UFCFEL-15-3 Security Data Analytics and Visualisation

# Portfolio Assignment 1: Visualisation for Network Traffic Analysis (2022)

The completion of this worksheet is worth a **maximum of 20 marks** towards your portfolio assignment for the UFCFEL-15-3 Security Data Analytics and Visualisation (SDAV) module.

### Brief

You have been asked to examine a sample of network traffic to investigate suspicious activity on some of the company workstations. The company directors need to be able to understand this data. Your task is to **produce a series of different visual representations to describe and understand the characteristics of the data, based on the task questions below**. You should use the Matplotlib documentation and the Pandas documentation to learn about the library functionality, as well as other online resources.

### Assessment and Marking

For each question you will see the maximum number of marks you may be awarded for a complete answer in brackets.

- **Task 1:** Plot a Line Chart that shows "Minutes" on the x-axis, and "Total Number of Packets" sent on the y-axis. (3)
- **Task 2:** Plot a Line Chart that shows "Minutes" on the x-axis, and "Total Packet Length" sent on the y-axis. (3)
- **Task 3:** Display a Bar Chart that shows "Protocol" on the x-axis, and "Count" on the y-axis. (2)
- **Task 4:** Display a Scatter Chart that shows the association between Source and Destination data. (2)
- **Task 5:** Filter the data so that only 10.x.x.x Source addresses are included in a new DataFrame. (1)
- **(Advanced) Task 6:** Display a Node Link Diagram for this new DataFrame. (3)
- **(Advanced) Task 7:** For each Protocol type contained in this Dataframe, create a new Column and assign whether the Protocol usage is True or False. (3)
- **(Advanced) Task 8:** Show a Multi-Line Chart that shows the Total Packet Length Per Protocol. (3)

This assignment should be submitted as as PDF to your Blackboard portfolio submission as per the instructions in the assignment specification available on Blackboard. A copy of your work should also be provided via a UWE Gitlab repository, with an accessible link provided with your portfolio.

### Contact

Questions about this assignment should be directed to your module leader (Phil.Legg@uwe.ac.uk). You can use the Blackboard Q&A feature to ask questions related to this module and this assignment, as well as the on-site teaching sessions.

```
### Load in the libraries and the data
!pip install networkx

import pandas as pd
import matplotlib.pyplot as plt
#import networkx as nx
import seaborn as sns

# The following line is useful before each plot to increase the
default size that it is rendered at:
# plt.figure(figsize=(20,10))

data = pd.read_csv('./T1_data/2022-task1_data.csv')
data
```

```
Requirement already satisfied: networkx in
/home/uwe/.local/lib/python3.8/site-packages (2.8.8)
```

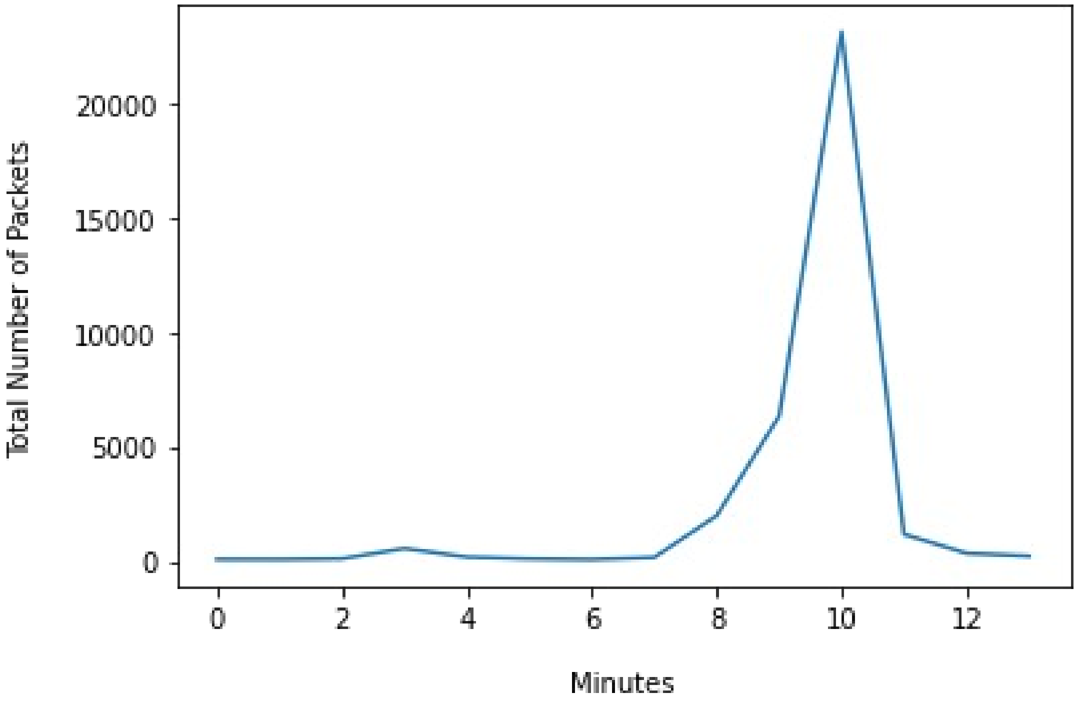
```
         No.        Time            Source Destination Protocol
Length  \
0          1    0.000000        10.10.5.11  10.10.5.10      TCP
5108
1          2    0.000050        10.10.5.10  10.10.5.11      TCP
54
2          3    0.000240        10.10.5.10  10.10.5.11      TCP
69
3          4    0.186710        10.10.5.11  10.10.5.10      TCP
60
4          5    1.119689        10.10.5.14  10.10.5.10      TCP
4697
...      ...         ...               ...         ...      ...      .
..
34465  34466  819.314740  PcsCompu_03:cb:a5   Broadcast      ARP
60
34466  34467  820.066244  PcsCompu_60:73:28   Broadcast      ARP
60
34467  34468  820.146617  PcsCompu_90:18:5a   Broadcast      ARP
60
34468  34469  820.224071  PcsCompu_c8:46:cd   Broadcast      ARP
```

```
60
34469  34470  820.296219  PcsCompu_03:cb:a5   Broadcast      ARP
60

                                                    Info
0      49205  >  1291 [PSH, ACK] Seq=1 Ack=1 Win=256 ...
1      1291  >  49205 [ACK] Seq=1 Ack=5055 Win=501 Len=0
2      1291  >  49205 [PSH, ACK] Seq=1 Ack=5055 Win=5...
3      49205  >  1291 [ACK] Seq=5055 Ack=16 Win=256 L...
4      49195  >  1294 [PSH, ACK] Seq=1 Ack=1 Win=256 ...
...                                                  ...
34465                 Who has 10.10.5.0? Tell 10.10.5.12
34466                 Who has 10.10.5.0? Tell 10.10.5.11
34467                 Who has 10.10.5.0? Tell 10.10.5.14
34468                 Who has 10.10.5.0? Tell 10.10.5.13
34469                 Who has 10.10.5.0? Tell 10.10.5.12

[34470 rows x 7 columns]
```

Task 1: Plot a Line Chart that shows "Minutes" on the x-axis, and "Total Number of Packets" sent on the y-axis. (3)

Hint: The Time column could be grouped by minute by changing the precision of how time is measured.

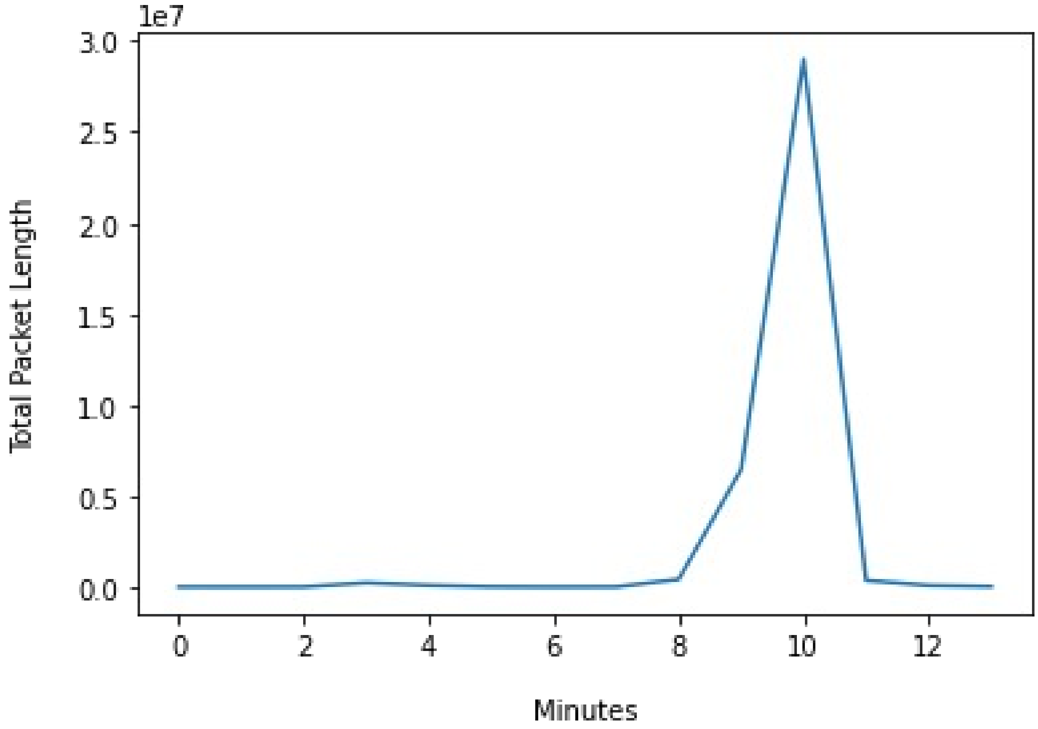
```python
# ANSWER
# importing the required module
import matplotlib.pyplot as plt
import seaborn as sns
import pandas as pd

data = pd.read_csv('./T1_data/2022-task1_data.csv')

data['Minutes']= data['Time'].astype(int)/60
data['Minutes']=data['Minutes'].astype(int)
# new_data = data.groupby(by=['Minutes'],sort=False)
plt.plot(data['Minutes'].value_counts().sort_index())

plt.xlabel("Minutes", labelpad=14)
plt.ylabel("Total Number of Packets", labelpad=14)

plt.show()
```



Task 2: Plot a Line Chart that shows "Minutes" on the x-axis, and "Total Packet Length" sent on the y-axis. (3)

Hint: Group you data by "Time" and then you can take the sum of the Length column.

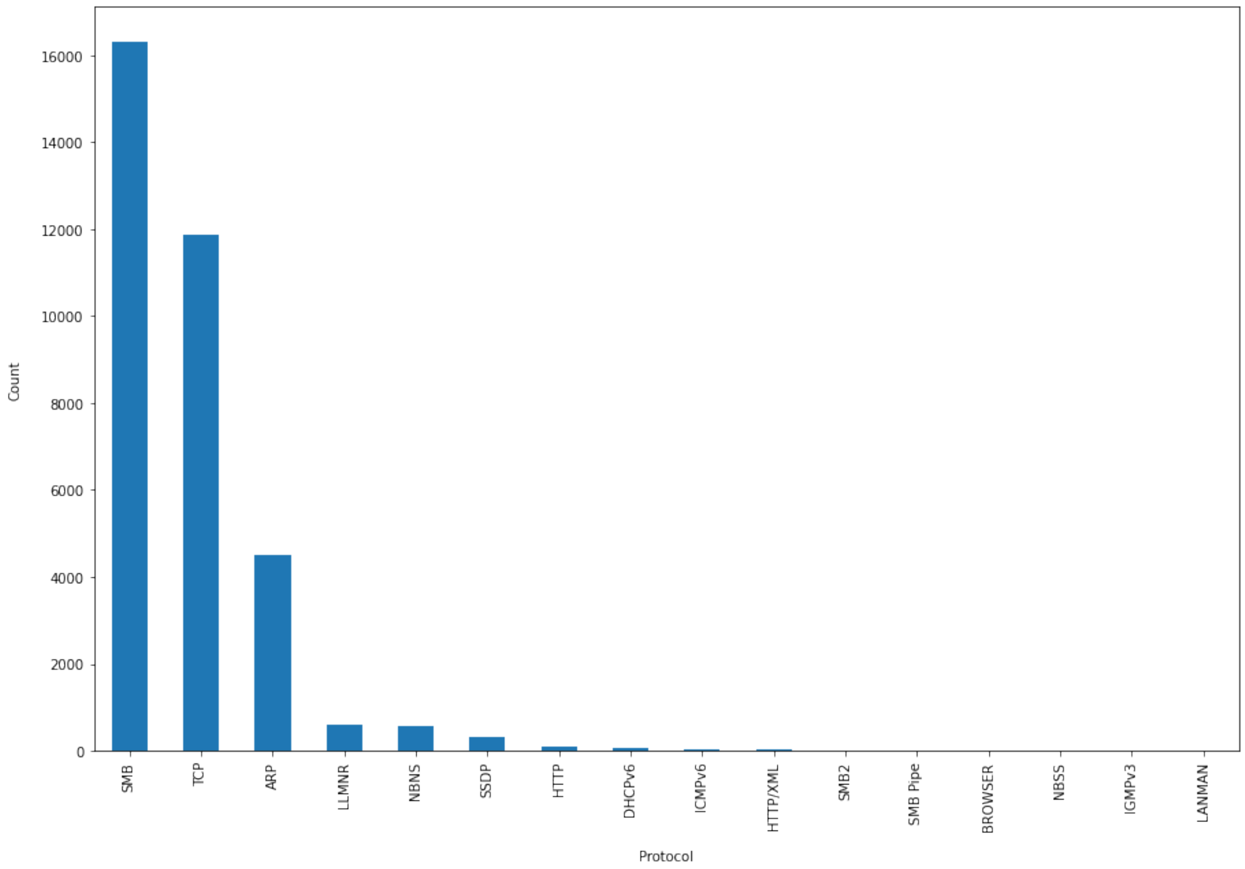
```
# ANSWER
# importing the required module
import matplotlib.pyplot as plt
import seaborn as sns
import pandas as pd
import matplotlib.pyplot as mp


data = pd.read_csv('./T1_data/2022-task1_data.csv')

data['Minutes']= data['Time'].astype(int)/60
data['Minutes']=data['Minutes'].astype(int)

data2= data.groupby(by=['Minutes']).sum()
#print(data.groupby(by=['Minutes']).sum())
mp.plot(data2['Length'])
plt.xlabel("Minutes", labelpad=14)
plt.ylabel("Total Packet Length", labelpad=14)
mp.show()
```



Task 3: Display a Bar Chart that shows "Protocol" on the x-axis, and "Count" on the y-axis. (2)

Hint: Search the pandas documentation for creating a Bar Chart from a DataFrame column.

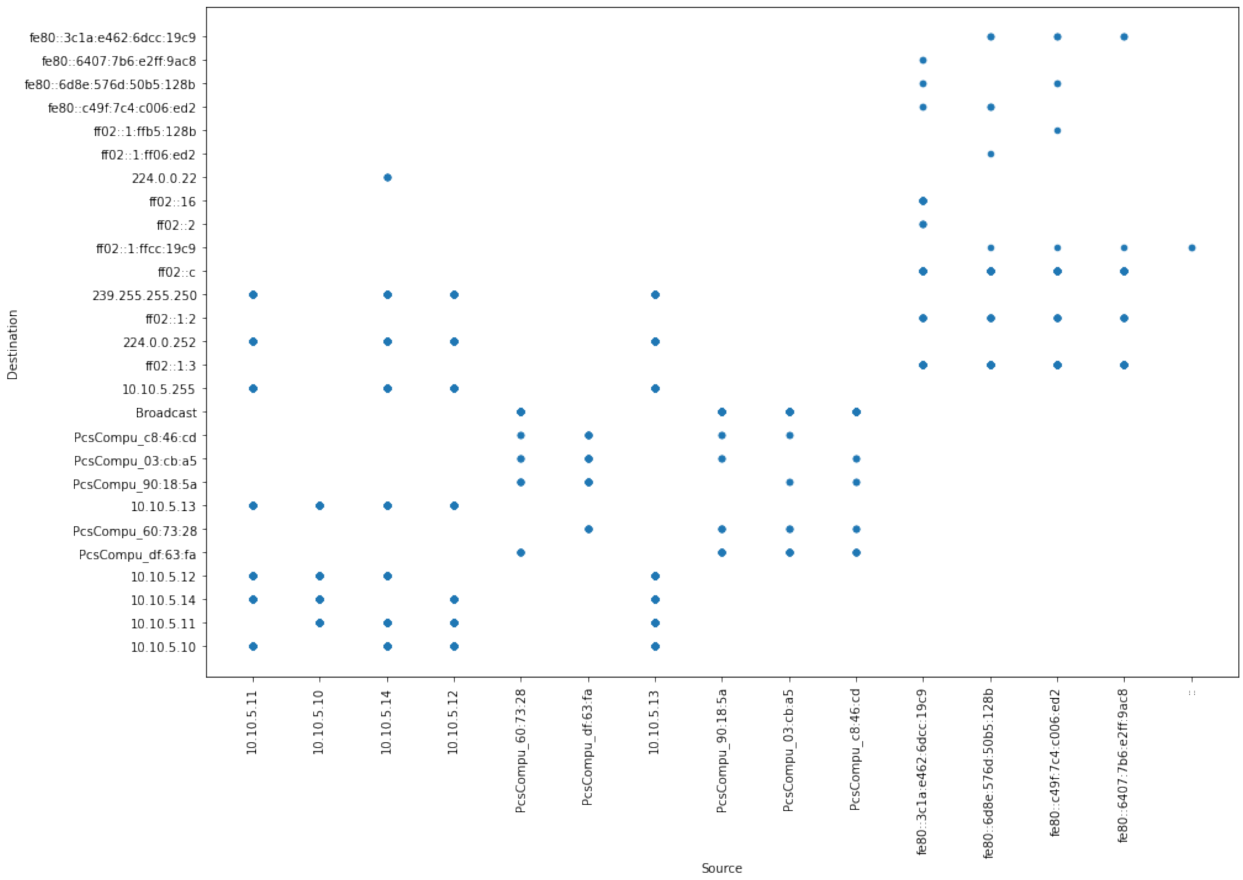
```
# ANSWER
import matplotlib.pyplot as plt
import pandas as pd
import seaborn as sns

data = pd.read_csv('./T1_data/2022-task1_data.csv')
plt.xlabel("Protocol", labelpad=14)
plt.ylabel("Count", labelpad=14)
data['Protocol'].value_counts().plot(kind='bar',figsize=(15, 10));
```



Task 4: Display a Scatter Chart that shows the association between Source and Destination data. (2)

Hint: Matplotlib has a scatterplot function that takes **x*** and ***y*** as inputs*

```
### ANSWER
import matplotlib.pyplot as plt
import pandas as pd
import seaborn as sns

data = pd.read_csv('./T1_data/2022-task1_data.csv')

data.plot.scatter(x = 'Source',  y = 'Destination',figsize=(15,10));
plt.xticks(rotation = 90)

plt.show()
```



Task 5: Filter the data so that only 10.x.x.x Source addresses are included in a new DataFrame. (1)

Hint: Retrieve all rows where the Source string starts with 10.

```
# ANSWER

# importing the required module
import matplotlib.pyplot as plt
import seaborn as sns
import pandas as pd


data2= data[data['Source'].str.startswith("10.")]
data2
```

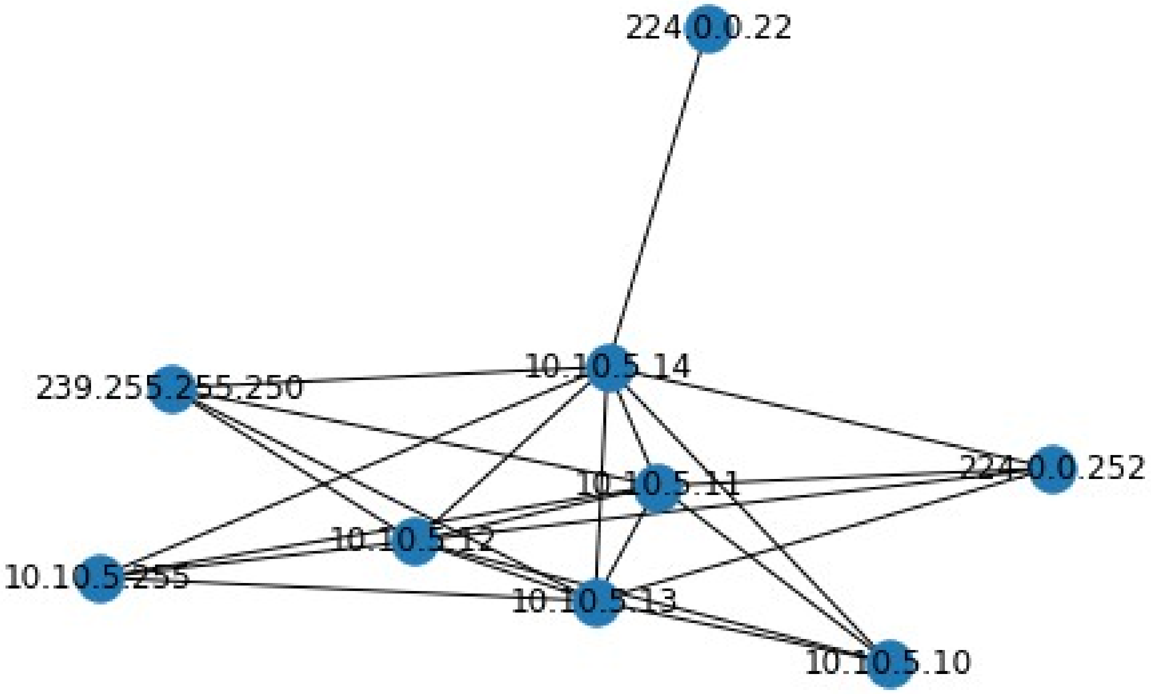
```
         No.        Time       Source  Destination  Protocol  Length  \
0          1    0.000000   10.10.5.11   10.10.5.10       TCP    5108
1          2    0.000050   10.10.5.10   10.10.5.11       TCP      54
2          3    0.000240   10.10.5.10   10.10.5.11       TCP      69
3          4    0.186710   10.10.5.11   10.10.5.10       TCP      60
4          5    1.119689   10.10.5.14   10.10.5.10       TCP    4697
...      ...         ...          ...          ...       ...     ...
```

```
34455  34456  818.104499  10.10.5.13  10.10.5.10      TCP    8214
34456  34457  818.104531  10.10.5.10  10.10.5.13      TCP      54
34457  34458  818.104875  10.10.5.10  10.10.5.13      TCP      69
34460  34461  818.294131  10.10.5.13  10.10.5.10      TCP      60
34461  34462  818.313646  10.10.5.12  10.10.5.13      TCP      60

                                                    Info
0      49205  >  1291 [PSH, ACK] Seq=1 Ack=1 Win=256 ...
1      1291  >  49205 [ACK] Seq=1 Ack=5055 Win=501 Len=0
2      1291  >  49205 [PSH, ACK] Seq=1 Ack=5055 Win=5...
3      49205  >  1291 [ACK] Seq=5055 Ack=16 Win=256 L...
4      49195  >  1294 [PSH, ACK] Seq=1 Ack=1 Win=256 ...
...                                                  ...
34455  49196  >  1293 [PSH, ACK] Seq=298831 Ack=811 W...
34456  1293  >  49196 [ACK] Seq=811 Ack=306991 Win=43...
34457  1293  >  49196 [PSH, ACK] Seq=811 Ack=306991 W...
34460  49196  >  1293 [ACK] Seq=306991 Ack=826 Win=25...
34461  2869  >  50023 [RST, ACK] Seq=5616 Ack=191 Win...

[29397 rows x 7 columns]
```

(Advanced) Task 6: Display a Node Link Diagram for this new DataFrame. (3)

Hint: Look at the NetworkX library: https://networkx.org/ and the online course notes.

```
# ANSWER

# importing the required module
import matplotlib.pyplot as plt
import seaborn as sns
import pandas as pd
import networkx as nx



G = nx.from_pandas_edgelist(data2,
                            source='Source',
                            target = 'Destination'
                           )


nx.draw(G, with_labels=True)
plt.draw()
plt.show()
```



(Advanced) Task 7: For each Protocol type contained in this Dataframe, create a new Column and assign whether the Protocol usage is True or False (3)

Hint: Get a list of unique protocol values, assign each value to be a new column where the Protocol column is equal to the Protocol name.

```
# ANSWER

#New Column to store the usage of True or False
data['TCP Usage'] = False
data['LLMNR Usage'] = False
data['SMB Usage'] = False
data['SMB2 Usage'] = False

data['NBNS Usage'] = False
data['NBSS Usage'] = False
data['SSDP Usage'] = False
data['HTTP Usage'] = False

data['DHCPv6 Usage'] = False
data['ICMPv6 Usage'] = False
data['IGMPv3 Usage'] = False
data['ARP Usage'] = False
```

```
data['HTTP/XML Usage'] = False
data['BROWSER Usage'] = False
data['SMB Pipe Usage'] = False
data['LANMAN Usage'] = False

#A function to check a specific protocol usage is true or false
def set_usage(row):
    if row['Protocol'] == 'TCP':
        row['TCP Usage'] = True

    elif row['Protocol'] == 'LLMNR':
          row['LLMNR Usage'] = True

    elif row['Protocol'] == 'SMB':
          row['SMB Usage'] = True

    elif row['Protocol'] == 'SMB2':
          row['SMB2 Usage'] = True

    elif row['Protocol'] == 'NBNS':
          row['NBNS Usage'] = True

    elif row['Protocol'] == 'NBSS':
          row['NBSS Usage'] = True

    elif row['Protocol'] == 'SSDP':
          row['SSDP Usage'] = True

    elif row['Protocol'] == 'HTTP':
          row['HTTP Usage'] = True

    elif row['Protocol'] == 'DHCPv6':
          row['DHCPv6 Usage'] = True

    elif row['Protocol'] == 'ICMPv6':
          row['ICMPv6 Usage'] = True

    elif row['Protocol'] == 'IGMPv3':
          row['IGMPv3 Usage'] = True

    elif row['Protocol'] == 'ARP':
          row['ARP Usage'] = True

    elif row['Protocol'] == 'HTTP/XML':
          row['HTTP/XML Usage'] = True

    elif row['Protocol'] == 'BROWSER':
          row['BROWSER Usage'] = True
    elif row['Protocol'] == 'SMB Pipe':
          row['SMB Pipe Usage'] = True

    elif row['Protocol'] == 'LANMAN':
          row['LANMAN Usage'] = True

    return row


#print(data['Protocol'].unique())

# Apply the function to set each row's boolean value
data = data.apply(set_usage, axis=1)

#data
data.loc[data['SMB Usage'] == True]

#data
```

```
         No.        Time      Source Destination Protocol  Length  \
1413    1414  491.045115  10.10.5.11  10.10.5.12      SMB     142
1414    1415  491.055208  10.10.5.12  10.10.5.11      SMB     185
1415    1416  491.055300  10.10.5.11  10.10.5.12      SMB     157
1416    1417  491.055798  10.10.5.12  10.10.5.11      SMB     179
1417    1418  491.055914  10.10.5.11  10.10.5.12      SMB     149
...      ...         ...         ...         ...      ...     ...
32219  32220  647.618617  10.10.5.14  10.10.5.13      SMB      93
32220  32221  647.618870  10.10.5.13  10.10.5.14      SMB    4232
32222  32223  647.618952  10.10.5.14  10.10.5.13      SMB      93
32223  32224  647.619255  10.10.5.13  10.10.5.14      SMB    4232
32225  32226  647.624783  10.10.5.14  10.10.5.13      SMB      93

                                                    Info  TCP Usage  \
1413                           Negotiate Protocol Request      False
1414                          Negotiate Protocol Response      False
1415                Session Setup AndX Request, User: .\\      False
1416                          Session Setup AndX Response      False
1417   Tree Connect AndX Request, Path: \\\\10.10.5.1...      False
...                                                   ...        ...
32219  Trans2 Response<unknown>, Error: STATUS_NOT_IM...      False
32220                       Trans2 Request, SESSION_SETUP      False
32222  Trans2 Response<unknown>, Error: STATUS_NOT_IM...      False
32223                       Trans2 Request, SESSION_SETUP      False
32225  Trans2 Response<unknown>, Error: STATUS_NOT_IM...      False

       LLMNR Usage  SMB Usage  ...  SSDP Usage  HTTP Usage  DHCPv6
Usage  \
1413         False       True  ...       False       False
False
1414         False       True  ...       False       False
```

```
False
1415         False       True  ...       False       False
False
1416         False       True  ...       False       False
False
1417         False       True  ...       False       False
False
...            ...        ...  ...         ...         ...            .
..
32219        False       True  ...       False       False
False
32220        False       True  ...       False       False
False
32222        False       True  ...       False       False
False
32223        False       True  ...       False       False
False
32225        False       True  ...       False       False
False

       ICMPv6 Usage  IGMPv3 Usage  ARP Usage  HTTP/XML Usage  BROWSER
Usage  \
1413          False         False      False           False
False
1414          False         False      False           False
False
1415          False         False      False           False
False
1416          False         False      False           False
False
1417          False         False      False           False
False
...             ...           ...        ...             ...
...
32219         False         False      False           False
False
32220         False         False      False           False
False
32222         False         False      False           False
False
32223         False         False      False           False
False
32225         False         False      False           False
False

       SMB Pipe Usage  LANMAN Usage
1413            False         False
1414            False         False
1415            False         False
```

```
1416          False       False
1417          False       False
...             ...         ...
32219         False       False
32220         False       False
32222         False       False
32223         False       False
32225         False       False

[16301 rows x 23 columns]
```

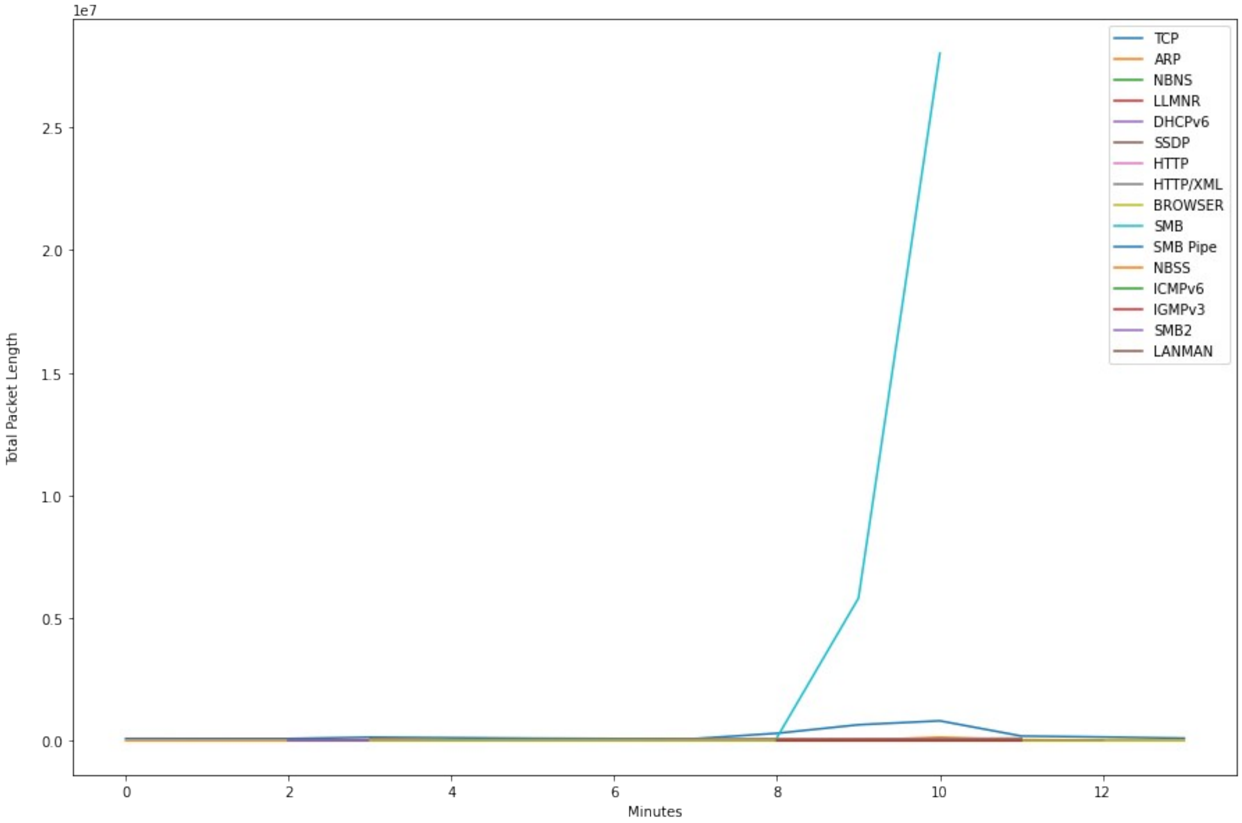
(Advanced) Task 8: Show a Multi-Line Chart that shows the Total Packet Length Per Protocol. (3)

Hint: Think about how you did this in Task 1 and Task 2, and recall that plt.plot can be used to append to a plot.

```python
# ANSWER
import matplotlib.pyplot as plt
import pandas as pd



# Extract the TCP, ARP, and UDP usage data
data['Protocol'].unique()

# Extract the time data
data['Minutes']= data['Time'].astype(int)/60
data['Minutes']=data['Minutes'].astype(int)
time = data['Minutes']

#TCP packet length dataframe
tcp_df = data[data['Protocol'] == 'TCP']
tcp_lensum = tcp_df.groupby('Minutes')['Length'].sum()
#print(tcp_lensum)

#ARP packet length
arp_df = data[data['Protocol'] == 'ARP']
arp_lensum = arp_df.groupby('Minutes')['Length'].sum()

#NBNS packet length
nbns_df = data[data['Protocol'] == 'NBNS']
nbns_lensum = nbns_df.groupby('Minutes')['Length'].sum()

#LLMNR packet length
llmnr_df = data[data['Protocol'] == 'LLMNR']
llmnr_lensum = llmnr_df.groupby('Minutes')['Length'].sum()

#DHCPv6 packet length
```

```
dhcp_df = data[data['Protocol'] == 'DHCPv6']
dhcp_lensum = dhcp_df.groupby('Minutes')['Length'].sum()

#SSDP packet length
ssdp_df = data[data['Protocol'] == 'SSDP']
ssdp_lensum = ssdp_df.groupby('Minutes')['Length'].sum()

#HTTP packet length
http_df = data[data['Protocol'] == 'HTTP']
http_lensum = http_df.groupby('Minutes')['Length'].sum()

#HTTP/XML packet length
hxml_df = data[data['Protocol'] == 'HTTP/XML']
hxml_lensum = hxml_df.groupby('Minutes')['Length'].sum()

#BROWSER packet length
browser_df = data[data['Protocol'] == 'BROWSER']
browser_lensum = browser_df.groupby('Minutes')['Length'].sum()

#SMB packet length
smb_df = data[data['Protocol'] == 'SMB']
smb_lensum = smb_df.groupby('Minutes')['Length'].sum()

#SMB Pipe packet length
smbpipe_df = data[data['Protocol'] == 'SMB Pipe']
smbpipe_lensum = smbpipe_df.groupby('Minutes')['Length'].sum()

#NBSS packet length
nbss_df = data[data['Protocol'] == 'NBSS']
nbss_lensum = nbss_df.groupby('Minutes')['Length'].sum()

#ICMPv6 packet length
icmp_df = data[data['Protocol'] == 'ICMPv6']
icmp_lensum = icmp_df.groupby('Minutes')['Length'].sum()

#IGMPv3 packet length
igmp_df = data[data['Protocol'] == 'IGMPv3']
igmp_lensum = igmp_df.groupby('Minutes')['Length'].sum()

#SMB2 packet length
smb2_df = data[data['Protocol'] == 'SMB2']
smb2_lensum = smb2_df.groupby('Minutes')['Length'].sum()

#LANMAN packet length
lanman_df = data[data['Protocol'] == 'LANMAN']
lanman_lensum = lanman_df.groupby('Minutes')['Length'].sum()

#Plot the lines
tcp_lensum.plot(kind='line', x='time', y='packet_length',label =
"TCP",figsize=(15, 10))
```

```
arp_lensum.plot(kind='line',label = "ARP")
nbns_lensum.plot(kind='line',label = "NBNS")
llmnr_lensum.plot(kind='line',label = "LLMNR")

dhcp_lensum.plot(kind='line',label = "DHCPv6")
ssdp_lensum.plot(kind='line',label = "SSDP")
http_lensum.plot(kind='line',label = "HTTP")
hxml_lensum.plot(kind='line',label = "HTTP/XML")

browser_lensum.plot(kind='line',label = "BROWSER")
smb_lensum.plot(kind='line',label = "SMB")
smbpipe_lensum.plot(kind='line',label = "SMB Pipe")
nbss_lensum.plot(kind='line',label = "NBSS")

icmp_lensum.plot(kind='line',label = "ICMPv6")
igmp_lensum.plot(kind='line',label = "IGMPv3")
smb2_lensum.plot(kind='line',label = "SMB2")
lanman_lensum.plot(kind='line',label = "LANMAN")

# Add a legend
plt.legend()

#Add a label for y axis
plt.ylabel("Total Packet Length", labelpad=14)

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



```
data['Protocol'].unique()
```

```
array(['TCP', 'ARP', 'NBNS', 'LLMNR', 'DHCPv6', 'SSDP', 'HTTP',
       'HTTP/XML', 'BROWSER', 'SMB', 'SMB Pipe', 'NBSS', 'ICMPv6',
       'IGMPv3', 'SMB2', 'LANMAN'], dtype=object)
```