Part A): Code Description

The code required for assignment one implements a client-server communication system using Python and associated socket and threading libraries. The server is multi-threaded, allowing it to handle multiple users at the same time, up to 3 users at once. The server uses a specific port and accepts incoming client connections, managing a cache of the user's details, specifically the start and end times.

Key Functionalities:

- Connection Management
  - The server listens for incoming connections and either accepts or rejects the user based on the current number of users relative to the max_clients limit which is set to 3. Once connected the server welcomes the user with a message, if the server is at capacity it will send a busy message.
- Client Communication (Commands)
  - Status: The server returns a list of all users and their connection times
  - List: Returns a list of available files in a specific directory on the server
  - get <filename>: Request a specific file, which the server will send in chunks, ending the transfer with a "EOF" marker.
  - exit: A user can end their connection to the server by using the "exit" command. This removes them from the active user list and logs the end time.
- Thread Safety
  - By using "client_lock" we ensure that only one thread can modify "current_clients" at a time. This helps keep the values accurate and consistent.
  - The same is done by "cache_lock" to keep the data accurate for "client_cache"
- File Transfer:
  - The server supports file transfer by sending requested files in chunks of 1024 bytes to the user.

Part B) Difficulties Faced

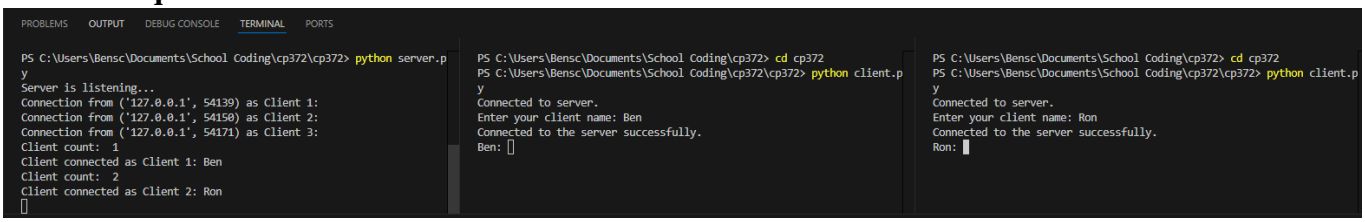
- Managing Concurrent Users:
  - A challenge was ensuring that multiple users could connect to the server and communicate without issues such as data corruption. This was addressed by using the thread locks mentioned above to synchronize access to "client_cache" and "current_clients". Without the locks multiple threads could have accessed or modified these variables at the same time causing inconsistent or wrong data.
- File Transfer
  - During file transfer, we had to make changes to allow for various chunks of data to be sent before prompting the user to accomindate larger files.

- Another challenge was informing the user that the tansfer had been complete. To solve this, we had the server send an “EOF” marker after the file content, allowing the client to determine the end of the transfer and stop reading.

Part C) Test Results:

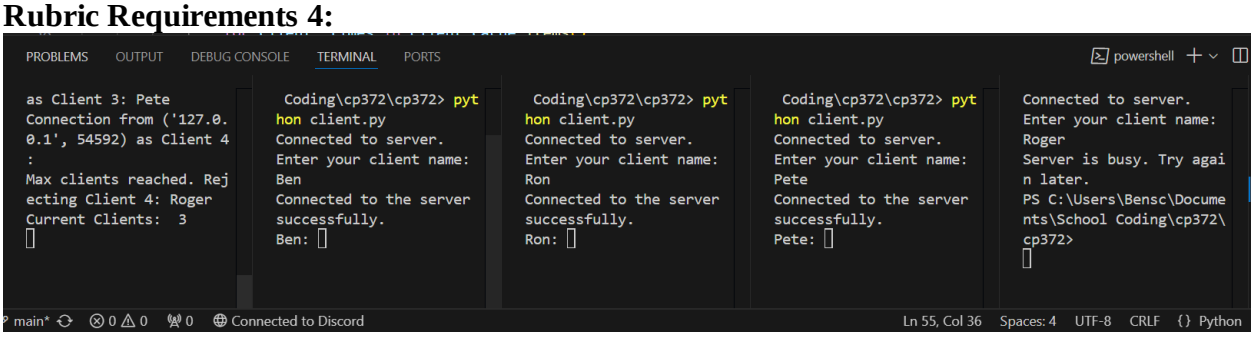
For the test results, VS Code’s built in terminal will be used, and multiple terminals will be used to demonstrate multiple clients. The far left terminal will be running the server, and all other subsequent terminals will clients.

Rubric Requirements 1-3:



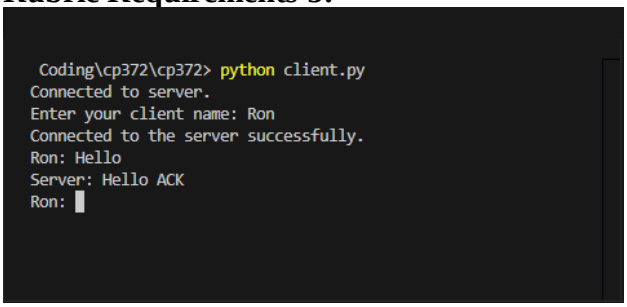
Displayed is 2 clients connected to the server, witch each client assigned a name and number.

Rubric Requirements 4:



As shown, when a 4th client attempts to join the server, they are rejected since the max clients allowed at a time is 3.

Rubric Requirements 5:



As shown when client sends message Hello, server responds with “Hello ACK”

Rubric Requirements 6:

```
PROBLEMS    OUTPUT    DEBUG CONSOLE    TERMINAL    PORTS

as Client 3: Pete
Connection from ('127.0.0.1', 54592) as Client 4:
Max clients reached. Rejecting Client 4: Roger
Current Clients:  3
Client 1: Ben has disconnected.
Current Clients:  2
```

```
 Coding\cp372\cp372> python client.py
Connected to server.
Enter your client name: Ben
Connected to the server successfully.
Ben: exit
Closing connection to server...
Connection closed.
PS C:\Users\Bensc\Documents\School Coding\cp372\cp372>
```

As shown, when client types “exit”, the server cleanly disconnects clients and makes room for other clients

Rubric Requirements 7:

```
Ron: Hello
Server: Hello ACK
Ron: Status
Server: Client 1: Ben - Start: 2024-10-19 17:45:47, End: 2024-10-19 17:46:20
Client 2: Ron - Start: 2024-10-19 17:45:54, End: Still Connected
Client 3: Pete - Start: 2024-10-19 17:45:58, End: Still Connected

Ron:
```

As shown server maintains connection details, including connection and disconnection time.

Rubric Requirements 8, 9:

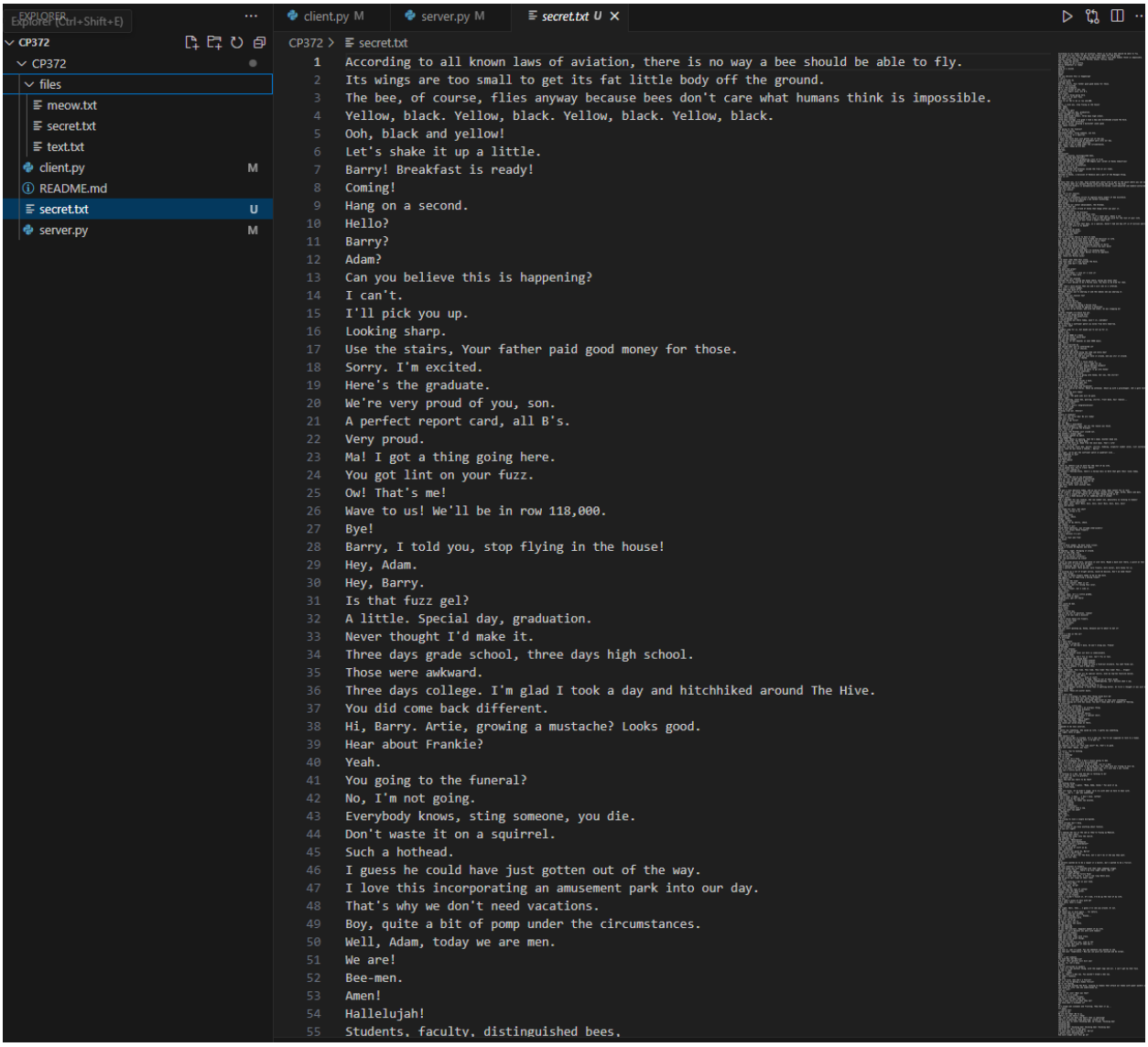
```
PROBLEMS    OUTPUT    DEBUG CONSOLE    TERMINAL    PORTS

Client connected as Client 3: Pete

Connection from ('127.0.0.1', 5505
1) as Client 4:
Max clients reached. Rejecting Cli
ent 4: Roger
Current Clients:  3
Client 1: Ben has disconnected.
Current Clients:  2
```

```
cted
Client 3: Pete - Start: 2024-10-19 17:45:58, End: Still Conn
ected

Ron: list
Server: meow.txt
secret.txt
text.txt
Ron: get secret.txt
File received successfully.
Ron:
```



When the user types “list,” it lists all the files in the files directory. Typing in get “file_name” will download the file and its contents to the current directory that client is running in.

Part D): Possible Improvements

Given more time, the biggest improvement would be enabling direct client-to-client communication. Currently, all communication is routed through the server. By implementing a peer-to-peer connection, clients could exchange messages directly after establishing an initial connection to the server.

Additionally, other improvements include

- File transfer between client and client
- User Authentication
- Implementing a proper graphical user interface instead of command line