

Project Report

Group members:

- Allen Zhu - zxz200023
- Naomi Zilber - nsz190000

Protocol design:

Message format for sending and receiving math calculations:

- Request from client- CALCULATION_REQUEST|operator|operand1|operand2
- Response from server- CALCULATION_ACK|operator|operand1|operand2|result

Message format for joining and terminating connection:

- Request to join from client- JOIN_REQUEST|clientName
- Response to joining from server- JOIN_ACK|clientName
- Request to terminate from client- TERMINATION_REQUEST|clientName
- Response to termination from server- TERMINATION_ACK|clientName

Format for keeping logs of clients' activities at server side:

- clientName, time of request, duration time of client and server connection after request was satisfied, the request itself
- With the exception of the join request, all other client request are documented as above. The join request doesn't have the duration time since the client had just set up the connection.
- For make_1client folder logs is stored as log.txt
- For make_3client folder logs is stored as make_log.txt

Programming environment used:

- Used Visual Studios Code for the programs written in Java.

Compiling and Executing:

- After opening the respective folder you intend to run, make sure to run 'make' command first before proceeding with the next steps.
- Executing with a Single Client (Requires User Input)
 - Open make_1client folder
 - Open two separate terminal windows: one for the client and one for the server.
 - In the server terminal window, run the following command: ``make server``
 - In the client terminal window, run the following command: ``make clients``
 - This setup will run the server and a single client that requires user input from the keyboard.
- Executing with Three Clients (No User Input Required)

- Open make_3client folder
- Open two separate terminal windows: one for the client and one for the server.
- In the server terminal window, run the following command: ``make server``
- In the client terminal window, run the following command: ``make clients``
- No parameters needed for execution

Challenges faced:

- While coding the TCP client, it was necessary to take into account that the user input might not be in the format it needs to be, so extra code to check that the input is valid was needed and a course of action needed to be determined for if the input is invalid.
- TCP server allowed only one client to connect at a time. This limitation was due to the server processing each client connection sequentially. To address the issue, we implemented multithreading in the server to handle multiple client connections concurrently to overcome this issue. We achieved this by creating a separate thread for each client connection. When a new client connects, the server creates a new ClientHandler instance, passes the client's connection socket, and starts a new thread to handle the connection.

What we learned:

- From this project, we learned how to implement a network application that consists of a server and clients using sockets. We learned how to set up sockets and input/output streams for processes to communicate, and how to design a protocol to allow the processes to exchange messages with one another in the most simple and efficient way.

Output screenshots:

make_1client:

```

● allenz@m1-mac-allen make_1client % ls
makefile          tcp_client.java  tcp_server.java

● allenz@m1-mac-allen make_1client % make
javac tcp_server.java
javac tcp_client.java
● allenz@m1-mac-allen make_1client % ls
ClientHandler.class  TCPServer.class  tcp_client.java
TCPClient.class      makefile         tcp_server.java

```

Client-side operations:

```
● allenz@m1-mac-allen make_1client % make clients
java TCPClient
Would you like to connect to server? (y/n): y
Client name: Bob
Connection established
Would you like to make a calculation request? (y/n): y
Enter request (operands are MUL, DIV, ADD, SUB) using the format 'ADD|5|2': ADD|5|7
Answer from server: 12
Enter request (operands are MUL, DIV, ADD, SUB) using the format 'ADD|5|2': DIV|6|2
Answer from server: 3
Enter request (operands are MUL, DIV, ADD, SUB) using the format 'ADD|5|2': MUL|4|5
Answer from server: 20
Would you like to make a calculation request? (y/n): n
Connection terminated
```

Server-side operations:

```
○ allenz@m1-mac-allen make_1client % make server
java TCPServer
New client joined: Bob
Calculation request received from Bob: ADD|5|7
Result sent to Bob: ADD|5|7|12
Calculation request received from Bob: DIV|6|2
Result sent to Bob: DIV|6|2|3
Calculation request received from Bob: MUL|4|5
Result sent to Bob: MUL|4|5|20
Client Bob terminated connection
```

Log:

```
Bob, 2023-04-16T03:21:10.818888Z, JOIN_REQUEST|Bob
Bob, 2023-04-16T03:21:22.013567Z, 11 seconds, CALCULATION_REQUEST|ADD|5|7
Bob, 2023-04-16T03:21:32.593398Z, 21 seconds, CALCULATION_REQUEST|DIV|6|2
Bob, 2023-04-16T03:21:41.259534Z, 30 seconds, CALCULATION_REQUEST|MUL|4|5
Bob, 2023-04-16T03:21:43.341004Z, 32 seconds, TERMINATION_REQUEST|Bob
```

make_3client (same 'makefile' steps):

Client-side operations: 3 client-side connections with no user input required

```
allenz@m1-mac-allen make_3clients % make clients
java TCPClientM1
Connection established
Server response: CALCULATION_ACK|ADD|1|2|3
Answer from server: 3
Server response: CALCULATION_ACK|SUB|3|4|-1
Answer from server: -1
Server response: CALCULATION_ACK|MUL|5|6|30
Answer from server: 30
Connection terminated
sleep 1
java TCPClientM2
Connection established
Server response: CALCULATION_ACK|ADD|4|2|6
Answer from server: 6
Server response: CALCULATION_ACK|SUB|7|4|3
Answer from server: 3
Server response: CALCULATION_ACK|MUL|5|2|10
Answer from server: 10
Connection terminated
sleep 1
java TCPClientM3
Connection established
Server response: CALCULATION_ACK|ADD|4|5|9
Answer from server: 9
Server response: CALCULATION_ACK|SUB|9|4|5
Answer from server: 5
Server response: CALCULATION_ACK|MUL|5|3|15
Answer from server: 15
Connection terminated
```

Server-side:

```
allenz@m1-mac-allen make_3clients % ls
ClientHandler.class      TCPServer.class          tcp_client_make3.java
TCPClientM1.class        makefile                 tcp_server_make.java
TCPClientM2.class        tcp_client_make1.java
TCPClientM3.class        tcp_client_make2.java
allenz@m1-mac-allen make_3clients % make server
java TCPServer
New client joined: Bob
Calculation request received from Bob: ADD|1|2
Result sent to Bob: ADD|1|2|3
Calculation request received from Bob: SUB|3|4
Result sent to Bob: SUB|3|4|-1
Calculation request received from Bob: MUL|5|6
Result sent to Bob: MUL|5|6|30
Client Bob terminated connection
New client joined: Alice
Calculation request received from Alice: ADD|4|2
Result sent to Alice: ADD|4|2|6
Calculation request received from Alice: SUB|7|4
Result sent to Alice: SUB|7|4|3
Calculation request received from Alice: MUL|5|2
Result sent to Alice: MUL|5|2|10
Client Alice terminated connection
New client joined: Jhon
Calculation request received from Jhon: ADD|4|5
Result sent to Jhon: ADD|4|5|9
Calculation request received from Jhon: SUB|9|4
Result sent to Jhon: SUB|9|4|5
Calculation request received from Jhon: MUL|5|3
Result sent to Jhon: MUL|5|3|15
Client Jhon terminated connection
```

Log:

```
make_3clients > ≡ make_log.txt
```

```
1 Bob, 2023-04-16T03:26:50.830230Z, JOIN_REQUEST|Bob
2 Bob, 2023-04-16T03:26:50.846854Z, 0 seconds, CALCULATION_REQUEST|ADD|1|2
3 Bob, 2023-04-16T03:26:50.855255Z, 0 seconds, CALCULATION_REQUEST|SUB|3|4
4 Bob, 2023-04-16T03:26:50.855858Z, 0 seconds, CALCULATION_REQUEST|MUL|5|6
5 Bob, 2023-04-16T03:26:50.856478Z, 0 seconds, TERMINATION_REQUEST|Bob
6 Alice, 2023-04-16T03:26:51.921355Z, JOIN_REQUEST|Alice
7 Alice, 2023-04-16T03:26:51.929878Z, 0 seconds, CALCULATION_REQUEST|ADD|4|2
8 Alice, 2023-04-16T03:26:51.930467Z, 0 seconds, CALCULATION_REQUEST|SUB|7|4
9 Alice, 2023-04-16T03:26:51.930920Z, 0 seconds, CALCULATION_REQUEST|MUL|5|2
10 Alice, 2023-04-16T03:26:51.931399Z, 0 seconds, TERMINATION_REQUEST|Alice
11 Jhon, 2023-04-16T03:26:53.016724Z, JOIN_REQUEST|Jhon
12 Jhon, 2023-04-16T03:26:53.025667Z, 0 seconds, CALCULATION_REQUEST|ADD|4|5
13 Jhon, 2023-04-16T03:26:53.026395Z, 0 seconds, CALCULATION_REQUEST|SUB|9|4
14 Jhon, 2023-04-16T03:26:53.026842Z, 0 seconds, CALCULATION_REQUEST|MUL|5|3
15 Jhon, 2023-04-16T03:26:53.027473Z, 0 seconds, TERMINATION_REQUEST|Jhon
16
```