Intrusion Detection System with deep learning

In [2]:

```
#Import neccessary packages
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

In [ ]:

```
monday_data = pd.read_csv("/content/drive/MyDrive/engEdosa/Dataset/Monday-   r
tuesday_data = pd.read_csv("/content/drive/MyDrive/engEdosa/Dataset/Tuesday-W
wednesday_data = pd.read_csv("/content/drive/MyDrive/engEdosa/Dataset/Wednesd
thursday_data_1 = pd.read_csv("/content/drive/MyDrive/engEdosa/Dataset/Thursd
thursday_data_2 = pd.read_csv("/content/drive/MyDrive/engEdosa/Dataset/Thursd
friday_data_1 = pd.read_csv("/content/drive/MyDrive/engEdosa/Dataset/Friday-W
friday_data_2 = pd.read_csv("/content/drive/MyDrive/engEdosa/Dataset/Friday-W
friday_data_3 = pd.read_csv("/content/drive/MyDrive/engEdosa/Dataset/Friday-W
```

In [ ]:

```
# wednesday_data.columns
```

In [ ]:

```
thursday_data_1.shape
```

Out[ ]:

```
(170366, 79)
```

In [ ]:

```
data_details = {
    "monday_details":monday_data[' Label'].value_counts(),
     "tuesday_details":tuesday_data[' Label'].value_counts(),
      "wednesday_details":wednesday_data[' Label'].value_counts(),
       "thursday_details_1":thursday_data_1[' Label'].value_counts(),
       "thursday_details_2":thursday_data_2[' Label'].value_counts(),
       "friday_details_1":friday_data_1[' Label'].value_counts(),
       "friday_details_2":friday_data_2[' Label'].value_counts(),
       "friday_details_3":friday_data_3[' Label'].value_counts()
}
```

In [ ]:

```
data_details
```

Out[ ]:

```
{'friday_details_1': DDoS      128027
 BENIGN     97718
 Name:  Label, dtype: int64, 'friday_details_2': PortScan    158930
 BENIGN      127537
 Name:  Label, dtype: int64, 'friday_details_3': BENIGN    189067
 Bot         1966
 Name:  Label, dtype: int64, 'monday_details': BENIGN    529918
 Name:  Label, dtype: int64, 'thursday_details_1': BENIGN
168186
 Web Attack � Brute Force       1507
 Web Attack � XSS                652
 Web Attack � Sql Injection       21
 Name:  Label, dtype: int64, 'thursday_details_2': BENIGN          288566
 Infiltration        36
 Name:  Label, dtype: int64, 'tuesday_details': BENIGN         432074
 FTP-Patator      7938
 SSH-Patator      5897
 Name:  Label, dtype: int64, 'wednesday_details': BENIGN              440031
 DoS Hulk            231073
 DoS GoldenEye        10293
 DoS slowloris         5796
 DoS Slowhttptest      5499
 Heartbleed              11
 Name:  Label, dtype: int64}
```

In [ ]:

```
frames = [wednesday_data, friday_data_1, friday_data_2]
```

In [ ]:

```
data = pd.concat(frames)
```

In [ ]:

```
data.shape
```

Out[ ]:

```
(1204915, 79)
```

In [ ]:

```
#data.describe()
```

In [ ]:

```
data[' Label'].value_counts()
```

Out[ ]:

```
BENIGN              665286
DoS Hulk            231073
PortScan            158930
DDoS                128027
DoS GoldenEye        10293
DoS slowloris         5796
DoS Slowhttptest      5499
Heartbleed              11
Name:  Label, dtype: int64
```

In [ ]:

```
#data.sample(10)
```

In [ ]:

```
# # Getting a sense of what the distribution of each column looks like
# fig = plt.figure(figsize=(15,10))

# ax1 = fig.add_subplot(221)
# data[' Label'].value_counts().plot(kind='bar', ax=ax1)
# ax1.set_ylabel('Count')
# ax1.set_title('Label');

# plt.tight_layout()
# plt.show()
```

In [ ]:

```
# data.isna().sum()
```

In [ ]:

```
np.isinf(data[" Flow Duration"]).sum()
```

Out[ ]:

```
0
```

In [ ]:

```
max_flow_bytes = data.loc[data['Flow Bytes/s'] != np.inf, 'Flow Bytes/s']
max_flow_pkts = data.loc[data[' Flow Packets/s'] != np.inf, ' Flow Packets/s'

print(max_flow_bytes, max_flow_pkts)
```

```
2070000000.0 3000000.0
```

In [ ]:

```

```

In [ ]:

```python
data['Flow Bytes/s'].replace(np.inf,max_flow_bytes+1,inplace=True)
data[' Flow Packets/s'].replace(np.inf,max_flow_pkts+1,inplace=True)
```

In [ ]:

```python
data[' Label'].value_counts()
#data[['Date','Time']] = data['Timestamp'].str.split(expand=True)
```

Out[ ]:

```
BENIGN              665286
DoS Hulk            231073
PortScan            158930
DDoS                128027
DoS GoldenEye        10293
DoS slowloris         5796
DoS Slowhttptest      5499
Heartbleed              11
Name:  Label, dtype: int64
```

In [ ]:

```

```

In [ ]:

```python
Mal = {'BENIGN':0, 'FTP-Patator':1, 'SSH-Patator':1, 'DoS slowloris':1,
       'DoS Slowhttptest':1, 'DoS Hulk':1, 'DoS GoldenEye':1, 'Heartbleed':1,
       'Web Attack � Brute Force':1, 'Web Attack � XSS':1,
       'Web Attack � Sql Injection':1, 'Infiltration':1, 'DDoS':1, 'PortScan'
       'Bot':1}
data[' Label'] = [Mal[item] for item in data[' Label']]
```

In [ ]:

```python
# # Getting a sense of what the distribution of each column looks like
# fig = plt.figure(figsize=(15,10))

# ax1 = fig.add_subplot(221)
# data[' Label'].value_counts().plot(kind='bar', ax=ax1)
# ax1.set_ylabel('Count')
# ax1.set_title('Label');

# plt.tight_layout()
# plt.show()
```

In [ ]:

```python
data.shape
```

Out[ ]:

```
(1204915, 79)
```

In [ ]:

```python
data.columns = data.columns.str.strip()
df = data.drop(columns=["Fwd Header Length.1"])
df.shape
```

Out[ ]:

```
(1204915, 78)
```

In [ ]:

```python
df['Label'].value_counts()
```

Out[ ]:

```
0    665286
1    539629
```

```
Name: Label, dtype: int64
```

In [ ]:

```
df.replace('Infinity', -1, inplace=True)
df[["Flow Bytes/s", "Flow Packets/s"]] = df[["Flow Bytes/s", "Flow Packets/s'
```

In [ ]:

```
df.replace([np.nan], -1, inplace=True)
```

In [ ]:

```
# df.describe()
```

In [ ]:

```
# df.to_csv("/content/drive/MyDrive/engEdosa/Dataset/web_attacks_unbalanc   c
# df['Label'].value_counts()
```

In [ ]:

```
benign_total = len(df[df['Label'] == 0])
attack_total = len(df[df['Label'] != 0])
attack_total
```

Out[ ]:

```
539629
```

In [ ]:

```
df.tail()
```

Out[ ]:

	Destination Port	Flow Duration	Total Fwd Packets	Total Backward Packets	Total Length of Fwd Packets	Total Length of Bwd Packets	Fwd Packet Length Max	Fwd Packet Length Min	Fwd Packet Length Mean
191022	80	101773597	6	6	349	11595	349	0	58.16666
191022	593	51	2	2	4	12	2	2	2.00000
191022	80	5323866	5	0	30	0	6	6	6.00000
191022	49159	52	1	1	0	6	0	0	0.00000
191022	8080	997161	3	3	0	18	0	0	0.00000

In [ ]:

```
df.to_csv("/content/drive/MyDrive/engEdosa/Dataset/web_attacks_balanced.c   ,
```

In [4]:

```
df = pd.read_csv("/content/drive/MyDrive/engEdosa/Dataset/web_attacks_bal   e
```

7 features (Flow ID, Source IP, Source Port, Destination IP, Destination Port, Protocol, Timestamp) are excluded from the dataset. The hypothesis is that the "shape" of the data being transmitted is more important than these attributes. In addition, ports and addresses can be substituted by an attacker, so it is better that the ML algorithm does not take these features into account in training [Kostas2018].

In [5]:

```
excluded = ['Flow ID', 'Source IP', 'Source Port', 'Destination IP', 'Des   a
df = df.drop(columns=excluded, errors='ignore')
```

In [ ]:

```
df.columns
```

Out[ ]:

```
Index(['Flow Duration', 'Total Fwd Packets', 'Total Backward Packets',
       'Total Length of Fwd Packets', 'Total Length of Bwd Packets',
       'Fwd Packet Length Max', 'Fwd Packet Length Min',
       'Fwd Packet Length Mean', 'Fwd Packet Length Std',
       'Bwd Packet Length Max', 'Bwd Packet Length Min',
       'Bwd Packet Length Mean', 'Bwd Packet Length Std', 'Flow Bytes/s',
       'Flow Packets/s', 'Flow IAT Mean', 'Flow IAT Std', 'Flow IAT Max',
       'Flow IAT Min', 'Fwd IAT Total', 'Fwd IAT Mean', 'Fwd IAT Std',
       'Fwd IAT Max', 'Fwd IAT Min', 'Bwd IAT Total', 'Bwd IAT Mean',
       'Bwd IAT Std', 'Bwd IAT Max', 'Bwd IAT Min', 'Fwd PSH Flags',
       'Bwd PSH Flags', 'Fwd URG Flags', 'Bwd URG Flags', 'Fwd Header Lengt
h',
       'Bwd Header Length', 'Fwd Packets/s', 'Bwd Packets/s',
       'Min Packet Length', 'Max Packet Length', 'Packet Length Mean',
       'Packet Length Std', 'Packet Length Variance', 'FIN Flag Count',
       'SYN Flag Count', 'RST Flag Count', 'PSH Flag Count', 'ACK Flag Coun
t',
       'URG Flag Count', 'CWE Flag Count', 'ECE Flag Count', 'Down/Up Ratio',
       'Average Packet Size', 'Avg Fwd Segment Size', 'Avg Bwd Segment Size',
       'Fwd Avg Bytes/Bulk', 'Fwd Avg Packets/Bulk', 'Fwd Avg Bulk Rate',
       'Bwd Avg Bytes/Bulk', 'Bwd Avg Packets/Bulk', 'Bwd Avg Bulk Rate',
       'Subflow Fwd Packets', 'Subflow Fwd Bytes', 'Subflow Bwd Packets',
       'Subflow Bwd Bytes', 'Init_Win_bytes_forward',
       'Init_Win_bytes_backward', 'act_data_pkt_fwd', 'min_seg_size_forward',
       'Active Mean', 'Active Std', 'Active Max', 'Active Min', 'Idle Mean',
       'Idle Std', 'Idle Max', 'Idle Min', 'Label'],
      dtype='object')
```

Below at the stage of importance estimation the "Init_Win_bytes_backward" feature has the maximum value. After viewing the source dataset, it seems that an inaccuracy was made in forming the dataset.

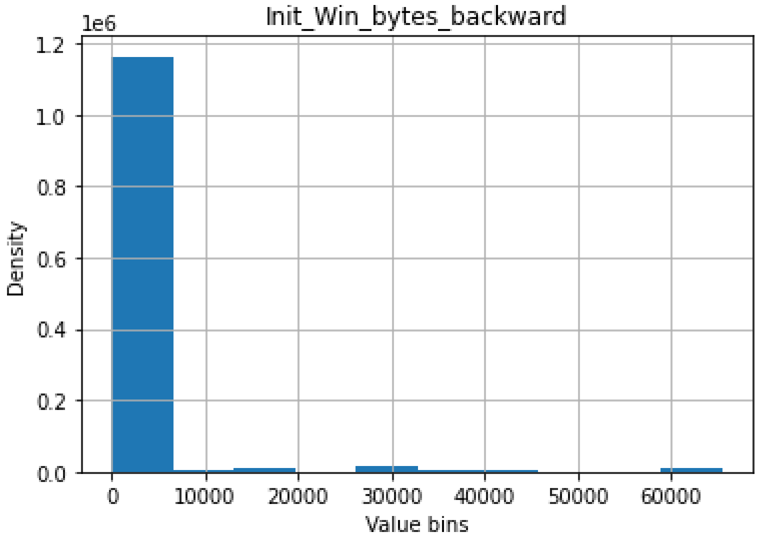
It turns out that it is possible to make a fairly accurate classification by one feature.

Description of features: http://www.netflowmeter.ca/netflowmeter.html

```
 Init_Win_bytes_backward - The total number of bytes sent in
initial window in the backward direction
 Init_Win_bytes_forward - The total number of bytes sent in
initial window in the forward direction
```

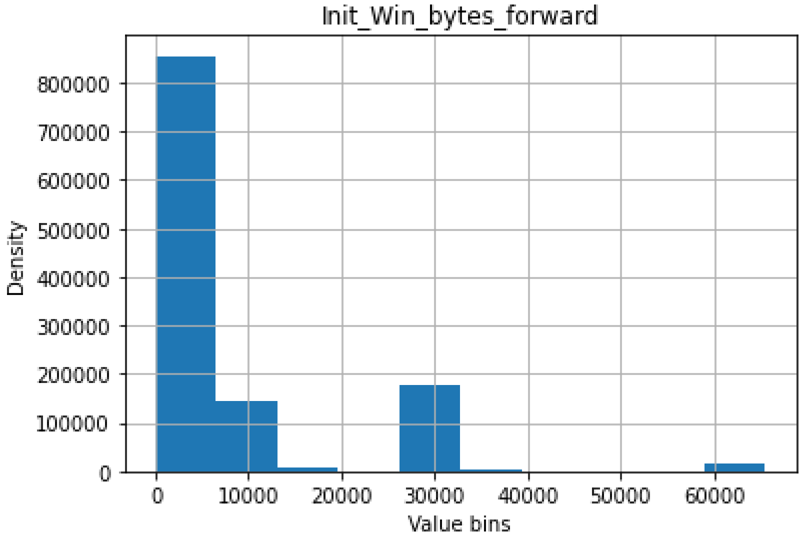
In [ ]:

```
if 'Init_Win_bytes_backward' in df.columns:
    df['Init_Win_bytes_backward'].hist(figsize=(6,4), bins=10);
    plt.title("Init_Win_bytes_backward")
    plt.xlabel("Value bins")
    plt.ylabel("Density")
    plt.savefig('Init_Win_bytes_backward.png', dpi=300)
```



In [ ]:

```
if 'Init_Win_bytes_forward' in df.columns:
    df['Init_Win_bytes_forward'].hist(figsize=(6,4), bins=10);
    plt.title("Init_Win_bytes_forward")
    plt.xlabel("Value bins")
    plt.ylabel("Density")
    plt.savefig('Init_Win_bytes_forward.png', dpi=300)
```



In [6]:

```
excluded2 = ['Init_Win_bytes_backward', 'Init_Win_bytes_forward']
df = df.drop(columns=excluded2, errors='ignore')
```

In [7]:

```
y = df['Label'].values
X = df.drop(columns=['Label'])
print(X.shape, y.shape)
```

```
(1204915, 74) (1204915,)
```

Feature importance

In [8]:

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, ranc

unique, counts = np.unique(y_train, return_counts=True)
dict(zip(unique, counts))
```

Out[8]:
```
{0: 465685, 1: 377755}
```

Visualization of the decision tree, importance evaluation using a single tree (DecisionTreeClassifier)

In [9]:
```
from sklearn.model_selection import cross_val_score
from sklearn.tree import DecisionTreeClassifier
decision_tree = DecisionTreeClassifier(max_leaf_nodes=5, random_state=0)
decision_tree = decision_tree.fit(X_train, y_train)
cross_val_score(decision_tree, X_train, y_train, cv=10)
```

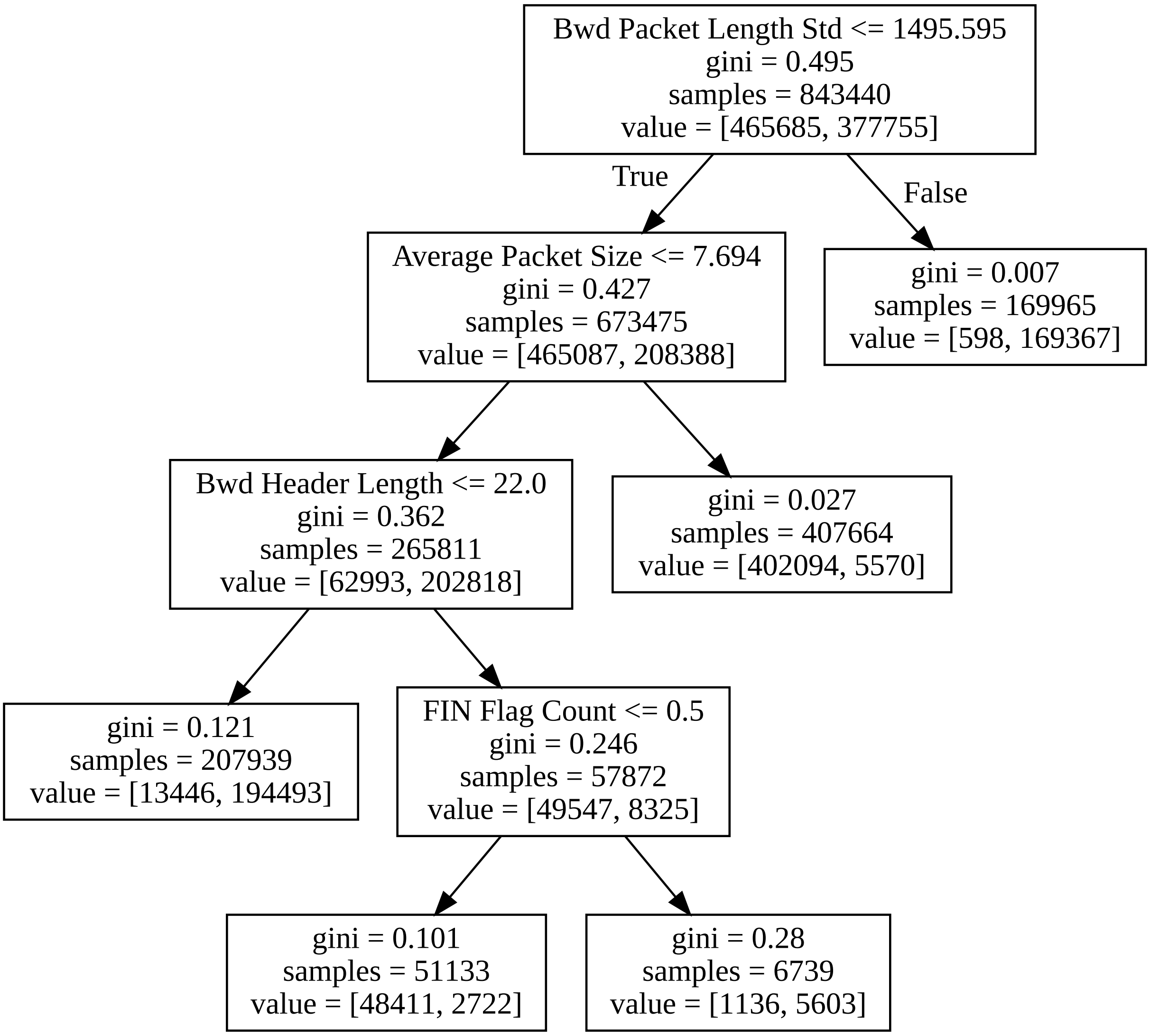
Out[9]:
```
array([0.97321683, 0.9724106 , 0.97206677, 0.97198378, 0.97150953,
       0.9722209 , 0.97209049, 0.97301527, 0.97159253, 0.97160438])
```

In [10]:
```
from sklearn.tree import export_text
r = export_text(decision_tree, feature_names=X_train.columns.to_list())
print(r)
```

```
|--- Bwd Packet Length Std <= 1495.59
|   |--- Average Packet Size <= 7.69
|   |   |--- Bwd Header Length <= 22.00
|   |   |   |--- class: 1
|   |   |--- Bwd Header Length >  22.00
|   |   |   |--- FIN Flag Count <= 0.50
|   |   |   |   |--- class: 0
|   |   |   |--- FIN Flag Count >  0.50
|   |   |   |   |--- class: 1
|   |--- Average Packet Size >  7.69
|   |   |--- class: 0
|--- Bwd Packet Length Std >  1495.59
|   |--- class: 1
```

In [11]:
```
from graphviz import Source
from sklearn import tree
Source(tree.export_graphviz(decision_tree, out_file=None, feature_names=X.col
```

Out[11]:



Analyze the confusion matrix. Which classes are confidently classified by the model?

```
In [ ]: unique, counts = np.unique(y_test, return_counts=True)
        dict(zip(unique, counts))
```

```
Out[ ]: {0: 199601, 1: 161874}
```

```
In [ ]: from sklearn.metrics import confusion_matrix
        y_pred = decision_tree.predict(X_test)
        confusion_matrix(y_test, y_pred)
```

```
Out[ ]: array([[193116,   6485],
               [  3385, 158489]])
```

Importance evaluation using SelectFromModel (still one decision tree)

```
In [ ]: from sklearn.feature_selection import SelectFromModel
        sfm = SelectFromModel(estimator=decision_tree).fit(X_train, y_train)
        sfm.estimator_.feature_importances_
```

```
Out[ ]: array([0.        , 0.        , 0.        , 0.        , 0.        ,
               0.        , 0.        , 0.        , 0.        , 0.        ,
               0.        , 0.        , 0.34372844, 0.        , 0.        ,
               0.        , 0.        , 0.        , 0.        , 0.        ,
               0.        , 0.        , 0.        , 0.        , 0.        ,
               0.        , 0.        , 0.        , 0.        , 0.        ,
               0.        , 0.        , 0.        , 0.        , 0.15216563,
               0.        , 0.        , 0.        , 0.        , 0.        ,
               0.        , 0.        , 0.01934663, 0.        , 0.        ,
               0.        , 0.        , 0.        , 0.        , 0.        ,
               0.        , 0.4847593 , 0.        , 0.        , 0.        ,
               0.        , 0.        , 0.        , 0.        , 0.        ,
               0.        , 0.        , 0.        , 0.        , 0.        ,
               0.        , 0.        , 0.        , 0.        , 0.        ,
               0.        , 0.        , 0.        , 0.        ])
```

In [ ]:

```
sfm.threshold_
```

Out[ ]:

```
0.013513513513513514
```

In [ ]:

```
X_train_new = sfm.transform(X_train)
print("Original num features: {}, selected num features: {}"
      .format(X_train.shape[1], X_train_new.shape[1]))
```

```
Original num features: 74, selected num features: 4
```

In [ ]:

```
indices = np.argsort(decision_tree.feature_importances_)[::-1]
for idx, i in enumerate(indices[:10]):
    print("{}.\t{} - {}".format(idx, X_train.columns[i], decision_tree.featur
```

```
0.      Average Packet Size - 0.4847592967746556
1.      Bwd Packet Length Std - 0.34372844337232183
2.      Bwd Header Length - 0.1521656320990684
3.      FIN Flag Count - 0.019346627753954213
4.      Bwd IAT Std - 0.0
5.      Fwd IAT Std - 0.0
6.      Fwd IAT Max - 0.0
7.      Fwd IAT Min - 0.0
8.      Bwd IAT Total - 0.0
9.      Bwd IAT Mean - 0.0
```

Evaluation of importance using RandomForestClassifier.feature*importances* (move from one tree to a random forest, classification quality increases)

In [13]:

```
from sklearn.ensemble import RandomForestClassifier

rf = RandomForestClassifier(n_estimators=250, random_state=42, oob_score=True
rf.fit(X_train, y_train)
# Score = mean accuracy on the given test data and labels
print('R^2 Training Score: {:.2f} \nR^2 Validation Score: {:.2f} \nOut-of-bag
      .format(rf.score(X_train, y_train), rf.score(X_test, y_test), rf.oob_sc
```

```
R^2 Training Score: 0.99
R^2 Validation Score: 0.99
Out-of-bag Score: 0.99
```

In [16]:

```
features = X.columns
importances = rf.feature_importances_
indices = np.argsort(importances)[::-1]
webattack_features = []


for index, i in enumerate(indices[:20]):
    webattack_features.append(features[i])
    print('{}.\t#{}\t{:.3f}\t{}'.format(index + 1, i, importances[i], feature
```

```
1.      #51     0.073   Average Packet Size
2.      #12     0.050   Bwd Packet Length Std
3.      #53     0.044   Avg Bwd Segment Size
4.      #11     0.043   Bwd Packet Length Mean
5.      #3      0.042   Total Length of Fwd Packets
6.      #7      0.040   Fwd Packet Length Mean
7.      #41     0.040   Packet Length Variance
8.      #9      0.038   Bwd Packet Length Max
9.      #39     0.037   Packet Length Mean
10.     #37     0.034   Min Packet Length
11.     #5      0.033   Fwd Packet Length Max
12.     #61     0.033   Subflow Fwd Bytes
13.     #63     0.031   Subflow Bwd Bytes
14.     #4      0.030   Total Length of Bwd Packets
15.     #34     0.030   Bwd Header Length
16.     #52     0.029   Avg Fwd Segment Size
17.     #40     0.025   Packet Length Std
18.     #6      0.025   Fwd Packet Length Min
19.     #10     0.020   Bwd Packet Length Min
20.     #38     0.020   Max Packet Length
```

In [21]:

```
indices
```

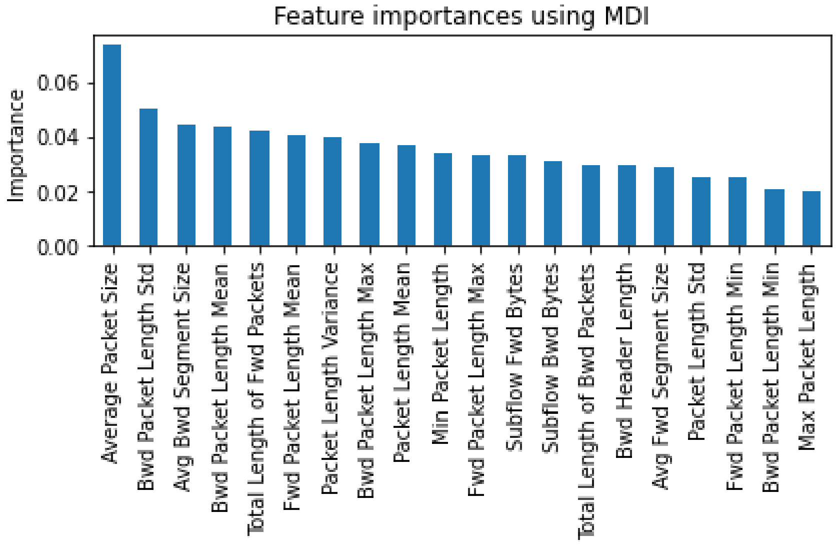
Out[21]:

```
array([51, 12, 53, 11,  3,  7, 41,  9, 39, 37,  5, 61, 63,  4, 34, 52, 40,
        6, 10, 38, 36,  0, 62, 47, 17, 33, 13,  2, 22, 19, 60,  1, 15, 20,
       64, 14,  8, 16, 21, 23, 72, 35, 46, 45, 18, 25, 50, 24, 27, 70, 65,
       73, 68, 42, 69, 28, 26, 66, 67, 29, 71, 43, 49, 44, 48, 30, 32, 59,
       31, 55, 56, 57, 58, 54])
```

In [27]:

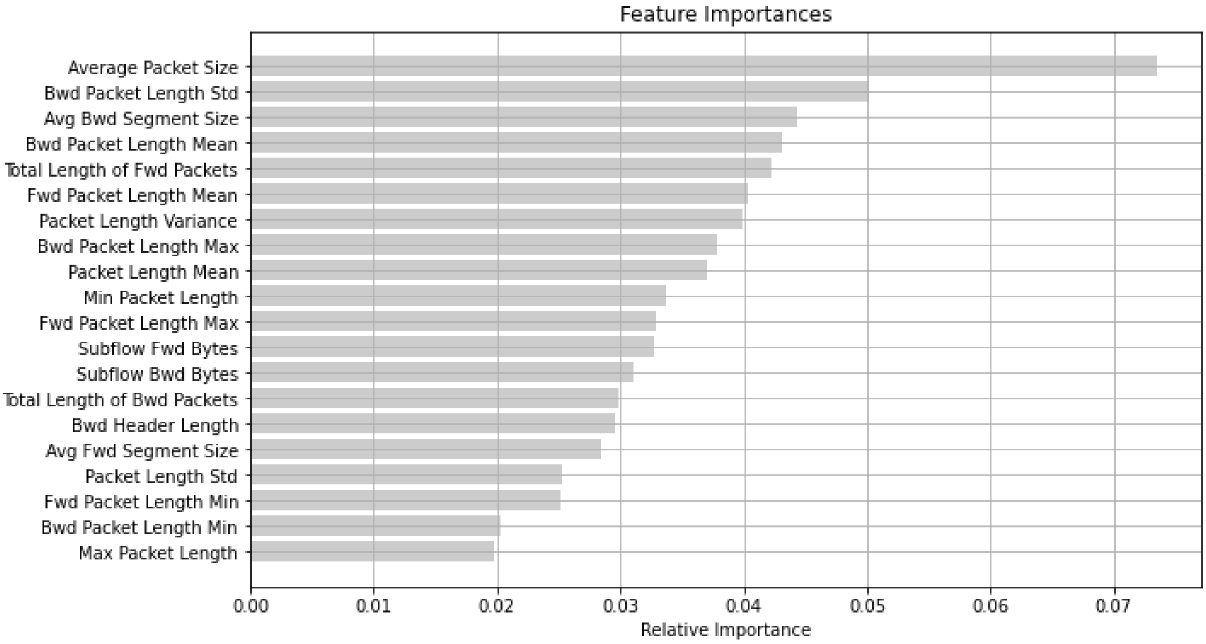
```
import pandas as pd
forest_importances = pd.Series(importances[indices[0:20]], webattack_features

fig, ax = plt.subplots()
forest_importances.plot.bar( ax=ax)
ax.set_title("Feature importances using MDI")
ax.set_ylabel("Importance")
fig.tight_layout()
```



In [28]:

```
indices = np.argsort(importances)[-20:]
plt.rcParams['figure.figsize'] = (10, 6)
plt.title('Feature Importances')
plt.barh(range(len(indices)), importances[indices], color='#cccccc', align='c
plt.yticks(range(len(indices)), [features[i] for i in indices])
plt.xlabel('Relative Importance')
plt.grid()
plt.savefig('feature_importances.png', dpi=300, bbox_inches='tight')
plt.show()
```



In [29]:

```
y_pred = rf.predict(X_test)
confusion_matrix(y_test, y_pred)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-29-a8fc3a69e28c> in <module>()
      1 y_pred = rf.predict(X_test)
----> 2 confusion_matrix(y_test, y_pred)

NameError: name 'confusion_matrix' is not defined
```

In [ ]:

```
max_features = 20
webattack_features = webattack_features[:max_features]
webattack_features
```

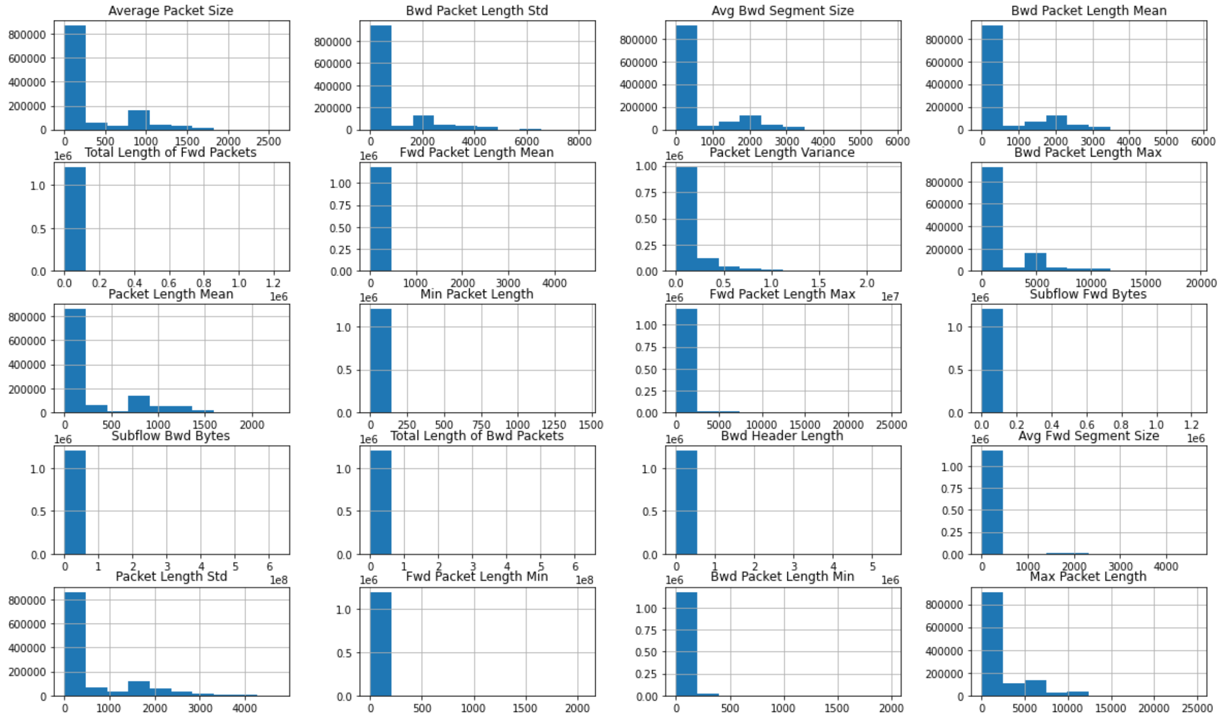
Out[ ]:

```
['Average Packet Size',
 'Bwd Packet Length Std',
 'Avg Bwd Segment Size',
 'Bwd Packet Length Mean',
 'Total Length of Fwd Packets',
 'Fwd Packet Length Mean',
 'Packet Length Variance',
 'Bwd Packet Length Max',
 'Packet Length Mean',
 'Min Packet Length',
 'Fwd Packet Length Max',
 'Subflow Fwd Bytes',
 'Subflow Bwd Bytes',
 'Total Length of Bwd Packets',
 'Bwd Header Length',
 'Avg Fwd Segment Size',
 'Packet Length Std',
 'Fwd Packet Length Min',
 'Bwd Packet Length Min',
 'Max Packet Length']
```

Analysis of selected features

In [ ]:

```
df[webattack_features].hist(figsize=(20,12), bins=10);
plt.savefig('features_hist.png', dpi=300)
```



In [ ]:

```
!pip install facets-overview
```

```
Collecting facets-overview
  Downloading facets_overview-1.0.0-py2.py3-none-any.whl (24 kB)
Requirement already satisfied: protobuf>=3.7.0 in /usr/local/lib/python3.7/di
st-packages (from facets-overview) (3.17.3)
Requirement already satisfied: numpy>=1.16.0 in /usr/local/lib/python3.7/dist
-packages (from facets-overview) (1.19.5)
Requirement already satisfied: pandas>=0.22.0 in /usr/local/lib/python3.7/dis
t-packages (from facets-overview) (1.1.5)
Requirement already satisfied: python-dateutil>=2.7.3 in /usr/local/lib/pytho
n3.7/dist-packages (from pandas>=0.22.0->facets-overview) (2.8.1)
Requirement already satisfied: pytz>=2017.2 in /usr/local/lib/python3.7/dist-
packages (from pandas>=0.22.0->facets-overview) (2018.9)
Requirement already satisfied: six>=1.9 in /usr/local/lib/python3.7/dist-pack
ages (from protobuf>=3.7.0->facets-overview) (1.15.0)
Installing collected packages: facets-overview
Successfully installed facets-overview-1.0.0
```

In [ ]:

```
import base64
from facets_overview.generic_feature_statistics_generator import GenericFeatu

gfsg = GenericFeatureStatisticsGenerator()
proto = gfsg.ProtoFromDataFrames([{'name': 'train + test', 'table': df[webatt
protostr = base64.b64encode(proto.SerializeToString()).decode("utf-8")
```

In [ ]:

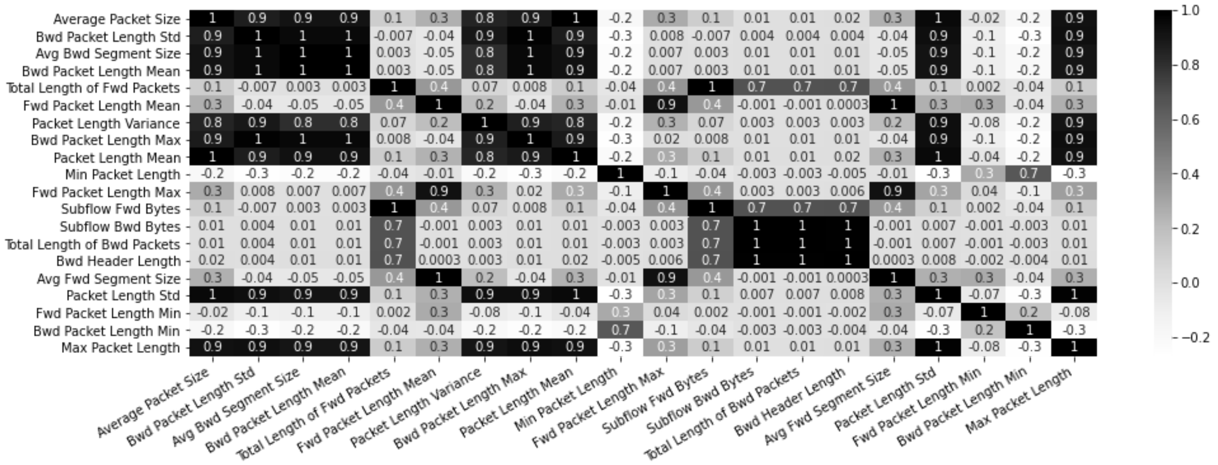
```
from IPython.core.display import display, HTML

HTML_TEMPLATE = """
```

```
        <script src="https://cdnjs.cloudflare.com/ajax/libs/webcomponentsjs/1
        <link rel="import" href="https://raw.githubusercontent.com/PAIR-code/
        <facets-overview id="elem"></facets-overview>
        <script>
          document.querySelector("#elem").protoInput = "{protostr}";
        </script>"""
html = HTML_TEMPLATE.format(protostr=protostr)
display(HTML(html))
```

In [ ]:

```
import seaborn as sns
corr_matrix = df[webattack_features].corr()
plt.rcParams['figure.figsize'] = (16, 5)
g = sns.heatmap(corr_matrix, annot=True, fmt='.1g', cmap='Greys')
g.set_xticklabels(g.get_xticklabels(), verticalalignment='top', horizontalali
plt.savefig('/content/drive/MyDrive/engEdosa/corr_heatmap.png', dpi=300, bbox
```



In [ ]:

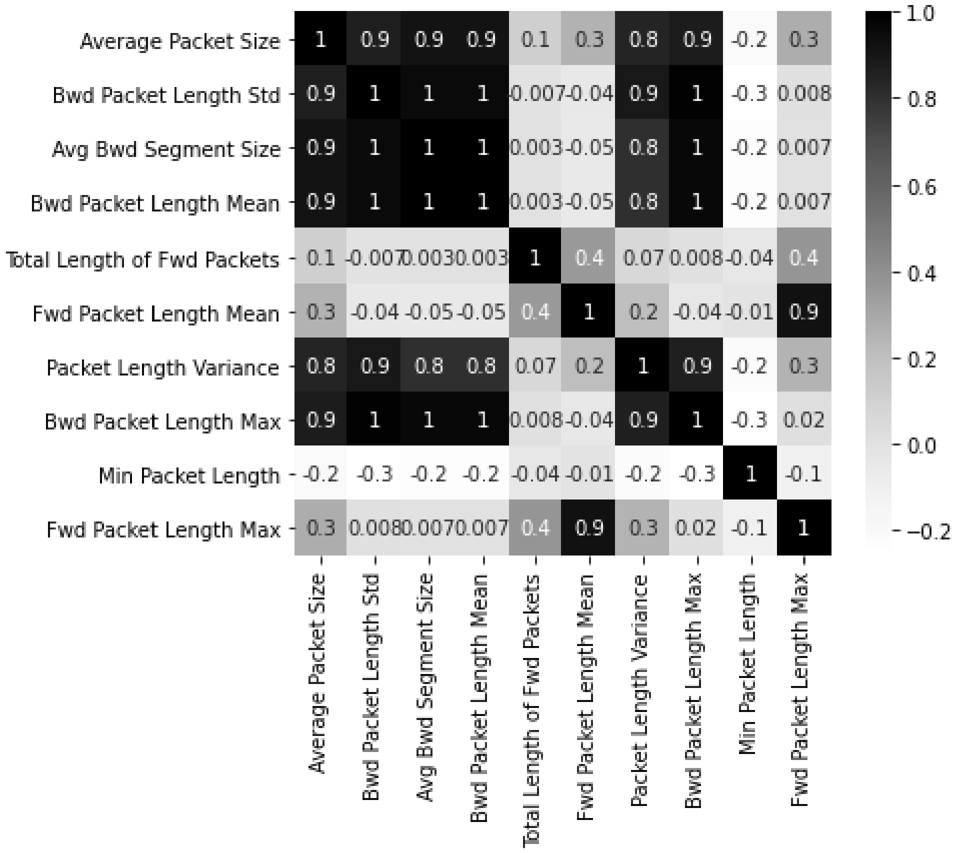
```
to_be_removed = {'Packet Length Mean', 'Avg Fwd Segment Size', 'Subflow F   E
                 'Fwd Packets/s', 'Fwd IAT Total', 'Fwd IAT Max'}
webattack_features = [item for item in webattack_features if item not in to_b
webattack_features = webattack_features[:10]
webattack_features
```

Out[ ]:

```
['Average Packet Size',
 'Bwd Packet Length Std',
 'Avg Bwd Segment Size',
 'Bwd Packet Length Mean',
 'Total Length of Fwd Packets',
 'Fwd Packet Length Mean',
 'Packet Length Variance',
 'Bwd Packet Length Max',
 'Min Packet Length',
 'Fwd Packet Length Max']
```

In [ ]:

```
corr_matrix = df[webattack_features].corr()
plt.rcParams['figure.figsize'] = (6, 5)
sns.heatmap(corr_matrix, annot=True, fmt='.1g', cmap='Greys');
```



Model Training

In [30]:

```
y = df['Label'].values
X = df[webattack_features]
print(X.shape, y.shape)
```

```
(1204915, 20) (1204915,)
```

In [31]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,
print(X_train.shape, y_train.shape)
print(X_test.shape, y_test.shape)
```

```
(843440, 20) (843440,)
(361475, 20) (361475,)
```

In [34]:

```
import pyforest
import warnings
warnings.filterwarnings("ignore")
from sklearn import metrics
from sklearn.metrics import accuracy_score
```

In [36]:

```
import lazypredict
from lazypredict.Supervised import LazyClassifier
```

In [1]:

```
clf = LazyClassifier(verbose=1, ignore_warnings=True, custom_metric = Non
models, predictions = clf.fit(X_train, X_test, y_train, y_test)
models
```

In [ ]: