HengLiEnShaun_task2

August 26, 2021

[1]:
```
# import tensorflow and keras
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers
from keras_tuner.tuners import RandomSearch
from sklearn.model_selection import train_test_split
from matplotlib import pyplot as plt

# importing helper library
import pandas as pd
import numpy as np
```

[2]:
```
import csv
# reading in sample dataset
df=pd.read_csv('kddcup.data_10_percent_corrected.csv',␣
 ↪names=('duration','protocol_type','service','flag','src_bytes','dst_bytes','land','wrong_fr
# df=pd.read_csv('d:\\316Tute\\data\\RealCombine.csv')
df.head(10)
```

[2]:

	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	
5	0	tcp	http	SF	217	2032	0	
6	0	tcp	http	SF	212	1940	0	
7	0	tcp	http	SF	159	4087	0	
8	0	tcp	http	SF	210	151	0	
9	0	tcp	http	SF	212	786	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	
5	0	0	0	…	59	

```
6               0       0    0  …                  69
7               0       0    0  …                  79
8               0       0    0  …                  89
9               0       0    1  …                  99

   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
5                     1.0                     0.0
6                     1.0                     0.0
7                     1.0                     0.0
8                     1.0                     0.0
9                     1.0                     0.0

   dst_host_same_srv_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
5                         0.02                         0.00
6                         1.00                         0.04
7                         0.09                         0.04
8                         0.12                         0.04
9                         0.12                         0.05

   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
5                   0.0                       0.0                   0.0
6                   0.0                       0.0                   0.0
7                   0.0                       0.0                   0.0
8                   0.0                       0.0                   0.0
9                   0.0                       0.0                   0.0

   dst_host_srv_error_rate  connection
0                      0.0     normal.
1                      0.0     normal.
2                      0.0     normal.
3                      0.0     normal.
4                      0.0     normal.
```

```
5                     0.0     normal.
6                     0.0     normal.
7                     0.0     normal.
8                     0.0     normal.
9                     0.0     normal.

[10 rows x 42 columns]
```

[3]:
```
#checking for columns with only 1 value
columns = list(df)
for column in columns:
    if len(df[column].unique())==1:
        print(column)
```

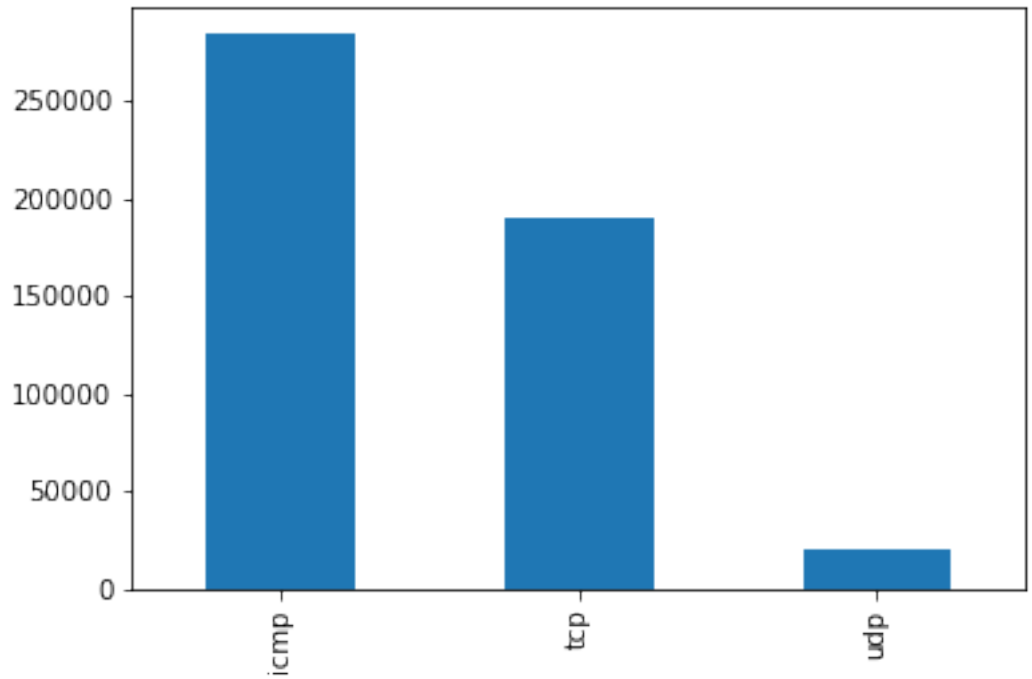
```
num_outbound_cmds
is_host_login
```

[4]:
```
df = df.drop(['num_outbound_cmds', 'is_host_login'], axis=1)
```

0.1 Displaying string column counts

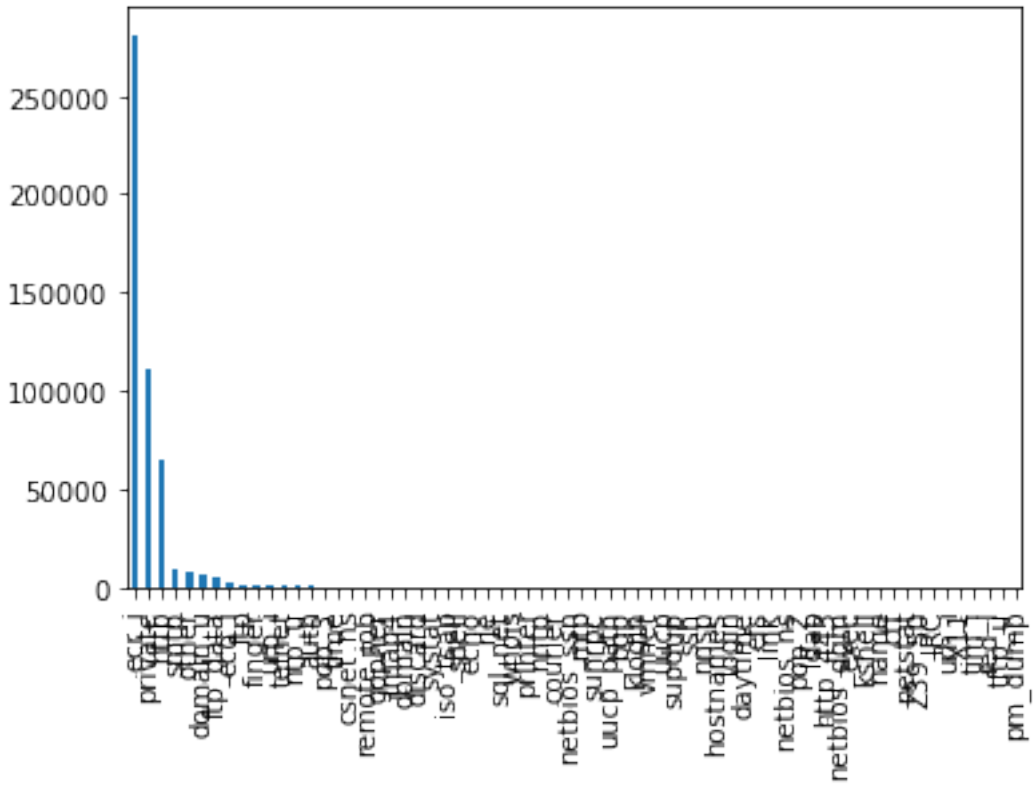
[5]:
```
import seaborn as sb
df['protocol_type'].value_counts().plot(kind='bar')
```

[5]: <AxesSubplot:>



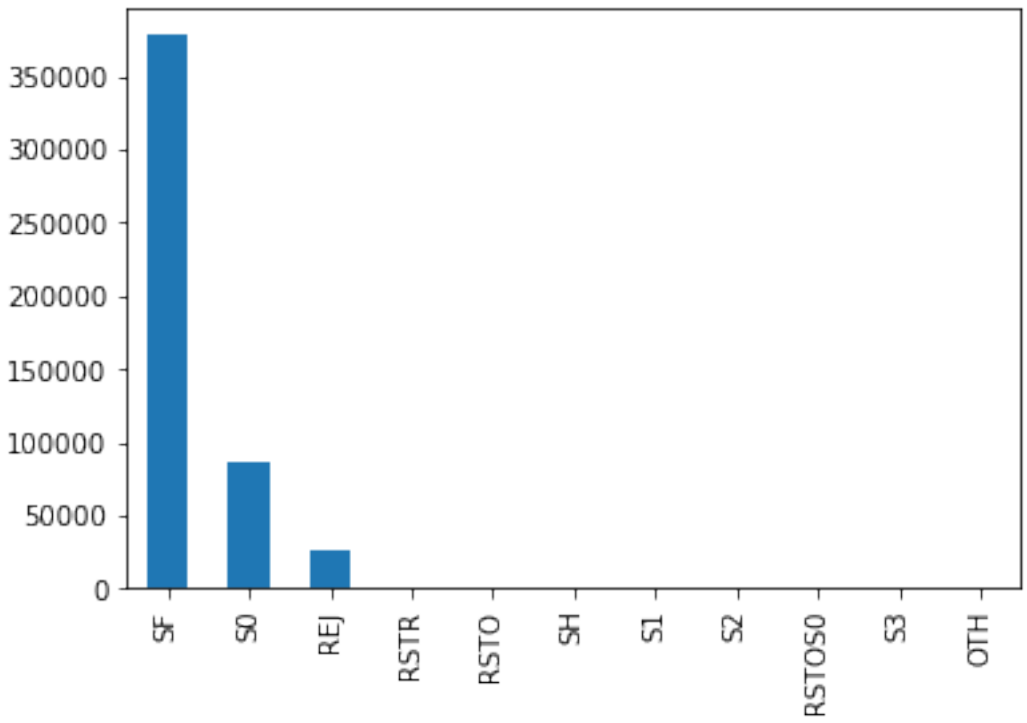
[6]:
```
df['service'].value_counts().plot(kind='bar')
```

[6]: <AxesSubplot:>



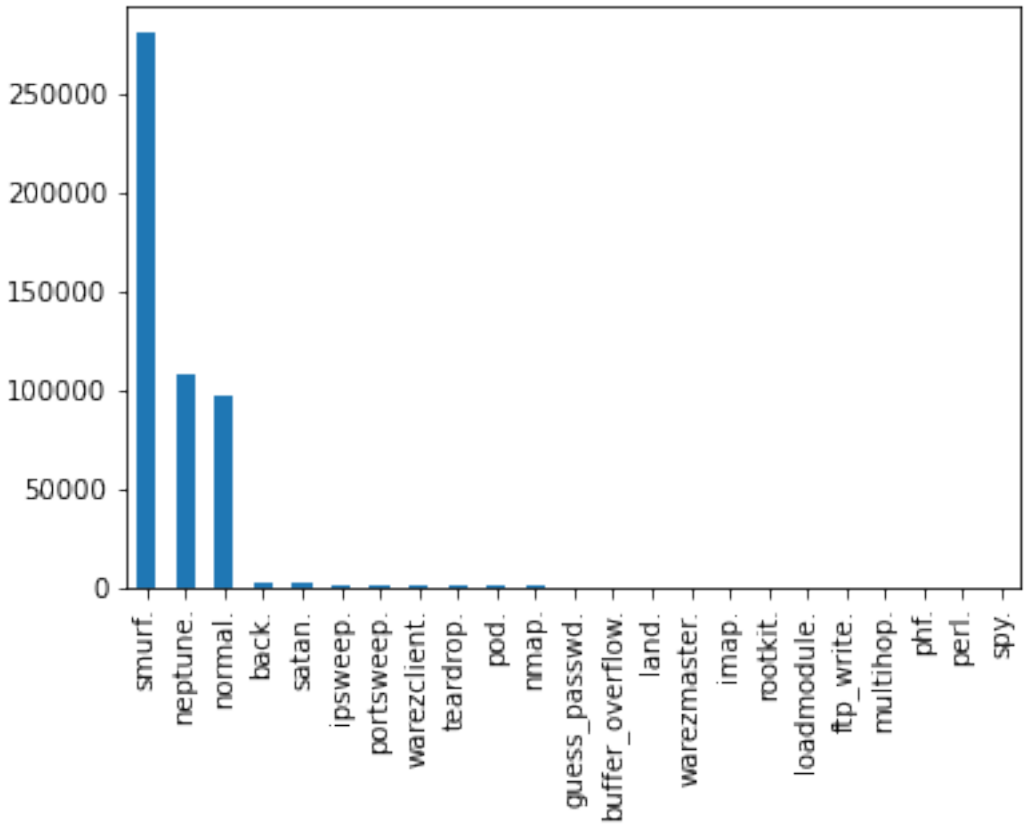
[7]:
```
df['flag'].value_counts().plot(kind='bar')
```

[7]: <AxesSubplot:>



[8]:
```
df['connection'].value_counts().plot(kind='bar')
```

[8]: <AxesSubplot:>



0.2 Changing string data to integer/float

[9]:
```
df = df.replace('icmp', 1)
df = df.replace('tcp', 2)
df = df.replace('udp', 3)
df
```

[9]:

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

[10]:
```
dfconn = df.connection.value_counts()
dfconnlist = dfconn.keys().tolist()
for i in range(len(dfconnlist)):
    df = df.replace(dfconnlist[i], i+1)
df
```

[10]:
```
        duration  protocol_type service flag  src_bytes  dst_bytes  land  \
0              0              2    http   SF        181       5450     0
1              0              2    http   SF        239        486     0
2              0              2    http   SF        235       1337     0
3              0              2    http   SF        219       1337     0
4              0              2    http   SF        217       2032     0
…            …              …      …  …         …         …   …
494016         0              2    http   SF        310       1881     0
494017         0              2    http   SF        282       2286     0
494018         0              2    http   SF        203       1200     0
494019         0              2    http   SF        291       1200     0
494020         0              2    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_srv_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_error_rate  connection
0                           0.0           3
1                           0.0           3
```

```
2                          0.0           3
3                          0.0           3
4                          0.0           3
…                          …             …
494016                     0.0           3
494017                     0.0           3
494018                     0.0           3
494019                     0.0           3
494020                     0.0           3

[494021 rows x 40 columns]
```

[11]:
```
dfservice = df.service.value_counts()
dfservicelist = dfservice.keys().tolist()
for i in range(len(dfservicelist)):
    df = df.replace(dfservicelist[i], i+1)
df
```

[11]:
```
        duration  protocol_type  service flag  src_bytes  dst_bytes  land  \
0              0              2        3   SF        181       5450     0
1              0              2        3   SF        239        486     0
2              0              2        3   SF        235       1337     0
3              0              2        3   SF        219       1337     0
4              0              2        3   SF        217       2032     0
…            …              …        …   …         …         …    …
494016         0              2        3   SF        310       1881     0
494017         0              2        3   SF        282       2286     0
494018         0              2        3   SF        203       1200     0
494019         0              2        3   SF        291       1200     0
494020         0              2        3   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_srv_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_error_rate  connection
0                           0.0           3
1                           0.0           3
2                           0.0           3
3                           0.0           3
4                           0.0           3
…                           …             …
494016                      0.0           3
494017                      0.0           3
494018                      0.0           3
494019                      0.0           3
```

```
494020                      0.0           3

[494021 rows x 40 columns]
```

[12]:
```
dfflag = df.flag.value_counts()
dfflaglist = dfflag.keys().tolist()
for i in range(len(dfflaglist)):
    df = df.replace(dfflaglist[i], i+1)
df
```

[12]:
```
        duration  protocol_type  service  flag  src_bytes  dst_bytes  land  \
0              0              2        3     1        181       5450     0
1              0              2        3     1        239        486     0
2              0              2        3     1        235       1337     0
3              0              2        3     1        219       1337     0
4              0              2        3     1        217       2032     0
…            …              …        …   …          …          …   …
494016         0              2        3     1        310       1881     0
494017         0              2        3     1        282       2286     0
494018         0              2        3     1        203       1200     0
494019         0              2        3     1        291       1200     0
494020         0              2        3     1        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_srv_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_error_rate  connection
0                           0.0           3
1                           0.0           3
2                           0.0           3
3                           0.0           3
4                           0.0           3
…                            …           …
494016                      0.0           3
494017                      0.0           3
494018                      0.0           3
494019                      0.0           3
494020                      0.0           3

[494021 rows x 40 columns]
```

[13]:
```
# Splitting the dataset into dependent (y) and independent features (X)
X = df.iloc[:,0:39]  # independent features
y = df.iloc[:,39]    # dependent features
```

[14]:
```
X
```

[14]:

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

	wrong_fragment	urgent	hot	…	dst_host_count	dst_host_srv_count	\
0	0	0	0	…	9	9	
1	0	0	0	…	19	19	
2	0	0	0	…	29	29	
3	0	0	0	…	39	39	
4	0	0	0	…	49	49	
…	…	…	…	…	…	…	
494016	0	0	0	…	86	255	
494017	0	0	0	…	6	255	
494018	0	0	0	…	16	255	
494019	0	0	0	…	26	255	
494020	0	0	0	…	6	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_srv_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_error_rate
0                           0.0
1                           0.0
2                           0.0
3                           0.0
4                           0.0
…                           …
494016                      0.0
494017                      0.0
494018                      0.0
494019                      0.0
494020                      0.0

[494021 rows x 39 columns]
```

[15]:
```
y
```

[15]:
```
0         3
1         3
2         3
3         3
4         3
         ..
494016    3
494017    3
494018    3
494019    3
```

```
494020    3
Name: connection, Length: 494021, dtype: int64
```

[16]:
```
XTrain, XTest, yTrain, yTest = train_test_split(X, y, test_size=0.33,␣
↪random_state=50)

print('========== Before stratify ==========')
print(XTrain.value_counts())
print(yTrain.value_counts())
print(XTrain.shape, yTrain.shape)
print(XTest.shape, yTest.shape)
```

```
========== Before stratify ==========
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  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_srv_port_rate  dst_host_srv_diff_host_rate
dst_host_serror_rate  dst_host_srv_serror_rate  dst_host_rerror_rate
dst_host_srv_error_rate
0         1              1        1     1032       0          0     0
0       0    0                  0          0               0           0
0         0                  0          0               0              511
511        0.0          0.0             0.0          0.0             1.0
0.0            0.00               255            255               1.00
0.00                   1.00                         0.00
0.0                  0.00                       0.00                 0.0
129656
                                        520        0          0     0
0       0    0                  0          0               0           0
0         0                  0          0               0              511
511        0.0          0.0             0.0          0.0             1.0
0.0            0.00               255            255               1.00
0.00                   1.00                         0.00
0.0                  0.00                       0.00                 0.0
22444
                                       1032       0          0     0
0       0    0                  0          0               0           0
0         0                  0          0               0              510
510        0.0          0.0             0.0          0.0             1.0
0.0            0.00               255            255               1.00
0.00                   1.00                         0.00
0.0                  0.00                       0.00                 0.0
17609
      509    509        0.0          0.0             0.0          0.0
1.0           0.0            0.00               255            255
```

1.00 0.00 1.00
0.00 0.0 0.00
0.00 0.0 3461
508 508 0.0 0.0 0.0 0.0
1.0 0.0 0.00 255 255
1.00 0.00 1.00
0.00 0.0 0.00
0.00 0.0 872
…
2 3 1 204 2182 0 0
0 0 0 1 0 0 0 0
0 0 0 0 0 3
3 0.0 0.0 0.0 0.0 1.0
0.0 0.00 7 255 1.00
0.00 0.14 0.02
0.0 0.00 0.00 0.0
1

2167 0 0
0 0 0 1 0 0 0 0
0 0 0 0 0 4
22 0.0 0.0 0.0 0.0 1.0
0.0 0.18 4 255 1.00
0.00 0.25 0.05
0.0 0.00 0.00 0.0
1

1996 0 0
0 0 0 1 0 0 0 0
0 0 0 0 0 10
10 0.0 0.0 0.0 0.0 1.0
0.0 0.00 10 255 1.00
0.00 0.10 0.06
0.0 0.01 0.00 0.0
1

1948 0 0
0 0 0 1 0 0 0 0
0 0 0 0 0 3
4 0.0 0.0 0.0 0.0 1.0
0.0 0.50 63 255 1.00
0.00 0.02 0.03
0.0 0.00 0.00 0.0
1
41065 2 3 4 1 0 0 0 0
0 0 0 0 0 0 0 0
0 0 0 0 0 2
3 0.0 0.0 1.0 1.0 1.0
0.0 0.67 255 2 0.01
0.32 0.62 0.00
0.0 0.00 0.62 1.0

```
1
Length: 102669, dtype: int64
1     188538
2      71687
3      64961
4       1466
5       1032
6        818
8        690
7        676
9        657
10       182
11       162
12        39
13        17
15        15
14        14
17        10
16         9
18         5
19         5
20         5
22         3
21         2
23         1
Name: connection, dtype: int64
(330994, 39) (330994,)
(163027, 39) (163027,)
```

0.3 Building the model

[17]:
```
# defining the tuning model
model = tf.keras.Sequential() # Initializing a keras sequential model (Dense␣
 ↪and fully connected layers)
#model.add(keras.layers.Dense(16, input_dim=8, activation='relu')) # First␣
 ↪hidden layer that contains 12 neurons
model.add(keras.layers.Dense(32, activation='relu')) # First hidden layer that␣
 ↪contains 12 neurons
model.add(keras.layers.Dense(64, activation='relu')) # second hidden layer with␣
 ↪8 neurons
model.add(keras.layers.Dense(1, activation='sigmoid')) # Output layer
```

[18]:
```
# Compile the model
# model.compile(optimizer='adam',
#               loss=keras.losses.SparseCategoricalCrossentropy(from_logits=True)
# )
model.compile(
```

```
        optimizer=keras.optimizers.Adam(),
        loss='binary_crossentropy',  # classification problem
        metrics=['accuracy']
    )
```

[19]:
```
# running (fitting) the model
model.fit(XTrain, yTrain, epochs=20, batch_size=10)
```

```
Epoch 1/20
33100/33100 [==============================] - 18s 526us/step - loss:
-353391136.0000 - accuracy: 0.5696
Epoch 2/20
33100/33100 [==============================] - 18s 533us/step - loss:
-1677357824.0000 - accuracy: 0.5696
Epoch 3/20
33100/33100 [==============================] - 18s 534us/step - loss:
-6346937856.0000 - accuracy: 0.5696
Epoch 4/20
33100/33100 [==============================] - 18s 536us/step - loss:
-11707570176.0000 - accuracy: 0.5696
Epoch 5/20
33100/33100 [==============================] - 18s 548us/step - loss:
-31769745408.0000 - accuracy: 0.5696
Epoch 6/20
33100/33100 [==============================] - 18s 529us/step - loss:
-45984153600.0000 - accuracy: 0.5696
Epoch 7/20
33100/33100 [==============================] - 17s 519us/step - loss:
-75814543360.0000 - accuracy: 0.5696
Epoch 8/20
33100/33100 [==============================] - 17s 512us/step - loss:
-104010293248.0000 - accuracy: 0.5696
Epoch 9/20
33100/33100 [==============================] - 18s 535us/step - loss:
-153595691008.0000 - accuracy: 0.5696
Epoch 10/20
33100/33100 [==============================] - 17s 525us/step - loss:
-228764975104.0000 - accuracy: 0.5696
Epoch 11/20
33100/33100 [==============================] - 17s 525us/step - loss:
-310190243840.0000 - accuracy: 0.5696
Epoch 12/20
33100/33100 [==============================] - 18s 538us/step - loss:
-399598714880.0000 - accuracy: 0.5696
Epoch 13/20
33100/33100 [==============================] - 17s 523us/step - loss:
-507800780800.0000 - accuracy: 0.5696
Epoch 14/20
```

```
33100/33100 [==============================] - 17s 521us/step - loss:
-641099169792.0000 - accuracy: 0.5696
Epoch 15/20
33100/33100 [==============================] - 17s 520us/step - loss:
-786611765248.0000 - accuracy: 0.5696
Epoch 16/20
33100/33100 [==============================] - 17s 524us/step - loss:
-962231795712.0000 - accuracy: 0.5696
Epoch 17/20
33100/33100 [==============================] - 18s 533us/step - loss:
-1226863935488.0000 - accuracy: 0.5696
Epoch 18/20
33100/33100 [==============================] - 18s 531us/step - loss:
-1421913620480.0000 - accuracy: 0.5696
Epoch 19/20
33100/33100 [==============================] - 18s 543us/step - loss:
-1597775937536.0000 - accuracy: 0.5696
Epoch 20/20
33100/33100 [==============================] - 17s 527us/step - loss:
-1859571810304.0000 - accuracy: 0.5696
```

[19]:
```
<tensorflow.python.keras.callbacks.History at 0x23d07e45bb0>
```

[20]:
```
print('========== Evaluation:')
model.evaluate(XTrain, yTrain)
```

```
========== Evaluation:
10344/10344 [==============================] - 4s 384us/step - loss:
-2065514889216.0000 - accuracy: 0.5696
```

[20]:
```
[-2065514889216.0, 0.5696115493774414]
```

[21]:
```
model.evaluate(XTest, yTest)
```

```
5095/5095 [==============================] - 2s 403us/step - loss:
-1294541258752.0000 - accuracy: 0.5659
```

[21]:
```
[-1294541258752.0, 0.5658694505691528]
```

0.3.1 20/20 epochs have 56.96 accuracy

0.4 Tuning model

[22]:
```
# defining the tuning model
def buildModel(hp):
    model = keras.Sequential()
    for i in range(hp.Int('numLayers', 2, 20)):
        model.add(layers.Dense(units=hp.Int('units_' + str(i),
                                            min_value=32,
```

```
                                                max_value=512,
                                                step=32),
                                    activation='relu'))

    #model.add(layers.Dense(1, activation='linear'))
    model.add(layers.Dense(1, activation='sigmoid'))

    model.compile(
        optimizer=keras.optimizers.Adam(
            #hp.Choice('learning_rate', [1e-2, 1e-3, 1e-4])),
            hp.Choice('learning_rate', [1e-2, 1e-4])),
            #loss='mean_absolute_error',
            #metrics=['mean_absolute_error']
            loss = 'binary_crossentropy',
            metrics=['accuracy']
    )
    return model
```

[34]:
```
tuner = RandomSearch(
    buildModel,
    # objective = 'val_mean_absolute_error',
    objective = 'val_accuracy',
    max_trials = 5,
    executions_per_trial = 2,
    directory = 'a2t2',
    project_name = 'condition'
)
```

[35]:
```
tuner.search_space_summary()
```

```
Search space summary
Default search space size: 4
numLayers (Int)
{'default': None, 'conditions': [], 'min_value': 2, 'max_value': 20, 'step': 1,
'sampling': None}
units_0 (Int)
{'default': None, 'conditions': [], 'min_value': 32, 'max_value': 512, 'step':
32, 'sampling': None}
units_1 (Int)
{'default': None, 'conditions': [], 'min_value': 32, 'max_value': 512, 'step':
32, 'sampling': None}
learning_rate (Choice)
{'default': 0.01, 'conditions': [], 'values': [0.01, 0.0001], 'ordered': True}
```

[36]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.33,␣
 ↪random_state=42)
```

[37]:
```
X_train
```

[37]:

	duration	protocol_type	service	flag	src_bytes	dst_bytes	land	\
482186	1470	3	5	1	147	105	0	
302290	0	1	1	1	1032	0	0	
9330	0	1	1	1	1032	0	0	
91417	6	2	4	1	2872	335	0	
293169	0	1	1	1	1032	0	0	
…	…	…	…	…	…	…	…	
259178	0	1	1	1	1032	0	0	
365838	0	2	2	2	0	0	0	
131932	0	1	1	1	1032	0	0	
146867	9141	3	5	1	147	105	0	
121958	0	2	2	2	0	0	0	

	wrong_fragment	urgent	hot	…	dst_host_count	dst_host_srv_count	\
482186	0	0	0	…	255	1	
302290	0	0	0	…	255	255	
9330	0	0	0	…	255	255	
91417	0	0	0	…	188	186	
293169	0	0	0	…	255	255	
…	…	…	…	…	…	…	
259178	0	0	0	…	255	255	
365838	0	0	0	…	255	8	
131932	0	0	0	…	255	255	
146867	0	0	0	…	255	3	
121958	0	0	0	…	255	5	

	dst_host_same_srv_rate	dst_host_diff_srv_rate	\
482186	0.00	0.82	
302290	1.00	0.00	
9330	1.00	0.00	
91417	0.67	0.02	
293169	1.00	0.00	
…	…	…	
259178	1.00	0.00	
365838	0.03	0.06	
131932	1.00	0.00	
146867	0.01	0.41	
121958	0.02	0.07	

	dst_host_same_srv_port_rate	dst_host_srv_diff_host_rate	\
482186	1.00	0.00	
302290	1.00	0.00	
9330	1.00	0.00	
91417	0.01	0.01	
293169	1.00	0.00	

```
…                              …                              …
259178                          1.00                           0.00
365838                          0.00                           0.00
131932                          1.00                           0.00
146867                          0.84                           0.00
121958                          0.00                           0.00

        dst_host_serror_rate  dst_host_srv_serror_rate  dst_host_rerror_rate  \
482186                   0.0                       0.0                   0.0
302290                   0.0                       0.0                   0.0
9330                     0.0                       0.0                   0.0
91417                    0.0                       0.0                   0.0
293169                   0.0                       0.0                   0.0
…                          …                         …                     …
259178                   0.0                       0.0                   0.0
365838                   1.0                       1.0                   0.0
131932                   0.0                       0.0                   0.0
146867                   0.0                       0.0                   0.0
121958                   1.0                       1.0                   0.0

        dst_host_srv_error_rate
482186                      0.0
302290                      0.0
9330                        0.0
91417                       0.0
293169                      0.0
…                             …
259178                      0.0
365838                      0.0
131932                      0.0
146867                      0.0
121958                      0.0

[330994 rows x 39 columns]
```

[38]:
```
X_test
```

[38]:
```
        duration  protocol_type  service  flag  src_bytes  dst_bytes  land  \
317921         0              1        1     1       1032          0     0
171422         0              1        1     1       1032          0     0
312181         0              1        1     1       1032          0     0
87346          0              2        3     1        345       5419     0
57449          0              2        2     2          0          0     0
…            …              …        …     …          …          …     …
351572         0              2        2     2          0          0     0
378352         0              2        2     2          0          0     0
33349          0              2        3     1        219       2367     0
```

```
119307         0              2        2     2          0          0     0
332656         0              1        1     1       1032          0     0

        wrong_fragment  urgent  hot  …  dst_host_count  dst_host_srv_count  \
317921               0       0    0  …             255                 255
171422               0       0    0  …             255                 255
312181               0       0    0  …             255                 255
87346                0       0    0  …             101                 255
57449                0       0    0  …             255                   2
…                  …     …  …  …  …               …                 …
351572               0       0    0  …             255                  19
378352               0       0    0  …             255                  22
33349                0       0    0  …             255                 255
119307               0       0    0  …             255                  14
332656               0       0    0  …             255                 255

        dst_host_same_srv_rate  dst_host_diff_srv_rate  \
317921                    1.00                    0.00
171422                    1.00                    0.00
312181                    1.00                    0.00
87346                     1.00                    0.00
57449                     0.01                    0.07
…                         …                       …
351572                    0.07                    0.06
378352                    0.09                    0.05
33349                     1.00                    0.00
119307                    0.05                    0.06
332656                    1.00                    0.00

        dst_host_same_srv_port_rate  dst_host_srv_diff_host_rate  \
317921                         1.00                         0.00
171422                         1.00                         0.00
312181                         1.00                         0.00
87346                          0.01                         0.02
57449                          0.00                         0.00
…                              …                            …
351572                         0.00                         0.00
378352                         0.00                         0.00
33349                          0.00                         0.00
119307                         0.00                         0.00
332656                         1.00                         0.00

        dst_host_serror_rate  dst_host_srv_serror_rate  dst_host_rerror_rate  \
317921                   0.0                       0.0                   0.0
171422                   0.0                       0.0                   0.0
312181                   0.0                       0.0                   0.0
87346                    0.0                       0.0                   0.0
```

```
57449                    1.0                      1.0                    0.0
…                        …                        …                      …
351572                   1.0                      1.0                    0.0
378352                   1.0                      1.0                    0.0
33349                    0.0                      0.0                    0.0
119307                   1.0                      1.0                    0.0
332656                   0.0                      0.0                    0.0

        dst_host_srv_error_rate
317921                      0.0
171422                      0.0
312181                      0.0
87346                       0.0
57449                       0.0
…                           …
351572                      0.0
378352                      0.0
33349                       0.0
119307                      0.0
332656                      0.0

[163027 rows x 39 columns]
```

[39]:
```
y_train
```

[39]:
```
482186    3
302290    1
9330      1
91417     3
293169    1
         ..
259178    1
365838    2
131932    1
146867    3
121958    2
Name: connection, Length: 330994, dtype: int64
```

[40]:
```
y_test
```

[40]:
```
317921    1
171422    1
312181    1
87346     3
57449     2
         ..
351572    2
```

```
378352    2
33349     3
119307    2
332656    1
Name: connection, Length: 163027, dtype: int64
```

[42]:
```
tuner.search(X_train, y_train,
             epochs = 10,
             validation_data = (X_test, y_test))
```

```
Trial 5 Complete [00h 14m 48s]
val_accuracy: 0.0

Best val_accuracy So Far: 0.5682923793792725
Total elapsed time: 00h 44m 04s
INFO:tensorflow:Oracle triggered exit
```

[43]:
```
tuner.results_summary()
```

```
Results summary
Results in a2t2\condition2
Showing 10 best trials
Objective(name='val_accuracy', direction='max')
Trial summary
Hyperparameters:
numLayers: 3
units_0: 384
units_1: 256
learning_rate: 0.01
units_2: 32
Score: 0.5682923793792725
Trial summary
Hyperparameters:
numLayers: 2
units_0: 416
units_1: 288
learning_rate: 0.01
units_2: 192
Score: 0.5682923793792725
Trial summary
Hyperparameters:
numLayers: 12
units_0: 128
units_1: 96
learning_rate: 0.01
units_2: 352
units_3: 32
units_4: 32
```

```
units_5: 32
units_6: 32
units_7: 32
units_8: 32
units_9: 32
units_10: 32
units_11: 32
Score: 0.0
Trial summary
Hyperparameters:
numLayers: 16
units_0: 128
units_1: 448
learning_rate: 0.0001
units_2: 448
units_3: 320
units_4: 448
units_5: 320
units_6: 256
units_7: 352
units_8: 448
units_9: 224
units_10: 128
units_11: 416
units_12: 32
units_13: 32
units_14: 32
units_15: 32
Score: 0.0
Trial summary
Hyperparameters:
numLayers: 13
units_0: 288
units_1: 384
learning_rate: 0.01
units_2: 512
units_3: 256
units_4: 96
units_5: 384
units_6: 256
units_7: 416
units_8: 96
units_9: 416
units_10: 64
units_11: 384
units_12: 160
units_13: 480
units_14: 64
```

```
units_15: 352
Score: 0.0
```

0.4.1 Best accuracy is still about 56.8, does not make much difference

[ ]: