Computer Networks Project

Vishnu Nair, VSN200001: Aiding in the creation of Client/Server code and how the protocol should work. Editing/ modifying the report.
Andrew Pham, AHP1900004: Screenshots, report formatting & editing, code touch-up
Martin Arriaga, MXA220083: Makefile code, server/user log code, created Design Document

Protocol design

1. Logging; the server will maintain two types of logs recording information of events in a log file.

    1.1 One log tracks the users who have connected to the server, recording the following details for each:

    - User names
    - Time of initial connection
    - Time when the user disconnected
    - IP address
    - Port number
    - Queries made
    - Total up time

    The format of the connection log is shown below along with a provided example**:**

    <time in MM-dd-YYYY HH:mm:ss> LogClass logUserInfo

    INFO:

    User ID: <name>

    IP Address: <IP address>

    Port Number: <port number>

    Queries Made: <number queries made>

    Time of Connection: <time in MM-dd-YYYY HH:mm:ss>

    Time Disconnected: <time in MM-dd-YYYY HH:mm:ss>

    Up time: <duration>

    Example:

    Apr 21, 2025 3:10:49 AM LogClass logUserInfo

    INFO:

    User ID: Steve

    IP Address: 127.0.0.1

Port Number: 49993

Queries Made: 3

Time of Connection: 04-21-2025 03:10:13

Time Disconnected: 04-21-2025 03:10:49

Up time: PT36.146067S

1.2 The other log tracks the activity in the server, such as:

- Time the activity took place
- Connection to server
- Disconnection from server
- Requests
- Responses
- Errors involving calculations that are not formatted correctly

The activity logs are formatted as the following:

<time in MM-dd-YYYY HH:mm:ss> LogClass logServerActivity

INFO:

<message>

Example:

Apr 21, 2025 3:10:13 AM LogClass logServerActivity

INFO:

ACK: Connected to Math Server as Steve

Apr 21, 2025 3:10:27 AM LogClass logServerActivity

INFO:

REQUEST: 5 + 9

RESULT: 14.0

2. Requests and Responses between Server and Client:

The server must be running first before the client can connect.

2.1 Client Connection

- Once the client script starts, it creates a socket that connects to “localhost” on port number 12345

- Socket socket = new Socket("localhost", 12345); // creates socket
- The “localhost” contains the default IP Address: 127.0.0.1
- If the server is running on a separate machine, “localhost” can change its IP address to the machine running the server code. This is done with the command: java Client <IPAdd>

2.2 Initial Handshake

- The server receives the initial connection, creates a thread, and runs the Client Handler.
- The user will be prompted to enter their name once the message appears on the console, which is sent to the server for records
- Once the server receives the name of the user, it sends an ACK message in response to the client.
- The user’s console displays the received ACK message, confirming the connection to the server.

2.3 Subsequent Requests and Responses

- The user can query three or more math operations randomly delayed to simulate natural user behavior.
- The server receives the query, evaluates it, logs the request and results, and sends the result back to the user.
- After three queries, the client is prompted with "Send more? (y/n): "
    - Entering y will continue the querying. The prompt is given after every query from this point onwards.
    - Entering n will exit.
- Once the client script sends exit to the server:
    - The server removes the client and logs messages.
    - The server logs the user’s information to user logs.
    - The client script then closes the socket connection.
    - The client script closes the scanner for user input.

3. Message Format

Our calculator can handle the following operations:

- *
- /
- +
- -

The format for the message is as follows:

<double> <Operator> <double>

Examples:

3 + 4

*4 * 5*

20 / 5

6 - 3

Programming Environment

The selected programming environment is Java.

Compilation and Execution of Application

In the terminal, traverse to the folder where the project is saved.

Note that UserInfo.java file must be in the same project folder.

To compile the Server.java script, execute the command below, and all classes referenced should be compiled as well. If not, run the following command, given that all classes are in the same directory: javac *.java

javac Server.java

To run script

java Server

Upon success the following message will print to the console:

“Math Server started on port 12345”

To compile Client.java execute the command

javac Client.java

To run script

Java Client

If successful the user will be prompted to enter their name with the console showing:
“Enter your name:”
The command above is using the IP address “localhost.”
From here, follow the prompts to input calculations, receive results, and end the client script.

To run the Client script with a custom IP address, input this command
java Client <IPAdd>
The code checks if the command line arguments are empty and assigns “localhost” to parameter “host”. If the user includes an IP address, it will assign the input to the host.

Makefile execution:

Traverse to folder containing saved java scripts:

1. make // compiles all classes in
2. make Server // runs server script
3. make Client // runs client script
    a. make Client HOST=xxx.xxx.xxx.xxx (optional)
4. When prompted, type “standby” for the name to enter “standby” mode, where the code automatically selects a random name and executes five random queries at random times.

Parameters needed for execution

If the user wants to use the provided 127.0.0.1 address, there are no parameters to be passed into the command line. To change the IP address simply execute the following: java Client <IPAdd>, where <IPAdd> is the IP address you want the socket to connect to on port number 12345.

Challenges

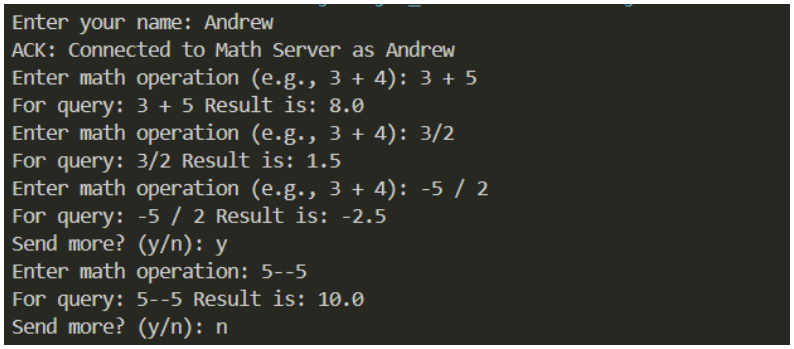
Some challenges we faced were making sure the queries could accept and differentiate between negative numbers and subtraction. An older version of our evaluation method used String.split() to parse the expressions and then evaluate them. The issue is that String.split() sometimes gets confused with the negative operator and subtraction, leading it to give out incorrect solutions. The fix to this was using regex to match the math expression so that it could find the solution correctly.

What we Learned:

We learnt how to implement a network client-server application using Java sockets. We learned how to simulate having a TCP connection by logging data of was being communicated between the server and the client sides of the application. Using threads gave us the ability to have multiple different clients attached to one server, asking for different math operations. Overall, we learned how to implement a simple communication protocol that allows communication between the server and the client and also keeps logs of how that data is being sent over the connection.

Screenshots

Client View:



Server View:

```
--------------
May 01, 2025 10:01:37 PM LogClass logServerActivity
INFO:
SESSION CLOSED WITH USER: Andrew. Duration: 61 seconds
```

2 simultaneous clients on one server:

```
Enter your name: Martin
ACK: Connected to Math Server as Martin
Enter math operation (e.g., 3 + 4): 4 * -5
For query: 4 * -5 Result is: -20.0
Enter math operation (e.g., 3 + 4): 5 +
Invalid input. Try again.
Enter math operation (e.g., 3 + 4): 33.2 / 5.5
For query: 33.2 / 5.5 Result is: 6.036363636363637
Send more? (y/n): o
Invalid input. Please enter 'y' or 'n'
Send more? (y/n): y
Enter math operation: 5/0
Invalid input. Try again.
Send more? (y/n): n
```

```
Enter your name: Vishnu
ACK: Connected to Math Server as Vishnu
Enter math operation (e.g., 3 + 4): 33
Invalid input. Try again.
Enter math operation (e.g., 3 + 4): a + b
Invalid input. Try again.
Enter math operation (e.g., 3 + 4): 4 - 4
For query: 4 - 4 Result is: 0.0
Send more? (y/n): o
Invalid input. Please enter 'y' or 'n'
Send more? (y/n): n
```

Server view of 2 concurrent clients below:

```
May 01, 2025 10:05:03 PM LogClass logServerActivity
INFO:
ACK: Connected to Math Server as Martin
May 01, 2025 10:05:13 PM LogClass logServerActivity
INFO:
REQUEST: 4 * -5
RESPONSE: -20.0
May 01, 2025 10:05:44 PM LogClass logServerActivity
INFO:
ACK: Connected to Math Server as Vishnu
java.lang.IllegalArgumentException: Invalid format or unsupported expression
        at ClientHandler.evaluate(Server.java:205)
        at ClientHandler.run(Server.java:152)
        at java.base/java.lang.Thread.run(Thread.java:1570)
May 01, 2025 10:05:58 PM LogClass logServerActivity
INFO:
INVALID REQUEST: 5 +
May 01, 2025 10:06:09 PM LogClass logServerActivity
INFO:
REQUEST: 33.2 / 5.5
RESPONSE: 6.036363636363637
java.lang.IllegalArgumentException: Invalid format or unsupported expression
        at ClientHandler.evaluate(Server.java:205)
        at ClientHandler.run(Server.java:152)
        at java.base/java.lang.Thread.run(Thread.java:1570)
May 01, 2025 10:06:19 PM LogClass logServerActivity
INFO:
INVALID REQUEST: 33
java.lang.IllegalArgumentException: Invalid format or unsupported expression
        at ClientHandler.evaluate(Server.java:205)
        at ClientHandler.run(Server.java:152)
        at java.base/java.lang.Thread.run(Thread.java:1570)
May 01, 2025 10:06:26 PM LogClass logServerActivity
INFO:
INVALID REQUEST: a + b
```

```
May 01, 2025 10:06:40 PM LogClass logServerActivity
INFO:
REQUEST: 4 - 4
RESPONSE: 0.0
May 01, 2025 10:06:49 PM LogClass logServerActivity
INFO:
DISCONNECTED
May 01, 2025 10:06:49 PM LogClass logUserInfo
INFO:
--------------
User ID: Vishnu
IP Address: 127.0.0.1
Port Number: 61136
Queries Made: 1
Time of Connection: 05-01-2025 22:05:44
Time Disconnected: 05-01-2025 22:06:49
Up time: PT1M4.4507749S
--------------
May 01, 2025 10:06:49 PM LogClass logServerActivity
INFO:
SESSION CLOSED WITH USER: Vishnu. Duration: 64 seconds
java.lang.ArithmeticException: Divide by zero
        at ClientHandler.evaluate(Server.java:217)
        at ClientHandler.run(Server.java:152)
        at java.base/java.lang.Thread.run(Thread.java:1570)
May 01, 2025 10:06:53 PM LogClass logServerActivity
INFO:
INVALID REQUEST: 5/0
May 01, 2025 10:06:55 PM LogClass logServerActivity
INFO:
DISCONNECTED
May 01, 2025 10:06:55 PM LogClass logUserInfo
INFO:
--------------
```

```
User ID: Martin
IP Address: 127.0.0.1
Port Number: 61114
Queries Made: 2
Time of Connection: 05-01-2025 22:05:03
Time Disconnected: 05-01-2025 22:06:55
Up time: PT1M52.1138751S
--------------
May 01, 2025 10:06:55 PM LogClass logServerActivity
INFO:
SESSION CLOSED WITH USER: Martin. Duration: 112 seconds
```

Server Logs in total:

serverlogs.log

```
May 01, 2025 10:00:36 PM LogClass logServerActivity
INFO:
ACK: Connected to Math Server as Andrew
May 01, 2025 10:01:04 PM LogClass logServerActivity
INFO:
REQUEST: 3 + 5
RESPONSE: 8.0
May 01, 2025 10:01:14 PM LogClass logServerActivity
INFO:
REQUEST: 3/2
RESPONSE: 1.5
May 01, 2025 10:01:21 PM LogClass logServerActivity
INFO:
REQUEST: -5 / 2
RESPONSE: -2.5
May 01, 2025 10:01:35 PM LogClass logServerActivity
INFO:
REQUEST: 5--5
RESPONSE: 10.0
May 01, 2025 10:01:37 PM LogClass logServerActivity
INFO:
DISCONNECTED
May 01, 2025 10:01:37 PM LogClass logServerActivity
INFO:
SESSION CLOSED WITH USER: Andrew. Duration: 61 seconds
May 01, 2025 10:05:03 PM LogClass logServerActivity
INFO:
ACK: Connected to Math Server as Martin
May 01, 2025 10:05:13 PM LogClass logServerActivity
INFO:
REQUEST: 4 * -5
RESPONSE: -20.0
May 01, 2025 10:05:44 PM LogClass logServerActivity
INFO:
ACK: Connected to Math Server as Vishnu
May 01, 2025 10:05:58 PM LogClass logServerActivity
INFO:
```

```
INVALID REQUEST: 5 +
May 01, 2025 10:06:09 PM LogClass logServerActivity
INFO:
REQUEST: 33.2 / 5.5
RESPONSE: 6.036363636363637
May 01, 2025 10:06:19 PM LogClass logServerActivity
INFO:
INVALID REQUEST: 33
May 01, 2025 10:06:26 PM LogClass logServerActivity
INFO:
INVALID REQUEST: a + b
May 01, 2025 10:06:40 PM LogClass logServerActivity
INFO:
REQUEST: 4 - 4
RESPONSE: 0.0
May 01, 2025 10:06:49 PM LogClass logServerActivity
INFO:
DISCONNECTED
May 01, 2025 10:06:49 PM LogClass logServerActivity
INFO:
SESSION CLOSED WITH USER: Vishnu. Duration: 64 seconds
May 01, 2025 10:06:53 PM LogClass logServerActivity
INFO:
INVALID REQUEST: 5/0
May 01, 2025 10:06:55 PM LogClass logServerActivity
INFO:
DISCONNECTED
May 01, 2025 10:06:55 PM LogClass logServerActivity
INFO:
SESSION CLOSED WITH USER: Martin. Duration: 112 seconds

```

User Logs in total:

userlogs.log

```
May 01, 2025 10:01:37 PM LogClass logUserInfo
INFO:
--------------
User ID: Andrew
IP Address: 127.0.0.1
Port Number: 60979
Queries Made: 4
Time of Connection: 05-01-2025 22:00:36
Time Disconnected: 05-01-2025 22:01:37
Up time: PT1M1.425315S
--------------
May 01, 2025 10:06:49 PM LogClass logUserInfo
INFO:
--------------
User ID: Vishnu
IP Address: 127.0.0.1
Port Number: 61136
Queries Made: 1
Time of Connection: 05-01-2025 22:05:44
Time Disconnected: 05-01-2025 22:06:49
Up time: PT1M4.4507749S
--------------
May 01, 2025 10:06:55 PM LogClass logUserInfo
INFO:
--------------
User ID: Martin
IP Address: 127.0.0.1
Port Number: 61114
Queries Made: 2
Time of Connection: 05-01-2025 22:05:03
Time Disconnected: 05-01-2025 22:06:55
Up time: PT1M52.1138751S
--------------

```

“Standby” mode:

```
PS C:\Users\Andrew Pham\Downloads\CS4390SocketProject-martinsbranch>  & 'C:\Program Files\Java\jdk-22\bin\java.exe' '-agentlib:jdwp=transport=dt_socket,server=n,
suspend=y,address=localhost:60429' '-XX:+ShowCodeDetailsInExceptionMessages' '-cp' 'C:\Users\Andrew Pham\AppData\Roaming\Code\User\workspaceStorage\f609e05844243
1645de38b6429b2ed8b\redhat.java\jdt_ws\CS4390SocketProject-martinsbranch_fec54932\bin' 'Client'
Enter your name: standby
ACK: Connected to Math Server as Jerry
Enter math operation (e.g., 3 + 4): For query: 100 / 10 Result is: 10.0
Enter math operation (e.g., 3 + 4): For query: 1999 * 999 Result is: 1997001.0
Enter math operation (e.g., 3 + 4): For query: 20 / 5 Result is: 4.0
Enter math operation (e.g., 3 + 4): For query: 20 / 5 Result is: 4.0
Enter math operation (e.g., 3 + 4): For query: 7 + 3 Result is: 10.0
PS C:\Users\Andrew Pham\Downloads\CS4390SocketProject-martinsbranch>
```