Project_PN_Group8

April 13, 2025

[21]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import numpy as np
%matplotlib inline
import seaborn as sns
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
from sklearn.ensemble import RandomForestClassifier
from sklearn.preprocessing import LabelEncoder
```

[22]:
```
def read_and_parse_label_file(path_to_label_file: str)-> pd.DataFrame:

    df = pd.read_csv(path_to_label_file,
                 sep = '\x09',
                 header = 6,
                index_col = False
                )

    # cutting off header detail row and the last row
    trimmed_df = df[1:-1].copy()

    trim_cols = list(trimmed_df.columns)[1:] # excluding the #fields column name

    data = trimmed_df.iloc[:, :-1].copy() # excluding the last column

    # creating a dictionary to rename the columns
    rename_cols_dic = {}

    for old_col, new_col in zip(data.columns, trim_cols):
        rename_cols_dic[old_col] = new_col

    # renaming the columns
    data = data.rename(columns = rename_cols_dic).copy()


    # splitting this column into three new columns
```

```
    last_cols = data['tunnel_parents   label   detailed-label'].str.split('  ',␣
 ↪expand = True)

    # renaming the newly split columns
    last_cols.rename(columns = {0:'tunnel_parents', 1:'label', 2:␣
 ↪'detailed-label'}, inplace = True)

    # merging the newly split columns onto the main df

    merge_df = data.merge(last_cols, left_index = True, right_index = True)

    # dropping the columns that was used to split into three

    final_df = merge_df.drop(columns = ['tunnel_parents   label   ␣
 ↪detailed-label']).copy()

    return final_df

example_data = "Malware_1.labeled"

final_df = read_and_parse_label_file(example_data)

final_df[:5]
```

```
/tmp/ipykernel_51446/2315226590.py:3: DtypeWarning: Columns
(0,3,5,14,16,17,18,19,21) have mixed types. Specify dtype option on import or
set low_memory=False.
  df = pd.read_csv(path_to_label_file,
```

[22]:

	ts	uid	id.orig_h	id.orig_p	\
1	1525879831.015811	CUmrqr4svHuSXJy5z7	192.168.100.103	51524	
2	1525879831.025055	CH98aB3s1kJeq6SFOc	192.168.100.103	56305	
3	1525879831.045045	C3GBTkINvXNjVGtN5	192.168.100.103	41101	
4	1525879832.016240	CDe43c1PtgynajGI6	192.168.100.103	60905	
5	1525879832.024985	CJaDcG3MZzvf1YVYI4	192.168.100.103	44301	

	id.resp_h	id.resp_p	proto	service	duration	orig_bytes	…	\
1	65.127.233.163	23	tcp	-	2.999051	0	…	
2	63.150.16.171	23	tcp	-	-	-	…	
3	111.40.23.49	23	tcp	-	-	-	…	
4	131.174.215.147	23	tcp	-	2.998796	0	…	
5	91.42.47.63	23	tcp	-	-	-	…	

	local_resp	missed_bytes	history	orig_pkts	orig_ip_bytes	resp_pkts	\
1	-	0	S	3	180	0	
2	-	0	S	1	60	0	
3	-	0	S	1	60	0	

```
4          -            0       S         3           180         0
5          -            0       S         1            60         0

  resp_ip_bytes tunnel_parents       label              detailed-label
1             0        (empty)   Malicious   PartOfAHorizontalPortScan
2             0        (empty)   Malicious   PartOfAHorizontalPortScan
3             0        (empty)   Malicious   PartOfAHorizontalPortScan
4             0        (empty)   Malicious   PartOfAHorizontalPortScan
5             0        (empty)   Malicious   PartOfAHorizontalPortScan

[5 rows x 23 columns]
```

[23]:
```
final_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1008748 entries, 1 to 1008748
Data columns (total 23 columns):
 #   Column          Non-Null Count    Dtype
---  ------          --------------    -----
 0   ts              1008748 non-null  object
 1   uid             1008748 non-null  object
 2   id.orig_h       1008748 non-null  object
 3   id.orig_p       1008748 non-null  object
 4   id.resp_h       1008748 non-null  object
 5   id.resp_p       1008748 non-null  object
 6   proto           1008748 non-null  object
 7   service         1008748 non-null  object
 8   duration        1008748 non-null  object
 9   orig_bytes      1008748 non-null  object
 10  resp_bytes      1008748 non-null  object
 11  conn_state      1008748 non-null  object
 12  local_orig      1008748 non-null  object
 13  local_resp      1008748 non-null  object
 14  missed_bytes    1008748 non-null  object
 15  history         1008748 non-null  object
 16  orig_pkts       1008748 non-null  object
 17  orig_ip_bytes   1008748 non-null  object
 18  resp_pkts       1008748 non-null  object
 19  resp_ip_bytes   1008748 non-null  object
 20  tunnel_parents  1008748 non-null  object
 21  label           1008748 non-null  object
 22  detailed-label  1008748 non-null  object
dtypes: object(23)
memory usage: 177.0+ MB
```

[24]:
```
# Printing the column from the data frame
final_df.columns
```

[24]:
```
Index(['ts', 'uid', 'id.orig_h', 'id.orig_p', 'id.resp_h', 'id.resp_p',
       'proto', 'service', 'duration', 'orig_bytes', 'resp_bytes',
       'conn_state', 'local_orig', 'local_resp', 'missed_bytes', 'history',
       'orig_pkts', 'orig_ip_bytes', 'resp_pkts', 'resp_ip_bytes',
       'tunnel_parents', 'label', 'detailed-label'],
      dtype='object')
```

[25]:
```
# Returning all unique value from the missed bytes
final_df['missed_bytes'].unique()
final_df.missed_bytes
```

[25]:
```
1            0
2            0
3            0
4            0
5            0
           …
1008744    0.0
1008745    0.0
1008746    0.0
1008747    0.0
1008748    0.0
Name: missed_bytes, Length: 1008748, dtype: object
```

[26]:
```
columns_to_remove = ['ts', 'id.orig_h', 'id.orig_p', 'id.resp_h', 'local_orig',␣
 ↪'local_resp', 'tunnel_parents', 'detailed-label']
columns_to_include = ['uid', 'id.resp_p', 'proto', 'service', 'duration',␣
 ↪'orig_bytes', 'resp_bytes', 'conn_state', 'missed_bytes', 'history',␣
 ↪'orig_pkts', 'orig_ip_bytes', 'resp_pkts', 'resp_ip_bytes']
```

[27]:
```
# Removing the column which is not useful and has insufficient data
columns_to_remove = ['ts', 'id.orig_h', 'id.orig_p', 'id.resp_h', 'local_orig',␣
 ↪'local_resp', 'tunnel_parents', 'detailed-label']

# Specifing included column in data frame
label = LabelEncoder()
columns_to_include = []
for column in final_df.columns:

    if final_df[column].dtype == object:
        # Convert all values in the column to string to avoid mixed types issue
        final_df[column] = final_df[column].astype(str)
        final_df[column] = label.fit_transform(final_df[column])

    if column not in columns_to_remove:
        columns_to_include.append(column)
```

[28]:
```
X = final_df[columns_to_include].drop('label', axis=1)
y = final_df['label']
X.head()
```

[28]:

	uid	id.resp_p	proto	service	duration	orig_bytes	resp_bytes	\
1	501604	16719	1	0	12941	1	1	
2	280436	16719	1	0	0	0	0	
3	53371	16719	1	0	0	0	0	
4	223063	16719	1	0	12686	1	1	
5	320278	16719	1	0	0	0	0	

	conn_state	missed_bytes	history	orig_pkts	orig_ip_bytes	resp_pkts	\
1	6	0	22	26	615	0	
2	6	0	22	1	949	0	
3	6	0	22	1	949	0	
4	6	0	22	26	615	0	
5	6	0	22	1	949	0	

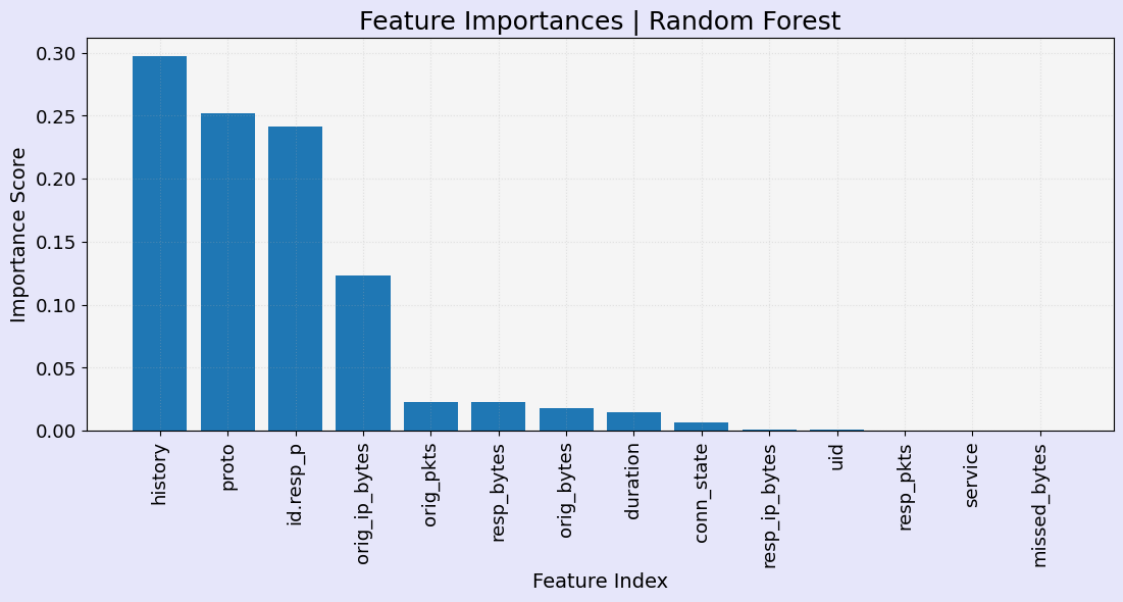
	resp_ip_bytes
1	0
2	0
3	0
4	0
5	0

[29]:
```
# Calling test_train_split on x and y to get new random instances of x_train,␣
 ↪x_test, y_train, y_test
x_train,x_test,y_train, y_test = train_test_split(X,y,test_size=0.2,␣
 ↪random_state=42)

# Defining the clf for random forest classifier
clf = RandomForestClassifier(random_state=0)

# fitting the model
clf.fit(x_train, y_train)

# Runing predictions
prediction = clf.predict(x_test)
score = accuracy_score(y_test, prediction)

# Printing the accuracy score of random forest classifier
print('Accuracy of Random Forest Classifier: {:.4f}'.format(score))
```

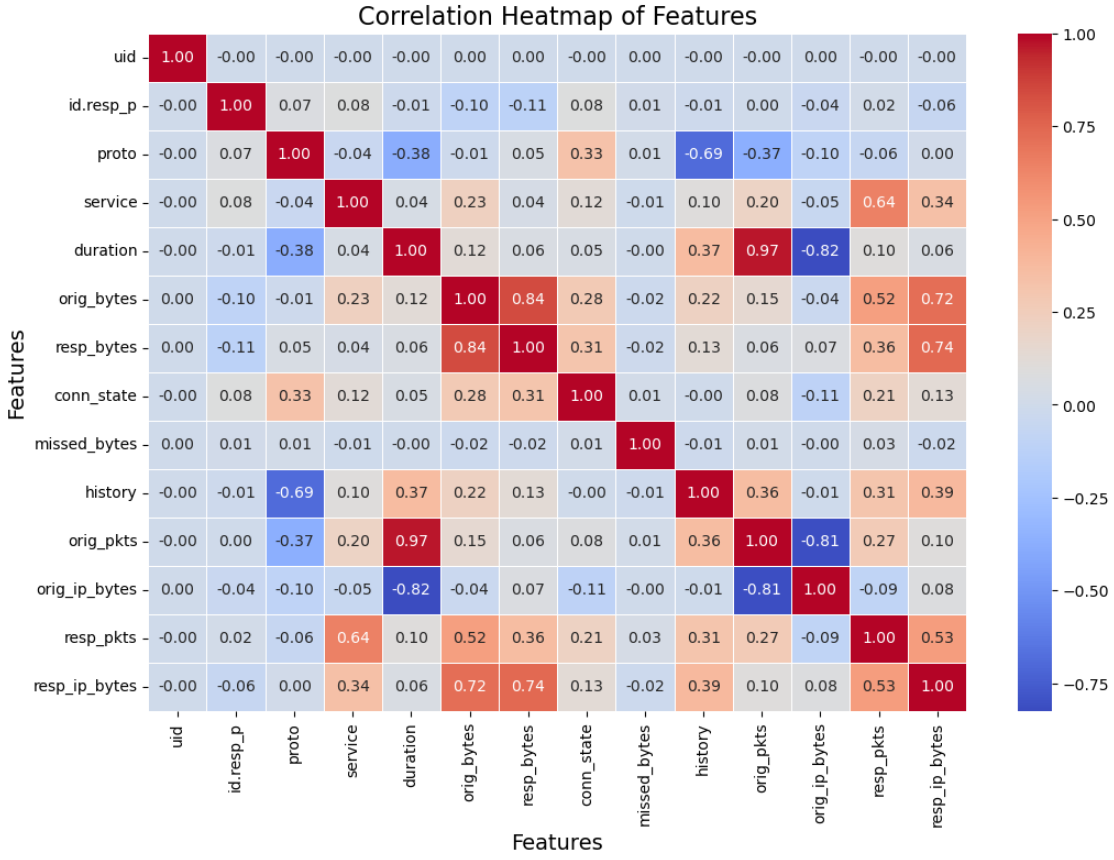
```
Accuracy of Random Forest Classifier: 0.9999
```

[30]:
```
# Getting the feature importance scores from the trained Random Forest␣
 ↪classifier
```

```
importances = clf.feature_importances_

# Sorting most importances in descending order
indices = np.argsort(importances)[::-1]

# Defining column name
cols = X.columns

# Reordering column name according to their features
ordered_cols_importance = [cols[X] for X in indices]

# Plotting a figure and axis object for the plot
fig, ax = plt.subplots(figsize=(13, 5))

# Plotting a bar chart for the feature importance
plt.title("Feature Importances | Random Forest", fontsize = 18)
plt.bar(range(x_train.shape[1]), importances[indices], align="center")
plt.xticks(range(x_train.shape[1]), ordered_cols_importance, rotation=90)

# Creating axis labels
plt.xlabel("Feature Index", fontsize = 14)
plt.ylabel("Importance Score", fontsize = 14)
ax.set_aspect('auto')

# Adding light gridlines for better readability
plt.grid(ls = ':', alpha = 0.3)

# Setting the background for better visibility
ax.set_aspect('auto')
fig.patch.set_facecolor('lavender')
ax.set_facecolor('whitesmoke')
ax.tick_params(axis='both', which='major', labelsize=13)

# Saving the plot as a high resulution image
plt.savefig('random forest feature importance.jpeg',
            dpi=1000,
            bbox_inches='tight'
           )

plt.show()
```



[31]:
```
# Computing the correlation matrix for the features
correlation_matrix = X.corr()

# Plotting the heatmap using seaborn
plt.figure(figsize=(12, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt='.2f',␣
 ↪linewidths=0.5)

# Adding title and axis labels
plt.title('Correlation Heatmap of Features', fontsize=16)
plt.xlabel('Features', fontsize=14)
plt.ylabel('Features', fontsize=14)

# Displaying the plot
plt.show()
```


Correlation Heatmap of Features
Features
uid 1.00 -0.00 -0.00 -0.00 -0.00 0.00 0.00 -0.00 0.00 -0.00 -0.00 0.00 -0.00 -0.00
id.resp_p -0.00 1.00 0.07 0.08 -0.01 -0.10 -0.11 0.08 0.01 -0.01 0.00 -0.04 0.02 -0.06
proto -0.00 0.07 1.00 -0.04 -0.38 -0.01 0.05 0.33 0.01 -0.69 -0.37 -0.10 -0.06 0.00
service -0.00 0.08 -0.04 1.00 0.04 0.23 0.04 0.12 -0.01 0.10 0.20 -0.05 0.64 0.34
duration -0.00 -0.01 -0.38 0.04 1.00 0.12 0.06 0.05 -0.00 0.37 0.97 -0.82 0.10 0.06
orig_bytes 0.00 -0.10 -0.01 0.23 0.12 1.00 0.84 0.28 -0.02 0.22 0.15 -0.04 0.52 0.72
resp_bytes 0.00 -0.11 0.05 0.04 0.06 0.84 1.00 0.31 -0.02 0.13 0.06 0.07 0.36 0.74
conn_state -0.00 0.08 0.33 0.12 0.05 0.28 0.31 1.00 0.01 -0.00 0.08 -0.11 0.21 0.13
missed_bytes 0.00 0.01 0.01 -0.01 -0.00 -0.02 -0.02 0.01 1.00 -0.01 0.01 -0.00 0.03 -0.02
history -0.00 -0.01 -0.69 0.10 0.37 0.22 0.13 -0.00 -0.01 1.00 0.36 -0.01 0.31 0.39
orig_pkts -0.00 0.00 -0.37 0.20 0.97 0.15 0.06 0.08 0.01 0.36 1.00 -0.81 0.27 0.10
orig_ip_bytes 0.00 -0.04 -0.10 -0.05 -0.82 -0.04 0.07 -0.11 -0.00 -0.01 -0.81 1.00 -0.09 0.08
resp_pkts -0.00 0.02 -0.06 0.64 0.10 0.52 0.36 0.21 0.03 0.31 0.27 -0.09 1.00 0.53
resp_ip_bytes -0.00 -0.06 0.00 0.34 0.06 0.72 0.74 0.13 -0.02 0.39 0.10 0.08 0.53 1.00
uid
id.resp_p
proto
service
duration
orig_bytes
resp_bytes
conn_state
missed_bytes
history
orig_pkts
orig_ip_bytes
resp_pkts
resp_ip_bytes
Features
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75