```
longest string: 46
string:  hsp22k57g23m69d20j46h44e61gzhwh54a17krb68b18ru
Labels to idx:
{'qakbot': 0, 'tinba': 1, 'nymaim': 2, 'vawtrak_v3': 3, 'dircrypt': 4, 'fobber_v2': 5, 'pykspa': 6, 'zeus-newgoz': 7, 'locky': 8, 'go
Domain Name:
 00000000000000000000000000000trailer-defensecom
second Domain Name:
 00000000000000000000000000000trailer-defensecom
Class Label encoded:
2
Domain Bigram Name:
 ['00', '00', '00', '00', '00', '00', '00', '00', '00', '00', '00', '00', '00', '00', '00', '00', '00', '00', '00', '00', '00', '00',
Domain Char Name:
 ['0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '0', '
Class Label encoded:
2
Char Vocabulary len: 37
Bigram Vocabulary len: 1344
A Dataset Domain:
 Char encode:
[31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 31, 19, 14, 34, 32, 12,
 Bigram encode:
[845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 845, 84
 Label:
2
dataset len: 50898

Fold 1/5
epoch 1 / 6, step 300/1358, loss = 1.5714
epoch 1 / 6, step 600/1358, loss = 0.6681
epoch 1 / 6, step 900/1358, loss = 1.0829
epoch 1 / 6, step 1200/1358, loss = 0.6036
Epoch 1/6:
Train Accuracy: 0.6935
Train Precision: 0.6905
Train Recall: 0.6935
Train F1 Score: 0.6908
Epoch 1/6:
Accuracy: 0.7593
Precision: 0.8016
Recall: 0.7593
F1 Score: 0.7461
=================================================
epoch 2 / 6, step 300/1358, loss = 0.9809
epoch 2 / 6, step 600/1358, loss = 0.6435
epoch 2 / 6, step 900/1358, loss = 0.4787
epoch 2 / 6, step 1200/1358, loss = 0.5786
Epoch 2/6:
Train Accuracy: 0.7997
Train Precision: 0.7989
Train Recall: 0.7997
Train F1 Score: 0.7983
Epoch 2/6:
Accuracy: 0.7999
Precision: 0.8141
Recall: 0.7999
F1 Score: 0.7915
=================================================
epoch 3 / 6, step 300/1358, loss = 0.8595
epoch 3 / 6, step 600/1358, loss = 0.2635
epoch 3 / 6, step 900/1358, loss = 0.4943
epoch 3 / 6, step 1200/1358, loss = 0.6103
Epoch 3/6:
Train Accuracy: 0.8287
Train Precision: 0.8284
Train Recall: 0.8287
Train F1 Score: 0.8277
Epoch 3/6:
Accuracy: 0.7969
Precision: 0.7985
Recall: 0.7969
F1 Score: 0.7883
=================================================
epoch 4 / 6, step 300/1358, loss = 0.1365
epoch 4 / 6, step 600/1358, loss = 0.3866
epoch 4 / 6, step 900/1358, loss = 0.1239
epoch 4 / 6, step 1200/1358, loss = 0.3072
Epoch 4/6:
Train Accuracy: 0.8522
Train Precision: 0.8521
Train Recall: 0.8522
Train F1 Score: 0.8515
Epoch 4/6:
Accuracy: 0.8026
Precision: 0.8108
Recall: 0.8026
```

```
F1 Score: 0.8002
=================================================
epoch 5 / 6, step 300/1358, loss = 0.2006
epoch 5 / 6, step 600/1358, loss = 0.2882
epoch 5 / 6, step 900/1358, loss = 0.2005
epoch 5 / 6, step 1200/1358, loss = 0.4436
Epoch 5/6:
Train Accuracy: 0.8751
Train Precision: 0.8753
Train Recall: 0.8751
Train F1 Score: 0.8748
Epoch 5/6:
Accuracy: 0.7955
Precision: 0.8092
Recall: 0.7955
F1 Score: 0.7981
=================================================
epoch 6 / 6, step 300/1358, loss = 0.1976
epoch 6 / 6, step 600/1358, loss = 0.0983
epoch 6 / 6, step 900/1358, loss = 0.2351
epoch 6 / 6, step 1200/1358, loss = 0.4932
Epoch 6/6:
Train Accuracy: 0.8910
Train Precision: 0.8907
Train Recall: 0.8910
Train F1 Score: 0.8906
Epoch 6/6:
Accuracy: 0.8015
Precision: 0.8054
Recall: 0.8015
F1 Score: 0.7988
=================================================

Fold 2/5
epoch 1 / 6, step 300/1358, loss = 0.8632
epoch 1 / 6, step 600/1358, loss = 0.8473
epoch 1 / 6, step 900/1358, loss = 0.9993
epoch 1 / 6, step 1200/1358, loss = 0.6316
Epoch 1/6:
Train Accuracy: 0.6911
Train Precision: 0.6874
Train Recall: 0.6911
Train F1 Score: 0.6881
Epoch 1/6:
Accuracy: 0.7785
Precision: 0.7808
Recall: 0.7785
F1 Score: 0.7694
=================================================
epoch 2 / 6, step 300/1358, loss = 0.5493
epoch 2 / 6, step 600/1358, loss = 0.5886
epoch 2 / 6, step 900/1358, loss = 0.5567
epoch 2 / 6, step 1200/1358, loss = 0.3498
Epoch 2/6:
Train Accuracy: 0.7993
Train Precision: 0.7988
Train Recall: 0.7993
Train F1 Score: 0.7979
Epoch 2/6:
Accuracy: 0.7969
Precision: 0.8016
Recall: 0.7969
F1 Score: 0.7870
=================================================
epoch 3 / 6, step 300/1358, loss = 0.4348
epoch 3 / 6, step 600/1358, loss = 0.6905
epoch 3 / 6, step 900/1358, loss = 0.4799
epoch 3 / 6, step 1200/1358, loss = 0.2919
Epoch 3/6:
Train Accuracy: 0.8281
Train Precision: 0.8279
Train Recall: 0.8281
Train F1 Score: 0.8273
Epoch 3/6:
Accuracy: 0.8112
Precision: 0.8157
Recall: 0.8112
F1 Score: 0.8052
=================================================
epoch 4 / 6, step 300/1358, loss = 0.3674
epoch 4 / 6, step 600/1358, loss = 0.2661
epoch 4 / 6, step 900/1358, loss = 0.3510
epoch 4 / 6, step 1200/1358, loss = 0.5653
Epoch 4/6:
Train Accuracy: 0.8549
Train Precision: 0.8547
```

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Train Recall: 0.8549
Train F1 Score: 0.8541
Epoch 4/6:
Accuracy: 0.7984
Precision: 0.8048
Recall: 0.7984
F1 Score: 0.7943
==================================================
epoch 5 / 6, step 300/1358, loss = 0.2288
epoch 5 / 6, step 600/1358, loss = 0.3460
epoch 5 / 6, step 900/1358, loss = 0.2859
epoch 5 / 6, step 1200/1358, loss = 0.5325
Epoch 5/6:
Train Accuracy: 0.8736
Train Precision: 0.8736
Train Recall: 0.8736
Train F1 Score: 0.8732
Epoch 5/6:
Accuracy: 0.8071
Precision: 0.8095
Recall: 0.8071
F1 Score: 0.8035
==================================================
epoch 6 / 6, step 300/1358, loss = 0.3408
epoch 6 / 6, step 600/1358, loss = 0.2342
epoch 6 / 6, step 900/1358, loss = 0.5507
epoch 6 / 6, step 1200/1358, loss = 0.1918
Epoch 6/6:
Train Accuracy: 0.8910
Train Precision: 0.8909
Train Recall: 0.8910
Train F1 Score: 0.8907
Epoch 6/6:
Accuracy: 0.7995
Precision: 0.8005
Recall: 0.7995
F1 Score: 0.7958
==================================================

Fold 3/5
epoch 1 / 6, step 300/1358, loss = 0.9127
epoch 1 / 6, step 600/1358, loss = 1.1152
epoch 1 / 6, step 900/1358, loss = 0.5760
epoch 1 / 6, step 1200/1358, loss = 0.7633
Epoch 1/6:
Train Accuracy: 0.6903
Train Precision: 0.6870
Train Recall: 0.6903
Train F1 Score: 0.6876
Epoch 1/6:
Accuracy: 0.7627
Precision: 0.7892
Recall: 0.7627
F1 Score: 0.7600
==================================================
epoch 2 / 6, step 300/1358, loss = 0.2916
epoch 2 / 6, step 600/1358, loss = 0.4572
epoch 2 / 6, step 900/1358, loss = 0.7481
epoch 2 / 6, step 1200/1358, loss = 1.3091
Epoch 2/6:
Train Accuracy: 0.7977
Train Precision: 0.7967
Train Recall: 0.7977
Train F1 Score: 0.7962
Epoch 2/6:
Accuracy: 0.7996
Precision: 0.8097
Recall: 0.7996
F1 Score: 0.7941
==================================================
epoch 3 / 6, step 300/1358, loss = 0.4438
epoch 3 / 6, step 600/1358, loss = 0.4745
epoch 3 / 6, step 900/1358, loss = 0.7962
epoch 3 / 6, step 1200/1358, loss = 0.4596
Epoch 3/6:
Train Accuracy: 0.8266
Train Precision: 0.8257
Train Recall: 0.8266
Train F1 Score: 0.8253
Epoch 3/6:
Accuracy: 0.7970
Precision: 0.8056
Recall: 0.7970
F1 Score: 0.7945
==================================================
epoch 4 / 6, step 300/1358, loss = 0.0849
```

```
epoch 4 / 6, step 600/1358, loss = 0.3092
epoch 4 / 6, step 900/1358, loss = 0.3500
epoch 4 / 6, step 1200/1358, loss = 0.5080
Epoch 4/6:
Train Accuracy: 0.8523
Train Precision: 0.8522
Train Recall: 0.8523
Train F1 Score: 0.8517
Epoch 4/6:
Accuracy: 0.7927
Precision: 0.7924
Recall: 0.7927
F1 Score: 0.7827
==================================================
epoch 5 / 6, step 300/1358, loss = 0.1670
epoch 5 / 6, step 600/1358, loss = 0.5906
epoch 5 / 6, step 900/1358, loss = 0.3056
epoch 5 / 6, step 1200/1358, loss = 0.5715
Epoch 5/6:
Train Accuracy: 0.8738
Train Precision: 0.8738
Train Recall: 0.8738
Train F1 Score: 0.8734
Epoch 5/6:
Accuracy: 0.7954
Precision: 0.8019
Recall: 0.7954
F1 Score: 0.7892
==================================================
epoch 6 / 6, step 300/1358, loss = 0.2526
epoch 6 / 6, step 600/1358, loss = 0.3576
epoch 6 / 6, step 900/1358, loss = 0.2409
epoch 6 / 6, step 1200/1358, loss = 0.1433
Epoch 6/6:
Train Accuracy: 0.8927
Train Precision: 0.8926
Train Recall: 0.8927
Train F1 Score: 0.8923
Epoch 6/6:
Accuracy: 0.7916
Precision: 0.7981
Recall: 0.7916
F1 Score: 0.7869
==================================================

Fold 4/5
epoch 1 / 6, step 300/1358, loss = 1.4181
epoch 1 / 6, step 600/1358, loss = 0.7796
epoch 1 / 6, step 900/1358, loss = 0.8612
epoch 1 / 6, step 1200/1358, loss = 0.8851
Epoch 1/6:
Train Accuracy: 0.6884
Train Precision: 0.6845
Train Recall: 0.6884
Train F1 Score: 0.6852
Epoch 1/6:
Accuracy: 0.7888
Precision: 0.8005
Recall: 0.7888
F1 Score: 0.7818
==================================================
epoch 2 / 6, step 300/1358, loss = 0.3224
epoch 2 / 6, step 600/1358, loss = 0.5575
epoch 2 / 6, step 900/1358, loss = 0.7326
epoch 2 / 6, step 1200/1358, loss = 0.7662
Epoch 2/6:
Train Accuracy: 0.8023
Train Precision: 0.8014
Train Recall: 0.8023
Train F1 Score: 0.8008
Epoch 2/6:
Accuracy: 0.7859
Precision: 0.7957
Recall: 0.7859
F1 Score: 0.7769
==================================================
epoch 3 / 6, step 300/1358, loss = 0.5319
epoch 3 / 6, step 600/1358, loss = 0.4974
epoch 3 / 6, step 900/1358, loss = 0.6769
epoch 3 / 6, step 1200/1358, loss = 0.6719
Epoch 3/6:
Train Accuracy: 0.8317
Train Precision: 0.8314
Train Recall: 0.8317
Train F1 Score: 0.8306
Epoch 3/6:
```

```
Accuracy: 0.8054
Precision: 0.8173
Recall: 0.8054
F1 Score: 0.8048
=================================================
epoch 4 / 6, step 300/1358, loss = 0.5027
epoch 4 / 6, step 600/1358, loss = 0.6488
epoch 4 / 6, step 900/1358, loss = 0.1585
epoch 4 / 6, step 1200/1358, loss = 0.5723
Epoch 4/6:
Train Accuracy: 0.8546
Train Precision: 0.8546
Train Recall: 0.8546
Train F1 Score: 0.8540
Epoch 4/6:
Accuracy: 0.7970
Precision: 0.8030
Recall: 0.7970
F1 Score: 0.7879
=================================================
epoch 5 / 6, step 300/1358, loss = 0.5067
epoch 5 / 6, step 600/1358, loss = 0.2097
epoch 5 / 6, step 900/1358, loss = 0.3782
epoch 5 / 6, step 1200/1358, loss = 0.1492
Epoch 5/6:
Train Accuracy: 0.8757
Train Precision: 0.8759
Train Recall: 0.8757
Train F1 Score: 0.8754
Epoch 5/6:
Accuracy: 0.7886
Precision: 0.7946
Recall: 0.7886
F1 Score: 0.7832
=================================================
epoch 6 / 6, step 300/1358, loss = 0.2365
epoch 6 / 6, step 600/1358, loss = 0.5967
epoch 6 / 6, step 900/1358, loss = 0.2248
epoch 6 / 6, step 1200/1358, loss = 0.6781
Epoch 6/6:
Train Accuracy: 0.8934
Train Precision: 0.8933
Train Recall: 0.8934
Train F1 Score: 0.8931
Epoch 6/6:
Accuracy: 0.7868
Precision: 0.7903
Recall: 0.7868
F1 Score: 0.7794
=================================================

Fold 5/5
epoch 1 / 6, step 300/1358, loss = 1.2827
epoch 1 / 6, step 600/1358, loss = 0.9534
epoch 1 / 6, step 900/1358, loss = 0.8200
epoch 1 / 6, step 1200/1358, loss = 0.8149
Epoch 1/6:
Train Accuracy: 0.6858
Train Precision: 0.6821
Train Recall: 0.6858
Train F1 Score: 0.6826
Epoch 1/6:
Accuracy: 0.7755
Precision: 0.7887
Recall: 0.7755
F1 Score: 0.7711
=================================================
epoch 2 / 6, step 300/1358, loss = 0.5216
epoch 2 / 6, step 600/1358, loss = 0.3350
epoch 2 / 6, step 900/1358, loss = 0.5238
epoch 2 / 6, step 1200/1358, loss = 0.4831
Epoch 2/6:
Train Accuracy: 0.7972
Train Precision: 0.7958
Train Recall: 0.7972
Train F1 Score: 0.7954
Epoch 2/6:
Accuracy: 0.8011
Precision: 0.8109
Recall: 0.8011
F1 Score: 0.7955
=================================================
epoch 3 / 6, step 300/1358, loss = 0.5312
epoch 3 / 6, step 600/1358, loss = 0.5875
epoch 3 / 6, step 900/1358, loss = 0.1729
epoch 3 / 6, step 1200/1358, loss = 0.3023
```
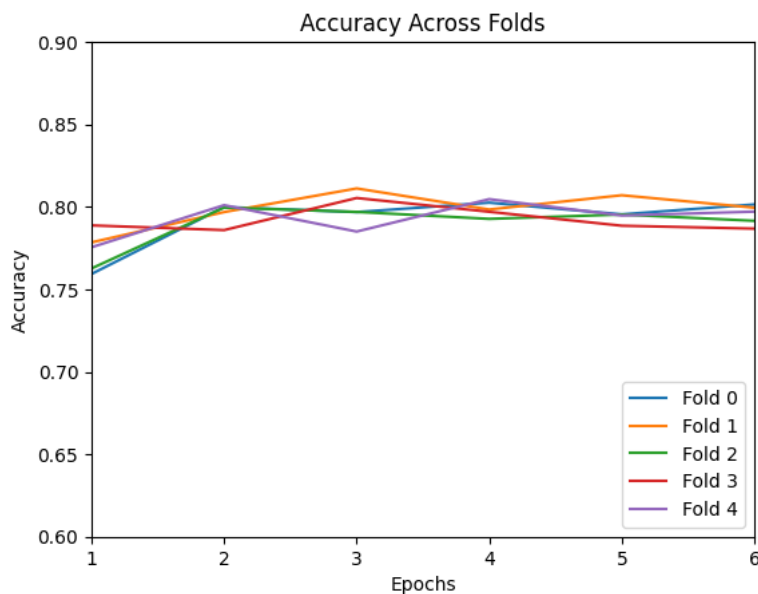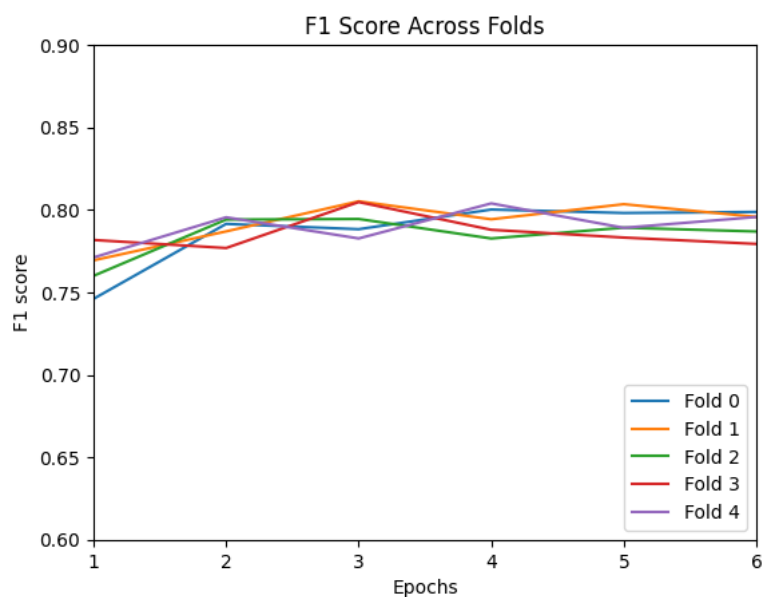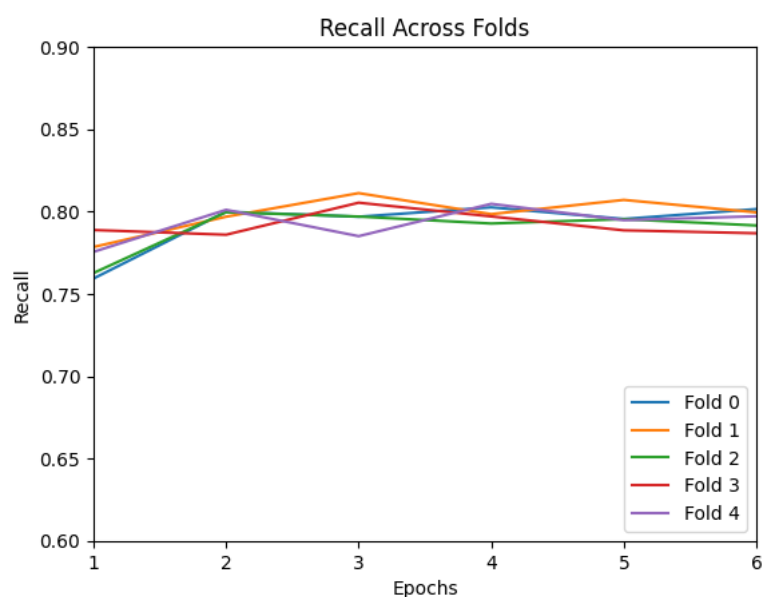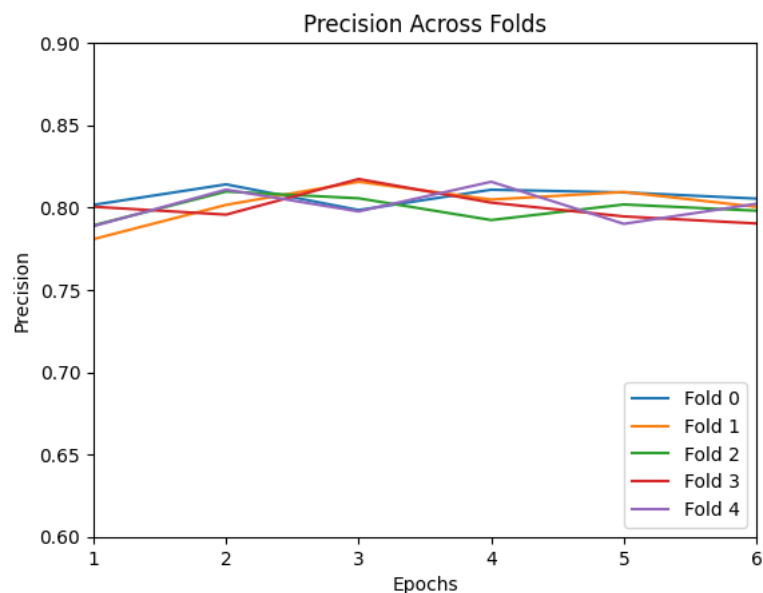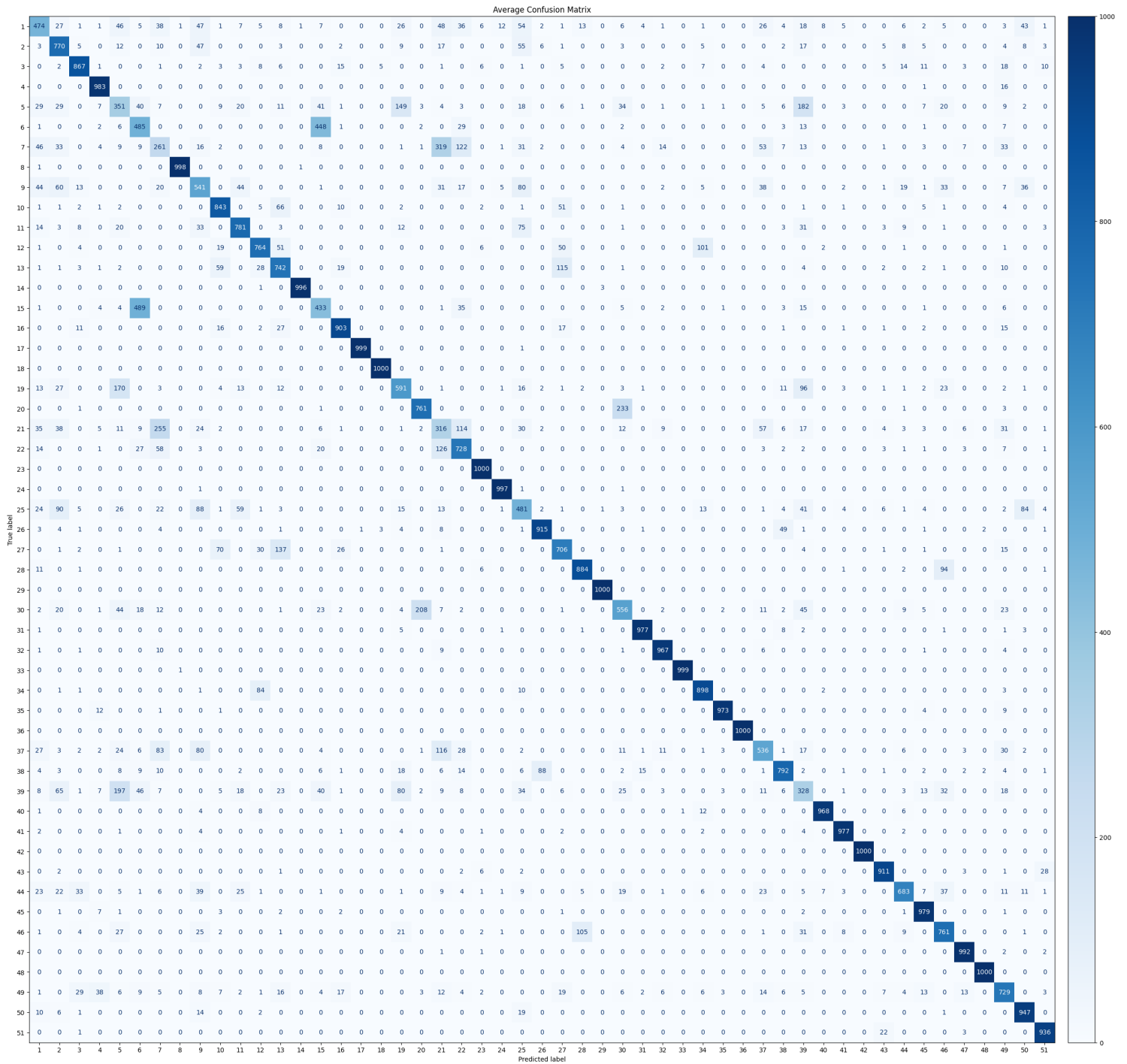
```
Epoch 3/6:
Train Accuracy: 0.8274
Train Precision: 0.8266
Train Recall: 0.8274
Train F1 Score: 0.8262
Epoch 3/6:
Accuracy: 0.7850
Precision: 0.7976
Recall: 0.7850
F1 Score: 0.7827
================================================
epoch 4 / 6, step 300/1358, loss = 0.4049
epoch 4 / 6, step 600/1358, loss = 0.2016
epoch 4 / 6, step 900/1358, loss = 0.5861
epoch 4 / 6, step 1200/1358, loss = 0.3899
Epoch 4/6:
Train Accuracy: 0.8510
Train Precision: 0.8509
Train Recall: 0.8510
Train F1 Score: 0.8503
Epoch 4/6:
Accuracy: 0.8047
Precision: 0.8157
Recall: 0.8047
F1 Score: 0.8039
================================================
epoch 5 / 6, step 300/1358, loss = 0.2673
epoch 5 / 6, step 600/1358, loss = 0.1950
epoch 5 / 6, step 900/1358, loss = 0.4260
epoch 5 / 6, step 1200/1358, loss = 0.0893
Epoch 5/6:
Train Accuracy: 0.8766
Train Precision: 0.8765
Train Recall: 0.8766
Train F1 Score: 0.8761
Epoch 5/6:
Accuracy: 0.7948
Precision: 0.7901
Recall: 0.7948
F1 Score: 0.7891
================================================
epoch 6 / 6, step 300/1358, loss = 0.2665
epoch 6 / 6, step 600/1358, loss = 0.0712
epoch 6 / 6, step 900/1358, loss = 0.2732
epoch 6 / 6, step 1200/1358, loss = 0.3990
Epoch 6/6:
Train Accuracy: 0.8928
Train Precision: 0.8927
Train Recall: 0.8928
Train F1 Score: 0.8925
Epoch 6/6:
Accuracy: 0.7971
Precision: 0.8023
Recall: 0.7971
F1 Score: 0.7957
================================================
```


Accuracy Across Folds

Precision Across Folds

Recall Across Folds

F1 Score Across Folds

Average Confusion Matrix


```
Classification report:
                 precision    recall  f1-score   support

       qakbot         0.59      0.47      0.53      1000
        tinba         0.64      0.77      0.70      1000
       nymaim         0.87      0.87      0.87      1000
   vawtrak_v3         0.91      0.98      0.95      1000
      dircrypt        0.36      0.35      0.36      1000
     fobber_v2        0.42      0.48      0.45      1000
       pykspa         0.32      0.26      0.29      1000
   zeus-newgoz        1.00      1.00      1.00      1000
        locky         0.55      0.54      0.55      1000
   gozi_luther        0.81      0.84      0.82      1000
    ranbyus_v1        0.80      0.78      0.79      1000
       rovnix         0.81      0.76      0.79      1000
    gozi_nasa         0.67      0.75      0.70       991
      corebot         1.00      1.00      1.00      1000
      alureon        0.42      0.43      0.42      1000
       matsnu        0.90      0.91      0.90       996
       sisron        1.00      1.00      1.00      1000
   vawtrak_v1        0.99      1.00      1.00      1000
        bedep        0.63      0.59      0.61      1000
    kraken_v1        0.77      0.76      0.77      1000
```

pykspa_noise	0.30	0.32	0.31	1000
tempedreve	0.64	0.73	0.68	1000
suppobox_3	0.96	1.00	0.98	1000
ramdo	0.98	1.00	0.99	1000
cryptolocker	0.52	0.48	0.50	1000
qadars	0.90	0.92	0.91	1000
gozi_rfc4343	0.72	0.71	0.71	995
fobber_v1	0.87	0.88	0.88	1000
symmi	1.00	1.00	1.00	1000
kraken_v2	0.60	0.56	0.58	1000
chinad	0.98	0.98	0.98	1000
simda	0.95	0.97	0.96	1000
murofet_v3	1.00	1.00	1.00	1000
gozi_gpl	0.85	0.90	0.87	1000
vawtrak_v2	0.99	0.97	0.98	1000
banjori	1.00	1.00	1.00	1000
proslikefan	0.68	0.54	0.60	1000
shiotob	0.86	0.79	0.83	1000
ramnit	0.37	0.33	0.35	1000
murofet_v1	0.98	0.97	0.97	1000
padcrypt	0.97	0.98	0.97	1000
dyre	1.00	1.00	1.00	1000
pizd	0.94	0.95	0.94	956
necurs	0.87	0.68	0.76	1000
pushdo	0.91	0.98	0.94	1000
ranbyus_v2	0.75	0.76	0.76	1000
suppobox_2	0.96	0.99	0.98	998
ccleaner	1.00	1.00	1.00	1000
legit	0.71	0.73	0.72	1000
murofet_v2	0.83	0.95	0.89	1000
suppobox_1	0.94	0.97	0.96	962
accuracy			0.80	50898
macro avg	0.79	0.80	0.79	50898
weighted avg	0.79	0.80	0.79	50898