

CSE 476/ CSE 575

Fall 2020 Term Project Assignments

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Instructions:

Please complete the below Socket Programming Assignments using Python.

1. Web Server (Please see attached Lab1 for the details.): **30 points**
2. UDP Pinger (Please see attached Lab2 for the details.): **30 points**
3. Mail Client (Please see attached Lab3 for the details.) : **30 points**
4. Progress Report (Please put all the results of the above 3 assignments including the codes into a single report): **Due Date: December 1, 2020 (5 points)**
5. Final Report (Please put all the results of the above 3 assignments including the codes into a single report): **Due Date: January 4, 2021 (5 points)**

Summary of Assignments:

Assignment 1: Web Server

In this assignment, you will develop a simple Web server in Python that is capable of processing only one request. Specifically, your Web server will (i) create a connection socket when contacted by a client (browser); (ii) receive the HTTP request from this connection; (iii) parse the request to determine the specific file being requested; (iv) get the requested file from the server's file system; (v) create an HTTP response message consisting of the requested file preceded by header lines; and (vi) send the response over the TCP connection to the requesting browser. If a browser requests a file that is not present in your server, your server should return a "404 Not Found" error message.

In the attached Lab1, we provide the skeleton code for your server. Your job is to complete the code, run your server, and then test your server by sending requests from browsers running on different hosts. If you run your server on a host that already has a Web server running on it, then you should use a different port than port 80 for your Web server.

Assignment 2: UDP Pinger

In this programming assignment, you will write a client ping program in Python. Your client will send a simple ping message to a server, receive a corresponding pong message back from the server, and determine the delay between when the client sent the ping message and received the pong message. This delay is called the Round Trip Time (RTT). The functionality provided by the client and server is similar to the functionality provided by

standard ping program available in modern operating systems. However, standard ping programs use the Internet Control Message Protocol (ICMP) (which we will study in Chapter 4). Here we will create a nonstandard (but simple!) UDP-based ping program.

Your ping program is to send 10 ping messages to the target server over UDP. For each message, your client is to determine and print the RTT when the corresponding pong message is returned. Because UDP is an unreliable protocol, a packet sent by the client or server may be lost. For this reason, the client cannot wait indefinitely for a reply to a ping message. You should have the client wait up to one second for a reply from the server; if no reply is received, the client should assume that the packet was lost and print a message accordingly.

In this assignment, you will be given the complete code for the server (available in the attached Lab2). Your job is to write the client code, which will be very similar to the server code. It is recommended that you first study carefully the server code. You can then write your client code, liberally cutting and pasting lines from the server code.

Assignment 3: Mail Client

The goal of this programming assignment is to create a simple mail client that sends email to any recipient. Your client will need to establish a TCP connection with a mail server (e.g., a Google mail server), dialogue with the mail server using the SMTP protocol, send an email message to a recipient (e.g., your friend) via the mail server, and finally close the TCP connection with the mail server.

For this assignment, the Lab3 document provides the skeleton code for your client. Your job is to complete the code and test your client by sending email to different user accounts. You may also try sending through different servers (for example, through a Google mail server and through your university mail server).

Lab 1: Web Server Lab

In this lab, you will learn the basics of socket programming for TCP connections in Python: how to create a socket, bind it to a specific address and port, as well as send and receive a HTTP packet. You will also learn some basics of HTTP header format.

You will develop a web server that handles one HTTP request at a time. Your web server should accept and parse the HTTP request, get the requested file from the server's file system, create an HTTP response message consisting of the requested file preceded by header lines, and then send the response directly to the client. If the requested file is not present in the server, the server should send an HTTP "404 Not Found" message back to the client.

Code

Below you will find the skeleton code for the Web server. You are to complete the skeleton code. The places where you need to fill in code are marked with `#Fill in start` and `#Fill in end`. Each place may require one or more lines of code.

Running the Server

Put an HTML file (e.g., HelloWorld.html) in the same directory that the server is in. Run the server program. Determine the IP address of the host that is running the server (e.g., 128.238.251.26). From another host, open a browser and provide the corresponding URL. For example:

`http://128.238.251.26:6789/HelloWorld.html`

'HelloWorld.html' is the name of the file you placed in the server directory. Note also the use of the port number after the colon. You need to replace this port number with whatever port you have used in the server code. In the above example, we have used the port number 6789. The browser should then display the contents of HelloWorld.html. If you omit ":6789", the browser will assume port 80 and you will get the web page from the server only if your server is listening at port 80.

Then try to get a file that is not present at the server. You should get a "404 Not Found" message.

What to Hand in

You will hand in the complete server code along with the screen shots of your client browser, verifying that you actually receive the contents of the HTML file from the server.

Skeleton Python Code for the Web Server

```
#import socket module

from socket import *

serverSocket = socket(AF_INET, SOCK_STREAM)

#Prepare a sever socket

#Fill in start

#Fill in end

while True:

    #Establish the connection

    print 'Ready to serve...'

    connectionSocket, addr = #Fill in start #Fill in end

    try:

        message = #Fill in start #Fill in end

        filename = message.split()[1]

        f = open(filename[1:])

        outputdata = #Fill in start #Fill in end

        #Send one HTTP header line into socket

        #Fill in start

        #Fill in end

        #Send the content of the requested file to the client

        for i in range(0, len(outputdata)):

            connectionSocket.send(outputdata[i])

        connectionSocket.close()

    except IOError:

        #Send response message for file not found

        #Fill in start

        #Fill in end

        #Close client socket

        #Fill in start

        #Fill in end
```

```
serverSocket.close()
```

Optional Exercises

1. Currently, the web server handles only one HTTP request at a time. Implement a multithreaded server that is capable of serving multiple requests simultaneously. Using threading, first create a main thread in which your modified server listens for clients at a fixed port. When it receives a TCP connection request from a client, it will set up the TCP connection through another port and services the client request in a separate thread. There will be a separate TCP connection in a separate thread for each request/response pair.
2. Instead of using a browser, write your own HTTP client to test your server. Your client will connect to the server using a TCP connection, send an HTTP request to the server, and display the server response as an output. You can assume that the HTTP request sent is a GET method. The client should take command line arguments specifying the server IP address or host name, the port at which the server is listening, and the path at which the requested object is stored at the server. The following is an input command format to run the client.

```
client.py server_host server_port filename
```

Lab 2: UDP Pinger Lab

In this lab, you will learn the basics of socket programming for UDP in Python. You will learn how to send and receive datagram packets using UDP sockets and also, how to set a proper socket timeout. Throughout the lab, you will gain familiarity with a Ping application and its usefulness in computing statistics such as packet loss rate.

You will first study a simple Internet ping server written in the Python, and implement a corresponding client. The functionality provided by these programs is similar to the functionality provided by standard ping programs available in modern operating systems. However, these programs use a simpler protocol, UDP, rather than the standard Internet Control Message Protocol (ICMP) to communicate with each other. The ping protocol allows a client machine to send a packet of data to a remote machine, and have the remote machine return the data back to the client unchanged (an action referred to as echoing). Among other uses, the ping protocol allows hosts to determine round-trip times to other machines.

You are given the complete code for the Ping server below. Your task is to write the Ping client.

Server Code

The following code fully implements a ping server. You need to compile and run this code before running your client program. *You do not need to modify this code.*

In this server code, 30% of the client's packets are simulated to be lost. You should study this code carefully, as it will help you write your ping client.

```
# UDPPingerServer.py
# We will need the following module to generate randomized lost packets
import random
from socket import *

# Create a UDP socket
# Notice the use of SOCK_DGRAM for UDP packets
serverSocket = socket(AF_INET, SOCK_DGRAM)
# Assign IP address and port number to socket
serverSocket.bind('', 12000)

while True:
    # Generate random number in the range of 0 to 10
    rand = random.randint(0, 10)
    # Receive the client packet along with the address it is coming from
    message, address = serverSocket.recvfrom(1024)
    # Capitalize the message from the client
    message = message.upper()
```

```
# If rand is less is than 4, we consider the packet lost and do not respond
if rand < 4:
    continue
# Otherwise, the server responds
serverSocket.sendto(message, address)
```

The server sits in an infinite loop listening for incoming UDP packets. When a packet comes in and if a randomized integer is greater than or equal to 4, the server simply capitalizes the encapsulated data and sends it back to the client.

Packet Loss

UDP provides applications with an unreliable transport service. Messages may get lost in the network due to router queue overflows, faulty hardware or some other reasons. Because packet loss is rare or even non-existent in typical campus networks, the server in this lab injects artificial loss to simulate the effects of network packet loss. The server creates a variable randomized integer which determines whether a particular incoming packet is lost or not.

Client Code

You need to implement the following client program.

The client should send 10 pings to the server. Because UDP is an unreliable protocol, a packet sent from the client to the server may be lost in the network, or vice versa. For this reason, the client cannot wait indefinitely for a reply to a ping message. You should get the client wait up to one second for a reply; if no reply is received within one second, your client program should assume that the packet was lost during transmission across the network. You will need to look up the Python documentation to find out how to set the timeout value on a datagram socket.

Specifically, your client program should

- (1) send the ping message using UDP (Note: Unlike TCP, you do not need to establish a connection first, since UDP is a connectionless protocol.)
- (2) print the response message from server, if any
- (3) calculate and print the round trip time (RTT), in seconds, of each packet, if server responses
- (4) otherwise, print "Request timed out"

During development, you should run the `UDPPingerServer.py` on your machine, and test your client by sending packets to *localhost* (or, 127.0.0.1). After you have fully debugged your code, you should see how your application communicates across the network with the ping server and ping client running on different machines.

Message Format

The ping messages in this lab are formatted in a simple way. The client message is one line, consisting of ASCII characters in the following format:

Ping *sequence_number* *time*

where *sequence_number* starts at 1 and progresses to 10 for each successive ping message sent by the

client, and *time* is the time when the client sends the message.

What to Hand in

You will hand in the complete client code and screenshots at the client verifying that your ping program works as required.

Optional Exercises

1. Currently, the program calculates the round-trip time for each packet and prints it out individually. Modify this to correspond to the way the standard ping program works. You will need to report the minimum, maximum, and average RTTs at the end of all pings from the client. In addition, calculate the packet loss rate (in percentage).
2. Another similar application to the UDP Ping would be the UDP Heartbeat. The Heartbeat can be used to check if an application is up and running and to report one-way packet loss. The client sends a sequence number and current timestamp in the UDP packet to the server, which is listening for the Heartbeat (i.e., the UDP packets) of the client. Upon receiving the packets, the server calculates the time difference and reports any lost packets. If the Heartbeat packets are missing for some specified period of time, we can assume that the client application has stopped. Implement the UDP Heartbeat (both client and server). You will need to modify the given `UDPPingerServer.py`, and your UDP ping client.

Lab 3: SMTP Lab

By the end of this lab, you will have acquired a better understanding of SMTP protocol. You will also gain experience in implementing a standard protocol using Python.

Your task is to develop a simple mail client that sends email to any recipient. Your client will need to connect to a mail server, dialogue with the mail server using the SMTP protocol, and send an email message to the mail server. Python provides a module, called `smtplib`, which has built in methods to send mail using SMTP protocol. However, we will not be using this module in this lab, because it hide the details of SMTP and socket programming.

In order to limit spam, some mail servers do not accept TCP connection from arbitrary sources. For the experiment described below, you may want to try connecting both to your university mail server and to a popular Webmail server, such as a AOL mail server. You may also try making your connection both from your home and from your university campus.

Code

Below you will find the skeleton code for the client. You are to complete the skeleton code. The places where you need to fill in code are marked with `#Fill in start` and `#Fill in end`. Each place may require one or more lines of code.

Additional Notes

In some cases, the receiving mail server might classify your e-mail as junk. Make sure you check the junk/spam folder when you look for the e-mail sent from your client.

What to Hand in

In your submission, you are to provide the complete code for your SMTP mail client as well as a screenshot showing that you indeed receive the e-mail message.

Skeleton Python Code for the Mail Client

```
from socket import *
msg = "\r\n I love computer networks!"
endmsg = "\r\n.\r\n"

# Choose a mail server (e.g. Google mail server) and call it mailserver
mailserver = #Fill in start    #Fill in end

# Create socket called clientSocket and establish a TCP connection with mailserver
#Fill in start


#Fill in end
recv = clientSocket.recv(1024)
print recv
if recv[:3] != '220':
    print '220 reply not received from server.'

# Send HELO command and print server response.
heloCommand = 'HELO Alice\r\n'
clientSocket.send(heloCommand)
recv1 = clientSocket.recv(1024)
print recv1
if recv1[:3] != '250':
    print '250 reply not received from server.'

# Send MAIL FROM command and print server response.
# Fill in start


# Fill in end

# Send RCPT TO command and print server response.
# Fill in start


# Fill in end

# Send DATA command and print server response.
# Fill in start


# Fill in end

# Send message data.
# Fill in start


# Fill in end
```

```
# Message ends with a single period.  
# Fill in start  
  
# Fill in end  
  
# Send QUIT command and get server response.  
# Fill in start  
  
# Fill in end
```

Optional Exercises

1. Mail servers like Google mail (address: smtp.gmail.com, port: 587) requires your client to add a Transport Layer Security (TLS) or Secure Sockets Layer (SSL) for authentication and security reasons, before you send MAIL FROM command. Add TLS/SSL commands to your existing ones and implement your client using Google mail server at above address and port.
2. Your current SMTP mail client only handles sending text messages in the email body. Modify your client such that it can send emails with both text and images.