2_Data_Analysis

June 5, 2024

1 Analyzing the dataset

After processing and cleaning the files, the full dataset is loaded to analyze basic information about the traffic before applying machine learning algorithms.

[1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import glob
import seaborn as sns
import os

file_path =␣
 ↪r"CIC-IDS-2017\CSVs\GeneratedLabelledFlows\TrafficLabelling\processed\ids2017_processed.
 ↪csv"
df = pd.read_csv(file_path)
convert_dict = {'label': 'category'}
df = df.astype(convert_dict)
df.info()
df.head()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2830743 entries, 0 to 2830742
Data columns (total 96 columns):
 #   Column                       Dtype
---  ------                       -----
 0   destination_port             int64
 1   protocol                     int64
 2   flow_duration                int64
 3   total_fwd_packets            int64
 4   total_backward_packets       int64
 5   total_length_of_fwd_packets  float64
 6   total_length_of_bwd_packets  float64
 7   fwd_packet_length_max        float64
 8   fwd_packet_length_min        float64
 9   fwd_packet_length_mean       float64
 10  fwd_packet_length_std        float64
 11  bwd_packet_length_max        float64
```

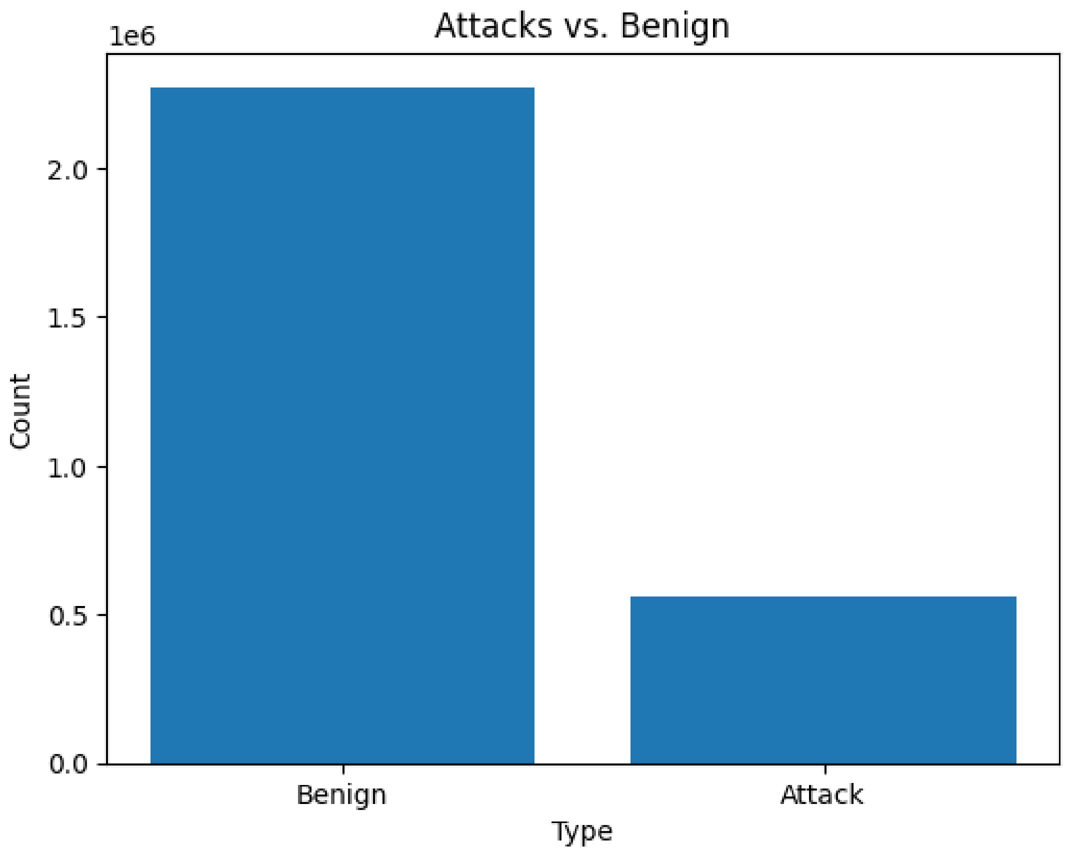
12	bwd_packet_length_min	float64
13	bwd_packet_length_mean	float64
14	bwd_packet_length_std	float64
15	flow_bytes_s	float64
16	flow_packets_s	float64
17	flow_iat_mean	float64
18	flow_iat_std	float64
19	flow_iat_max	float64
20	flow_iat_min	float64
21	fwd_iat_total	float64
22	fwd_iat_mean	float64
23	fwd_iat_std	float64
24	fwd_iat_max	float64
25	fwd_iat_min	float64
26	bwd_iat_total	float64
27	bwd_iat_mean	float64
28	bwd_iat_std	float64
29	bwd_iat_max	float64
30	bwd_iat_min	float64
31	fwd_psh_flags	int64
32	bwd_psh_flags	int64
33	fwd_urg_flags	int64
34	bwd_urg_flags	int64
35	fwd_header_length	int64
36	bwd_header_length	int64
37	fwd_packets_s	float64
38	bwd_packets_s	float64
39	min_packet_length	float64
40	max_packet_length	float64
41	packet_length_mean	float64
42	packet_length_std	float64
43	packet_length_variance	float64
44	fin_flag_count	int64
45	syn_flag_count	int64
46	rst_flag_count	int64
47	psh_flag_count	int64
48	ack_flag_count	int64
49	urg_flag_count	int64
50	cwe_flag_count	int64
51	ece_flag_count	int64
52	down_up_ratio	float64
53	average_packet_size	float64
54	avg_fwd_segment_size	float64
55	avg_bwd_segment_size	float64
56	fwd_header_length_1	int64
57	fwd_avg_bytes_bulk	int64
58	fwd_avg_packets_bulk	int64
59	fwd_avg_bulk_rate	int64

```
 60  bwd_avg_bytes_bulk           int64
 61  bwd_avg_packets_bulk         int64
 62  bwd_avg_bulk_rate            int64
 63  subflow_fwd_packets          int64
 64  subflow_fwd_bytes            int64
 65  subflow_bwd_packets          int64
 66  subflow_bwd_bytes            int64
 67  init_win_bytes_forward       int64
 68  init_win_bytes_backward      int64
 69  act_data_pkt_fwd             int64
 70  min_seg_size_forward         int64
 71  active_mean                  float64
 72  active_std                   float64
 73  active_max                   float64
 74  active_min                   float64
 75  idle_mean                    float64
 76  idle_std                     float64
 77  idle_max                     float64
 78  idle_min                     float64
 79  label                        category
 80  is_attack                    int64
 81  label_code                   int64
 82  is_dos_hulk                  int64
 83  is_portscan                  int64
 84  is_ddos                      int64
 85  is_dos_goldeneye             int64
 86  is_ftppatator                int64
 87  is_sshpatator                int64
 88  is_dos_slowloris             int64
 89  is_dos_slowhttptest          int64
 90  is_bot                       int64
 91  is_web_attack_brute_force    int64
 92  is_web_attack_xss            int64
 93  is_infiltration              int64
 94  is_web_attack_sql_injection  int64
 95  is_heartbleed                int64
dtypes: category(1), float64(45), int64(50)
memory usage: 2.0 GB
```

[1]:
```
   destination_port  protocol  flow_duration  total_fwd_packets  \
0             49188         6              4                  2
1             49188         6              1                  2
2             49188         6              1                  2
3             49188         6              1                  2
4             49486         6              3                  2

   total_backward_packets  total_length_of_fwd_packets  \
0                       0                          12.0
1                       0                          12.0
2                       0                          12.0
3                       0                          12.0
4                       0                          12.0

   total_length_of_bwd_packets  fwd_packet_length_max  fwd_packet_length_min  \
0                          0.0                    6.0                    6.0
1                          0.0                    6.0                    6.0
2                          0.0                    6.0                    6.0
3                          0.0                    6.0                    6.0
4                          0.0                    6.0                    6.0

   fwd_packet_length_mean  …  is_ftppatator  is_sshpatator  \
0                     6.0  …              0              0
1                     6.0  …              0              0
2                     6.0  …              0              0
3                     6.0  …              0              0
4                     6.0  …              0              0

   is_dos_slowloris  is_dos_slowhttptest  is_bot  is_web_attack_brute_force  \
0                 0                    0       0                          0
1                 0                    0       0                          0
2                 0                    0       0                          0
3                 0                    0       0                          0
4                 0                    0       0                          0

   is_web_attack_xss  is_infiltration  is_web_attack_sql_injection  \
0                  0                0                            0
1                  0                0                            0
2                  0                0                            0
3                  0                0                            0
4                  0                0                            0

   is_heartbleed
0              0
1              0
2              0
3              0
4              0

[5 rows x 96 columns]
```

1.0.1 1. Benign Network flows vs Attacks

[2]:
```
attack_counts = df['is_attack'].value_counts()
plt.bar(attack_counts.index, attack_counts.values)
plt.xlabel('Type')
plt.ylabel('Count')
plt.title('Attacks vs. Benign')
plt.xticks(ticks=[0, 1], labels=['Benign', 'Attack'])  # Add custom x-axis␣
 ↪labels
plt.show()
```

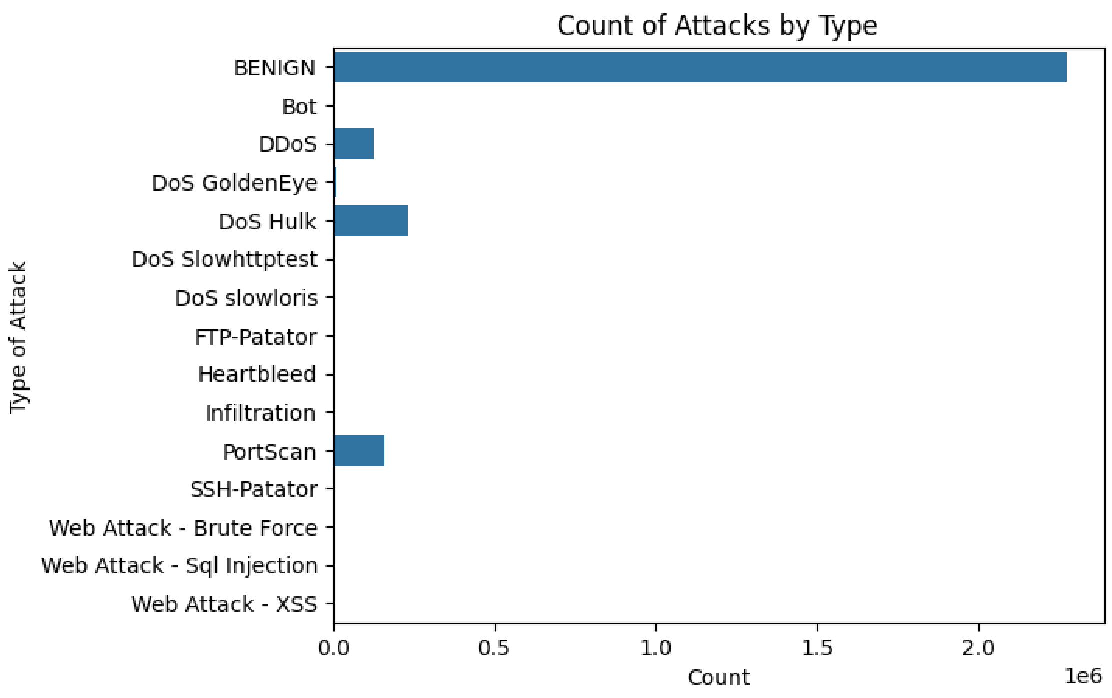


[3]:
```
attack_percentages = (attack_counts / attack_counts.sum()) * 100

# Create a new DataFrame for the table
table_data = pd.DataFrame({'Type': attack_counts.index, 'Number of Attacks':␣
 ↪attack_counts.values, 'Percentage': attack_percentages.values})

# Display the table
table_data
```

[3]:
```
   Type  Number of Attacks  Percentage
0     0            2273097   80.300366
1     1             557646   19.699634
```

1.0.2 2. Plot by the Type of Network Traffic

[5]:
```
sns.countplot(y='label', data=df)
plt.xlabel('Count')
plt.ylabel('Type of Attack')
plt.title('Count of Attacks by Type')
plt.show()
```



[7]:
```
attack_counts = df['label'].value_counts()
table_data = pd.DataFrame({'Type of Attack': attack_counts.index, 'Number of␣
 ↪Attacks': attack_counts.values})
table_data
```

[7]:
```
                Type of Attack  Number of Attacks
0                       BENIGN            2273097
1                     DoS Hulk             231073
2                     PortScan             158930
3                         DDoS             128027
4                DoS GoldenEye              10293
5                  FTP-Patator               7938
```

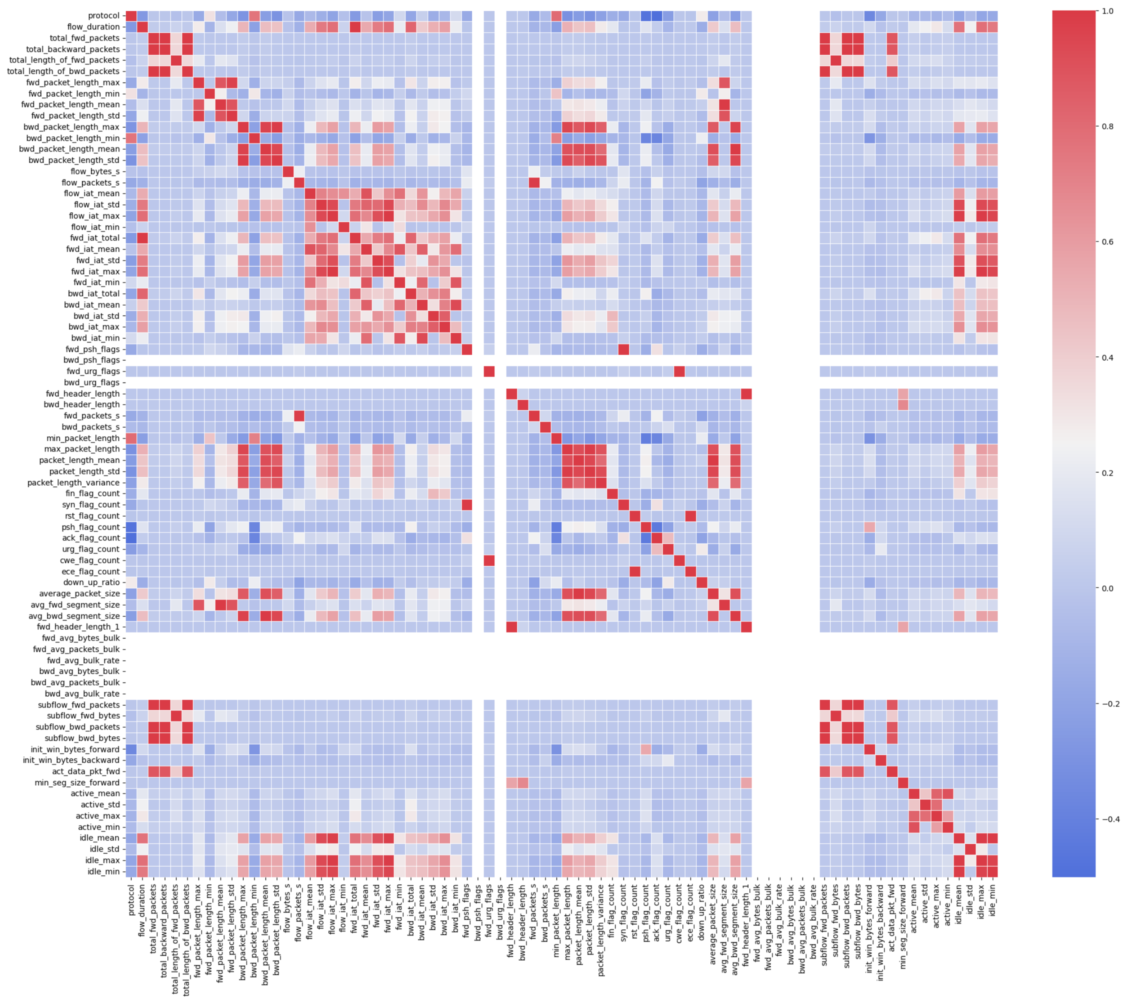
```
6                    SSH-Patator           5897
7                   DoS slowloris          5796
8                DoS Slowhttptest          5499
9                             Bot          1966
10     Web Attack - Brute Force            1507
11             Web Attack - XSS             652
12                   Infiltration            36
13   Web Attack - Sql Injection              21
14                     Heartbleed            11
```

1.0.3 3. Correlation Between Features

A heatmap for the correlation matrix of all relevant features is used to visualize groups of highly correlated features.

```
[16]: new_df = df.iloc[:, 1:79]
      corr = new_df.corr()
      plt.figure(figsize=(25, 20))
      sns.heatmap(corr, xticklabels=corr.columns, yticklabels=corr.columns,␣
       ↪linewidths=.5, cmap=sns.diverging_palette(620, 10, as_cmap=True))
```

```
[16]: <Axes: >
```



1.0.4 Conclusion

From this preliminary analysis of the dataset, it can be concluded that the number of benign traffics is much higher than the number of attacks, which will make the machine learning models very heavily skewed towards benign traffics. Some attacks are also very underrepresented, meaning that a binary classifier will be more accurate for detecting certain attacks. Finally, the dataset contains a number of highly correlated features that could be redundant for training machine learning models. Feature engineering must be applied before creating the models.