CS305 PA 2

Introduction

The ability to analyze TCP traffic is a crucial skill in computer networking, as it allows us to understand how applications communicate over the network, identify performance issues and security threats, and optimize network configurations. The TCP stream analyzer that we will be introducing in this article is a key tool for achieving these objectives, as it will enable you to extract important information from TCP packets, such as sequence and acknowledgement numbers, payload data, and statistics. By the end of this assignment, you should have a solid understanding of how TCP stream analysis works. In this time of assigment, you should implement a TCP stream analyzer using `Python` and `Scapy`.

Environment Setup

In this assignment, you are suggested to use `Python 3.11`, as we will test your code in this environment. And you should install few libraries. With anaconda, you can do this by this command in shell

```
conda create -y -n PA2 python=3.11 && conda activate PA2 && pip install
-r requirements.txt
```

MAKE SURE that when running this command, the `PWD` must contain all files needed by test. To check this, run command

```
ls
```

and make sure the output countains these files:

```
RENAME_TO_SID.GRADER
pkt_analyzer.py
TCP_PKTS.pcap
HTTP_.pcap
PACKET_INFO.txt
requirements.txt
```

Otherwise you can manually install each library by `pip`. Required libraries are listed in `requirements.txt`.

Requirements

Task 1

In this task, you should implement a simple TCP packet analyzer, which can be used to do:

TCP Connection Analyzer (5pts)

Extract all TCP connections in a given `pcap` file, print them and save them into a `txt` file in the format of

```
/*Src. IP*/:/*Src. Port*/ -> /*Dst. IP*/:/*Dst. Port*/
```

Note that you only need to implement `IPv4/TCP` in this part. Make sure to output connection in time order. If you use the code skeleton, it should be easy to do.

TCP Stream Analyzer (45pts)

1. Tell which packet in the `pcap` file belongs to which TCP stream, save them into a `txt` file, each packet occupied each line. You should tell the number sequence of the packet. You should also tell which packet belongs to the client (sent by the client), and which belongs to the server.
2. And you should calculate relative `ACK` and `SEQ` nums, correctly. You must have learnt the definitions of relative `ACK` and `SEQ`, so detailed information about them are omitted for brevity.
3. You should also label flags in `TCP` packets.

and the line is in the format of, if the sender is the server and receiver is client:

```
Server -> Client; Num: /*Packet Number*/ SEQ: /*SEQ NUM*/ ACK: /*ACK
NUM*/ /*FLAGS*/
```

otherwise if the sender is the client and receiver is server:

```
Client -> Server; Num: /*Packet Number*/ SEQ: /*SEQ NUM*/ ACK: /*ACK
NUM*/ /*FLAGS*/
```

Besides each packet, you are also requested to save these properties into the `txt` file, in the first line of the file, in the format of

```
Server : /*Server. IP*/:/*Serevr. Port*/ <-> Client : /*Client
IP*/:/*Client Port*/
```

IPv6 (10pts)

Handle IPv6 packets. You should implement your packet analyzer to handle `TCP` carried by `IPv6` packets. After implementation, your pkt analyzer should be able to read out `IPv6` packets and analyze `TCP` streams containing `IPv6` packets.

HTTP Analyzer(20pts)

Decode `HTTP/1.1` stream. The first line of the file is

```
Server : /*Server. IP*/:/*Serevr. Port*/ <-> Client : /*Client
IP*/:/*Client Port*/
```

analyze http stream, read out the host of the stream, and identify each packet: response or request? Status code? Payload length? Please decode the HTTP in the format of

```
METHOD URL PROTOCAL_VERSION
```

```
PROTOCAL_VERSION STATUS_CODE STATUS
```

You only need to implement `HTTP/1.1`. You do not need to implement `HTTPS`. You are guarenteed that when testing this part, a `.pcap` that contains only `HTTP` packets will be provided. For those packets which does not have a HTTP header but does belong to a HTTP stream, you should use

```
..NO HEADER..
```

to indicate.

There are three example txt files to demonstrate correct format of output of your program. If you are confused, carefully check them to make sure you have understand the idea.

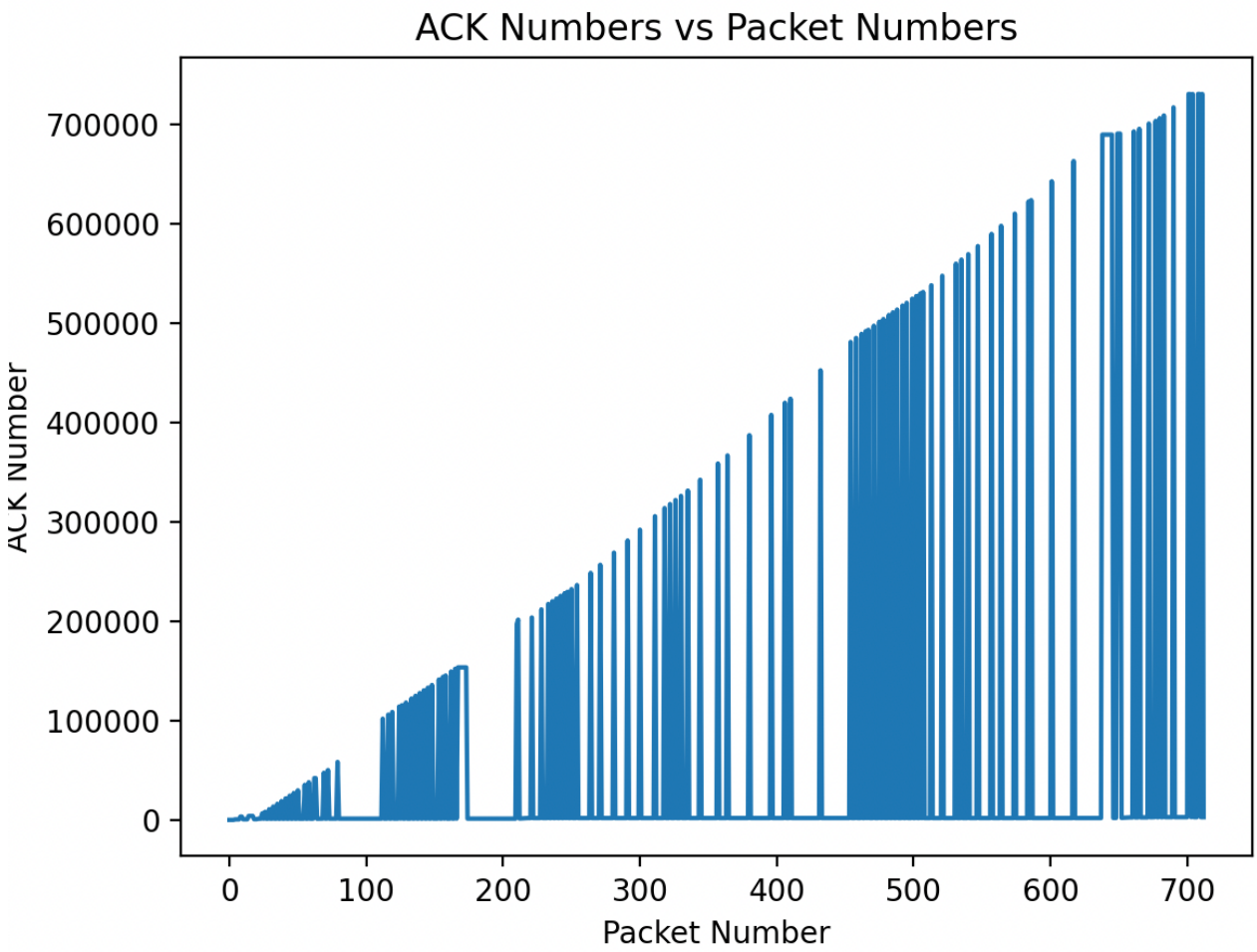
Task 2

TCP Behaviour Demonstration (20pts)

Use the packet analyzer programmed by you to demonstrate some behaviors of TCP stream, including:

1. RENO-TCP Fast Recovery
2. Sliding of Congestion Window
3. Slow Start
4. So on.

The demonstration methods are suggested to include at least one figure automatically plotted by `matplotlib` or other plotting libraries. Note that you are **not allowed** to submit a figure plotted by **hand-making data**, like plotted by `excel` or any other alike tools. You have to **specificate**(submit) the code clip you used to plot in your report. You must **clearly indicate** which part of the figure tells which TCP behavior. **Note** that you do not need to demonstrate all behaviours, one or two of them are sufficient. Also, spending too much time on making your plots fancy may not help you gain more grades. A simple example is provided like



The code to plot this figure is (suppose you have stored ACK numbers in list `ackss`)

```
import matplotlib.pyplot as plt

# Create x-axis values (just the index of each ACK)
x_values = list(range(len(ackss)))

# Plot the line chart
plt.plot(x_values, ackss)

# Add x and y labels and a title
plt.xlabel('Packet Number')
plt.ylabel('ACK Number')
plt.title('ACK Numbers vs Packet Numbers')

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

Grading Rules

For Task 1, a script file will be provided. To use this script, you have to use `Python 3.11` environment. You can use

```
python *your_sid*.GRADER
```

to run grader script. Make sure to **submit the screenshot** of it in your report, or your grade for this part may be lost. Do not try to modify answer txt. BIG BROTHER IS WATCHING YOU.

For Task 2, you have to demonstrate behaviors of TCP streams, using a code clip to plot arguements of a `TCP` packet. You must clearly indicate which behavior is presented, explain reasons and give your code to do plotting.

Step by step Tutorial

In this assignment you are required to use `scapy` library to decode packets saved in a `.pcap` file. In task 1, you can only use `pcap` file provided by us. Usage of `scapy` is very easy.

```
def packet_info(pcap_file, save_file):
    # Open the pcap file
    packets = rdpcap(pcap_file)

    # Loop through all packets in the pcap file
    with open(save_file, 'w') as f:
        for packet in packets:
            # Check if the packet is an IPv4 packet
            f.write("{}:{} -> {}:{}\n".format(packet['IP'].src,
packet['TCP'].sport, packet['IP'].dst,packet['TCP'].dport))
```

You can simply use `packet['TCP']` to access the `TCP` layer of the packet.

Tips

1. Carefully handle `LAYER_NAME`.
2. Carefully handle packets of different protocols, since different protocols have different members.

3. For application layer, i.e., the payload of `TCP` layer, you should note that directly use `packet['HTTP']` may not be a proper way. Use `packet['TCP'].payload` instead.
4. If you are confused, you can try `breakpoint` and use `debugger` to observe members and status of your code, as well as `packet` object. Or you can turn to official documents of course.
5. Note the difference of stream and connection. In this assignment you may assume that streams are specified by `(server address, client address, server port, client port)` and connections are specified by `(dst address, src address, dst port, src port)`. This may be slightly different with precise definition of stream and connection in textbook.
6. You may encounter a lot of exceptions, like `KeyError`, `UnicodeDecodeError` and so no. Try to use `try..except` block.