Student Name : _____BHATI NANCY_____

Group : ____SCEX_____

Date : _____27/3/2024_____

LAB 4: ANALZING NETWORK DATA LOG

You are provided with the data file, in .csv format, in the working directory. Write the program to extract the following informations.

EXERCISE 4A: TOP TALKERS AND LISTENERS

One of the most commonly used function in analyzing data log is finding out the IP address of the hosts that send out large amount of packet and hosts that receive large number of packets, usually know as TOP TALKERS and LISTENERS. Based on the IP address we can obtained the organization who owns the IP address.

List the TOP 5 TALKERS

Rank	IP address	# of packets	Organisation
1	193.62.192.8	3041	JANET Jisc Services Limited, GB
2	155.69.160.32	2975	NTU-AS-AP Nanyang Technological University, SG
3	130.14.250.11	2604	NLM-GW, US
4	14.139.196.58	2452	NKN-EDGE-NW NKN EDGE Network, IN
5	140.112.8.139	2056	NTU-TW National Taiwan University, TW

TOP 5 LISTENERS

Rank	IP address	# of packets	Organisation
1	103.37.198.100	3841	A-STAR-AS-AP A-STAR, SG
2	137.132.228.15	3715	NUS-AS-AP NUS Information Technology, SG
3	202.21.159.244	2446	REPUBLICPOLYTECHNIC-AS Republic Polytechnic. Multihoming AS Singapore, SG
4	192.101.107.153	2368	ESNET-AS, US
5	103.21.126.2	2056	IITB-IN Powai, IN

EXERCISE 4B: TRANSPORT PROTOCOL

Using the IP protocol type attribute, determine the percentage of TCP and UDP protocol

	Header value	Transport layer protocol	# of packets
1	6	TCP	56063 (82.36%)
2	17	UDP	9462 (13.9%)

EXERCISE 4C: APPLICATIONS PROTOCOL

Using the Destination IP port number determine the most frequently used application protocol. (For finding the service given the port number https://www.adminsub.net/tcp-udp-port-finder/)

Rank	Destination IP port number	# of packets	Service
1	443	13423	HTTPS
2	80	2647	HTTP
3	52866	2068	DYNAMIC AND/ OR PRIVATE P ORTS
4	45512	1356	UNASSIGNED
5	56152	1341	DYNAMIC AND/ OR PRIVATE P ORTS

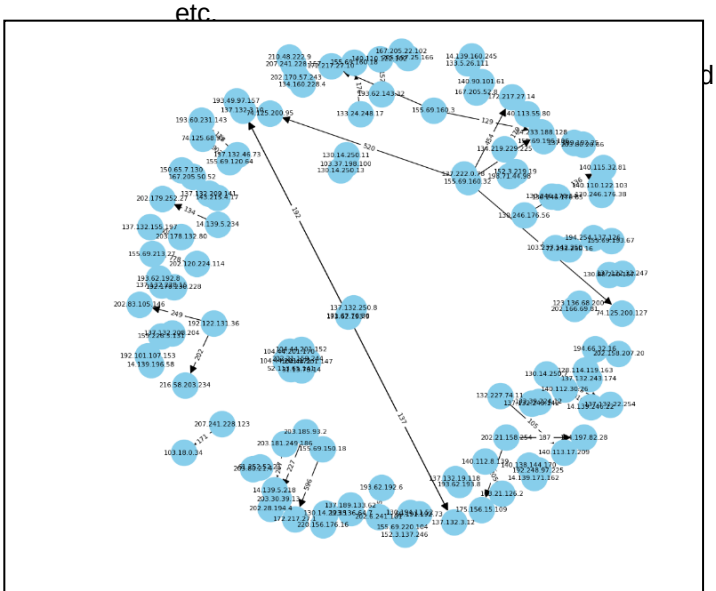
EXERCISE 4D: TRAFFIC

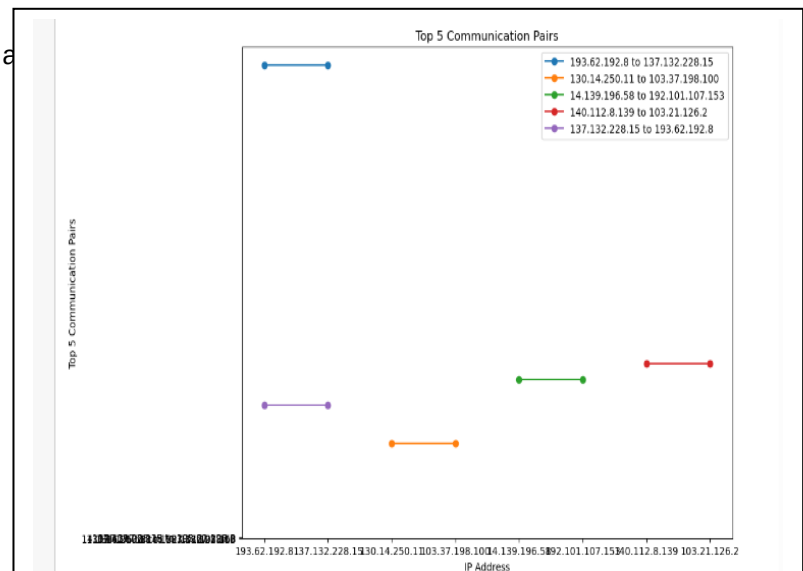
The traffic intensity is an important parameter that a network engineer needs to monitor closely to determine if there is congestion. You would use the IP packet size to calculate the estimated total traffic over the monitored period of 15 seconds. (Assume the sampling rate is 1 in 2048)

Total Traffic(MB)	126516.254 MB

EXERCISE 4E: ADDITIONAL ANALYSIS

Please append ONE page to provide additional analysis of the data and the insight it provides.
Examples include:
Top 5 communication pairs;
Visualization of communications between different IP hosts;
etc.





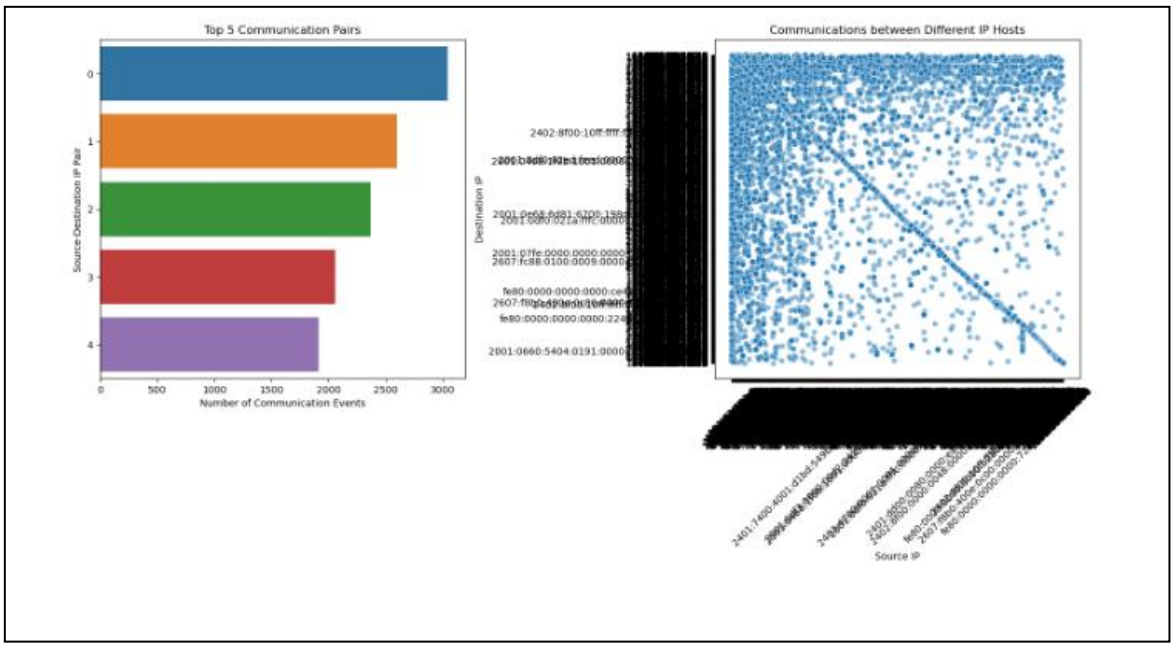


FIG 1 : Visualization of communications between different IP hosts
FIG 2: Top 5 communication pairs
FIG 3: TOGETHER

EXERCISE 4F: SOFTWARE CODE

Please also submit your code to the NTULearn lab site.

```
: import pandas as pd

# Read the CSV file into a DataFrame
df = pd.read_csv(r'C:\Users\Nancy\Downloads\Data_3.csv', error_bad_lines=False)

# Remove the last column from the DataFrame
df = df.iloc[:, :-1]

# Display the DataFrame
print(df)
```

```
1 import pandas as pd
2 import requests
3 import math
4 from ipwhois import IPWhois
5 from ipwhois.exceptions import IPDefinedError
6 import warnings
7
8 warnings.filterwarnings('ignore')
```

```
1 col_names=["A", "B", "C", "D", "E", "F", "G", "H", "I", "J", "K",
2           "L", "M", "N", "O", "P", "Q", "R", "S"]
3 df.columns=col_names
4 df
```

Out[67]:

	A	B	C	D	E	F	G	H	I	
0	FLOW	203.30.38.251	129	193	609c9f851b00	0031466b23cf	0x0800	11	919	155.69.160
1	FLOW	203.30.38.251	137	200	d404ff55fd4d	80711fc76001	0x0800	919	280	130.246.17
2	FLOW	203.30.38.251	129	135	609c9f851b00	002688cd5fc7	0x0800	11	919	155.69.160
3	FLOW	203.30.38.251	130	199	00239cd087c1	544b8cf9a7df	0x0800	919	600	137.132.22
4	FLOW	203.30.38.251	129	135	609c9f851b00	002688cd5fc7	0x0800	11	919	155.69.160
...	...	...	...	...	...	...	...	...	...	...
68059	FLOW	203.30.38.251	258	199	204e71cf1b0f	ccef48570144	0x0800	537	601	207.241.228.
68060	FLOW	203.30.38.251	131	193	00a742233e9e	0031466b23cf	0x0800	43	919	192.122.131
68061	FLOW	203.30.38.251	130	199	00239cd087c1	544b8cf9a7df	0x0800	919	600	137.132.22
68062	FLOW	203.30.38.251	129	193	609c9f851b00	0031466b23cf	0x0800	11	919	155.69.1
68063	FLOW	203.30.38.251	137	200	d404ff55fd4d	80711fc76001	0x0800	919	280	14.139.19

68064 rows × 19 columns

Top 5 Talkers. (ie sender nodes)

In [68]:
```
talkers = df['J'].value_counts().head(5) # source IP
listeners = df['K'].value_counts().head(5) # destination IP

# take IP address as input
#perform a lookup using PIWhois library to retrieve info
#retrieve info about organisation associated with IP address
# retrun organisation name
def get_organization(ip_address):
    try:
        ipwhois = IPWhois(ip_address)
        result = ipwhois.lookup_rdap()
        return result['asn_description']
    except:
        return 'Unknown'
```

```
print("Top 5 Talkers")

print("Rank\tIP address\t\t no. of packets\t Organization name")

for index, (ip_address, packets) in enumerate(talkers.iteritems(), start=1):
    organization = get_organization(ip_address)
    print(f"{index}\t{ip_address}\t{packets}\t{organization}")
```

```
Top 5 Talkers
Rank    IP address              no. of packets  Organization name
1       193.62.192.8    3041    JANET Jisc Services Limited, GB
2       155.69.160.32   2975    NTU-AS-AP Nanyang Technological University, SG
3       130.14.250.11   2604    NLM-GW, US
4       14.139.196.58   2452    NKN-EDGE-NW NKN EDGE Network, IN
5       140.112.8.139   2056    NTU-TW National Taiwan University, TW
```

Top 5 Listeners (ie receiving node)

)]:
```

print("\nTop 5 Listeners")

print("Ranks\tIP address\t\t no. of packets\t Organization name")

for index, (ip_address, packets) in enumerate(listeners.iteritems(), start=1
    organization = get_organization(ip_address)
    print(f"{index}\t{ip_address}\t{packets}\t{organization}")
```

```
Top 5 Listeners
Ranks   IP address              no. of packets  Organization name
1       103.37.198.100  3841    A-STAR-AS-AP A-STAR, SG
2       137.132.228.15  3715    NUS-AS-AP NUS Information Technology, SG
3       202.21.159.244  2446    REPUBLICPOLYTECHNIC-AS Republic Polytechnic. Mu
ltihoming AS Singapore, SG
4       192.101.107.153 2368    ESNET-AS, US
5       103.21.126.2    2056    IITB-IN Powai, IN
```

```
#changing column names for simplicity
```

```
col_names = [
        "type", "sflow_agent_address", "inputPort", "outputPort",
    "src_MAC", "dst_MAC", "ethernet_type", "in_vlan", "out_vlan", "src_IP",
    "dst_IP", "IP_protocol", "ip_tos", "ip_ttl", "src_transport_port",
    "dst_transport_port", "tcp_flags", "packet_size", "IP_size"]
df.columns = col_names
df
```

sflow_agent_address	inputPort	outputPort	src_MAC	dst_MAC	ethernet_type	in_vlan	out
203.30.38.251	129	193	609c9f851b00	0031466b23cf	0x0800	11	
203.30.38.251	137	200	d404ff55fd4d	80711fc76001	0x0800	919	
203.30.38.251	129	135	609c9f851b00	002688cd5fc7	0x0800	11	
203.30.38.251	130	199	00239cd087c1	544b8cf9a7df	0x0800	919	
203.30.38.251	129	135	609c9f851b00	002688cd5fc7	0x0800	11	
...	...	...	...	...	...	...	...
203.30.38.251	258	199	204e71cf1b0f	ccef48570144	0x0800	537	
203.30.38.251	131	193	00a742233e9e	0031466b23cf	0x0800	43	
203.30.38.251	130	199	00239cd087c1	544b8cf9a7df	0x0800	919	
203.30.38.251	129	193	609c9f851b00	0031466b23cf	0x0800	11	
203.30.38.251	137	200	d404ff55fd4d	80711fc76001	0x0800	919	

19 columns

Top 5 applications

```
# Group the data by the destination transport port number and count the occu
top_applications = df['dst_transport_port'].value_counts().head(5)

# Print the top 5 applications
print("Top 5 Applications:")
print(top_applications)
```

```
Top 5 Applications:
443      13423
80        2647
52866     2068
45512     1356
56152     1341
Name: dst_transport_port, dtype: int64
```

Below are the top five most frequently used application protocols using destination port numbers, along with the destination port number, number of packets, and corresponding service

```
#Group the data by destination port number
port_groups = df.groupby('dst_transport_port')
#  Count the number of packets for each destination port
packet_counts_per_port = port_groups.size()
# Find the top five most frequently occurring destination ports
top_ports = packet_counts_per_port.nlargest(5)

# Identify the corresponding application protocol and service for each top p
for port in top_ports.index:
    # Get the rows corresponding to the destination port
    port_data = df[df['dst_transport_port'] == port]
    # Group by application protocol
    protocol_groups = port_data.groupby('IP_protocol')
    # Count the number of packets for each protocol
    packet_counts_per_protocol = protocol_groups.size()
    # Find the most frequent protocol
    most_frequent_protocol = packet_counts_per_protocol.idxmax()
    # Get the corresponding service for the port
    corresponding_service = port_data['type'].iloc[0]

    print("Destination Port:", port)
    print("Number of Packets:", top_ports[port])
    print("Most Frequent Protocol:", most_frequent_protocol)
    print("Corresponding Service:", corresponding_service)
    print()
```

```
Destination Port: 443
Number of Packets: 13423
Most Frequent Protocol: 6
Corresponding Service: FLOW

Destination Port: 80
Number of Packets: 2647
Most Frequent Protocol: 6
Corresponding Service: FLOW

Destination Port: 52866
Number of Packets: 2068
Most Frequent Protocol: 6
Corresponding Service: FLOW

Destination Port: 45512
Number of Packets: 1356
Most Frequent Protocol: 17
Corresponding Service: FLOW

Destination Port: 56152
Number of Packets: 1341
Most Frequent Protocol: 6
Corresponding Service: FLOW
```

Total traffic

```
# total traffic by summing up the packet sizes
total_traffic = df['packet_size'].sum()

print("Total traffic:", total_traffic, "bytes")

# total traffic in megabytes
total_traffic_mb = df['IP_size'].sum() * 2048 / (1024 ** 2)

#  total traffic in MB
print(f"Total traffic: {total_traffic_mb:.3f} MB")

#  total traffic in gigabytes
total_traffic_gb = total_traffic / (1024 ** 3)

print(f"Total traffic: {total_traffic_gb:.3f} GB")
```

```
Total traffic: 66198960 bytes
Total traffic: 126516.254 MB
Total traffic: 0.062 GB
```

Proportion of TCP and UDP packets

Below are the proportions of TCP and UDP Packets

```
# Count the occurrences of each IP protocol type
protocol_counts = df['IP_protocol'].value_counts()

# total number of packets
total_packets = protocol_counts.sum()

#  the proportion of TCP packets
tcp_packets = protocol_counts.get(6, 0)  # Assuming TCP is represented by pr
tcp_proportion = tcp_packets / total_packets

# the proportion of UDP packets
udp_packets = protocol_counts.get(17, 0)  # Assuming UDP is represented by p
udp_proportion = udp_packets / total_packets

print("Proportion of TCP packets:", tcp_proportion)
print("Proportion of UDP packets:", udp_proportion)
```

```
Proportion of TCP packets: 0.8236806535025858
Proportion of UDP packets: 0.13901622002820874
```

Below are the number of packets of TCP and UDP Packets

```
# Count the occurrences of each IP protocol type
protocol_counts = df['IP_protocol'].value_counts()

# the number of TCP packets
tcp_packets = protocol_counts.get(6, 0)  # Assuming TCP is represented by pr

# the number of UDP packets
udp_packets = protocol_counts.get(17, 0)  # Assuming UDP is represented by p

#  the number of TCP and UDP packets
print("Number of TCP packets:", tcp_packets)
print("Number of UDP packets:", udp_packets)
```

```
Number of TCP packets: 56063
Number of UDP packets: 9462
```

```
# Print the percentages
print("Percentage of TCP packets:", tcp_percentage)
print("Percentage of UDP packets:", udp_percentage)
```

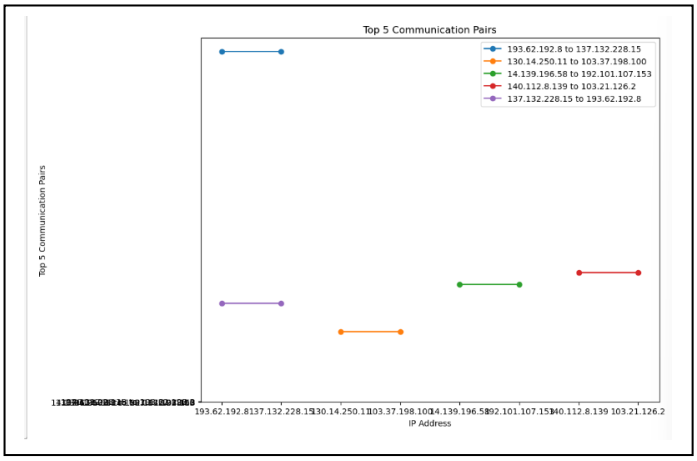
```
Percentage of TCP packets: 82.36806535025858
Percentage of UDP packets: 13.901622002820874
```

Top 5 communication pair

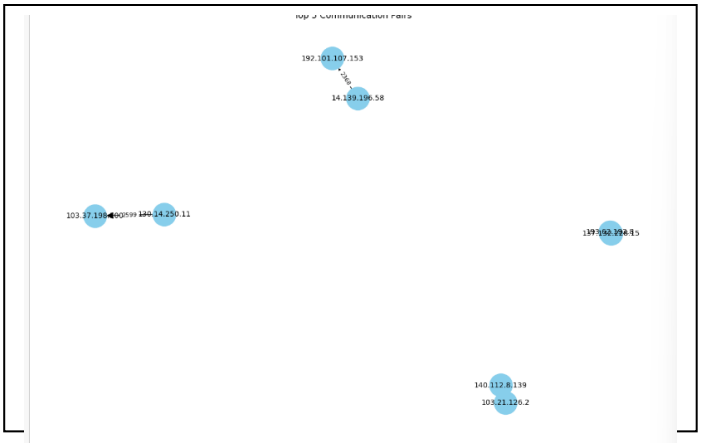
```
print("\nTop 5 Communication pair")
# Group the DataFrame by source and destination IP addresses and count occur
communication_pairs = df.groupby(["src_IP", "dst_IP"]).size().reset_index(na

# Sort the pairs by count in descending order and select the top 5 pairs
top_5_pairs = communication_pairs.sort_values("count", ascending=False).head

# Print the top 5 communication pairs
print(top_5_pairs)
```

```
Top 5 Communication pair
              src_IP          dst_IP  count
3935    193.62.192.8   137.132.228.15   3041
787    130.14.250.11   103.37.198.100   2599
1319   14.139.196.58  192.101.107.153   2368
1451   140.112.8.139     103.21.126.2   2056
1109  137.132.228.15     193.62.192.8   1910
```

```
# Visualization of Top 5 Communication Pairs
plt.figure(figsize=(10, 8))
for i, row in top_5_pairs.iterrows():
    plt.plot([row["src_IP"], row["dst_IP"]], [i, i], marker='o',
             label=f"{row['src_IP']} to {row['dst_IP']}")

plt.yticks(range(len(top_5_pairs)), [f"{row['src_IP']} to {row['dst_IP']}"
                                     for _, row in top_5_pairs.iterrows()])
plt.xlabel("IP Address")
plt.ylabel("Top 5 Communication Pairs")
plt.title("Top 5 Communication Pairs")
plt.legend()
plt.show()
```

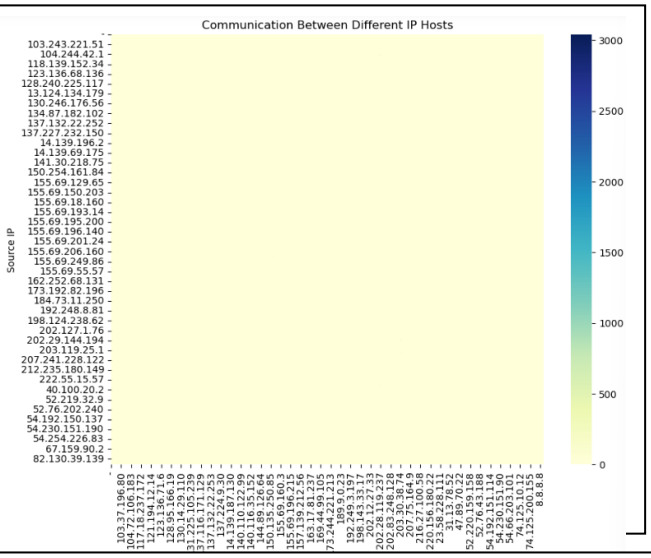


```python
# visualisation using network graph
import pandas as pd
import networkx as nx
import matplotlib.pyplot as plt

# Group the DataFrame by source and destination IP addresses and count occur
communication_pairs = df.groupby(["src_IP", "dst_IP"]).size().reset_index(na

# Sort the pairs by count in descending order and select the top 5 pairs
top_5_pairs = communication_pairs.sort_values("count", ascending=False).head

# Create a directed graph
G = nx.DiGraph()

# Add nodes and edges to the graph
for index, row in top_5_pairs.iterrows():
    G.add_edge(row['src_IP'], row['dst_IP'], weight=row['count'])

# Draw the network graph
plt.figure(figsize=(12, 8))
pos = nx.spring_layout(G, seed=42)
nx.draw(G, pos, with_labels=True, node_size=1000, node_color="skyblue", arro

# Add edge labels with the count of communication occurrences
edge_labels = nx.get_edge_attributes(G, 'weight')
nx.draw_networkx_edge_labels(G, pos, edge_labels=edge_labels, font_size=8)

plt.title("Top 5 Communication Pairs")
plt.show()
```



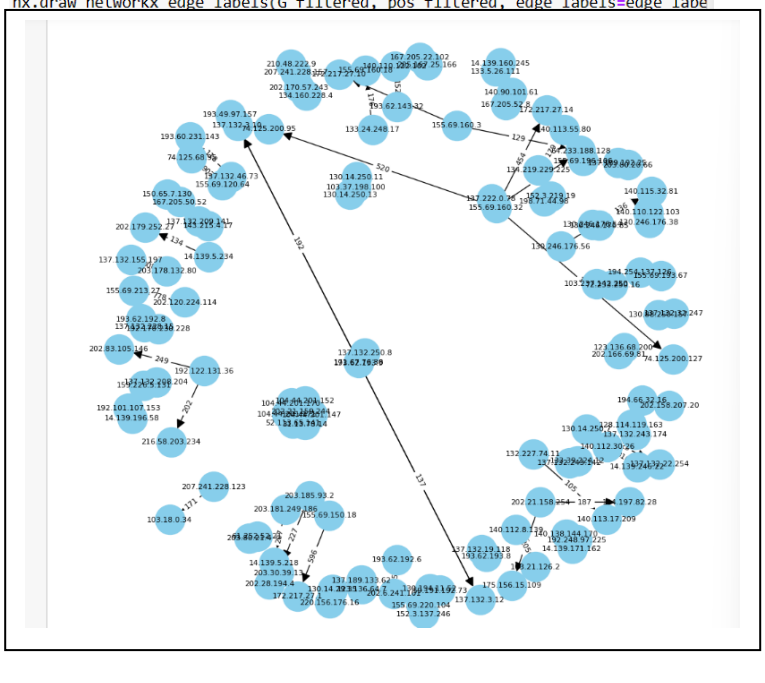
Visualizing the communication between different IP hosts ¶

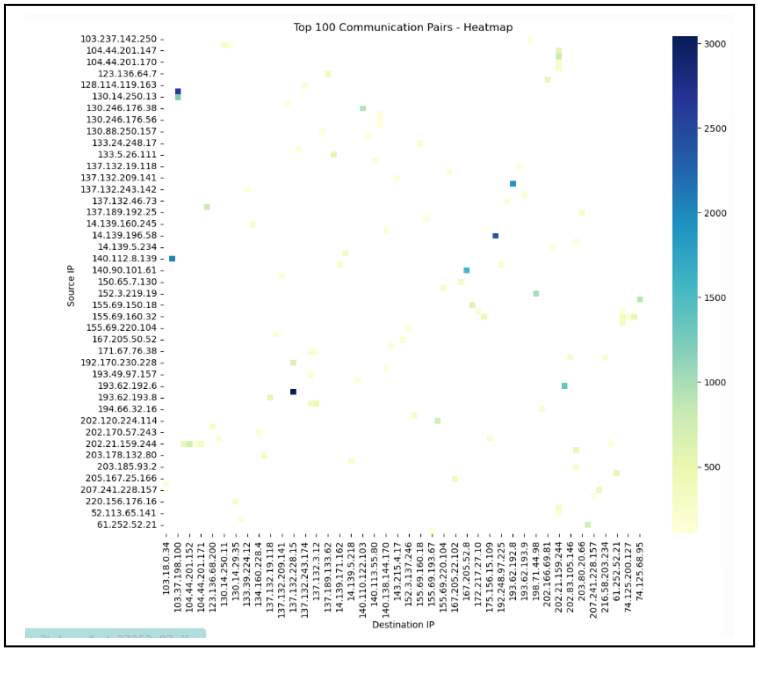
```python
# visualisation using heatmap

import seaborn as sns

# Create a pivot table with source IP addresses as rows, destination IP addr
pivot_table = df.pivot_table(index='src_IP', columns='dst_IP', values='packe

#  heatmap
plt.figure(figsize=(10, 8))
sns.heatmap(pivot_table, cmap='YlGnBu')
plt.title('Communication Between Different IP Hosts')
plt.xlabel('Destination IP')
plt.ylabel('Source IP')
plt.show()
```




```python
# visualisation using network graph

import networkx as nx
import matplotlib.pyplot as plt

communication_pairs = df.groupby(["src_IP", "dst_IP"]).size().reset_index(na
top_100_pairs = communication_pairs.sort_values("count", ascending=False).he

# Create a new column in the top_100_pairs DataFrame
top_100_pairs['src_IP_dst_IP'] = list(zip(top_100_pairs['src_IP'], top_100_p
top_pairs = top_100_pairs["src_IP_dst_IP"].tolist()

# Filter the data to include only the top 100 communication pairs
filtered_df = df[df.apply(lambda row: (row["src_IP"], row["dst_IP"]) in top_

# Create a directed graph from the filtered dataframe
G_filtered = nx.from_pandas_edgelist(filtered_df, "src_IP", "dst_IP", create

# Draw the filtered graph with node labels
pos_filtered = nx.spring_layout(G_filtered, seed=42)
plt.figure(figsize=(10, 10))
nx.draw(G_filtered, pos_filtered, with_labels=True, node_size=1000, node_col

# Add edge labels with packet count
edge_labels_filtered = {(src, dst): filtered_df[(filtered_df["src_IP"] == sr
nx.draw_networkx_edge_labels(G_filtered, pos_filtered, edge_labels=edge_labe
```

```python
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

# Group the DataFrame by source and destination IP addresses and count occur
communication_pairs = df.groupby(["src_IP", "dst_IP"]).size().reset_index(na

# Sort the pairs by count in descending order and select the top 100 pairs
top_100_pairs = communication_pairs.sort_values("count", ascending=False).he

# Pivot the DataFrame to create a matrix for the heatmap
heatmap_data = top_100_pairs.pivot(index='src_IP', columns='dst_IP', values=

#  heatmap
plt.figure(figsize=(12, 10))
sns.heatmap(heatmap_data, cmap='YlGnBu')
plt.title('Top 100 Communication Pairs - Heatmap')
plt.xlabel('Destination IP')
plt.ylabel('Source IP')
plt.show()
```





Additional analysis of the data and the insight of

Top 5 communication pairs and Visualization of communications between different IP hosts; (together)

```python
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

# Top 5 communication pairs
top_pairs = df.groupby(['src_IP', 'dst_IP']).size().nlargest(5).reset_index(

# Visualization of Communications between Different IP Hosts
plt.figure(figsize=(15, 8))

# Subplot 1: Top 5 communication pairs
plt.subplot(1, 2, 1)
sns.barplot(data=top_pairs, x='count', y=top_pairs.index, orient='h')
plt.title("Top 5 Communication Pairs")
plt.xlabel("Number of Communication Events")
plt.ylabel("Source-Destination IP Pair")

# Subplot 2: Visualization of communications between different IP hosts
plt.subplot(1, 2, 2)
sns.scatterplot(data=df, x="src_IP", y="dst_IP", alpha=0.5)
plt.title("Communications between Different IP Hosts")
plt.xlabel("Source IP")
plt.ylabel("Destination IP")
plt.xticks(rotation=45)

plt.tight_layout()
plt.show()
```