SOFE 4790U: Distributed Systems (Fall 2024)

Assignment #1

Honour code: By submitting this assignment, I (name and banner id# below) affirm this is my own work, and I have not asked any of my fellow students or others for their source code or solutions to complete this assignment, and I have not offered my source code or solutions for this assignment to any of my fellow students.

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1. Application idea

My project is a multi client chat application. The application allows multiple users to connect to a centralized server and communicate with each other in real-time. It supports several features including private messaging, file transfer, chat rooms, activity status monitoring and administrator commands, making it a versatile platform for managing group communications. The goal of the application was to provide a feature-rich environment for real-time communication, similar to commercial chat systems, but with additional features that make it distinct and tailored for specific use cases.

2. Describe the two core functionalities

- Messaging: Users can send messages to either the entire group or specific users through private messaging. The messaging functionality is real-time and supports basic text communication.
- File Transfer: Users can send files to each other. This feature allows the sharing of important documents or media within the chat environment, enhancing collaboration.

3. Describe the two novel features

- Chat Rooms: The application allows users to create and join separate chat rooms. Each room can be used for different topics or groups, providing an organized way to manage multiple conversations. Users can join or leave rooms dynamically, and admins have the ability to manage rooms.

- Typing Indicator and Idle Status: The typing indicator feature shows when a user is currently typing, which enhances communication flow. Additionally, the idle status update marks users as idle after a set period of inactivity, helping others know who is actively available in the chat.

- User Authentication and Admin Features: The application supports secure user authentication, allowing users to register or log in before accessing chat functionalities. Admins have special privileges, such as kicking users or shutting down the server, providing greater control over the chat environment.

4. Challenges and solutions

- Concurrent User Management: Handling multiple user requests concurrently was a key challenge due to the multi-threaded nature of the server. Each client runs on its own thread, which required careful synchronization. To solve this, thread-safe data structures were used to store client handlers.

- File Transfer: Managing the transfer of large files without blocking server activities was challenging. Buffered streams were used for efficient file handling, and the transfers were managed on separate threads to keep the server responsive. A dialog box was also implemented for file selection to make the process easier.

5. Testing

User Registration and Login Test

Action: Created new user accounts and logged in from different clients to verify the registration and login process.
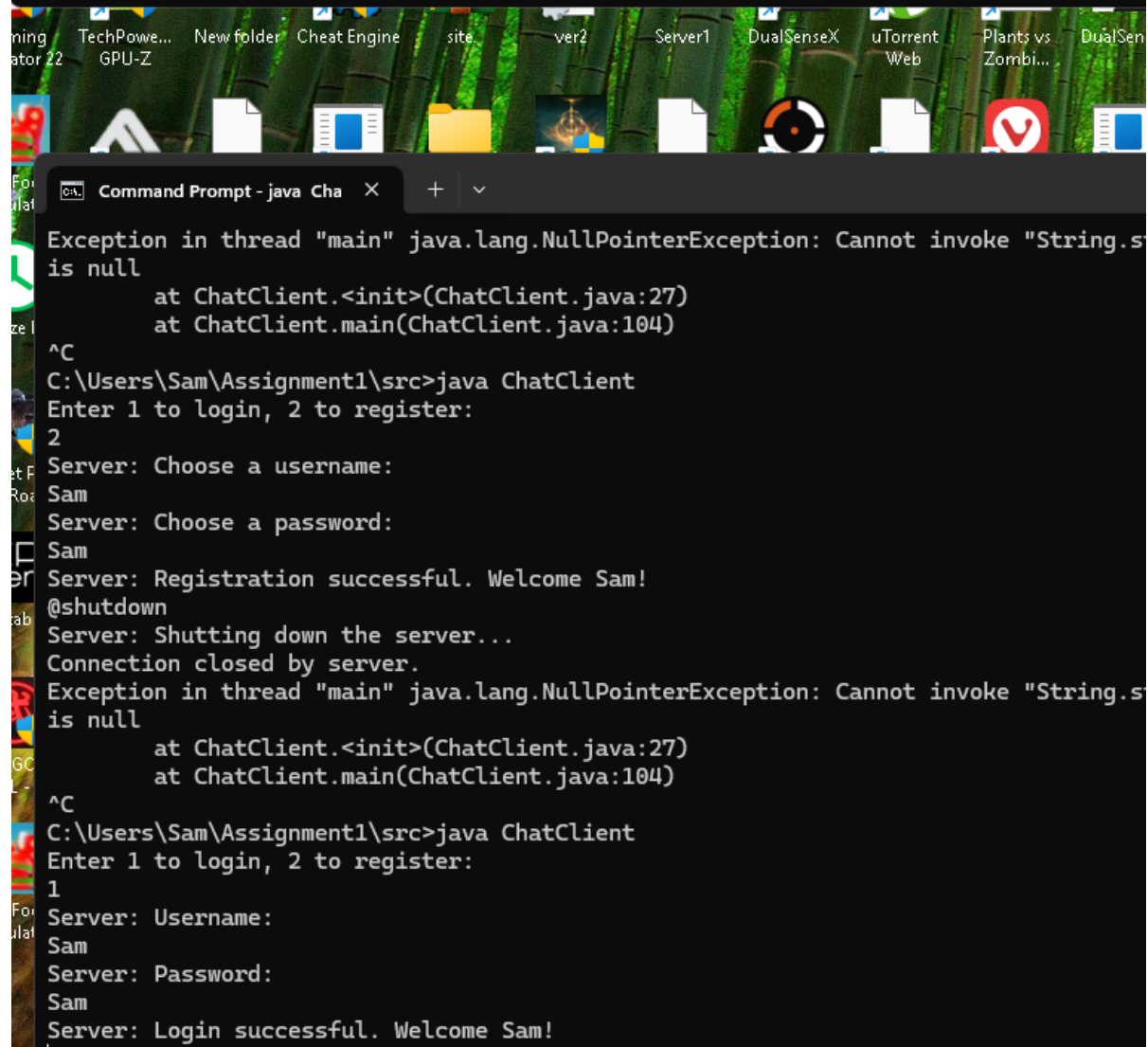
```
C:\Users\Sam\Assignment1\src>javac ChatServer.java ChatClient.java ClientHandler.java

C:\Users\Sam\Assignment1\src>java ChatServer
Server is listening on port 12345
New client connected
Admin assigned: null
Sam has joined the chat.
Broadcasting: Sam has joined the chat.
Broadcasting: Sam has left the chat.
Broadcasting: Sam has left the chat.
Exception in thread "Thread-0" java.util.ConcurrentModificationException
        at java.base/java.util.ArrayList$Itr.checkForComodification(ArrayList.java:1096)
        at java.base/java.util.ArrayList$Itr.next(ArrayList.java:1050)
        at ChatServer.shutdownServer(ChatServer.java:81)
        at ClientHandler.run(ClientHandler.java:45)
        at java.base/java.lang.Thread.run(Thread.java:1575)
^C
C:\Users\Sam\Assignment1\src>java ChatServer
Server is listening on port 12345
New client connected
Admin assigned: null
Sam has joined the chat.
Broadcasting: Sam has joined the chat.
```

```
Exception in thread "main" java.lang.NullPointerException: Cannot invoke "String.s
is null
        at ChatClient.<init>(ChatClient.java:27)
        at ChatClient.main(ChatClient.java:104)
^C
C:\Users\Sam\Assignment1\src>java ChatClient
Enter 1 to login, 2 to register:
2
Server: Choose a username:
Sam
Server: Choose a password:
Sam
Server: Registration successful. Welcome Sam!
@shutdown
Server: Shutting down the server...
Connection closed by server.
Exception in thread "main" java.lang.NullPointerException: Cannot invoke "String.s
is null
        at ChatClient.<init>(ChatClient.java:27)
        at ChatClient.main(ChatClient.java:104)
^C
C:\Users\Sam\Assignment1\src>java ChatClient
Enter 1 to login, 2 to register:
1
Server: Username:
Sam
Server: Password:
Sam
Server: Login successful. Welcome Sam!
```
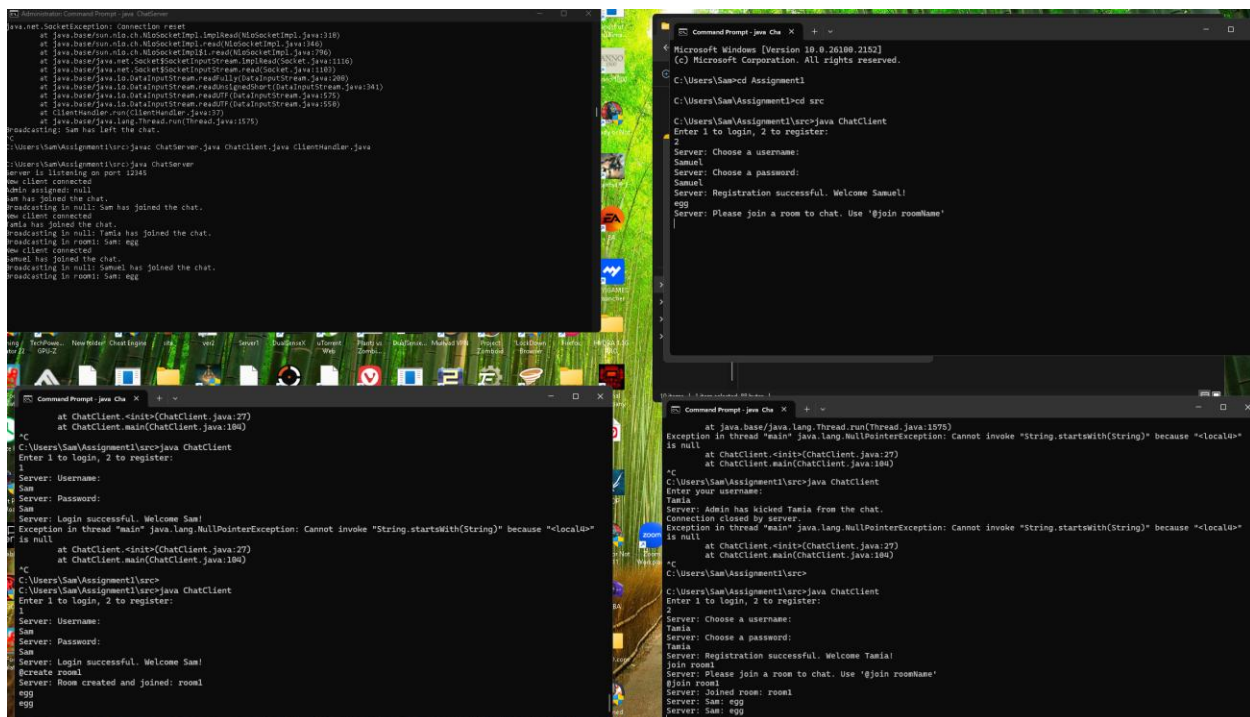
Private Messaging Test

Action: Sent private messages between two clients to confirm that messages were received correctly by the intended recipients.

Chat Room Creation and Messaging Test

Action: Created a new chat room, joined it with multiple users, and exchanged messages within the room to validate chat room functionality.

File Transfer Test

Action: Selected and transferred a file between two clients to verify that the file was transmitted successfully without data loss.
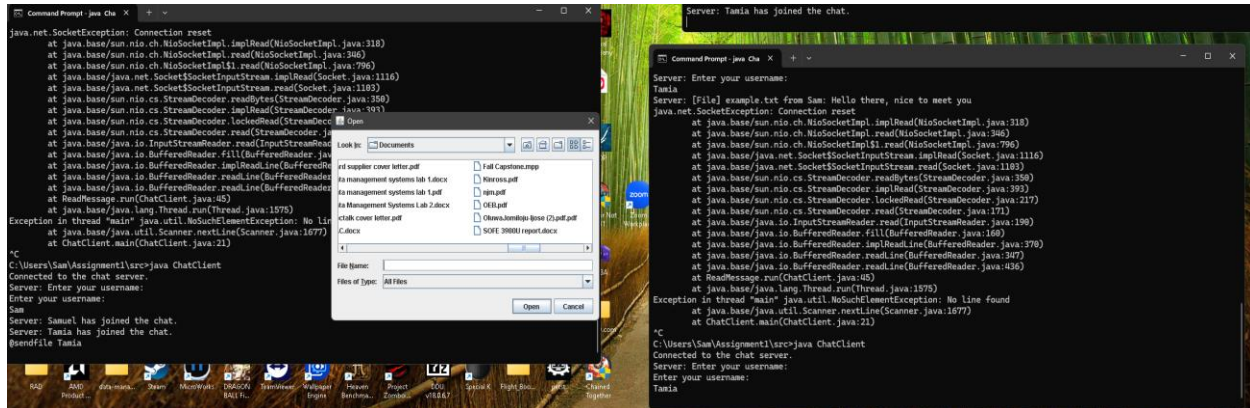
Admin Command Test

Action: Used the "@kick" command to remove a user from the chat and the "@shutdown" command to terminate the server, ensuring both commands worked as expected.

Top-left window (Command Prompt - java Cha):

```
@history
Server: Chat History:
Server: Sam has joined the chat.
Server: Tamia has joined the chat.
Server: Sam: egg
java.net.SocketException: Connection reset
        at java.base/sun.nio.ch.NioSocketImpl.implRead(NioSocketImpl.java:318)
        at java.base/sun.nio.ch.NioSocketImpl.read(NioSocketImpl.java:346)
        at java.base/sun.nio.ch.NioSocketImpl$1.read(NioSocketImpl.java:796)
        at java.base/java.net.Socket$SocketInputStream.implRead(Socket.java:1116)
        at java.base/java.net.Socket$SocketInputStream.read(Socket.java:1103)
        at java.base/java.io.DataInputStream.readFully(DataInputStream.java:208)
        at java.base/java.io.DataInputStream.readUnsignedShort(DataInputStream.java:341)
        at java.base/java.io.DataInputStream.readUTF(DataInputStream.java:575)
        at java.base/java.io.DataInputStream.readUTF(DataInputStream.java:550)
        at ChatClient$ReceiveMessages.run(ChatClient.java:76)
        at java.base/java.lang.Thread.run(Thread.java:1575)
Exception in thread "main" java.lang.NullPointerException: Cannot invoke "String.startsWith(String)" because "<local4>"
is null
        at ChatClient.<init>(ChatClient.java:27)
        at ChatClient.main(ChatClient.java:104)
^C
C:\Users\Sam\Assignment1\src>java ChatClient
Enter your username:
Sam
Server: Tamia has joined the chat.
@kick Tamia
Server: Tamia has left the chat.
Server: Tamia has left the chat.
```

Top-right window (Command Prompt - java Cha):

```
        at ChatClient.main(ChatClient.java:104)
^C
C:\Users\Sam\Assignment1\src>Java ChatClient
Enter your username:
Tamia
Server: Sam: egg
Server: [Private] Sam: egg
java.net.SocketException: Connection reset
        at java.base/sun.nio.ch.NioSocketImpl.implRead(NioSocketImpl.java:318)
        at java.base/sun.nio.ch.NioSocketImpl.read(NioSocketImpl.java:346)
        at java.base/sun.nio.ch.NioSocketImpl$1.read(NioSocketImpl.java:796)
        at java.base/java.net.Socket$SocketInputStream.implRead(Socket.java:1116)
        at java.base/java.net.Socket$SocketInputStream.read(Socket.java:1103)
        at java.base/java.io.DataInputStream.readFully(DataInputStream.java:208)
        at java.base/java.io.DataInputStream.readUnsignedShort(DataInputStream.java:341)
        at java.base/java.io.DataInputStream.readUTF(DataInputStream.java:575)
        at java.base/java.io.DataInputStream.readUTF(DataInputStream.java:550)
        at ChatClient$ReceiveMessages.run(ChatClient.java:76)
        at java.base/java.lang.Thread.run(Thread.java:1575)
Exception in thread "main" java.lang.NullPointerException: Cannot invoke "String.startsWith(String)" because "<local4>"
is null
        at ChatClient.<init>(ChatClient.java:27)
        at ChatClient.main(ChatClient.java:104)
^C
C:\Users\Sam\Assignment1\src>java ChatClient
Enter your username:
Tamia
Server: Admin has kicked Tamia from the chat.
Connection closed by server.
```

Middle window (Administrator: Command Prompt - java ChatServer):

```
        at java.base/java.io.DataInputStream.readFully(DataInputStream.java:208)
        at java.base/java.io.DataInputStream.readUnsignedShort(DataInputStream.java:341)
        at java.base/java.io.DataInputStream.readUTF(DataInputStream.java:575)
        at java.base/java.io.DataInputStream.readUTF(DataInputStream.java:550)
        at ClientHandler.run(ClientHandler.java:29)
        at java.base/java.lang.Thread.run(Thread.java:1575)
Broadcasting: Tamia has left the chat.
^C
C:\Users\Sam\Assignment1\src>javac ChatServer.java ChatClient.java ClientHandler.java
ChatServer.java:45: error: closeConnections() has private access in ClientHandler
            clientHandler.closeConnections();
                         ^
1 error

C:\Users\Sam\Assignment1\src>javac ChatServer.java ChatClient.java ClientHandler.java

C:\Users\Sam\Assignment1\src>java ClientServer
Error: Could not find or load main class ClientServer
Caused by: java.lang.ClassNotFoundException: ClientServer

C:\Users\Sam\Assignment1\src>java ChatServer
Server is listening on port 12345
New client connected
Admin assigned: null
Sam has joined the chat.
Broadcasting: Sam has joined the chat.
Shutting down the server...
Broadcasting: Sam has left the chat.
Broadcasting: Sam has left the chat.
Exception in thread "Thread-0" java.util.ConcurrentModificationException
        at java.base/java.util.ArrayList$Itr.checkForComodification(ArrayList.java:1096)
        at java.base/java.util.ArrayList$Itr.next(ArrayList.java:1050)
        at ChatServer.shutdownServer(ChatServer.java:44)
        at ClientHandler.run(ClientHandler.java:42)
        at java.base/java.lang.Thread.run(Thread.java:1575)
```

Taskbar labels: ning ator 22 | TechPowe... GPU-Z | New folder | Cheat Engine | site. | ver2 | Server1 | DualSenseX | uTorrent Web | Plants vs Zombi... | DualSense... | Mullvad VPN | Project Zomboid | LockDown Browser | Firefox | H

Bottom window (Command Prompt - java Cha):

```
Enter your username:
Sam
Server: Tamia has joined the chat.
@kick Tamia
Server: Tamia has left the chat.
Server: Tamia has left the chat.
java.net.SocketException: Connection reset
        at java.base/sun.nio.ch.NioSocketImpl.implRead(NioSocketImpl.java:318)
        at java.base/sun.nio.ch.NioSocketImpl.read(NioSocketImpl.java:346)
        at java.base/sun.nio.ch.NioSocketImpl$1.read(NioSocketImpl.java:796)
        at java.base/java.net.Socket$SocketInputStream.implRead(Socket.java:1116)
        at java.base/java.net.Socket$SocketInputStream.read(Socket.java:1103)
        at java.base/java.io.DataInputStream.readFully(DataInputStream.java:208)
        at java.base/java.io.DataInputStream.readUnsignedShort(DataInputStream.java:341)
        at java.base/java.io.DataInputStream.readUTF(DataInputStream.java:575)
        at java.base/java.io.DataInputStream.readUTF(DataInputStream.java:550)
        at ChatClient$ReceiveMessages.run(ChatClient.java:76)
        at java.base/java.lang.Thread.run(Thread.java:1575)
Exception in thread "main" java.lang.NullPointerException: Cannot invoke "String.startsWith(String)" because "<local4>"
is null
        at ChatClient.<init>(ChatClient.java:27)
        at ChatClient.main(ChatClient.java:104)
^C
C:\Users\Sam\Assignment1\src>java ChatClient
Enter your username:
Sam
@shutdown
Server: Shutting down the server...
Connection closed by server.
```

Chat History Test

Action: Used the "@history" command to display all messages that were previously sent to the server or from the server to the user.

```
C:\Users\Sam\Assignment1\src>java ChatClient
Enter your username:
Sam
Server: Tamia has joined the chat.
@history
Server: Chat History:
Server: Sam has joined the chat.
Server: Tamia has joined the chat.
egg
@Tamia egg
Server: [Private to Tamia] egg
@history
Server: Chat History:
Server: Sam has joined the chat.
Server: Tamia has joined the chat.
Server: Sam: egg
```