58975.9999999
True negative	79652.0000001
True positive	55452.0
Positive training samples	6545
Negative training samples	4956

Table 5.66: Gaussian Naive Bayes with Country feature set Cross: Experiment 6.

Multi-class F-score	0.339101802592
Multi-class Precision	0.31602696355
Multi-class Recall	0.404114952509
Binary F-score	0.497120030984
Binary Precision	0.483250446538
Binary Recall	0.511809271228
Total amount of samples	246467
False negative	52646.0
False positive	59019.0
True negative	79609.0
True positive	55193.0
Positive training samples	6545
Negative training samples	4956

Table 5.67: Gaussian Naive Bayes with Country feature set Cross: Experiment 7.

Multi-class F-score	0.337467078615
Multi-class Precision	0.315092655799
Multi-class Recall	0.40198079256
Binary F-score	0.497850379213
Binary Precision	0.482368185336
Binary Recall	0.514359369059
Total amount of samples	246467
False negative	52371.0
False positive	59523.0
True negative	79105.0
True positive	55468.0
Positive training samples	6545
Negative training samples	4956

Table 5.68: Gaussian Naive Bayes with Country feature set Cross: Experiment 8.

Multi-class F-score	0.338124510272
Multi-class Precision	0.315676559178
Multi-class Recall	0.402743572162
Binary F-score	0.498315108385
Binary Precision	0.482751425789
Binary Recall	0.514915754041
Total amount of samples	246467
False negative	52311.0
False positive	59496.0000001
True negative	79131.9999999
True positive	55528.0
Positive training samples	6545
Negative training samples	4956

Table 5.69: Gaussian Naive Bayes with Country feature set Cross: Experiment 9.

Multi-class F-score	0.340235706247
Multi-class Precision	0.317439863455
Multi-class Recall	0.405100885717
Binary F-score	0.499326609943
Binary Precision	0.48547805066
Binary Recall	0.513988445739
Total amount of samples	246467
False negative	52411.0
False positive	58744.0000001
True negative	79883.9999999
True positive	55428.0
Positive training samples	6545
Negative training samples	4956

Table 5.70: Gaussian Naive Bayes with Country feature set Cross: Experiment 10.

Multi-class F-score	0.345258922589
Multi-class Precision	0.322384127836
Multi-class Recall	0.409722194046
Binary F-score	0.50151021778
Binary Precision	0.490781917113
Binary Recall	0.512718033365
Total amount of samples	246467
False negative	52548.0
False positive	57368.0
True negative	81260.0
True positive	55291.0
Positive training samples	6545
Negative training samples	4956

Table 5.71: Gaussian Naive Bayes with Country feature set Cross: Average.

Multi-class F-score	0.33985999517
Multi-class Precision	0.317030241792
Multi-class Recall	0.404701237894
Binary F-score	0.498804319701
Binary Precision	0.484796188246
Binary Recall	0.513653687441
Total amount of samples	246467
False negative	52474.5
False positive	58695.1
True negative	79932.9
True positive	55364.5
Positive training samples	6545.0
Negative training samples	4956.0

Table 5.72: Gaussian Naive Bayes with Country feature set Cross: Variance.

Multi-class F-score	4.92734524861e-06
Multi-class Precision	4.52670488202e-06
Multi-class Recall	3.95123662258e-06
Binary F-score	1.2649697161e-06
Binary Precision	3.95026286532e-06
Binary Recall	9.28753579524e-07

Chapter 6

Support Vector Machines with Linear Kernel

6.1 Standard feature set

6.1.1 CTU Dataset

Table 6.1: LinearSVC with Standard feature set CTU: Experiment 1.

Multi-class F-score	0.0731447621491
Multi-class Precision	0.193679286641
Multi-class Recall	0.0464098118341
Binary F-score	0.000179821078027
Binary Precision	0.00060963218858
Binary Recall	0.000105464836266
Total amount of samples	195519
False negative	56885
False positive	9836
True negative	128792
True positive	6
Positive training samples	10069
Negative training samples	9932

Table 6.2: LinearSVC with Standard feature set CTU: Experiment 2.

Multi-class F-score	0.00861973900158
Multi-class Precision	0.10392192579
Multi-class Recall	0.0113288222628
Binary F-score	6.24736439315e-05
Binary Precision	0.000280269058296
Binary Recall	3.51549454219e-05
Total amount of samples	195519
False negative	56889
False positive	7134
True negative	131494
True positive	2
Positive training samples	10069
Negative training samples	9932

Table 6.3: LinearSVC with Standard feature set CTU: Experiment 3.

Multi-class F-score	0.0108550011243
Multi-class Precision	0.0955771357678
Multi-class Recall	0.00723203371539
Binary F-score	0.454321756985
Binary Precision	0.293966822954
Binary Recall	0.999578140655
Total amount of samples	195519
False negative	24
False positive	136580
True negative	2048
True positive	56867
Positive training samples	10069
Negative training samples	9932

Table 6.4: LinearSVC with Standard feature set CTU: Experiment 4.

Multi-class F-score	5.39428618225e-11
Multi-class Precision	2.69715731439e-11
Multi-class Recall	5.1145924437e-06
Binary F-score	0.450782457113
Binary Precision	0.290974278715
Binary Recall	1.0
Total amount of samples	195519
False negative	0
False positive	138628
True negative	0
True positive	56891
Positive training samples	10069
Negative training samples	9932

Table 6.5: LinearSVC with Standard feature set CTU: Experiment 5.

Multi-class F-score	0.390589045323
Multi-class Precision	0.520065636569
Multi-class Recall	0.370117482188
Binary F-score	0.659999276594
Binary Precision	0.502252479563
Binary Recall	0.962208433671
Total amount of samples	195519
False negative	2150
False positive	54250
True negative	84378
True positive	54741
Positive training samples	10069
Negative training samples	9932

Table 6.6: LinearSVC with Standard feature set CTU: Experiment 6.

Multi-class F-score	0.107538011822
Multi-class Precision	0.295607746689
Multi-class Recall	0.084666963313
Binary F-score	0.493619591094
Binary Precision	0.328625284784
Binary Recall	0.991351883426
Total amount of samples	195519
False negative	492
False positive	115222
True negative	23406
True positive	56399
Positive training samples	10069
Negative training samples	9932

Table 6.7: LinearSVC with Standard feature set CTU: Experiment 7.

Multi-class F-score	0.0046423430834
Multi-class Precision	0.0218711429796
Multi-class Recall	0.0027618799196
Binary F-score	0.452538482043
Binary Precision	0.29246631698
Binary Recall	0.999683605491
Total amount of samples	195519
False negative	18
False positive	137587
True negative	1041
True positive	56873
Positive training samples	10069
Negative training samples	9932

Table 6.8: LinearSVC with Standard feature set CTU: Experiment 8.

Multi-class F-score	0.01988865948
Multi-class Precision	0.179211395417
Multi-class Recall	0.0107559879091
Binary F-score	0.470009792215
Binary Precision	0.307219479523
Binary Recall	0.999771492855
Total amount of samples	195519
False negative	13
False positive	128260
True negative	10368
True positive	56878
Positive training samples	10069
Negative training samples	9932

Table 6.9: LinearSVC with Standard feature set CTU: Experiment 9.

Multi-class F-score	0.39357608393
Multi-class Precision	0.527211740039
Multi-class Recall	0.381001334909
Binary F-score	0.724048957989
Binary Precision	0.580528119331
Binary Recall	0.961839306744
Total amount of samples	195519
False negative	2171
False positive	39539
True negative	99089
True positive	54720
Positive training samples	10069
Negative training samples	9932

Table 6.10: LinearSVC with Standard feature set CTU: Experiment 10.

Multi-class F-score	0.00657950586219
Multi-class Precision	0.15413517859
Multi-class Recall	0.00374388166879
Binary F-score	0.453557926975
Binary Precision	0.293326043338
Binary Recall	0.999595718128
Total amount of samples	195519
False negative	23
False positive	137005
True negative	1623
True positive	56868
Positive training samples	10069
Negative training samples	9932

Table 6.11: LinearSVC with Standard feature set CTU: Average.

Multi-class F-score	0.101543315183
Multi-class Precision	0.209128118851
Multi-class Recall	0.0918023312312
Binary F-score	0.415912053573
Binary Precision	0.289024872643
Binary Recall	0.791416920075
Total amount of samples	195519.0
False negative	11866.5
False positive	90404.1
True negative	48223.9
True positive	45024.5
Positive training samples	10069.0
Negative training samples	9932.0

Table 6.12: LinearSVC with Standard feature set CTU: Variance.

Multi-class F-score	0.0221918598774
Multi-class Precision	0.0312257870173
Multi-class Recall	0.0207512633398
Binary F-score	0.0514706070687
Binary Precision	0.0298954755235
Binary Recall	0.156760948513

6.1.2 Cross Dataset

Table 6.13: LinearSVC with Standard feature set Cross: Experiment 1.

Multi-class F-score	0.228491874033
Multi-class Precision	0.469141761631
Multi-class Recall	0.176417126836
Binary F-score	0.651732275802
Binary Precision	0.484892092842
Binary Recall	0.993610845798
Total amount of samples	246467
False negative	689
False positive	113827
True negative	24801
True positive	107150
Positive training samples	10045
Negative training samples	4956

Table 6.14: LinearSVC with Standard feature set Cross: Experiment 2.

Multi-class F-score	0.142158318144
Multi-class Precision	0.340972450684
Multi-class Recall	0.0949620030268
Binary F-score	0.609669294633
Binary Precision	0.438508458035
Binary Recall	0.999990726917
Total amount of samples	246467
False negative	1
False positive	138082
True negative	546
True positive	107838
Positive training samples	10045
Negative training samples	4956

Table 6.15: LinearSVC with Standard feature set Cross: Experiment 3.

Multi-class F-score	0.189041649905
Multi-class Precision	0.404663455052
Multi-class Recall	0.124069348026
Binary F-score	0.6250192034
Binary Precision	0.454615605181
Binary Recall	0.999758899841
Total amount of samples	246467
False negative	26
False positive	129339
True negative	9289
True positive	107813
Positive training samples	10045
Negative training samples	4956

Table 6.16: LinearSVC with Standard feature set Cross: Experiment 4.

Multi-class F-score	0.148483705387
Multi-class Precision	0.297016905178
Multi-class Recall	0.100313632251
Binary F-score	0.612415543906
Binary Precision	0.441803167616
Binary Recall	0.997700275411
Total amount of samples	246467
False negative	248
False positive	135936
True negative	2692
True positive	107591
Positive training samples	10045
Negative training samples	4956

Table 6.17: LinearSVC with Standard feature set Cross: Experiment 5.

Multi-class F-score	0.305722399073
Multi-class Precision	0.47608506946
Multi-class Recall	0.253551185351
Binary F-score	0.64853334947
Binary Precision	0.481304675852
Binary Recall	0.993842672873
Total amount of samples	246467
False negative	664
False positive	115501
True negative	23127
True positive	107175
Positive training samples	10045
Negative training samples	4956

Table 6.18: LinearSVC with Standard feature set Cross: Experiment 6.

Multi-class F-score	0.234710403125
Multi-class Precision	0.397794059596
Multi-class Recall	0.18572060357
Binary F-score	0.652382039226
Binary Precision	0.485527662774
Binary Recall	0.993963222953
Total amount of samples	246467
False negative	651
False positive	113578
True negative	25050
True positive	107188
Positive training samples	10045
Negative training samples	4956

Table 6.19: LinearSVC with Standard feature set Cross: Experiment 7.

Multi-class F-score	0.22511289817
Multi-class Precision	0.450074920328
Multi-class Recall	0.174546693878
Binary F-score	0.652337148651
Binary Precision	0.485632939512
Binary Recall	0.993314107141
Total amount of samples	246467
False negative	721
False positive	113456
True negative	25172
True positive	107118
Positive training samples	10045
Negative training samples	4956

Table 6.20: LinearSVC with Standard feature set Cross: Experiment 8.

Multi-class F-score	0.139388432253
Multi-class Precision	0.279366424343
Multi-class Recall	0.0928643591231
Binary F-score	0.610476438486
Binary Precision	0.439345851888
Binary Recall	0.999981453834
Total amount of samples	246467
False negative	2
False positive	137612
True negative	1016
True positive	107837
Positive training samples	10045
Negative training samples	4956

Table 6.21: LinearSVC with Standard feature set Cross: Experiment 9.

Multi-class F-score	0.193932553955
Multi-class Precision	0.399109896362
Multi-class Recall	0.138343064183
Binary F-score	0.333973629464
Binary Precision	0.764891427054
Binary Recall	0.213624013576
Total amount of samples	246467
False negative	84802
False positive	7081
True negative	131547
True positive	23037
Positive training samples	10045
Negative training samples	4956

Table 6.22: LinearSVC with Standard feature set Cross: Experiment 10.

Multi-class F-score	0.202254406451
Multi-class Precision	0.41171227465
Multi-class Recall	0.137442335079
Binary F-score	0.644249684855
Binary Precision	0.475740047936
Binary Recall	0.99760754458
Total amount of samples	246467
False negative	258
False positive	118553
True negative	20075
True positive	107581
Positive training samples	10045
Negative training samples	4956

Table 6.23: LinearSVC with Standard feature set Cross: Average.

Multi-class F-score	0.20092966405
Multi-class Precision	0.392593721729
Multi-class Recall	0.147823035132
Binary F-score	0.604078860789
Binary Precision	0.495226192869
Binary Recall	0.918339376292
Total amount of samples	246467.0
False negative	8806.2
False positive	112296.5
True negative	26331.5
True positive	99032.8
Positive training samples	10045.0
Negative training samples	4956.0

Table 6.24: LinearSVC with Standard feature set Cross: Variance.

Multi-class F-score	0.0023651172141
Multi-class Precision	0.00413353016849
Multi-class Recall	0.00229801980393
Binary F-score	0.00840598202009
Binary Precision	0.00844284960399
Binary Recall	0.0551873566326

6.2 TCP feature set

6.2.1 CTU Dataset

Table 6.25: LinearSVC with TCP feature set CTU: Experiment 1.

Multi-class F-score	5.10229538331e-05
Multi-class Precision	0.0105701579524
Multi-class Recall	4.09167395496e-05
Binary F-score	0.45079317285
Binary Precision	0.290983208278
Binary Recall	1.0
Total amount of samples	195519
False negative	0
False positive	138622
True negative	6
True positive	56891
Positive training samples	10069
Negative training samples	9932

Table 6.26: LinearSVC with TCP feature set CTU: Experiment 2.

Multi-class F-score	0.00620597311193
Multi-class Precision	0.0147049805449
Multi-class Recall	0.0550483584716
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	6
True negative	138622
True positive	0
Positive training samples	10069
Negative training samples	9932

Table 6.27: LinearSVC with TCP feature set CTU: Experiment 3.

Multi-class F-score	0.0929545885223
Multi-class Precision	0.115675737817
Multi-class Recall	0.0832655649835
Binary F-score	0.00447319234727
Binary Precision	0.00555512088256
Binary Recall	0.00374400168744
Total amount of samples	195519
False negative	56678
False positive	38130
True negative	100498
True positive	213
Positive training samples	10069
Negative training samples	9932

Table 6.28: LinearSVC with TCP feature set CTU: Experiment 4.

Multi-class F-score	5.10227220434e-05
Multi-class Precision	0.0105701578365
Multi-class Recall	3.58021471059e-05
Binary F-score	0.45079317285
Binary Precision	0.290983208278
Binary Recall	1.0
Total amount of samples	195519
False negative	0
False positive	138622
True negative	6
True positive	56891
Positive training samples	10069
Negative training samples	9932

Table 6.29: LinearSVC with TCP feature set CTU: Experiment 5.

Multi-class F-score	0.00561883185789
Multi-class Precision	0.155052852158
Multi-class Recall	0.0028795155458
Binary F-score	0.452073789478
Binary Precision	0.292051253093
Binary Recall	1.0
Total amount of samples	195519
False negative	0
False positive	137907
True negative	721
True positive	56891
Positive training samples	10069
Negative training samples	9932

Table 6.30: LinearSVC with TCP feature set CTU: Experiment 6.

Multi-class F-score	0.000242466361569
Multi-class Precision	0.010668061237
Multi-class Recall	0.0048332898593
Binary F-score	0.00458547716949
Binary Precision	0.00591485934853
Binary Recall	0.00374400168744
Total amount of samples	195519
False negative	56678
False positive	35798
True negative	102830
True positive	213
Positive training samples	10069
Negative training samples	9932

Table 6.31: LinearSVC with TCP feature set CTU: Experiment 7.

Multi-class F-score	0.000173509608218
Multi-class Precision	0.039144273832
Multi-class Recall	8.69480715429e-05
Binary F-score	0.45083425456
Binary Precision	0.291017443347
Binary Recall	1.0
Total amount of samples	195519
False negative	0
False positive	138599
True negative	29
True positive	56891
Positive training samples	10069
Negative training samples	9932

Table 6.32: LinearSVC with TCP feature set CTU: Experiment 8.

Multi-class F-score	5.10228981084e-05
Multi-class Precision	0.0105701579246
Multi-class Recall	3.06875546622e-05
Binary F-score	0.454319311625
Binary Precision	0.293928309412
Binary Recall	1.0
Total amount of samples	195519
False negative	0
False positive	136663
True negative	1965
True positive	56891
Positive training samples	10069
Negative training samples	9932

Table 6.33: LinearSVC with TCP feature set CTU: Experiment 9.

Multi-class F-score	0.0853428817889
Multi-class Precision	0.0701185457415
Multi-class Recall	0.179895560022
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	12
True negative	138616
True positive	0
Positive training samples	10069
Negative training samples	9932

Table 6.34: LinearSVC with TCP feature set CTU: Experiment 10.

Multi-class F-score	0.000503402749181
Multi-class Precision	0.000268434472523
Multi-class Recall	0.00428602846782
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	6
True negative	138622
True positive	0
Positive training samples	10069
Negative training samples	9932

Table 6.35: LinearSVC with TCP feature set CTU: Average.

Multi-class F-score	0.0191194722574
Multi-class Precision	0.0437343359516
Multi-class Recall	0.0330402671863
Binary F-score	0.226787237088
Binary Precision	0.147043340264
Binary Recall	0.500748800337
Total amount of samples	195519.0
False negative	28402.9
False positive	76436.5
True negative	62191.5
True positive	28488.1
Positive training samples	10069.0
Negative training samples	9932.0

Table 6.36: LinearSVC with TCP feature set CTU: Variance.

Multi-class F-score	0.00123388562989
Multi-class Precision	0.0025409527256
Multi-class Recall	0.00314593298391
Binary F-score	0.05061737695
Binary Precision	0.0209569798608
Binary Recall	0.24925344247

6.2.2 Cross Dataset

Table 6.37: LinearSVC with TCP feature set Cross: Experiment 1.

Multi-class F-score	0.108532746023
Multi-class Precision	0.125127779618
Multi-class Recall	0.102910328766
Binary F-score	0.608737129697
Binary Precision	0.437542855984
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138626
True negative	2
True positive	107839
Positive training samples	10045
Negative training samples	4956

Table 6.38: LinearSVC with TCP feature set Cross: Experiment 2.

Multi-class F-score	8.01755264511e-05
Multi-class Precision	0.0101434277619
Multi-class Recall	6.08600745739e-05
Binary F-score	0.000183911428256
Binary Precision	0.01100110011
Binary Recall	9.27308302191e-05
Total amount of samples	246467
False negative	107829
False positive	899
True negative	137729
True positive	10
Positive training samples	10045
Negative training samples	4956

Table 6.39: LinearSVC with TCP feature set Cross: Experiment 3.

Multi-class F-score	1.62954972964e-05
Multi-class Precision	0.0100622386203
Multi-class Recall	0.000129834825758
Binary F-score	0.476419220448
Binary Precision	0.51002031574
Binary Recall	0.446971874739
Total amount of samples	246467
False negative	59638
False positive	46307
True negative	92321
True positive	48201
Positive training samples	10045
Negative training samples	4956

Table 6.40: LinearSVC with TCP feature set Cross: Experiment 4.

Multi-class F-score	7.62589583616e-05
Multi-class Precision	0.0100927905008
Multi-class Recall	0.00161887798367
Binary F-score	0.608737129697
Binary Precision	0.437542855984
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138626
True negative	2
True positive	107839
Positive training samples	10045
Negative training samples	4956

Table 6.41: LinearSVC with TCP feature set Cross: Experiment 5.

Multi-class F-score	3.62596829657e-05
Multi-class Precision	0.0100723070876
Multi-class Recall	0.00118880012334
Binary F-score	0.608737129697
Binary Precision	0.437542855984
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138626
True negative	2
True positive	107839
Positive training samples	10045
Negative training samples	4956

Table 6.42: LinearSVC with TCP feature set Cross: Experiment 6.

Multi-class F-score	6.5126032129e-05
Multi-class Precision	0.0100868194595
Multi-class Recall	0.00368000584257
Binary F-score	0.528169231434
Binary Precision	0.3958282254
Binary Recall	0.79345134877
Total amount of samples	246467
False negative	22274
False positive	130602
True negative	8026
True positive	85565
Positive training samples	10045
Negative training samples	4956

Table 6.43: LinearSVC with TCP feature set Cross: Experiment 7.

Multi-class F-score	0.130240462931
Multi-class Precision	0.243463021893
Multi-class Recall	0.092263873054
Binary F-score	0.571056832052
Binary Precision	0.447269308148
Binary Recall	0.78958447315
Total amount of samples	246467
False negative	22691
False positive	105225
True negative	33403
True positive	85148
Positive training samples	10045
Negative training samples	4956

Table 6.44: LinearSVC with TCP feature set Cross: Experiment 8.

Multi-class F-score	0.0264893245373
Multi-class Precision	0.0262573233188
Multi-class Recall	0.0745454766764
Binary F-score	0.424805730801
Binary Precision	0.539588898253
Binary Recall	0.350290711153
Total amount of samples	246467
False negative	70064
False positive	32232
True negative	106396
True positive	37775
Positive training samples	10045
Negative training samples	4956

Table 6.45: LinearSVC with TCP feature set Cross: Experiment 9.

Multi-class F-score	1.62162755781e-05
Multi-class Precision	0.0100621989962
Multi-class Recall	8.11467660985e-06
Binary F-score	0.596627255263
Binary Precision	0.64006246481
Binary Recall	0.558712525153
Total amount of samples	246467
False negative	47588
False positive	33882
True negative	104746
True positive	60251
Positive training samples	10045
Negative training samples	4956

Table 6.46: LinearSVC with TCP feature set Cross: Experiment 10.

Multi-class F-score	0.104080794792
Multi-class Precision	0.0781017463055
Multi-class Recall	0.221173625678
Binary F-score	0.551523272088
Binary Precision	0.406614392199
Binary Recall	0.856907055889
Total amount of samples	246467
False negative	15431
False positive	134854
True negative	3774
True positive	92408
Positive training samples	10045
Negative training samples	4956

Table 6.47: LinearSVC with TCP feature set Cross: Average.

Multi-class F-score	0.0369633660257
Multi-class Precision	0.0533469653561
Multi-class Recall	0.0497579797701
Binary F-score	0.49749968426
Binary Precision	0.426301327261
Binary Recall	0.679601071968
Total amount of samples	246467.0
False negative	34551.5
False positive	89987.9
True negative	48640.1
True positive	73287.5
Positive training samples	10045.0
Negative training samples	4956.0

Table 6.48: LinearSVC with TCP feature set Cross: Variance.

Multi-class F-score	0.00266135453516
Multi-class Precision	0.00538719922764
Multi-class Recall	0.00488369903997
Binary F-score	0.0309269181023
Binary Precision	0.0240146002847
Binary Recall	0.100336934882

6.3 Country feature set

6.3.1 CTU Dataset

Table 6.49: LinearSVC with Country feature set CTU: Experiment 1.

Multi-class F-score	0.303801903048
Multi-class Precision	0.448969320545
Multi-class Recall	0.245991438172
Binary F-score	0.564173466985
Binary Precision	0.394522601799
Binary Recall	0.989805065828
Total amount of samples	195519
False negative	580
False positive	86421
True negative	52207
True positive	56311
Positive training samples	10069
Negative training samples	9932

Table 6.50: LinearSVC with Country feature set CTU: Experiment 2.

Multi-class F-score	0.0988947758146
Multi-class Precision	0.301453071171
Multi-class Recall	0.0641676767987
Binary F-score	0.498707964758
Binary Precision	0.33285849673
Binary Recall	0.993953349387
Total amount of samples	195519
False negative	344
False positive	113336
True negative	25292
True positive	56547
Positive training samples	10069
Negative training samples	9932

Table 6.51: LinearSVC with Country feature set CTU: Experiment 3.

Multi-class F-score	0.0117301645298
Multi-class Precision	0.170689165683
Multi-class Recall	0.0064136989244
Binary F-score	0.455460057833
Binary Precision	0.294929847766
Binary Recall	0.999472675819
Total amount of samples	195519
False negative	30
False positive	135934
True negative	2694
True positive	56861
Positive training samples	10069
Negative training samples	9932

Table 6.52: LinearSVC with Country feature set CTU: Experiment 4.

Multi-class F-score	0.256120061765
Multi-class Precision	0.433501058495
Multi-class Recall	0.199822012183
Binary F-score	0.000180940892642
Binary Precision	0.000636334712059
Binary Recall	0.000105464836266
Total amount of samples	195519
False negative	56885
False positive	9423
True negative	129205
True positive	6
Positive training samples	10069
Negative training samples	9932

Table 6.53: LinearSVC with Country feature set CTU: Experiment 5.

Multi-class F-score	0.369573304134
Multi-class Precision	0.52862308828
Multi-class Recall	0.33181941397
Binary F-score	0.624197890958
Binary Precision	0.45836937449
Binary Recall	0.978028159111
Total amount of samples	195519
False negative	1250
False positive	65748
True negative	72880
True positive	55641
Positive training samples	10069
Negative training samples	9932

Table 6.54: LinearSVC with Country feature set CTU: Experiment 6.

Multi-class F-score	0.346945514394
Multi-class Precision	0.448438923011
Multi-class Recall	0.377687079005
Binary F-score	0.000200950207409
Binary Precision	0.000547816559712
Binary Recall	0.000123042308977
Total amount of samples	195519
False negative	56884
False positive	12771
True negative	125857
True positive	7
Positive training samples	10069
Negative training samples	9932

Table 6.55: LinearSVC with Country feature set CTU: Experiment 7.

Multi-class F-score	0.0726501930296
Multi-class Precision	0.190972327977
Multi-class Recall	0.046420041019
Binary F-score	0.485813047879
Binary Precision	0.321299516113
Binary Recall	0.995570476877
Total amount of samples	195519
False negative	252
False positive	119642
True negative	18986
True positive	56639
Positive training samples	10069
Negative training samples	9932

Table 6.56: LinearSVC with Country feature set CTU: Experiment 8.

Multi-class F-score	0.00206531712084
Multi-class Precision	0.014322138707
Multi-class Recall	0.00112521033761
Binary F-score	0.451256221619
Binary Precision	0.2913691909
Binary Recall	1.0
Total amount of samples	195519
False negative	0
False positive	138363
True negative	265
True positive	56891
Positive training samples	10069
Negative training samples	9932

Table 6.57: LinearSVC with Country feature set CTU: Experiment 9.

Multi-class F-score	0.0730009614252
Multi-class Precision	0.173619859268
Multi-class Recall	0.0467576041203
Binary F-score	0.472512805112
Binary Precision	0.309761179501
Binary Recall	0.995623209295
Total amount of samples	195519
False negative	249
False positive	126215
True negative	12413
True positive	56642
Positive training samples	10069
Negative training samples	9932

Table 6.58: LinearSVC with Country feature set CTU: Experiment 10.

Multi-class F-score	0.348164413822
Multi-class Precision	0.508277815233
Multi-class Recall	0.301060255014
Binary F-score	0.605764019856
Binary Precision	0.437888320419
Binary Recall	0.982387372344
Total amount of samples	195519
False negative	1002
False positive	71744
True negative	66884
True positive	55889
Positive training samples	10069
Negative training samples	9932

Table 6.59: LinearSVC with Country feature set CTU: Average.

Multi-class F-score	0.188294660908
Multi-class Precision	0.321886676837
Multi-class Recall	0.162126442954
Binary F-score	0.41582673661
Binary Precision	0.284218267899
Binary Recall	0.793506881581
Total amount of samples	195519.0
False negative	11747.6
False positive	87959.7
True negative	50668.3
True positive	45143.4
Positive training samples	10069.0
Negative training samples	9932.0

Table 6.60: LinearSVC with Country feature set CTU: Variance.

Multi-class F-score	0.0202047595102
Multi-class Precision	0.027910062049
Multi-class Recall	0.0189480705569
Binary F-score	0.046481442443
Binary Precision	0.0231556981645
Binary Recall	0.157412145258

6.3.2 Cross Dataset

Table 6.61: LinearSVC with Country feature set Cross: Experiment 1.

Multi-class F-score	0.142274185538
Multi-class Precision	0.378411433359
Multi-class Recall	0.094406147679
Binary F-score	0.611484800363
Binary Precision	0.440427122438
Binary Recall	0.999795992174
Total amount of samples	246467
False negative	22
False positive	136984
True negative	1644
True positive	107817
Positive training samples	10045
Negative training samples	4956

Table 6.62: LinearSVC with Country feature set Cross: Experiment 2.

Multi-class F-score	0.207532436407
Multi-class Precision	0.411213439099
Multi-class Recall	0.154422295885
Binary F-score	0.636269485246
Binary Precision	0.467226401401
Binary Recall	0.996976974935
Total amount of samples	246467
False negative	326
False positive	122596
True negative	16032
True positive	107513
Positive training samples	10045
Negative training samples	4956

Table 6.63: LinearSVC with Country feature set Cross: Experiment 3.

Multi-class F-score	0.212799558804
Multi-class Precision	0.459057956113
Multi-class Recall	0.149172100119
Binary F-score	0.640119583957
Binary Precision	0.471446366539
Binary Recall	0.996726601693
Total amount of samples	246467
False negative	353
False positive	120506
True negative	18122
True positive	107486
Positive training samples	10045
Negative training samples	4956

Table 6.64: LinearSVC with Country feature set Cross: Experiment 4.

Multi-class F-score	0.203939842743
Multi-class Precision	0.415425443938
Multi-class Recall	0.151269744023
Binary F-score	0.636998678746
Binary Precision	0.468015270831
Binary Recall	0.996967701852
Total amount of samples	246467
False negative	327
False positive	122207
True negative	16421
True positive	107512
Positive training samples	10045
Negative training samples	4956

Table 6.65: LinearSVC with Country feature set Cross: Experiment 5.

Multi-class F-score	0.206202673685
Multi-class Precision	0.415030414849
Multi-class Recall	0.15326189713
Binary F-score	0.635996556712
Binary Precision	0.46696060119
Binary Recall	0.996847151773
Total amount of samples	246467
False negative	340
False positive	122711
True negative	15917
True positive	107499
Positive training samples	10045
Negative training samples	4956

Table 6.66: LinearSVC with Country feature set Cross: Experiment 6.

Multi-class F-score	0.256280523309
Multi-class Precision	0.416608903462
Multi-class Recall	0.210381105787
Binary F-score	0.66139523726
Binary Precision	0.494804656942
Binary Recall	0.997097525014
Total amount of samples	246467
False negative	313
False positive	109784
True negative	28844
True positive	107526
Positive training samples	10045
Negative training samples	4956

Table 6.67: LinearSVC with Country feature set Cross: Experiment 7.

Multi-class F-score	0.189587907203
Multi-class Precision	0.408559005194
Multi-class Recall	0.124292501633
Binary F-score	0.624578064276
Binary Precision	0.454563505475
Binary Recall	0.997755913909
Total amount of samples	246467
False negative	242
False positive	129107
True negative	9521
True positive	107597
Positive training samples	10045
Negative training samples	4956

Table 6.68: LinearSVC with Country feature set Cross: Experiment 8.

Multi-class F-score	0.207362980373
Multi-class Precision	0.421636559419
Multi-class Recall	0.154641392154
Binary F-score	0.638054167794
Binary Precision	0.469501473972
Binary Recall	0.995409823904
Total amount of samples	246467
False negative	495
False positive	121290
True negative	17338
True positive	107344
Positive training samples	10045
Negative training samples	4956

Table 6.69: LinearSVC with Country feature set Cross: Experiment 9.

Multi-class F-score	0.252863575445
Multi-class Precision	0.421852311896
Multi-class Recall	0.200562347089
Binary F-score	0.660845297262
Binary Precision	0.494239451254
Binary Recall	0.996893517188
Total amount of samples	246467
False negative	335
False positive	110010
True negative	28618
True positive	107504
Positive training samples	10045
Negative training samples	4956

Table 6.70: LinearSVC with Country feature set Cross: Experiment 10.

Multi-class F-score	0.216213720761
Multi-class Precision	0.443349454823
Multi-class Recall	0.163863722121
Binary F-score	0.644557552781
Binary Precision	0.476353028798
Binary Recall	0.996392770704
Total amount of samples	246467
False negative	389
False positive	118118
True negative	20510
True positive	107450
Positive training samples	10045
Negative training samples	4956

Table 6.71: LinearSVC with Country feature set Cross: Average.

Multi-class F-score	0.209505740427
Multi-class Precision	0.419114492215
Multi-class Recall	0.155627325362
Binary F-score	0.63902994244
Binary Precision	0.470353787884
Binary Recall	0.997086397315
Total amount of samples	246467.0
False negative	314.2
False positive	121331.3
True negative	17296.7
True positive	107524.8
Positive training samples	10045.0
Negative training samples	4956.0

Table 6.72: LinearSVC with Country feature set Cross: Variance.

Multi-class F-score	0.000909080528027
Multi-class Precision	0.00040638208873
Multi-class Recall	0.000988355251415
Binary F-score	0.000199734926887
Binary Precision	0.000237798221837
Binary Recall	1.13322528018e-06

Chapter 7

Support Vector Machine with RBF Kernel

7.1 Standard feature set

7.1.1 CTU Dataset

Table 7.1: SupportVectorMachine with Standard feature set CTU: Experiment 1.

Multi-class F-score	0.364164896326
Multi-class Precision	0.5124492757
Multi-class Recall	0.403786844245
Binary F-score	0.0455568604424
Binary Precision	0.0749205327325
Binary Recall	0.0327292541878
Total amount of samples	195519
False negative	55029
False positive	22991
True negative	115637
True positive	1862
Positive training samples	2522
Negative training samples	2479

Table 7.2: SupportVectorMachine with Standard feature set CTU: Experiment 2.

Multi-class F-score	0.364164896326
Multi-class Precision	0.5124492757
Multi-class Recall	0.403786844245
Binary F-score	0.0455568604424
Binary Precision	0.0749205327325
Binary Recall	0.0327292541878
Total amount of samples	195519
False negative	55029
False positive	22991
True negative	115637
True positive	1862
Positive training samples	2522
Negative training samples	2479

Table 7.3: SupportVectorMachine with Standard feature set CTU: Experiment 3.

Multi-class F-score	0.364164896326
Multi-class Precision	0.5124492757
Multi-class Recall	0.403786844245
Binary F-score	0.0455568604424
Binary Precision	0.0749205327325
Binary Recall	0.0327292541878
Total amount of samples	195519
False negative	55029
False positive	22991
True negative	115637
True positive	1862
Positive training samples	2522
Negative training samples	2479

Table 7.4: SupportVectorMachine with Standard feature set CTU: Experiment 4.

Multi-class F-score	0.364164896326
Multi-class Precision	0.5124492757
Multi-class Recall	0.403786844245
Binary F-score	0.0455568604424
Binary Precision	0.0749205327325
Binary Recall	0.0327292541878
Total amount of samples	195519
False negative	55029
False positive	22991
True negative	115637
True positive	1862
Positive training samples	2522
Negative training samples	2479

Table 7.5: SupportVectorMachine with Standard feature set CTU: Experiment 5.

Multi-class F-score	0.364164896326
Multi-class Precision	0.5124492757
Multi-class Recall	0.403786844245
Binary F-score	0.0455568604424
Binary Precision	0.0749205327325
Binary Recall	0.0327292541878
Total amount of samples	195519
False negative	55029
False positive	22991
True negative	115637
True positive	1862
Positive training samples	2522
Negative training samples	2479

Table 7.6: SupportVectorMachine with Standard feature set CTU: Experiment 6.

Multi-class F-score	0.364164896326
Multi-class Precision	0.5124492757
Multi-class Recall	0.403786844245
Binary F-score	0.0455568604424
Binary Precision	0.0749205327325
Binary Recall	0.0327292541878
Total amount of samples	195519
False negative	55029
False positive	22991
True negative	115637
True positive	1862
Positive training samples	2522
Negative training samples	2479

Table 7.7: SupportVectorMachine with Standard feature set CTU: Experiment 7.

Multi-class F-score	0.364164896326
Multi-class Precision	0.5124492757
Multi-class Recall	0.403786844245
Binary F-score	0.0455568604424
Binary Precision	0.0749205327325
Binary Recall	0.0327292541878
Total amount of samples	195519
False negative	55029
False positive	22991
True negative	115637
True positive	1862
Positive training samples	2522
Negative training samples	2479

Table 7.8: SupportVectorMachine with Standard feature set CTU: Experiment 8.

Multi-class F-score	0.364164896326
Multi-class Precision	0.5124492757
Multi-class Recall	0.403786844245
Binary F-score	0.0455568604424
Binary Precision	0.0749205327325
Binary Recall	0.0327292541878
Total amount of samples	195519
False negative	55029
False positive	22991
True negative	115637
True positive	1862
Positive training samples	2522
Negative training samples	2479

Table 7.9: SupportVectorMachine with Standard feature set CTU: Experiment 9.

Multi-class F-score	0.364164896326
Multi-class Precision	0.5124492757
Multi-class Recall	0.403786844245
Binary F-score	0.0455568604424
Binary Precision	0.0749205327325
Binary Recall	0.0327292541878
Total amount of samples	195519
False negative	55029
False positive	22991
True negative	115637
True positive	1862
Positive training samples	2522
Negative training samples	2479

Table 7.10: SupportVectorMachine with Standard feature set CTU: Experiment 10.

Multi-class F-score	0.364164896326
Multi-class Precision	0.5124492757
Multi-class Recall	0.403786844245
Binary F-score	0.0455568604424
Binary Precision	0.0749205327325
Binary Recall	0.0327292541878
Total amount of samples	195519
False negative	55029
False positive	22991
True negative	115637
True positive	1862
Positive training samples	2522
Negative training samples	2479

Table 7.11: SupportVectorMachine with Standard feature set CTU: Average.

Multi-class F-score	0.364164896326
Multi-class Precision	0.5124492757
Multi-class Recall	0.403786844245
Binary F-score	0.0455568604424
Binary Precision	0.0749205327325
Binary Recall	0.0327292541878
Total amount of samples	195519.0
False negative	55029.0
False positive	22991.0
True negative	115637.0
True positive	1862.0
Positive training samples	2522.0
Negative training samples	2479.0

Table 7.12: SupportVectorMachine with Standard feature set CTU: Variance.

Multi-class F-score	3.08148791102e-33
Multi-class Precision	0.0
Multi-class Recall	1.23259516441e-32
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	4.81482486097e-35

7.1.2 Cross Dataset

Table 7.13: SupportVectorMachine with Standard feature set Cross: Experiment 1.

Multi-class F-score	0.335081994289
Multi-class Precision	0.654163480256
Multi-class Recall	0.427659686692
Binary F-score	0.674000068751
Binary Precision	0.508295704145
Binary Recall	1.0
Total amount of samples	246467
False negative	0.0
False positive	104319.0
True negative	34309.0
True positive	107839.0
Positive training samples	4522
Negative training samples	2479

Table 7.14: SupportVectorMachine with Standard feature set Cross: Experiment 2.

Multi-class F-score	0.334890285075
Multi-class Precision	0.653538976327
Multi-class Recall	0.427485221145
Binary F-score	0.673905299929
Binary Precision	0.508187914403
Binary Recall	1.0
Total amount of samples	246467
False negative	0.0
False positive	104364.0
True negative	34264.0000001
True positive	107839.0
Positive training samples	4522
Negative training samples	2479

Table 7.15: SupportVectorMachine with Standard feature set Cross: Experiment 3.

Multi-class F-score	0.335357929338
Multi-class Precision	0.647710365227
Multi-class Recall	0.427821980225
Binary F-score	0.673980378
Binary Precision	0.50832123258
Binary Recall	0.99981453834
Total amount of samples	246467
False negative	19.9999999527
False positive	104289.0
True negative	34339.0000001
True positive	107819.0
Positive training samples	4522
Negative training samples	2479

Table 7.16: SupportVectorMachine with Standard feature set Cross: Experiment 4.

Multi-class F-score	0.335281942093
Multi-class Precision	0.653733416642
Multi-class Recall	0.427826037563
Binary F-score	0.674073796263
Binary Precision	0.508379572229
Binary Recall	1.0
Total amount of samples	246467
False negative	0.0
False positive	104284.0
True negative	34343.9999999
True positive	107839.0
Positive training samples	4522
Negative training samples	2479

Table 7.17: SupportVectorMachine with Standard feature set Cross: Experiment 5.

Multi-class F-score	0.335312871722
Multi-class Precision	0.653842430198
Multi-class Recall	0.42776112015
Binary F-score	0.674084330082
Binary Precision	0.508391555644
Binary Recall	1.0
Total amount of samples	246467
False negative	0.0
False positive	104279.0
True negative	34349.0000002
True positive	107839.0
Positive training samples	4522
Negative training samples	2479

Table 7.18: SupportVectorMachine with Standard feature set Cross: Experiment 6.

Multi-class F-score	0.335507295397
Multi-class Precision	0.653597362073
Multi-class Recall	0.427931528359
Binary F-score	0.674153861542
Binary Precision	0.508470660348
Binary Recall	1.0
Total amount of samples	246467
False negative	0.0
False positive	104246.0
True negative	34381.9999998
True positive	107839.0
Positive training samples	4522
Negative training samples	2479

Table 7.19: SupportVectorMachine with Standard feature set Cross: Experiment 7.

Multi-class F-score	0.335479635422
Multi-class Precision	0.653845182633
Multi-class Recall	0.427963987065
Binary F-score	0.674118040514
Binary Precision	0.508429906366
Binary Recall	1.0
Total amount of samples	246467
False negative	0.0
False positive	104263.0
True negative	34365.0000001
True positive	107839.0
Positive training samples	4522
Negative training samples	2479

Table 7.20: SupportVectorMachine with Standard feature set Cross: Experiment 8.

Multi-class F-score	0.335132276178
Multi-class Precision	0.64703765115
Multi-class Recall	0.427777349503
Binary F-score	0.67396563256
Binary Precision	0.508304457488
Binary Recall	0.99981453834
Total amount of samples	246467
False negative	19.9999999527
False positive	104296.0
True negative	34332.0000001
True positive	107819.0
Positive training samples	4522
Negative training samples	2479

Table 7.21: SupportVectorMachine with Standard feature set Cross: Experiment 9.

Multi-class F-score	0.334867706718
Multi-class Precision	0.653567657531
Multi-class Recall	0.427542023881
Binary F-score	0.673960051997
Binary Precision	0.508250187344
Binary Recall	1.0
Total amount of samples	246467
False negative	0.0
False positive	104338.0
True negative	34290.0000002
True positive	107839.0
Positive training samples	4522
Negative training samples	2479

Table 7.22: SupportVectorMachine with Standard feature set Cross: Experiment 10.

Multi-class F-score	0.335293380236
Multi-class Precision	0.653598846776
Multi-class Recall	0.427821980225
Binary F-score	0.674065369446
Binary Precision	0.508369985905
Binary Recall	1.0
Total amount of samples	246467
False negative	0.0
False positive	104288.0
True negative	34340.0000001
True positive	107839.0
Positive training samples	4522
Negative training samples	2479

Table 7.23: SupportVectorMachine with Standard feature set Cross: Average.

Multi-class F-score	0.335220531647
Multi-class Precision	0.652463536881
Multi-class Recall	0.427759091481
Binary F-score	0.674030682908
Binary Precision	0.508340117645
Binary Recall	0.999962907668
Total amount of samples	246467
False negative	10.8
False positive	104306.8
True negative	34321.2
True positive	107828.2
Positive training samples	4522.0
Negative training samples	2479.0

Table 7.24: SupportVectorMachine with Standard feature set Cross: Variance.

Multi-class F-score	4.46381045318e-08
Multi-class Precision	6.52957111283e-06
Multi-class Recall	2.16450529695e-08
Binary F-score	5.71532387962e-09
Binary Precision	6.50521942293e-09
Binary Recall	5.5033643988e-09

7.2 TCP feature set

7.2.1 CTU Dataset

Table 7.25: SupportVectorMachine with TCP feature set CTU: Experiment 1.

Multi-class F-score	0.303097321166
Multi-class Precision	0.555459222519
Multi-class Recall	0.358998358216
Binary F-score	0.0282803077563
Binary Precision	0.998776009792
Binary Recall	0.0143432177322
Total amount of samples	195519
False negative	56077.5
False positive	0.999999999939
True negative	138627.0
True positive	813.5
Positive training samples	2522
Negative training samples	2479

Table 7.26: SupportVectorMachine with TCP feature set CTU: Experiment 2.

Multi-class F-score	0.303097321166
Multi-class Precision	0.555459222519
Multi-class Recall	0.358998358216
Binary F-score	0.0282803077563
Binary Precision	0.998776009792
Binary Recall	0.0143432177322
Total amount of samples	195519
False negative	56077.5
False positive	0.999999999939
True negative	138627.0
True positive	813.5
Positive training samples	2522
Negative training samples	2479

Table 7.27: SupportVectorMachine with TCP feature set CTU: Experiment 3.

Multi-class F-score	0.303097321166
Multi-class Precision	0.555459222519
Multi-class Recall	0.358998358216
Binary F-score	0.0282803077563
Binary Precision	0.998776009792
Binary Recall	0.0143432177322
Total amount of samples	195519
False negative	56077.5
False positive	0.999999999939
True negative	138627.0
True positive	813.5
Positive training samples	2522
Negative training samples	2479

Table 7.28: SupportVectorMachine with TCP feature set CTU: Experiment 4.

Multi-class F-score	0.303097321166
Multi-class Precision	0.555459222519
Multi-class Recall	0.358998358216
Binary F-score	0.0282803077563
Binary Precision	0.998776009792
Binary Recall	0.0143432177322
Total amount of samples	195519
False negative	56077.5
False positive	0.999999999939
True negative	138627.0
True positive	813.5
Positive training samples	2522
Negative training samples	2479

Table 7.29: SupportVectorMachine with TCP feature set CTU: Experiment 5.

Multi-class F-score	0.303097321166
Multi-class Precision	0.555459222519
Multi-class Recall	0.358998358216
Binary F-score	0.0282803077563
Binary Precision	0.998776009792
Binary Recall	0.0143432177322
Total amount of samples	195519
False negative	56077.5
False positive	0.999999999939
True negative	138627.0
True positive	813.5
Positive training samples	2522
Negative training samples	2479

Table 7.30: SupportVectorMachine with TCP feature set CTU: Experiment 6.

Multi-class F-score	0.303097321166
Multi-class Precision	0.555459222519
Multi-class Recall	0.358998358216
Binary F-score	0.0282803077563
Binary Precision	0.998776009792
Binary Recall	0.0143432177322
Total amount of samples	195519
False negative	56077.5
False positive	0.999999999939
True negative	138627.0
True positive	813.5
Positive training samples	2522
Negative training samples	2479

Table 7.31: SupportVectorMachine with TCP feature set CTU: Experiment 7.

Multi-class F-score	0.303097321166
Multi-class Precision	0.555459222519
Multi-class Recall	0.358998358216
Binary F-score	0.0282803077563
Binary Precision	0.998776009792
Binary Recall	0.0143432177322
Total amount of samples	195519
False negative	56077.5
False positive	0.999999999939
True negative	138627.0
True positive	813.5
Positive training samples	2522
Negative training samples	2479

Table 7.32: SupportVectorMachine with TCP feature set CTU: Experiment 8.

Multi-class F-score	0.303097321166
Multi-class Precision	0.555459222519
Multi-class Recall	0.358998358216
Binary F-score	0.0282803077563
Binary Precision	0.998776009792
Binary Recall	0.0143432177322
Total amount of samples	195519
False negative	56077.5
False positive	0.999999999939
True negative	138627.0
True positive	813.5
Positive training samples	2522
Negative training samples	2479

Table 7.33: SupportVectorMachine with TCP feature set CTU: Experiment 9.

Multi-class F-score	0.303097321166
Multi-class Precision	0.555459222519
Multi-class Recall	0.358998358216
Binary F-score	0.0282803077563
Binary Precision	0.998776009792
Binary Recall	0.0143432177322
Total amount of samples	195519
False negative	56077.5
False positive	0.999999999939
True negative	138627.0
True positive	813.5
Positive training samples	2522
Negative training samples	2479

Table 7.34: SupportVectorMachine with TCP feature set CTU: Experiment 10.

Multi-class F-score	0.303097321166
Multi-class Precision	0.555459222519
Multi-class Recall	0.358998358216
Binary F-score	0.0282803077563
Binary Precision	0.998776009792
Binary Recall	0.0143432177322
Total amount of samples	195519
False negative	56077.5
False positive	0.999999999939
True negative	138627.0
True positive	813.5
Positive training samples	2522
Negative training samples	2479

Table 7.35: SupportVectorMachine with TCP feature set CTU: Average.

Multi-class F-score	0.303097321166
Multi-class Precision	0.555459222519
Multi-class Recall	0.358998358216
Binary F-score	0.0282803077563
Binary Precision	0.998776009792
Binary Recall	0.0143432177322
Total amount of samples	195519
False negative	56077.5
False positive	0.999999999939
True negative	138627.0
True positive	813.5
Positive training samples	2522.0
Negative training samples	2479.0

Table 7.36: SupportVectorMachine with TCP feature set CTU: Variance.

Multi-class F-score	0.0
Multi-class Precision	1.23259516441e-32
Multi-class Recall	0.0
Binary F-score	1.20370621524e-35
Binary Precision	1.23259516441e-32
Binary Recall	0.0

7.2.2 Cross Dataset

Table 7.37: SupportVectorMachine with TCP feature set Cross: Experiment 1.

Multi-class F-score	0.576127838108
Multi-class Precision	0.694445418738
Multi-class Recall	0.597812283186
Binary F-score	0.697075315944
Binary Precision	0.74899315988
Binary Recall	0.651888463357
Total amount of samples	246467
False negative	37540
False positive	23559
True negative	115069
True positive	70299
Positive training samples	4522
Negative training samples	2479

Table 7.38: SupportVectorMachine with TCP feature set Cross: Experiment 2.

Multi-class F-score	0.576104441882
Multi-class Precision	0.694401916249
Multi-class Recall	0.597877200599
Binary F-score	0.697293277811
Binary Precision	0.749129216774
Binary Recall	0.652166655848
Total amount of samples	246467
False negative	37510
False positive	23552
True negative	115076
True positive	70329
Positive training samples	4522
Negative training samples	2479

Table 7.39: SupportVectorMachine with TCP feature set Cross: Experiment 3.

Multi-class F-score	0.576345140073
Multi-class Precision	0.694817862182
Multi-class Recall	0.598177443633
Binary F-score	0.697823792083
Binary Precision	0.749473034258
Binary Recall	0.652834317826
Total amount of samples	246467
False negative	37438
False positive	23533
True negative	115095
True positive	70401
Positive training samples	4522
Negative training samples	2479

Table 7.40: SupportVectorMachine with TCP feature set Cross: Experiment 4.

Multi-class F-score	0.576196985317
Multi-class Precision	0.694194751648
Multi-class Recall	0.598080067514
Binary F-score	0.69766150857
Binary Precision	0.749379758292
Binary Recall	0.652621036916
Total amount of samples	246467
False negative	37461
False positive	23537
True negative	115091
True positive	70378
Positive training samples	4522
Negative training samples	2479

Table 7.41: SupportVectorMachine with TCP feature set Cross: Experiment 5.

Multi-class F-score	0.575723197218
Multi-class Precision	0.694479290264
Multi-class Recall	0.597240198485
Binary F-score	0.696364790856
Binary Precision	0.748711931303
Binary Recall	0.650859151142
Total amount of samples	246467
False negative	37651
False positive	23557
True negative	115071
True positive	70188
Positive training samples	4522
Negative training samples	2479

Table 7.42: SupportVectorMachine with TCP feature set Cross: Experiment 6.

Multi-class F-score	0.576383268415
Multi-class Precision	0.694693113487
Multi-class Recall	0.59820990234
Binary F-score	0.697922189902
Binary Precision	0.749467858663
Binary Recall	0.653010506403
Total amount of samples	246467
False negative	37419
False positive	23540
True negative	115088
True positive	70420
Positive training samples	4522
Negative training samples	2479

Table 7.43: SupportVectorMachine with TCP feature set Cross: Experiment 7.

Multi-class F-score	0.576073699095
Multi-class Precision	0.694439374102
Multi-class Recall	0.597836627216
Binary F-score	0.697177757177
Binary Precision	0.749009373669
Binary Recall	0.652055378852
Total amount of samples	246467
False negative	37522
False positive	23563
True negative	115065
True positive	70317
Positive training samples	4522
Negative training samples	2479

Table 7.44: SupportVectorMachine with TCP feature set Cross: Experiment 8.

Multi-class F-score	0.576460087341
Multi-class Precision	0.6942921524
Multi-class Recall	0.598453342638
Binary F-score	0.698203509745
Binary Precision	0.749603719189
Binary Recall	0.65339997589
Total amount of samples	246467
False negative	37377
False positive	23537
True negative	115091
True positive	70462
Positive training samples	4522
Negative training samples	2479

Table 7.45: SupportVectorMachine with TCP feature set Cross: Experiment 9.

Multi-class F-score	0.576216083238
Multi-class Precision	0.694392106287
Multi-class Recall	0.59797051938
Binary F-score	0.697481866364
Binary Precision	0.749429989985
Binary Recall	0.652268659761
Total amount of samples	246467
False negative	37499
False positive	23518
True negative	115110
True positive	70340
Positive training samples	4522
Negative training samples	2479

Table 7.46: SupportVectorMachine with TCP feature set Cross: Experiment 10.

Multi-class F-score	0.576312761844
Multi-class Precision	0.694249672545
Multi-class Recall	0.598250475723
Binary F-score	0.697986311079
Binary Precision	0.749664643884
Binary Recall	0.652973414071
Total amount of samples	246467
False negative	37423
False positive	23514
True negative	115114
True positive	70416
Positive training samples	4522
Negative training samples	2479

Table 7.47: SupportVectorMachine with TCP feature set Cross: Average.

Multi-class F-score	0.576194350253
Multi-class Precision	0.69444056579
Multi-class Recall	0.597990806071
Binary F-score	0.697499031953
Binary Precision	0.74928626859
Binary Recall	0.652407756007
Total amount of samples	246467.0
False negative	37484.0
False positive	23541.0
True negative	115087.0
True positive	70355.0
Positive training samples	4522.0
Negative training samples	2479.0

Table 7.48: SupportVectorMachine with TCP feature set Cross: Variance.

Multi-class F-score	3.92593677479e-08
Multi-class Precision	3.30390931029e-08
Multi-class Recall	1.00454380523e-07
Binary F-score	2.65654537644e-07
Binary Precision	8.58307384168e-08
Binary Recall	4.7647097084e-07

7.3 Country feature set

7.3.1 CTU Dataset

Table 7.49: SupportVectorMachine with Country feature set CTU: Experiment 1.

Multi-class F-score	0.3643449875
Multi-class Precision	0.516778173267
Multi-class Recall	0.406267421581
Binary F-score	0.0449382593848
Binary Precision	0.0758848355689
Binary Recall	0.0319206904431
Total amount of samples	195519
False negative	55075
False positive	22115
True negative	116513
True positive	1816
Positive training samples	2522
Negative training samples	2479

Table 7.50: SupportVectorMachine with Country feature set CTU: Experiment 2.

Multi-class F-score	0.3643449875
Multi-class Precision	0.516778173267
Multi-class Recall	0.406267421581
Binary F-score	0.0449382593848
Binary Precision	0.0758848355689
Binary Recall	0.0319206904431
Total amount of samples	195519
False negative	55075
False positive	22115
True negative	116513
True positive	1816
Positive training samples	2522
Negative training samples	2479

Table 7.51: SupportVectorMachine with Country feature set CTU: Experiment 3.

Multi-class F-score	0.3643449875
Multi-class Precision	0.516778173267
Multi-class Recall	0.406267421581
Binary F-score	0.0449382593848
Binary Precision	0.0758848355689
Binary Recall	0.0319206904431
Total amount of samples	195519
False negative	55075
False positive	22115
True negative	116513
True positive	1816
Positive training samples	2522
Negative training samples	2479

Table 7.52: SupportVectorMachine with Country feature set CTU: Experiment 4.

Multi-class F-score	0.3643449875
Multi-class Precision	0.516778173267
Multi-class Recall	0.406267421581
Binary F-score	0.0449382593848
Binary Precision	0.0758848355689
Binary Recall	0.0319206904431
Total amount of samples	195519
False negative	55075
False positive	22115
True negative	116513
True positive	1816
Positive training samples	2522
Negative training samples	2479

Table 7.53: SupportVectorMachine with Country feature set CTU: Experiment 5.

Multi-class F-score	0.3643449875
Multi-class Precision	0.516778173267
Multi-class Recall	0.406267421581
Binary F-score	0.0449382593848
Binary Precision	0.0758848355689
Binary Recall	0.0319206904431
Total amount of samples	195519
False negative	55075
False positive	22115
True negative	116513
True positive	1816
Positive training samples	2522
Negative training samples	2479

Table 7.54: SupportVectorMachine with Country feature set CTU: Experiment 6.

Multi-class F-score	0.3643449875
Multi-class Precision	0.516778173267
Multi-class Recall	0.406267421581
Binary F-score	0.0449382593848
Binary Precision	0.0758848355689
Binary Recall	0.0319206904431
Total amount of samples	195519
False negative	55075
False positive	22115
True negative	116513
True positive	1816
Positive training samples	2522
Negative training samples	2479

Table 7.55: SupportVectorMachine with Country feature set CTU: Experiment 7.

Multi-class F-score	0.3643449875
Multi-class Precision	0.516778173267
Multi-class Recall	0.406267421581
Binary F-score	0.0449382593848
Binary Precision	0.0758848355689
Binary Recall	0.0319206904431
Total amount of samples	195519
False negative	55075
False positive	22115
True negative	116513
True positive	1816
Positive training samples	2522
Negative training samples	2479

Table 7.56: SupportVectorMachine with Country feature set CTU: Experiment 8.

Multi-class F-score	0.3643449875
Multi-class Precision	0.516778173267
Multi-class Recall	0.406267421581
Binary F-score	0.0449382593848
Binary Precision	0.0758848355689
Binary Recall	0.0319206904431
Total amount of samples	195519
False negative	55075
False positive	22115
True negative	116513
True positive	1816
Positive training samples	2522
Negative training samples	2479

Table 7.57: SupportVectorMachine with Country feature set CTU: Experiment 9.

Multi-class F-score	0.3643449875
Multi-class Precision	0.516778173267
Multi-class Recall	0.406267421581
Binary F-score	0.0449382593848
Binary Precision	0.0758848355689
Binary Recall	0.0319206904431
Total amount of samples	195519
False negative	55075
False positive	22115
True negative	116513
True positive	1816
Positive training samples	2522
Negative training samples	2479

Table 7.58: SupportVectorMachine with Country feature set CTU: Experiment 10.

Multi-class F-score	0.3643449875
Multi-class Precision	0.516778173267
Multi-class Recall	0.406267421581
Binary F-score	0.0449382593848
Binary Precision	0.0758848355689
Binary Recall	0.0319206904431
Total amount of samples	195519
False negative	55075
False positive	22115
True negative	116513
True positive	1816
Positive training samples	2522
Negative training samples	2479

Table 7.59: SupportVectorMachine with Country feature set CTU: Average.

Multi-class F-score	0.3643449875
Multi-class Precision	0.516778173267
Multi-class Recall	0.406267421581
Binary F-score	0.0449382593848
Binary Precision	0.0758848355689
Binary Recall	0.0319206904431
Total amount of samples	195519.0
False negative	55075.0
False positive	22115.0
True negative	116513.0
True positive	1816.0
Positive training samples	2522.0
Negative training samples	2479.0

Table 7.60: SupportVectorMachine with Country feature set CTU: Variance.

Multi-class F-score	3.08148791102e-33
Multi-class Precision	1.23259516441e-32
Multi-class Recall	3.08148791102e-33
Binary F-score	4.81482486097e-35
Binary Precision	0.0
Binary Recall	4.81482486097e-35

7.3.2 Cross Dataset

Table 7.61: SupportVectorMachine with Country feature set Cross: Experiment 1.

Multi-class F-score	0.576699770615
Multi-class Precision	0.698364297614
Multi-class Recall	0.600137138035
Binary F-score	0.700650521513
Binary Precision	0.75688473252
Binary Recall	0.652194475097
Total amount of samples	246467
False negative	37507
False positive	22591
True negative	116037
True positive	70332
Positive training samples	4522
Negative training samples	2479

Table 7.62: SupportVectorMachine with Country feature set Cross: Experiment 2.

Multi-class F-score	0.57645994583
Multi-class Precision	0.697973107152
Multi-class Recall	0.599873411045
Binary F-score	0.700264062578
Binary Precision	0.756694770165
Binary Recall	0.651665909365
Total amount of samples	246467
False negative	37564
False positive	22596
True negative	116032
True positive	70275
Positive training samples	4522
Negative training samples	2479

Table 7.63: SupportVectorMachine with Country feature set Cross: Experiment 3.

Multi-class F-score	0.576216479163
Multi-class Precision	0.698105514479
Multi-class Recall	0.599439275846
Binary F-score	0.699741741203
Binary Precision	0.756726155173
Binary Recall	0.650738601063
Total amount of samples	246467
False negative	37664
False positive	22560
True negative	116068
True positive	70175
Positive training samples	4522
Negative training samples	2479

Table 7.64: SupportVectorMachine with Country feature set Cross: Experiment 4.

Multi-class F-score	0.576702064191
Multi-class Precision	0.698249311267
Multi-class Recall	0.600137138035
Binary F-score	0.700773046961
Binary Precision	0.757008340059
Binary Recall	0.652315025176
Total amount of samples	246467
False negative	37494
False positive	22580
True negative	116048
True positive	70345
Positive training samples	4522
Negative training samples	2479

Table 7.65: SupportVectorMachine with Country feature set Cross: Experiment 5.

Multi-class F-score	0.577233701994
Multi-class Precision	0.698983617468
Multi-class Recall	0.600839057561
Binary F-score	0.701764863977
Binary Precision	0.757388567193
Binary Recall	0.653752353045
Total amount of samples	246467
False negative	37339
False positive	22583
True negative	116045
True positive	70500
Positive training samples	4522
Negative training samples	2479

Table 7.66: SupportVectorMachine with Country feature set Cross: Experiment 6.

Multi-class F-score	0.575312780666
Multi-class Precision	0.697879815347
Multi-class Recall	0.598011092763
Binary F-score	0.697451418126
Binary Precision	0.75576361078
Binary Recall	0.647493022005
Total amount of samples	246467
False negative	38014
False positive	22565
True negative	116063
True positive	69825
Positive training samples	4522
Negative training samples	2479

Table 7.67: SupportVectorMachine with Country feature set Cross: Experiment 7.

Multi-class F-score	0.577074358873
Multi-class Precision	0.698338190635
Multi-class Recall	0.600774140149
Binary F-score	0.701738498741
Binary Precision	0.757115708779
Binary Recall	0.653909995456
Total amount of samples	246467
False negative	37322
False positive	22622
True negative	116006
True positive	70517
Positive training samples	4522
Negative training samples	2479

Table 7.68: SupportVectorMachine with Country feature set Cross: Experiment 8.

Multi-class F-score	0.576557997792
Multi-class Precision	0.69847122856
Multi-class Recall	0.599857181692
Binary F-score	0.700226210525
Binary Precision	0.756706404333
Binary Recall	0.651591724701
Total amount of samples	246467
False negative	37572
False positive	22592
True negative	116036
True positive	70267
Positive training samples	4522
Negative training samples	2479

Table 7.69: SupportVectorMachine with Country feature set Cross: Experiment 9.

Multi-class F-score	0.576065824657
Multi-class Precision	0.698080193406
Multi-class Recall	0.59919177821
Binary F-score	0.699203286568
Binary Precision	0.756143850758
Binary Recall	0.65023785458
Total amount of samples	246467
False negative	37718
False positive	22614
True negative	116014
True positive	70121
Positive training samples	4522
Negative training samples	2479

Table 7.70: SupportVectorMachine with Country feature set Cross: Experiment 10.

Multi-class F-score	0.576345182373
Multi-class Precision	0.698367236219
Multi-class Recall	0.599581282687
Binary F-score	0.69978365121
Binary Precision	0.756648663799
Binary Recall	0.650868424225
Total amount of samples	246467
False negative	37650
False positive	22574
True negative	116054
True positive	70189
Positive training samples	4522
Negative training samples	2479

Table 7.71: SupportVectorMachine with Country feature set Cross: Average.

Multi-class F-score	0.576466810615
Multi-class Precision	0.698281251215
Multi-class Recall	0.599784149602
Binary F-score	0.70015973014
Binary Precision	0.756708080356
Binary Recall	0.651476738471
Total amount of samples	246467.0
False negative	37584.4
False positive	22587.7
True negative	116040.3
True positive	70254.6
Positive training samples	4522.0
Negative training samples	2479.0

Table 7.72: SupportVectorMachine with Country feature set Cross: Variance.

Multi-class F-score	2.64524823102e-07
Multi-class Precision	8.75373291227e-08
Multi-class Recall	6.01014235748e-07
Binary F-score	1.42671919089e-06
Binary Precision	1.96499995857e-07
Binary Recall	3.06857624029e-06

Chapter 8

Neural Networks

8.1 Standard feature set

8.1.1 CTU Dataset

Table 8.1: NeuralNetwork with Standard feature set CTU: Experiment 1.

Multi-class F-score	0.243655874242
Multi-class Precision	0.235658804648
Multi-class Recall	0.369892440121
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.2: NeuralNetwork with Standard feature set CTU: Experiment 2.

Multi-class F-score	0.243801168354
Multi-class Precision	0.234790607874
Multi-class Recall	0.37018397189
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.3: NeuralNetwork with Standard feature set CTU: Experiment 3.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.4: NeuralNetwork with Standard feature set CTU: Experiment 4.

Multi-class F-score	0.243577193912
Multi-class Precision	0.234865079466
Multi-class Recall	0.369958929823
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.5: NeuralNetwork with Standard feature set CTU: Experiment 5.

Multi-class F-score	0.241730070031
Multi-class Precision	0.236738896603
Multi-class Recall	0.367723852925
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.6: NeuralNetwork with Standard feature set CTU: Experiment 6.

Multi-class F-score	0.243923231885
Multi-class Precision	0.234226049471
Multi-class Recall	0.370419243143
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.7: NeuralNetwork with Standard feature set CTU: Experiment 7.

Multi-class F-score	0.244902249838
Multi-class Precision	0.254393648371
Multi-class Recall	0.368051186841
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.8: NeuralNetwork with Standard feature set CTU: Experiment 8.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.9: NeuralNetwork with Standard feature set CTU: Experiment 9.

Multi-class F-score	0.243904454241
Multi-class Precision	0.23417680388
Multi-class Recall	0.370409013958
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.10: NeuralNetwork with Standard feature set CTU: Experiment 10.

Multi-class F-score	0.243795223494
Multi-class Precision	0.234838898031
Multi-class Recall	0.370168628113
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.11: NeuralNetwork with Standard feature set CTU: Average.

Multi-class F-score	0.221369506642
Multi-class Precision	0.207053027235
Multi-class Recall	0.354134380802
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519.0
False negative	56891.0
False positive	0.0
True negative	138628.0
True positive	0.0
Positive training samples	25195.0
Negative training samples	24806.0

Table 8.12: NeuralNetwork with Standard feature set CTU: Variance.

Multi-class F-score	0.00198821957777
Multi-class Precision	0.00373185120153
Multi-class Recall	0.000957666209719
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0

8.1.2 Cross Dataset

Table 8.13: NeuralNetwork with Standard feature set Cross: Experiment 1.

Multi-class F-score	0.125320851921
Multi-class Precision	0.0804311665229
Multi-class Recall	0.283603890176
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.14: NeuralNetwork with Standard feature set Cross: Experiment 2.

Multi-class F-score	0.210134083389
Multi-class Precision	0.184544842999
Multi-class Recall	0.349024413005
Binary F-score	0.649750919503
Binary Precision	0.48832261857
Binary Recall	0.970613599904
Total amount of samples	246467
False negative	3169
False positive	109676
True negative	28952
True positive	104670
Positive training samples	45195
Negative training samples	24806

Table 8.15: NeuralNetwork with Standard feature set Cross: Experiment 3.

Multi-class F-score	0.125352749911
Multi-class Precision	0.0804541817077
Multi-class Recall	0.283644463559
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.16: NeuralNetwork with Standard feature set Cross: Experiment 4.

Multi-class F-score	0.125311283131
Multi-class Precision	0.0804242626095
Multi-class Recall	0.283591718161
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.17: NeuralNetwork with Standard feature set Cross: Experiment 5.

Multi-class F-score	0.125375080357
Multi-class Precision	0.080470294296
Multi-class Recall	0.283672864927
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.18: NeuralNetwork with Standard feature set Cross: Experiment 6.

Multi-class F-score	0.12532404158
Multi-class Precision	0.0804334678933
Multi-class Recall	0.283607947514
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.19: NeuralNetwork with Standard feature set Cross: Experiment 7.

Multi-class F-score	0.125336800527
Multi-class Precision	0.0804426737038
Multi-class Recall	0.283624176867
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.20: NeuralNetwork with Standard feature set Cross: Experiment 8.

Multi-class F-score	0.125336800527
Multi-class Precision	0.0804426737038
Multi-class Recall	0.283624176867
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.21: NeuralNetwork with Standard feature set Cross: Experiment 9.

Multi-class F-score	0.125343180187
Multi-class Precision	0.0804472768066
Multi-class Recall	0.283632291544
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.22: NeuralNetwork with Standard feature set Cross: Experiment 10.

Multi-class F-score	0.125308093597
Multi-class Precision	0.0804219613709
Multi-class Recall	0.283587660823
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.23: NeuralNetwork with Standard feature set Cross: Average.

Multi-class F-score	0.133814296513
Multi-class Precision	0.0908512801613
Multi-class Recall	0.290161360344
Binary F-score	0.612835416077
Binary Precision	0.442617636775
Binary Recall	0.99706135999
Total amount of samples	246467.0
False negative	316.9
False positive	135732.8
True negative	2895.2
True positive	107522.1
Positive training samples	45195.0
Negative training samples	24806.0

Table 8.24: NeuralNetwork with Standard feature set Cross: Variance.

Multi-class F-score	0.000647190345167
Multi-class Precision	0.000975387266967
Multi-class Recall	0.000384984911854
Binary F-score	0.000151417154799
Binary Precision	0.000232105040094
Binary Recall	7.77204459565e-05

8.2 TCP feature set

8.2.1 CTU Dataset

Table 8.25: NeuralNetwork with TCP feature set CTU: Experiment 1.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.26: NeuralNetwork with TCP feature set CTU: Experiment 2.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.27: NeuralNetwork with TCP feature set CTU: Experiment 3.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.28: NeuralNetwork with TCP feature set CTU: Experiment 4.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.29: NeuralNetwork with TCP feature set CTU: Experiment 5.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.30: NeuralNetwork with TCP feature set CTU: Experiment 6.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.31: NeuralNetwork with TCP feature set CTU: Experiment 7.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.32: NeuralNetwork with TCP feature set CTU: Experiment 8.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.33: NeuralNetwork with TCP feature set CTU: Experiment 9.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.34: NeuralNetwork with TCP feature set CTU: Experiment 10.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.35: NeuralNetwork with TCP feature set CTU: Average.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195.0
Negative training samples	24806.0

Table 8.36: NeuralNetwork with TCP feature set CTU: Variance.

Multi-class F-score	7.70371977755e-34
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0

8.2.2 Cross Dataset

Table 8.37: NeuralNetwork with TCP feature set Cross: Experiment 1.

Multi-class F-score	0.444908073078
Multi-class Precision	0.371416680914
Multi-class Recall	0.559993832846
Binary F-score	0.59370192118
Binary Precision	0.633987341106
Binary Recall	0.558230324836
Total amount of samples	246467
False negative	47640.0
False positive	34753.9999999
True negative	103874.0
True positive	60199.0
Positive training samples	45195
Negative training samples	24806

Table 8.38: NeuralNetwork with TCP feature set Cross: Experiment 2.

Multi-class F-score	0.352860954395
Multi-class Precision	0.368490890056
Multi-class Recall	0.516255725919
Binary F-score	0.568809922141
Binary Precision	0.502204989454
Binary Recall	0.655783158227
Total amount of samples	246467
False negative	37120.0
False positive	70098.0000002
True negative	68529.9999998
True positive	70719.0
Positive training samples	45195
Negative training samples	24806

Table 8.39: NeuralNetwork with TCP feature set Cross: Experiment 3.

Multi-class F-score	0.40063415398
Multi-class Precision	0.386404795438
Multi-class Recall	0.540912170798
Binary F-score	0.609406034647
Binary Precision	0.570214210105
Binary Recall	0.65438292269
Total amount of samples	246467
False negative	37271.0
False positive	53189.0
True negative	85439.0
True positive	70568.0
Positive training samples	45195
Negative training samples	24806

Table 8.40: NeuralNetwork with TCP feature set Cross: Experiment 4.

Multi-class F-score	0.398920444483
Multi-class Precision	0.351032590862
Multi-class Recall	0.516413962113
Binary F-score	0.585193122595
Binary Precision	0.616316648029
Binary Recall	0.557061916375
Total amount of samples	246467
False negative	47766.0
False positive	37397.9999999
True negative	101230.0
True positive	60073.0
Positive training samples	45195
Negative training samples	24806

Table 8.41: NeuralNetwork with TCP feature set Cross: Experiment 5.

Multi-class F-score	0.326104814486
Multi-class Precision	0.25186312523
Multi-class Recall	0.475337469114
Binary F-score	0.553660227654
Binary Precision	0.548350129152
Binary Recall	0.559074175391
Total amount of samples	246467
False negative	47549.0
False positive	49658.0
True negative	88970.0
True positive	60290.0
Positive training samples	45195
Negative training samples	24806

Table 8.42: NeuralNetwork with TCP feature set Cross: Experiment 6.

Multi-class F-score	0.385157389632
Multi-class Precision	0.372406129514
Multi-class Recall	0.532188893442
Binary F-score	0.583213702292
Binary Precision	0.525283675031
Binary Recall	0.655504965736
Total amount of samples	246467
False negative	37150.0
False positive	63884.0000001
True negative	74743.9999999
True positive	70689.0
Positive training samples	45195
Negative training samples	24806

Table 8.43: NeuralNetwork with TCP feature set Cross: Experiment 7.

Multi-class F-score	0.390846502036
Multi-class Precision	0.345252139451
Multi-class Recall	0.491242235269
Binary F-score	0.528654546653
Binary Precision	0.648623506889
Binary Recall	0.446137297267
Total amount of samples	246467
False negative	59728.0
False positive	26063.0
True negative	112565.0
True positive	48111.0
Positive training samples	45195
Negative training samples	24806

Table 8.44: NeuralNetwork with TCP feature set Cross: Experiment 8.

Multi-class F-score	0.367956797261
Multi-class Precision	0.356127480544
Multi-class Recall	0.522836728649
Binary F-score	0.565785682269
Binary Precision	0.497680116593
Binary Recall	0.65548641957
Total amount of samples	246467
False negative	37152.0
False positive	71345.9999999
True negative	67282.0000001
True positive	70687.0
Positive training samples	45195
Negative training samples	24806

Table 8.45: NeuralNetwork with TCP feature set Cross: Experiment 9.

Multi-class F-score	0.3249724891
Multi-class Precision	0.305090110586
Multi-class Recall	0.441848198745
Binary F-score	0.480201576689
Binary Precision	0.519771875439
Binary Recall	0.446230028097
Total amount of samples	246467
False negative	59718.0
False positive	44459.9999999
True negative	94168.0000001
True positive	48121.0
Positive training samples	45195
Negative training samples	24806

Table 8.46: NeuralNetwork with TCP feature set Cross: Experiment 10.

Multi-class F-score	0.286754093818
Multi-class Precision	0.220118230822
Multi-class Recall	0.424462504108
Binary F-score	0.446086586809
Binary Precision	0.444635865309
Binary Recall	0.447546805887
Total amount of samples	246467
False negative	59576.0
False positive	60282.0000001
True negative	78345.9999999
True positive	48263.0
Positive training samples	45195
Negative training samples	24806

Table 8.47: NeuralNetwork with TCP feature set Cross: Average.

Multi-class F-score	0.367911571227
Multi-class Precision	0.332820217342
Multi-class Recall	0.5021491721
Binary F-score	0.551471332293
Binary Precision	0.550706835711
Binary Recall	0.563543801408
Total amount of samples	246467
False negative	47067.0
False positive	51113.2
True negative	87514.8
True positive	60772.0
Positive training samples	45195.0
Negative training samples	24806.0

Table 8.48: NeuralNetwork with TCP feature set Cross: Variance.

Multi-class F-score	0.00191888371786
Multi-class Precision	0.00282546544484
Multi-class Recall	0.00170906682532
Binary F-score	0.00245008364966
Binary Precision	0.0039232677926
Binary Recall	0.00747624826972

8.3 Country feature set

8.3.1 CTU Dataset

Table 8.49: NeuralNetwork with Country feature set CTU: Experiment 1.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.50: NeuralNetwork with Country feature set CTU: Experiment 2.

Multi-class F-score	0.241018324268
Multi-class Precision	0.261504591305
Multi-class Recall	0.363529887121
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.51: NeuralNetwork with Country feature set CTU: Experiment 3.

Multi-class F-score	0.244035849184
Multi-class Precision	0.232914667847
Multi-class Recall	0.370792608391
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.52: NeuralNetwork with Country feature set CTU: Experiment 4.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.53: NeuralNetwork with Country feature set CTU: Experiment 5.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.54: NeuralNetwork with Country feature set CTU: Experiment 6.

Multi-class F-score	0.241486315609
Multi-class Precision	0.23696994016
Multi-class Recall	0.367437435748
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.55: NeuralNetwork with Country feature set CTU: Experiment 7.

Multi-class F-score	0.243665589538
Multi-class Precision	0.235657994565
Multi-class Recall	0.369902669306
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.56: NeuralNetwork with Country feature set CTU: Experiment 8.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.57: NeuralNetwork with Country feature set CTU: Experiment 9.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.58: NeuralNetwork with Country feature set CTU: Experiment 10.

Multi-class F-score	0.132202800215
Multi-class Precision	0.0854207420012
Multi-class Recall	0.292268270603
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519
False negative	56891
False positive	0
True negative	138628
True positive	0
Positive training samples	25195
Negative training samples	24806

Table 8.59: NeuralNetwork with Country feature set CTU: Average.

Multi-class F-score	0.176342287989
Multi-class Precision	0.147957164588
Multi-class Recall	0.322527222418
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0
Total amount of samples	195519.0
False negative	56891.0
False positive	0.0
True negative	138628.0
True positive	0.0
Positive training samples	25195.0
Negative training samples	24806.0

Table 8.60: NeuralNetwork with Country feature set CTU: Variance.

Multi-class F-score	0.00292313454479
Multi-class Precision	0.00591903301675
Multi-class Recall	0.00137657512147
Binary F-score	0.0
Binary Precision	0.0
Binary Recall	0.0

8.3.2 Cross Dataset

Table 8.61: NeuralNetwork with Country feature set Cross: Experiment 1.

Multi-class F-score	0.125292146392
Multi-class Precision	0.0804104556717
Multi-class Recall	0.283567374131
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.62: NeuralNetwork with Country feature set Cross: Experiment 2.

Multi-class F-score	0.125359129883
Multi-class Precision	0.0804587851397
Multi-class Recall	0.283652578236
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.63: NeuralNetwork with Country feature set Cross: Experiment 3.

Multi-class F-score	0.208589447004
Multi-class Precision	0.165789278349
Multi-class Recall	0.34879720206
Binary F-score	0.650359774815
Binary Precision	0.48902251564
Binary Recall	0.970567234488
Total amount of samples	246467
alse negative	3174
False positive	109364
True negative	29264
True positive	104665
Positive training samples	45195
Negative training samples	24806

Table 8.64: NeuralNetwork with Country feature set Cross: Experiment 4.

Multi-class F-score	0.125308093597
Multi-class Precision	0.0804219613709
Multi-class Recall	0.283587660823
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.65: NeuralNetwork with Country feature set Cross: Experiment 5.

Multi-class F-score	0.125292146392
Multi-class Precision	0.0804104556717
Multi-class Recall	0.283567374131
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.66: NeuralNetwork with Country feature set Cross: Experiment 6.

Multi-class F-score	0.125336800527
Multi-class Precision	0.0804426737038
Multi-class Recall	0.283624176867
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.67: NeuralNetwork with Country feature set Cross: Experiment 7.

Multi-class F-score	0.125330420991
Multi-class Precision	0.0804380707327
Multi-class Recall	0.283616062191
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.68: NeuralNetwork with Country feature set Cross: Experiment 8.

Multi-class F-score	0.222189550677
Multi-class Precision	0.159044649423
Multi-class Recall	0.368491522192
Binary F-score	0.53672959848
Binary Precision	0.447326110616
Binary Recall	0.670796279639
Total amount of samples	246467
False negative	35501
False positive	89374
True negative	49254
True positive	72338
Positive training samples	45195
Negative training samples	24806

Table 8.69: NeuralNetwork with Country feature set Cross: Experiment 9.

Multi-class F-score	0.125301714621
Multi-class Precision	0.0804173589924
Multi-class Recall	0.283579546146
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.70: NeuralNetwork with Country feature set Cross: Experiment 10.

Multi-class F-score	0.125285767728
Multi-class Precision	0.0804058536224
Multi-class Recall	0.283559259455
Binary F-score	0.608733693474
Binary Precision	0.437539305465
Binary Recall	1.0
Total amount of samples	246467
False negative	0
False positive	138628
True negative	0
True positive	107839
Positive training samples	45195
Negative training samples	24806

Table 8.71: NeuralNetwork with Country feature set Cross: Average.

Multi-class F-score	0.143328521781
Multi-class Precision	0.0968239542678
Multi-class Recall	0.298604275623
Binary F-score	0.605695892109
Binary Precision	0.443666306998
Binary Recall	0.964136351413
Total amount of samples	246467.0
False negative	3867.5
False positive	130776.2
True negative	7851.8
True positive	103971.5
Positive training samples	45195.0
Negative training samples	24806.0

Table 8.72: NeuralNetwork with Country feature set Cross: Variance.

Multi-class F-score	0.0013074447207
Multi-class Precision	0.00107788547647
Multi-class Recall	0.000920597079294
Binary F-score	0.000682503797226
Binary Precision	0.000237090100724
Binary Recall	0.00963793642852

Chapter 9

One class Support Vector Machines

9.1 Standard feature set

9.1.1 Cross Dataset

Table 9.1: OneClassSVM: Experiment 1.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0765430205298
Binary Precision	0.0737608867775
Binary Recall	0.0795432552739
Total amount of samples	226467
False negative	80852
False positive	87738
True negative	50890
True positive	6987
Positive training samples	65000
Negative training samples	0

Table 9.2: OneClassSVM: Experiment 2.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0551628688646
Binary Precision	0.0532894736842
Binary Recall	0.0571727820217
Total amount of samples	226467
False negative	82817
False positive	89218
True negative	49410
True positive	5022
Positive training samples	65000
Negative training samples	0

Table 9.3: OneClassSVM: Experiment 3.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0494521962103
Binary Precision	0.0482482265663
Binary Recall	0.0507177905031
Total amount of samples	226467
False negative	83384
False positive	87880
True negative	50748
True positive	4455
Positive training samples	65000
Negative training samples	0

Table 9.4: OneClassSVM: Experiment 4.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0604785842209
Binary Precision	0.0593010787982
Binary Recall	0.0617037989959
Total amount of samples	226467
False negative	82419
False positive	85978
True negative	52650
True positive	5420
Positive training samples	65000
Negative training samples	0

Table 9.5: OneClassSVM: Experiment 5.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0535564672623
Binary Precision	0.0509870113831
Binary Recall	0.056398638418
Total amount of samples	226467
False negative	82885
False positive	92208
True negative	46420
True positive	4954
Positive training samples	65000
Negative training samples	0

Table 9.6: OneClassSVM: Experiment 6.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.35119217522
Binary Precision	0.301646712704
Binary Recall	0.420211978734
Total amount of samples	226467
False negative	50928
False positive	85454
True negative	53174
True positive	36911
Positive training samples	65000
Negative training samples	0

Table 9.7: OneClassSVM: Experiment 7.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0488124831201
Binary Precision	0.0473127470884
Binary Recall	0.0504104099546
Total amount of samples	226467
False negative	83411
False positive	89162
True negative	49466
True positive	4428
Positive training samples	65000
Negative training samples	0

Table 9.8: OneClassSVM: Experiment 8.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0716615229715
Binary Precision	0.0689924032494
Binary Recall	0.0745454752445
Total amount of samples	226467
False negative	81291
False positive	88361
True negative	50267
True positive	6548
Positive training samples	65000
Negative training samples	0

Table 9.9: OneClassSVM: Experiment 9.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.449117180648
Binary Precision	0.367581481347
Binary Recall	0.577135440977
Total amount of samples	226467
False negative	37144
False positive	87220
True negative	51408
True positive	50695
Positive training samples	65000
Negative training samples	0

Table 9.10: OneClassSVM: Experiment 10.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0588795700227
Binary Precision	0.057022783514
Binary Recall	0.0608613486037
Total amount of samples	226467
False negative	82493
False positive	88406
True negative	50222
True positive	5346
Positive training samples	65000
Negative training samples	0

Table 9.11: OneClassSVM: Average.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.127485606907
Binary Precision	0.112814280511
Binary Recall	0.148870091873
Total amount of samples	226467.0
False negative	74762.4
False positive	88162.5
True negative	50465.5
True positive	13076.6
Positive training samples	65000.0
Negative training samples	0.0

Table 9.12: OneClassSVM: Variance.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0191374472492
Binary Precision	0.0125810932492
Binary Recall	0.031899903879

9.2 TCP feature set

9.2.1 Cross Dataset

Table 9.13: OneClassSVM: Experiment 1.

Multi-class F-score	-1.0
Multi-class Precision	-1.0
Multi-class Recall	-1.0
Binary F-score	0.430337370692
Binary Precision	0.30933258933
Binary Recall	0.706838647981
Total amount of samples	226467
False negative	25751.0
False positive	138628.0
True negative	0.0
True positive	62088.0
Positive training samples	65000
Negative training samples	0

Table 9.14: OneClassSVM: Experiment 2.

Multi-class F-score	-1.0
Multi-class Precision	-1.0
Multi-class Recall	-1.0
Binary F-score	0.378835168296
Binary Precision	0.276279176608
Binary Recall	0.602477259532
Total amount of samples	226467
False negative	34918.0
False positive	138628.0
True negative	0.0
True positive	52921.0
Positive training samples	65000
Negative training samples	0

Table 9.15: OneClassSVM: Experiment 3.

Multi-class F-score	-1.0
Multi-class Precision	-1.0
Multi-class Recall	-1.0
Binary F-score	0.436956694286
Binary Precision	0.31351206806
Binary Recall	0.720750463917
Total amount of samples	226467
False negative	24529.0
False positive	138628.0
True negative	0.0
True positive	6331-1.0
Positive training samples	65000
Negative training samples	0

Table 9.16: OneClassSVM: Experiment 4.

Multi-class F-score	-1.0
Multi-class Precision	-1.0
Multi-class Recall	-1.0
Binary F-score	0.38251721281
Binary Precision	0.278674194136
Binary Recall	0.609717779119
Total amount of samples	226467
False negative	34282.0
False positive	138628.0
True negative	0.0
True positive	53557.0
Positive training samples	65000
Negative training samples	0

Table 9.17: OneClassSVM: Experiment 5.

Multi-class F-score	-1.0
Multi-class Precision	-1.0
Multi-class Recall	-1.0
Binary F-score	0.37479816573
Binary Precision	0.273647533468
Binary Recall	0.594576440989
Total amount of samples	226467
False negative	35612.0
False positive	138628.0
True negative	0.0
True positive	52227.0
Positive training samples	65000
Negative training samples	0

Table 9.18: OneClassSVM: Experiment 6.

Multi-class F-score	-1.0
Multi-class Precision	-1.0
Multi-class Recall	-1.0
Binary F-score	0.377261148551
Binary Precision	0.275253819049
Binary Recall	0.599392069582
Total amount of samples	226467
False negative	35189.0
False positive	138628.0
True negative	0.0
True positive	5265-1.0
Positive training samples	65000
Negative training samples	0

Table 9.19: OneClassSVM: Experiment 7.

Multi-class F-score	-1.0
Multi-class Precision	-1.0
Multi-class Recall	-1.0
Binary F-score	0.380226586751
Binary Precision	0.277184822904
Binary Recall	0.605209531074
Total amount of samples	226467
False negative	34678.0
False positive	138628.0
True negative	0.0
True positive	53161.0
Positive training samples	65000
Negative training samples	0

Table 9.20: OneClassSVM: Experiment 8.

Multi-class F-score	-1.0
Multi-class Precision	-1.0
Multi-class Recall	-1.0
Binary F-score	0.382176343472
Binary Precision	0.278452682094
Binary Recall	0.609046095698
Total amount of samples	226467
False negative	34341.0
False positive	138628.0
True negative	0.0
True positive	53498.0
Positive training samples	65000
Negative training samples	0

Table 9.21: OneClassSVM: Experiment 9.

Multi-class F-score	-1.0
Multi-class Precision	-1.0
Multi-class Recall	-1.0
Binary F-score	0.422426404001
Binary Precision	0.304317279657
Binary Recall	0.690365327474
Total amount of samples	226467
False negative	27198.0
False positive	138628.0
True negative	0.0
True positive	60641.0
Positive training samples	65000
Negative training samples	0

Table 9.22: OneClassSVM: Experiment 10.

Multi-class F-score	-1.0
Multi-class Precision	-1.0
Multi-class Recall	-1.0
Binary F-score	0.365868002064
Binary Precision	0.26780470285
Binary Recall	0.57723790116
Total amount of samples	226467
False negative	37135.0
False positive	138628.0
True negative	0.0
True positive	50704.0
Positive training samples	65000
Negative training samples	0

Table 9.23: OneClassSVM: Average.

Multi-class F-score	-1.0
Multi-class Precision	-1.0
Multi-class Recall	-1.0
Binary F-score	0.393140309665
Binary Precision	0.285445886816
Binary Recall	0.631561151652
Total amount of samples	226467
False negative	30912.0
False positive	138628.0
True negative	0.0
True positive	56927.0
Positive training samples	6500
Negative training samples	0.0

Table 9.24: OneClassSVM: Variance.

Multi-class F-score	-1.0
Multi-class Precision	-1.0
Multi-class Recall	-1.0
Binary F-score	0.0006
Binary Precision	0.0002
Binary Recall	0.0024

9.3 Country feature set

9.3.1 Cross Dataset

Table 9.25: OneClassSVM: Experiment 1.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0565320452614
Binary Precision	0.055540298573
Binary Recall	0.0575598538235
Total amount of samples	226467
False negative	82783
False positive	85977
True negative	52651
True positive	5056
Positive training samples	65000
Negative training samples	0

Table 9.26: OneClassSVM: Experiment 2.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.349199994281
Binary Precision	0.300339422162
Binary Recall	0.417047097531
Total amount of samples	226467
False negative	51206
False positive	85339
True negative	53289
True positive	36633
Positive training samples	65000
Negative training samples	0

Table 9.27: OneClassSVM: Experiment 3.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.127975137974
Binary Precision	0.120881456813
Binary Recall	0.135953278157
Total amount of samples	226467
False negative	75897
False positive	86849
True negative	51779
True positive	11942
Positive training samples	65000
Negative training samples	0

Table 9.28: OneClassSVM: Experiment 4.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0635439797849
Binary Precision	0.061150586873
Binary Recall	0.0661323557873
Total amount of samples	226467
False negative	82030
False positive	89186
True negative	49442
True positive	5809
Positive training samples	65000
Negative training samples	0

Table 9.29: OneClassSVM: Experiment 5.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0578720682068
Binary Precision	0.0561224489796
Binary Recall	0.0597342865925
Total amount of samples	226467
False negative	82592
False positive	88245
True negative	50383
True positive	5247
Positive training samples	65000
Negative training samples	0

Table 9.30: OneClassSVM: Experiment 6.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0507543820723
Binary Precision	0.0494910267089
Binary Recall	0.0520839262742
Total amount of samples	226467
False negative	83264
False positive	87866
True negative	50762
True positive	4575
Positive training samples	65000
Negative training samples	0

Table 9.31: OneClassSVM: Experiment 7.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0805607682967
Binary Precision	0.0781864346857
Binary Recall	0.083083823814
Total amount of samples	226467
False negative	80541
False positive	86043
True negative	52585
True positive	7298
Positive training samples	65000
Negative training samples	0

Table 9.32: OneClassSVM: Experiment 8.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.351814425899
Binary Precision	0.300083579787
Binary Recall	0.425095914116
Total amount of samples	226467
False negative	50499
False positive	87092
True negative	51536
True positive	37340
Positive training samples	65000
Negative training samples	0

Table 9.33: OneClassSVM: Experiment 9.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0645550726546
Binary Precision	0.0623139427712
Binary Recall	0.0669634217147
Total amount of samples	226467
False negative	81957
False positive	88511
True negative	50117
True positive	5882
Positive training samples	65000
Negative training samples	0

Table 9.34: OneClassSVM: Experiment 10.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.354553090058
Binary Precision	0.30157247765
Binary Recall	0.430116463074
Total amount of samples	226467
False negative	50058
False positive	87499
True negative	51129
True positive	37781
Positive training samples	65000
Negative training samples	0

Table 9.35: OneClassSVM: Average.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.155736096449
Binary Precision	0.1385681675
Binary Recall	0.179377042088
Total amount of samples	226467.0
False negative	72082.7
False positive	87260.7
True negative	51367.3
True positive	15756.3
Positive training samples	65000.0
Negative training samples	0.0

Table 9.36: OneClassSVM: Variance.

Multi-class F-score	0.0
Multi-class Precision	0.0
Multi-class Recall	0.0
Binary F-score	0.0169078526394
Binary Precision	0.0116220194873
Binary Recall	0.0261711618374