ICT607: Artificial Intelligence for Cybersecurity
Experiment 5

Lab 5: Preprocessing dataset – intrusion detection

Data preprocessing is the process of preparing raw data for analysis by applying various techniques to make the data more useful and meaningful. It involves transforming data into a format that can be easily analyzed by machine learning algorithms.

In this laboratory, we will preprocess the KDD Cup 1999 dataset, which is a widely used dataset for evaluating intrusion detection systems. It contains a sample of network traffic data from the DARPA 1998 Intrusion Detection System Evaluation, which aimed to evaluate the ability of intrusion detection systems to detect various types of network attacks.

The dataset includes network connections, each represented by 41 features. The connections are classified into one of five categories: normal, DoS, probe, R2L (unauthorized access from a remote machine), and U2R (unauthorized access to local superuser privileges).

The 41 features include basic features such as duration, protocol type, and service, as well as more detailed features such as number of failed login attempts, number of root accesses, and number of file creations. Some features are continuous, while others are categorical or binary.

1 Load and orgainse the dataset

Download the dataset from Kaggle. Unzip and upload *kddcup.data_10_percent.gz* file into */content* folder of your colab session.

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

```
[ ]: # feature_names found from https://www.kaggle.com/datasets/galaxyh/
      ↪kdd-cup-1999-data?resource=download&select=kddcup.names
     feature_names=['duration',
      'protocol_type',
      'service',
      'flag',
      'src_bytes',
      'dst_bytes',
      'land',
      'wrong_fragment',
      'urgent',
      'hot',
      'num_failed_logins',
      'logged_in',
      'num_compromised',
      'root_shell',
      'su_attempted',
      'num_root',
      'num_file_creations',
      'num_shells',
      'num_access_files',
      'num_outbound_cmds',
      'is_host_login',
      'is_guest_login',
      'count',
      'srv_count',
      'serror_rate',
      'srv_serror_rate',
      'rerror_rate',
      'srv_rerror_rate',
      'same_srv_rate',
      'diff_srv_rate',
      'srv_diff_host_rate',
      'dst_host_count',
      'dst_host_srv_count',
      'dst_host_same_srv_rate',
      'dst_host_diff_srv_rate',
      'dst_host_same_src_port_rate',
      'dst_host_srv_diff_host_rate',
      'dst_host_serror_rate',
      'dst_host_srv_serror_rate',
      'dst_host_rerror_rate',
      'dst_host_srv_rerror_rate',
      'target']
```

[ ]:
```
len(feature_names)
```

[ ]:
```
42
```

[ ]:
```
# attack_types found from https://www.kaggle.com/datasets/galaxyh/
 ↪kdd-cup-1999-data?resource=download&select=training_attack_types
# dot (.) added with each type to match the dataset
attack_types = {
    'normal.': 'normal',
    'back.': 'dos',
    'buffer_overflow.': 'u2r',
    'ftp_write.': 'r2l',
    'guess_passwd.': 'r2l',
    'imap.': 'r2l',
    'ipsweep.': 'probe',
    'land.': 'dos',
    'loadmodule.': 'u2r',
    'multihop.': 'r2l',
    'neptune.': 'dos',
    'nmap.': 'probe',
    'perl.': 'u2r',
    'phf.': 'r2l',
    'pod.': 'dos',
    'portsweep.': 'probe',
    'rootkit.': 'u2r',
    'satan.': 'probe',
    'smurf.': 'dos',
    'spy.': 'r2l',
    'teardrop.': 'dos',
    'warezclient.': 'r2l',
    'warezmaster.': 'r2l',
}
```

```
[ ]: # Load the dataset
     df = pd.read_csv("kddcup.data_10_percent.gz", names=feature_names)
```

```
[ ]: df
```

```
[ ]:         duration protocol_type service flag  src_bytes  dst_bytes  land  \
     0              0           tcp    http   SF        181       5450     0
     1              0           tcp    http   SF        239        486     0
     2              0           tcp    http   SF        235       1337     0
     3              0           tcp    http   SF        219       1337     0
     4              0           tcp    http   SF        217       2032     0
     …            …           …     …   …          …        …  …
     494016         0           tcp    http   SF        310       1881     0
     494017         0           tcp    http   SF        282       2286     0
     494018         0           tcp    http   SF        203       1200     0
     494019         0           tcp    http   SF        291       1200     0
     494020         0           tcp    http   SF        219       1234     0

             wrong_fragment  urgent  hot  …  dst_host_srv_count  \
     0                    0       0    0  …                   9
     1                    0       0    0  …                  19
     2                    0       0    0  …                  29
```

```
3                     0       0    0  …               39
4                     0       0    0  …               49
…                  …      …   …   …             …
494016                0       0    0  …              255
494017                0       0    0  …              255
494018                0       0    0  …              255
494019                0       0    0  …              255
494020                0       0    0  …              255

        dst_host_same_srv_rate  dst_host_diff_srv_rate  \
0                          1.0                     0.0
1                          1.0                     0.0
2                          1.0                     0.0
3                          1.0                     0.0
4                          1.0                     0.0
…                        …                     …
494016                     1.0                     0.0
494017                     1.0                     0.0
494018                     1.0                     0.0
494019                     1.0                     0.0
494020                     1.0                     0.0

        dst_host_same_src_port_rate  dst_host_srv_diff_host_rate  \
0                              0.11                         0.00
1                              0.05                         0.00
2                              0.03                         0.00
3                              0.03                         0.00
4                              0.02                         0.00
…                             …                          …
494016                         0.01                         0.05
494017                         0.17                         0.05
494018                         0.06                         0.05
494019                         0.04                         0.05
494020                         0.17                         0.05

        dst_host_serror_rate  dst_host_srv_serror_rate  dst_host_rerror_rate  \
0                       0.00                      0.00                   0.0
1                       0.00                      0.00                   0.0
2                       0.00                      0.00                   0.0
3                       0.00                      0.00                   0.0
4                       0.00                      0.00                   0.0
…                    …                       …                    …
494016                  0.00                      0.01                   0.0
494017                  0.00                      0.01                   0.0
494018                  0.06                      0.01                   0.0
494019                  0.04                      0.01                   0.0
494020                  0.00                      0.01                   0.0
```

```
        dst_host_srv_rerror_rate   target
0                            0.0  normal.
1                            0.0  normal.
2                            0.0  normal.
3                            0.0  normal.
4                            0.0  normal.
…                          …        …
494016                       0.0  normal.
494017                       0.0  normal.
494018                       0.0  normal.
494019                       0.0  normal.
494020                       0.0  normal.

[494021 rows x 42 columns]
```

[ ]:
```
df['target'].value_counts()
```

[ ]:
```
smurf.              280790
neptune.            107201
normal.              97278
back.                 2203
satan.                1589
ipsweep.              1247
portsweep.            1040
warezclient.          1020
teardrop.              979
pod.                   264
nmap.                  231
guess_passwd.           53
buffer_overflow.        30
land.                   21
warezmaster.            20
imap.                   12
rootkit.                10
loadmodule.              9
ftp_write.               8
multihop.                7
phf.                     4
perl.                    3
spy.                     2
Name: target, dtype: int64
```

[ ]:
```
attack_types['back.']
```

[ ]:
```
'dos'
```

```
[ ]: # adding attack_type column
     df['attack_type'] = df.target.apply(lambda r:attack_types[r])
```

```
[ ]: df
```

```
[ ]:         duration protocol_type service flag  src_bytes  dst_bytes  land  \
     0              0           tcp    http   SF        181       5450     0
     1              0           tcp    http   SF        239        486     0
     2              0           tcp    http   SF        235       1337     0
     3              0           tcp    http   SF        219       1337     0
     4              0           tcp    http   SF        217       2032     0
     …            …           …     …   …          …         …   …
     494016         0           tcp    http   SF        310       1881     0
     494017         0           tcp    http   SF        282       2286     0
     494018         0           tcp    http   SF        203       1200     0
     494019         0           tcp    http   SF        291       1200     0
     494020         0           tcp    http   SF        219       1234     0

             wrong_fragment  urgent  hot  …  dst_host_same_srv_rate  \
     0                    0       0    0  …                     1.0
     1                    0       0    0  …                     1.0
     2                    0       0    0  …                     1.0
     3                    0       0    0  …                     1.0
     4                    0       0    0  …                     1.0
     …                  …     …   …  …                   …
     494016               0       0    0  …                     1.0
     494017               0       0    0  …                     1.0
     494018               0       0    0  …                     1.0
     494019               0       0    0  …                     1.0
     494020               0       0    0  …                     1.0

             dst_host_diff_srv_rate  dst_host_same_src_port_rate  \
     0                          0.0                         0.11
     1                          0.0                         0.05
     2                          0.0                         0.03
     3                          0.0                         0.03
     4                          0.0                         0.02
     …                        …                         …
     494016                     0.0                         0.01
     494017                     0.0                         0.17
     494018                     0.0                         0.06
     494019                     0.0                         0.04
     494020                     0.0                         0.17

             dst_host_srv_diff_host_rate  dst_host_serror_rate  \
     0                              0.00                  0.00
     1                              0.00                  0.00
```

```
2                            0.00                 0.00
3                            0.00                 0.00
4                            0.00                 0.00
…                             …                   …
494016                       0.05                 0.00
494017                       0.05                 0.00
494018                       0.05                 0.06
494019                       0.05                 0.04
494020                       0.05                 0.00

        dst_host_srv_serror_rate  dst_host_rerror_rate  \
0                           0.00                   0.0
1                           0.00                   0.0
2                           0.00                   0.0
3                           0.00                   0.0
4                           0.00                   0.0
…                            …                   …
494016                      0.01                   0.0
494017                      0.01                   0.0
494018                      0.01                   0.0
494019                      0.01                   0.0
494020                      0.01                   0.0

        dst_host_srv_rerror_rate   target  attack_type
0                            0.0  normal.       normal
1                            0.0  normal.       normal
2                            0.0  normal.       normal
3                            0.0  normal.       normal
4                            0.0  normal.       normal
…                            …      …        …
494016                       0.0  normal.       normal
494017                       0.0  normal.       normal
494018                       0.0  normal.       normal
494019                       0.0  normal.       normal
494020                       0.0  normal.       normal

[494021 rows x 43 columns]
```

[ ]:
```
df.drop(['target'],axis=1,inplace=True)
```

[ ]:
```
df.head()
```

[ ]:
```
   duration protocol_type service flag  src_bytes  dst_bytes  land  \
0         0           tcp    http   SF        181       5450     0
1         0           tcp    http   SF        239        486     0
2         0           tcp    http   SF        235       1337     0
3         0           tcp    http   SF        219       1337     0
```

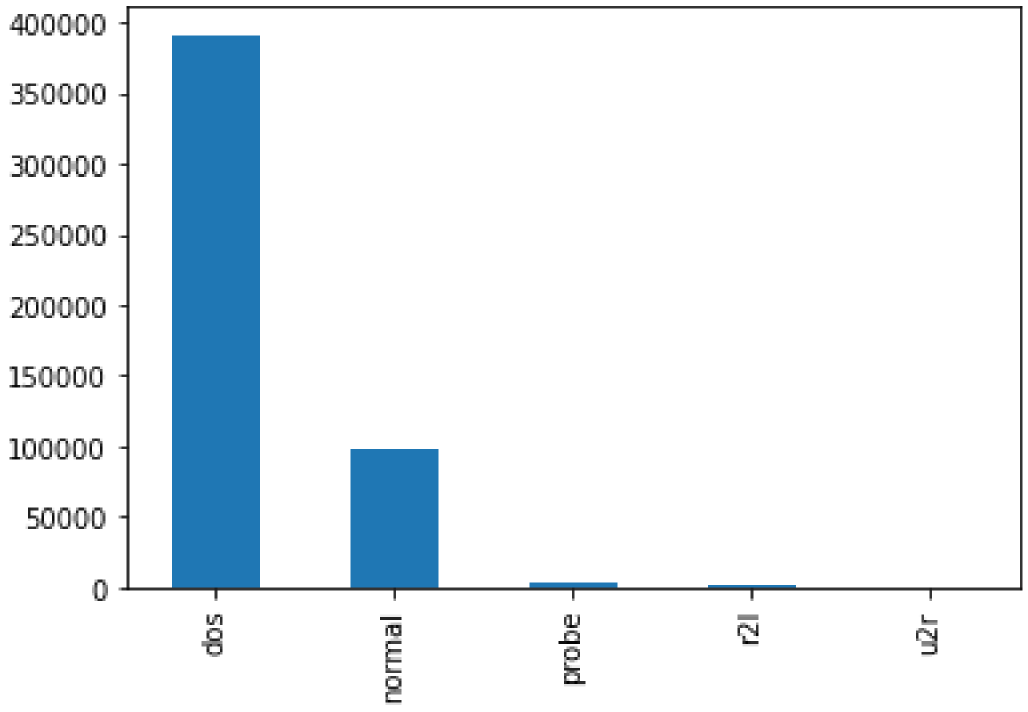
```
4         0           tcp    http   SF        217       2032     0

   wrong_fragment  urgent  hot  …  dst_host_srv_count  \
0               0       0    0  …                   9
1               0       0    0  …                  19
2               0       0    0  …                  29
3               0       0    0  …                  39
4               0       0    0  …                  49

   dst_host_same_srv_rate  dst_host_diff_srv_rate  \
0                     1.0                     0.0
1                     1.0                     0.0
2                     1.0                     0.0
3                     1.0                     0.0
4                     1.0                     0.0

   dst_host_same_src_port_rate  dst_host_srv_diff_host_rate  \
0                         0.11                          0.0
1                         0.05                          0.0
2                         0.03                          0.0
3                         0.03                          0.0
4                         0.02                          0.0

   dst_host_serror_rate  dst_host_srv_serror_rate  dst_host_rerror_rate  \
0                   0.0                       0.0                   0.0
1                   0.0                       0.0                   0.0
2                   0.0                       0.0                   0.0
3                   0.0                       0.0                   0.0
4                   0.0                       0.0                   0.0

   dst_host_srv_rerror_rate  attack_type
0                       0.0       normal
1                       0.0       normal
2                       0.0       normal
3                       0.0       normal
4                       0.0       normal

[5 rows x 42 columns]
```

[ ]:
```
df['attack_type'].value_counts()
```

[ ]:
```
dos       391458
normal     97278
probe       4107
r2l         1126
u2r           52
Name: attack_type, dtype: int64
```

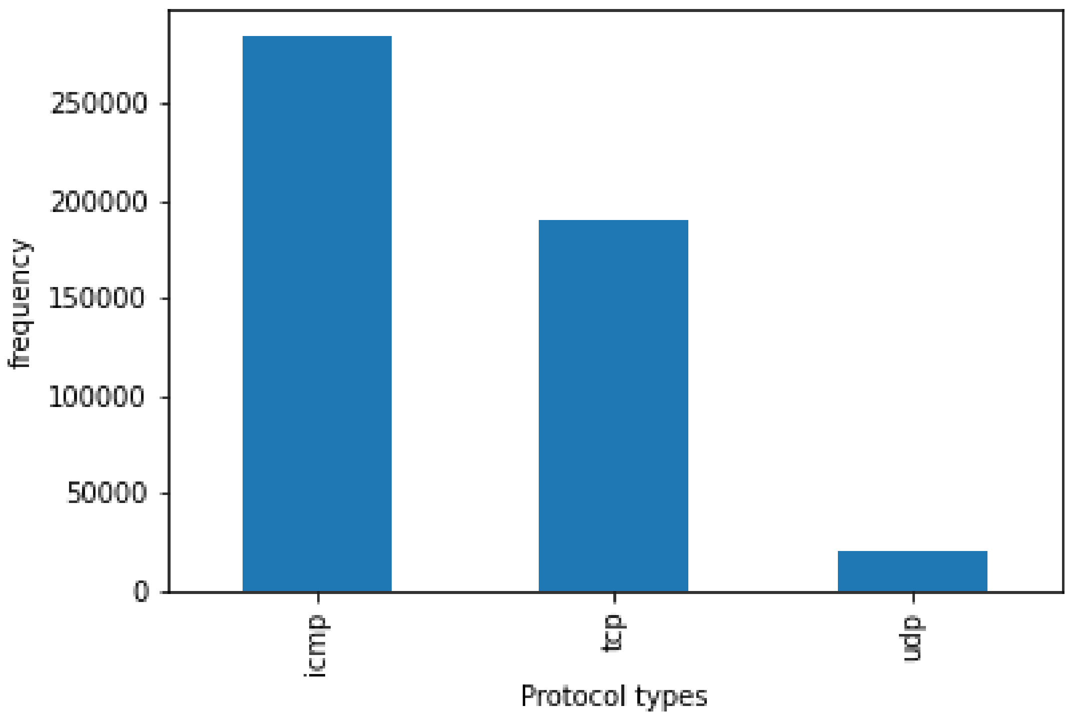
```
[ ]: # Visualisation
     df['attack_type'].value_counts().plot(kind="bar")
```

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



```
[ ]: df['protocol_type'].value_counts().plot(kind="bar",xlabel="Protocol␣
      ↪types",ylabel="frequency")
```

```
[ ]: <Axes: xlabel='Protocol types', ylabel='frequency'>
```



2 Removing NA values and constant features

[ ]:
```
df.isna().any() # checking NA values
```

[ ]:
```
duration                         False
protocol_type                    False
service                          False
flag                             False
src_bytes                        False
dst_bytes                        False
land                             False
wrong_fragment                   False
urgent                           False
hot                              False
num_failed_logins                False
logged_in                        False
num_compromised                  False
root_shell                       False
su_attempted                     False
num_root                         False
num_file_creations               False
num_shells                       False
```

```
num_access_files                  False
num_outbound_cmds                 False
is_host_login                     False
is_guest_login                    False
count                             False
srv_count                         False
serror_rate                       False
srv_serror_rate                   False
rerror_rate                       False
srv_rerror_rate                   False
same_srv_rate                     False
diff_srv_rate                     False
srv_diff_host_rate                False
dst_host_count                    False
dst_host_srv_count                False
dst_host_same_srv_rate            False
dst_host_diff_srv_rate            False
dst_host_same_src_port_rate       False
dst_host_srv_diff_host_rate       False
dst_host_serror_rate              False
dst_host_srv_serror_rate          False
dst_host_rerror_rate              False
dst_host_srv_rerror_rate          False
attack_type                       False
dtype: bool
```

[ ]:
```
# df.dropna('columns',inplace=True)
```

[ ]:
```
df = df[[col for col in df if df[col].nunique()>1]] # keep columns where there␣
 ↪are more than 1 unique values
```

[ ]:
```
df
```

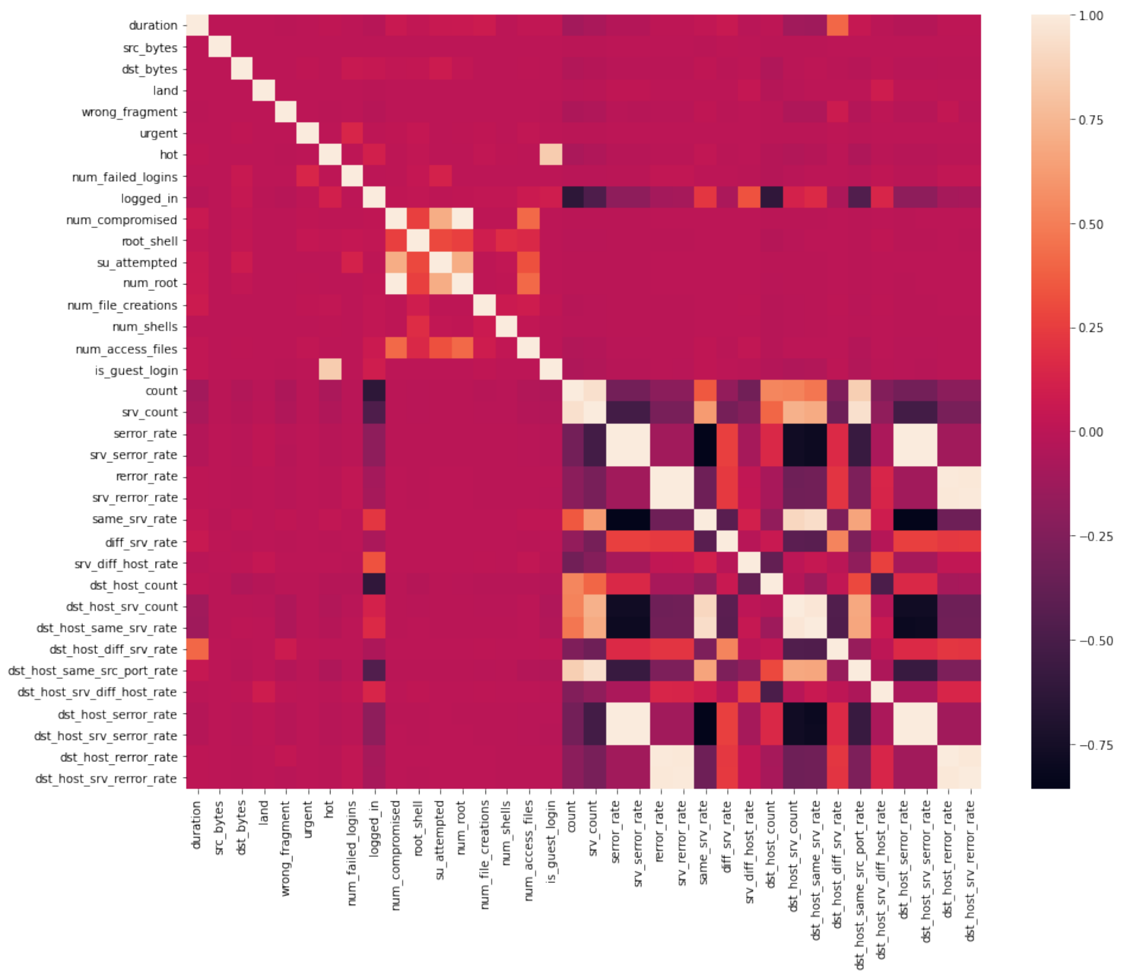
[ ]:
```
        duration protocol_type service flag  src_bytes  dst_bytes  land  \
0              0           tcp    http   SF        181       5450     0
1              0           tcp    http   SF        239        486     0
2              0           tcp    http   SF        235       1337     0
3              0           tcp    http   SF        219       1337     0
4              0           tcp    http   SF        217       2032     0
…            …           …      …   …          …        …   …
494016         0           tcp    http   SF        310       1881     0
494017         0           tcp    http   SF        282       2286     0
494018         0           tcp    http   SF        203       1200     0
494019         0           tcp    http   SF        291       1200     0
494020         0           tcp    http   SF        219       1234     0

        wrong_fragment  urgent  hot  …  dst_host_srv_count  \
0                          0         0     0  …                      9
1                          0         0     0  …                     19
2                          0         0     0  …                     29
3                          0         0     0  …                     39
4                          0         0     0  …                     49
…                      …       …   …   …                  …
494016                     0         0     0  …                    255
494017                     0         0     0  …                    255
494018                     0         0     0  …                    255
494019                     0         0     0  …                    255
494020                     0         0     0  …                    255

        dst_host_same_srv_rate  dst_host_diff_srv_rate  \
0                          1.0                     0.0
1                          1.0                     0.0
2                          1.0                     0.0
3                          1.0                     0.0
4                          1.0                     0.0
…                        …                      …
494016                     1.0                     0.0
494017                     1.0                     0.0
494018                     1.0                     0.0
494019                     1.0                     0.0
494020                     1.0                     0.0

        dst_host_same_src_port_rate  dst_host_srv_diff_host_rate  \
0                              0.11                         0.00
1                              0.05                         0.00
2                              0.03                         0.00
3                              0.03                         0.00
4                              0.02                         0.00
…                             …                           …
494016                         0.01                         0.05
494017                         0.17                         0.05
494018                         0.06                         0.05
494019                         0.04                         0.05
494020                         0.17                         0.05

        dst_host_serror_rate  dst_host_srv_serror_rate  dst_host_rerror_rate  \
0                       0.00                      0.00                   0.0
1                       0.00                      0.00                   0.0
2                       0.00                      0.00                   0.0
3                       0.00                      0.00                   0.0
4                       0.00                      0.00                   0.0
…                     …                         …                    …
494016                  0.00                      0.01                   0.0
494017                  0.00                      0.01                   0.0
```

```
494018                 0.06                      0.01                      0.0
494019                 0.04                      0.01                      0.0
494020                 0.00                      0.01                      0.0

        dst_host_srv_rerror_rate  attack_type
0                            0.0       normal
1                            0.0       normal
2                            0.0       normal
3                            0.0       normal
4                            0.0       normal
…                            …          …
494016                       0.0       normal
494017                       0.0       normal
494018                       0.0       normal
494019                       0.0       normal
494020                       0.0       normal

[494021 rows x 40 columns]
```

3 Removing highly-correlated features

[ ]:
```
corr = df.corr() # Pearson correlation coefficient between the columns
plt.figure(figsize=(15,12)) # creates a new figure with a specified size of 15␣
 ↪inches by 12 inches.
sns.heatmap(corr) # creates a heatmap of the correlation matrix using seaborn
```

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

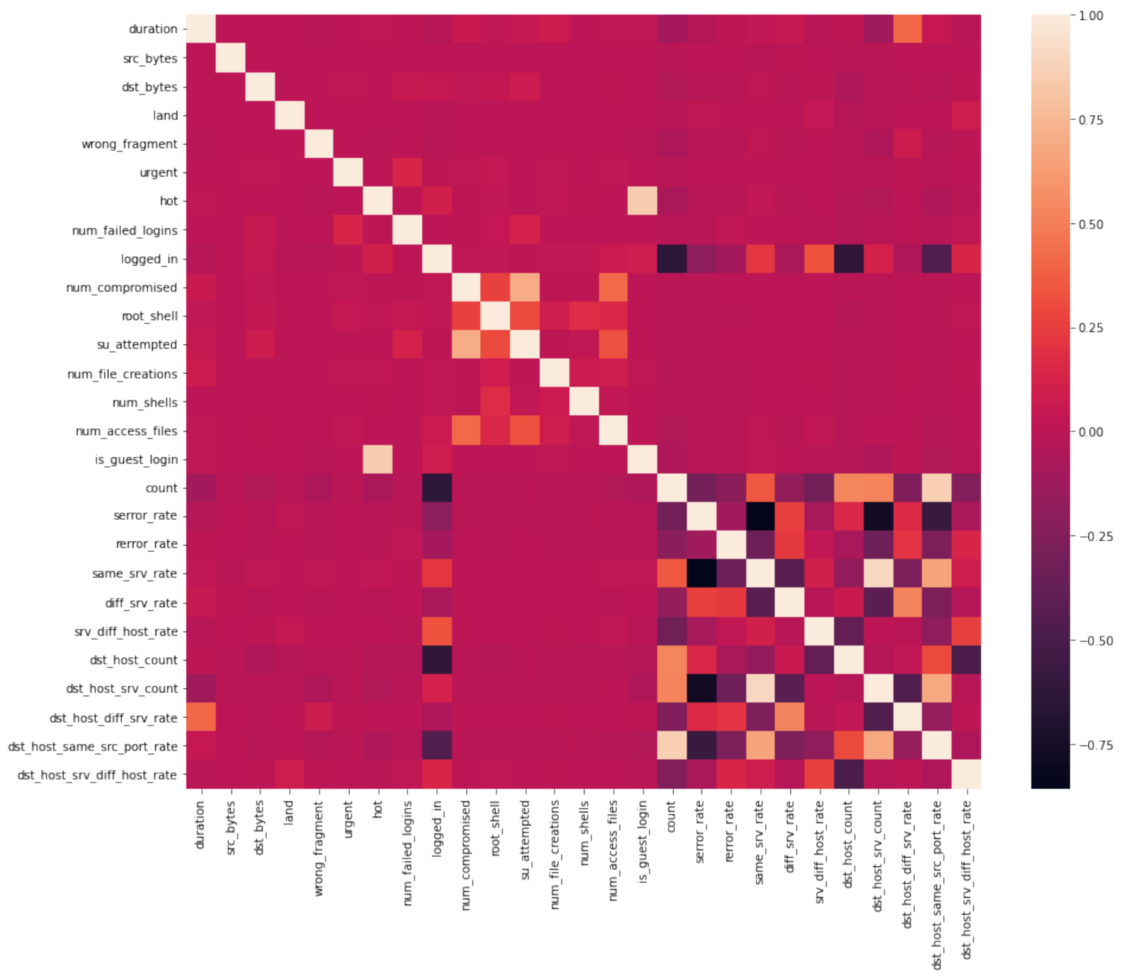


[ ]:
```
# num_root is highly correlated with num_compromised and should be ignored for␣
↪analysis.
df.drop('num_root',axis = 1,inplace = True) # axis=1 specifies that we want to␣
↪drop the columns axis

# srv_serror_rate is highly correlated with serror_rate and should be ignored␣
↪for analysis.
df.drop('srv_serror_rate',axis = 1,inplace = True)

# srv_rerror_rate is highly correlated with rerror_rate and should be ignored␣
↪for analysis.
df.drop('srv_rerror_rate',axis = 1, inplace=True)

# dst_host_srv_serror_rate is highly correlated with srv_serror_rate and should␣
↪be ignored for analysis.
df.drop('dst_host_srv_serror_rate',axis = 1, inplace=True)
```

```
# dst_host_serror_rate is highly correlated with rerror_rate and should be␣
 ↪ignored for analysis.
df.drop('dst_host_serror_rate',axis = 1, inplace=True)

# dst_host_rerror_rate is highly correlated with srv_rerror_rate and should be␣
 ↪ignored for analysis.
df.drop('dst_host_rerror_rate',axis = 1, inplace=True)

# dst_host_srv_rerror_rate is highly correlated with rerror_rate and should be␣
 ↪ignored for analysis.
df.drop('dst_host_srv_rerror_rate',axis = 1, inplace=True)

# dst_host_same_srv_rate is highly correlated with dst_host_srv_count and␣
 ↪should be ignored for analysis.
df.drop('dst_host_same_srv_rate',axis = 1, inplace=True)

# srv_count is highly correlated with count and should be ignored for analysis.
df.drop('srv_count',axis = 1, inplace=True)
```

[ ]:
```
corr = df.corr() # Pearson correlation coefficient between the columns
plt.figure(figsize=(15,12)) # creates a new figure with a specified size of 15␣
 ↪inches by 12 inches.
sns.heatmap(corr) # creates a heatmap of the correlation matrix using seaborn
```

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



4 Label encoding the features

```
[ ]: df
```

```
[ ]:         duration protocol_type service flag  src_bytes  dst_bytes  land  \
     0              0           tcp    http   SF        181       5450     0
     1              0           tcp    http   SF        239        486     0
     2              0           tcp    http   SF        235       1337     0
     3              0           tcp    http   SF        219       1337     0
     4              0           tcp    http   SF        217       2032     0
     …            …           …     …   …          …        …   …
     494016         0           tcp    http   SF        310       1881     0
     494017         0           tcp    http   SF        282       2286     0
     494018         0           tcp    http   SF        203       1200     0
     494019         0           tcp    http   SF        291       1200     0
     494020         0           tcp    http   SF        219       1234     0
```

```
        wrong_fragment  urgent  hot  …  rerror_rate  same_srv_rate  \
0                    0       0    0  …          0.0            1.0
1                    0       0    0  …          0.0            1.0
2                    0       0    0  …          0.0            1.0
3                    0       0    0  …          0.0            1.0
4                    0       0    0  …          0.0            1.0
…                  …      …   …  …          …            …
494016               0       0    0  …          0.0            1.0
494017               0       0    0  …          0.0            1.0
494018               0       0    0  …          0.0            1.0
494019               0       0    0  …          0.0            1.0
494020               0       0    0  …          0.0            1.0

        diff_srv_rate  srv_diff_host_rate  dst_host_count  dst_host_srv_count  \
0                 0.0                0.00               9                   9
1                 0.0                0.00              19                  19
2                 0.0                0.00              29                  29
3                 0.0                0.00              39                  39
4                 0.0                0.00              49                  49
…               …                 …               …                 …
494016            0.0                0.40              86                 255
494017            0.0                0.00               6                 255
494018            0.0                0.17              16                 255
494019            0.0                0.17              26                 255
494020            0.0                0.14               6                 255

        dst_host_diff_srv_rate  dst_host_same_src_port_rate  \
0                          0.0                         0.11
1                          0.0                         0.05
2                          0.0                         0.03
3                          0.0                         0.03
4                          0.0                         0.02
…                        …                          …
494016                     0.0                         0.01
494017                     0.0                         0.17
494018                     0.0                         0.06
494019                     0.0                         0.04
494020                     0.0                         0.17

        dst_host_srv_diff_host_rate  attack_type
0                              0.00       normal
1                              0.00       normal
2                              0.00       normal
3                              0.00       normal
4                              0.00       normal
…                            …          …
```

```
494016                              0.05       normal
494017                              0.05       normal
494018                              0.05       normal
494019                              0.05       normal
494020                              0.05       normal

[494021 rows x 31 columns]
```

[ ]:
```
df['protocol_type'].value_counts()
```

[ ]:
```
icmp    283602
tcp     190065
udp      20354
Name: protocol_type, dtype: int64
```

[ ]:
```
pmap = {"icmp":0,"tcp":1,"udp":2}
df['protocol_type'] = df['protocol_type'].map(pmap)
```

[ ]:
```
df['protocol_type'].value_counts()
```

[ ]:
```
0    283602
1    190065
2     20354
Name: protocol_type, dtype: int64
```

[ ]:
```
#flag feature mapping
fmap = {'SF':0,'S0':1,'REJ':2,'RSTR':3,'RSTO':4,'SH':5 ,'S1':6 ,'S2':7,'RSTOS0':
 ↪8,'S3':9 ,'OTH':10}
df['flag'] = df['flag'].map(fmap)
```

[ ]:
```
#attack type feature mapping
amap = {'dos':0,'normal':1,'probe':2,'r2l':3,'u2r':4}
df['attack_type'] = df['attack_type'].map(amap)
```

[ ]:
```
df["service"].value_counts()
```

[ ]:
```
ecr_i       281400
private     110893
http         64293
smtp          9723
other         7237
             …
X11             11
tim_i            7
pm_dump          1
tftp_u           1
red_i            1
```

```
Name: service, Length: 66, dtype: int64
```

[ ]:
```
df.drop('service',axis = 1,inplace= True)
```

[ ]:
```
df
```

[ ]:
```
        duration  protocol_type  flag  src_bytes  dst_bytes  land  \
0              0              1     0        181       5450     0
1              0              1     0        239        486     0
2              0              1     0        235       1337     0
3              0              1     0        219       1337     0
4              0              1     0        217       2032     0
…            …            …    …         …         …    …
494016         0              1     0        310       1881     0
494017         0              1     0        282       2286     0
494018         0              1     0        203       1200     0
494019         0              1     0        291       1200     0
494020         0              1     0        219       1234     0

        wrong_fragment  urgent  hot  num_failed_logins  …  rerror_rate  \
0                    0       0    0                  0  …          0.0
1                    0       0    0                  0  …          0.0
2                    0       0    0                  0  …          0.0
3                    0       0    0                  0  …          0.0
4                    0       0    0                  0  …          0.0
…                  …     …   …                …   …           …
494016               0       0    0                  0  …          0.0
494017               0       0    0                  0  …          0.0
494018               0       0    0                  0  …          0.0
494019               0       0    0                  0  …          0.0
494020               0       0    0                  0  …          0.0

        same_srv_rate  diff_srv_rate  srv_diff_host_rate  dst_host_count  \
0                 1.0            0.0                0.00               9
1                 1.0            0.0                0.00              19
2                 1.0            0.0                0.00              29
3                 1.0            0.0                0.00              39
4                 1.0            0.0                0.00              49
…                …            …                  …              …
494016            1.0            0.0                0.40              86
494017            1.0            0.0                0.00               6
494018            1.0            0.0                0.17              16
494019            1.0            0.0                0.17              26
494020            1.0            0.0                0.14               6

        dst_host_srv_count  dst_host_diff_srv_rate  \
0                        9                     0.0
```

```
1                       19                   0.0
2                       29                   0.0
3                       39                   0.0
4                       49                   0.0
…                      …                    …
494016                 255                   0.0
494017                 255                   0.0
494018                 255                   0.0
494019                 255                   0.0
494020                 255                   0.0

        dst_host_same_src_port_rate  dst_host_srv_diff_host_rate  attack_type
0                              0.11                         0.00            1
1                              0.05                         0.00            1
2                              0.03                         0.00            1
3                              0.03                         0.00            1
4                              0.02                         0.00            1
…                              …                            …          …
494016                         0.01                         0.05            1
494017                         0.17                         0.05            1
494018                         0.06                         0.05            1
494019                         0.04                         0.05            1
494020                         0.17                         0.05            1

[494021 rows x 30 columns]
```

5 Scaling

[ ]:
```
from sklearn.preprocessing import MinMaxScaler
```

[ ]:
```
y = df[['attack_type']]
X = df.drop(['attack_type'],axis=1)
```

[ ]:
```
y
```

[ ]:
```
        attack_type
0                 1
1                 1
2                 1
3                 1
4                 1
…              …
494016            1
494017            1
494018            1
494019            1
```

```
494020            1

[494021 rows x 1 columns]
```

[ ]:
```
X
```

[ ]:
```
        duration  protocol_type  flag  src_bytes  dst_bytes  land  \
0              0              1     0        181       5450     0
1              0              1     0        239        486     0
2              0              1     0        235       1337     0
3              0              1     0        219       1337     0
4              0              1     0        217       2032     0
…            …              …   …        …        …    …
494016         0              1     0        310       1881     0
494017         0              1     0        282       2286     0
494018         0              1     0        203       1200     0
494019         0              1     0        291       1200     0
494020         0              1     0        219       1234     0

        wrong_fragment  urgent  hot  num_failed_logins  …  serror_rate  \
0                    0       0    0                  0  …         0.00
1                    0       0    0                  0  …         0.00
2                    0       0    0                  0  …         0.00
3                    0       0    0                  0  …         0.00
4                    0       0    0                  0  …         0.00
…                  …     …   …                …   …          …
494016               0       0    0                  0  …         0.00
494017               0       0    0                  0  …         0.00
494018               0       0    0                  0  …         0.17
494019               0       0    0                  0  …         0.00
494020               0       0    0                  0  …         0.00

        rerror_rate  same_srv_rate  diff_srv_rate  srv_diff_host_rate  \
0               0.0            1.0            0.0                0.00
1               0.0            1.0            0.0                0.00
2               0.0            1.0            0.0                0.00
3               0.0            1.0            0.0                0.00
4               0.0            1.0            0.0                0.00
…            …              …            …                 …
494016          0.0            1.0            0.0                0.40
494017          0.0            1.0            0.0                0.00
494018          0.0            1.0            0.0                0.17
494019          0.0            1.0            0.0                0.17
494020          0.0            1.0            0.0                0.14

        dst_host_count  dst_host_srv_count  dst_host_diff_srv_rate  \
0                    9                   9                     0.0
```

```
1                    19                  19                      0.0
2                    29                  29                      0.0
3                    39                  39                      0.0
4                    49                  49                      0.0
…                 …                  …                     …
494016               86                 255                      0.0
494017                6                 255                      0.0
494018               16                 255                      0.0
494019               26                 255                      0.0
494020                6                 255                      0.0

        dst_host_same_src_port_rate  dst_host_srv_diff_host_rate
0                              0.11                         0.00
1                              0.05                         0.00
2                              0.03                         0.00
3                              0.03                         0.00
4                              0.02                         0.00
…                             …                            …
494016                         0.01                         0.05
494017                         0.17                         0.05
494018                         0.06                         0.05
494019                         0.04                         0.05
494020                         0.17                         0.05

[494021 rows x 29 columns]
```

```
[ ]: scaler = MinMaxScaler() #  MinMaxScaler scales the data to a fixed range (by␣
      ↪default, between 0 and 1) by subtracting the minimum value and dividing by␣
      ↪the range of the data.
     X = scaler.fit_transform(X)
```

```
[ ]: X
```

```
[ ]: array([[0.  , 0.5 , 0.  , …, 0.  , 0.11, 0.  ],
            [0.  , 0.5 , 0.  , …, 0.  , 0.05, 0.  ],
            [0.  , 0.5 , 0.  , …, 0.  , 0.03, 0.  ],
            …,
            [0.  , 0.5 , 0.  , …, 0.  , 0.06, 0.05],
            [0.  , 0.5 , 0.  , …, 0.  , 0.04, 0.05],
            [0.  , 0.5 , 0.  , …, 0.  , 0.17, 0.05]])
```

6 Train-test split

```
[ ]: from sklearn.model_selection import train_test_split
[ ]: # Split test and train data
     X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.33,␣
      ↪random_state=42)
     print(X_train.shape, X_test.shape)
     print(y_train.shape, y_test.shape)
```

```
(330994, 29) (163027, 29)
(330994, 1) (163027, 1)
```

```
[ ]: X_train.shape[1]
```

```
[ ]: 29
```

NB: Parts of this program is taken and improved from https://www.kaggle.com/code/iamyajat/intrusion-detection-system-using-neural-networks, which has been released under the Apache 2.0 open source license

7 Practice task

Visulalise at least 10 features of the KDD Cup dataset using different types of plots (such as bar, histogram, line, etc.).