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ChatRoom Project Report

Introduction

For this project, we decided to implement a Java-programmed chat room. This project was written in Eclipse because it would be easier to interact with the console for input and output, and because it works better for native JFrames that anything else we know how to use. Before we describe the project itself, we would like to explain UDP sockets, how to program them, how they work, and how it was possible to use it in our final project.

According to Keil.com, UDP socket programming “enable[s] simple IP communication user the user datagram protocol (UDP). The User Datagram Protocol (UDP) runs on top of the Internet Protocol (IP) and was developed for applications that do not require reliability, acknowledgment, or flow control features at the transport layer. This simple protocol provides transport layer addressing in the form of UDP ports and an optional checksum capability.” In short, UDP sockets are a form of internet communication where the speed of the transportation of data is prioritized over reliability. On the contrary, the TCP protocol is used when the reliability of the data being sent is higher priority than the speed that it gets there.

A classic example of this UDP vs. TCP usage is in online multiplayer games. Among others, games like Call of Duty or Battlefield use a UDP protocol because they care more about getting constant client updates to the server. This is so the game doesn’t play frame by frame while it wait for every single packet from every single player, which may be nearly impossible if the player count even exceeds a few players. Meanwhile, TCP may be used for games like Street Fighter or Smash Bros. This is not only because those games’ maximum players per game is around 2-4, but it is crucial for those games to run frame by frame in order to work properly; otherwise inputs may be dropped.

It is important to distinguish between TCP and UDP when we would start our project in order to make sure we are using the right one to program our project around. In short, this project is about using as local socket (we chose 1023 because that is what Kyle was used to in our Cyber Security class) to emulate communication through UDP. The main challenges we will run into is the GUI implementation. When we were creating the JFrame customization, some lines of code would work (ex. setVisible() and pack()), and some would not (ex. setBackgroundColor()). We decided to leave the default GUI as is and spend our time focusing on the more important aspects of the project.

Design & Implementation

To begin, we knew what classes we wanted to implement right off the bat. We created a Client and a Server class, along with many others for Drivers (for each), the Chat Room itself, a Member class, and a Message class. The code was split into these classes because we thought it would be easier to make an Object for every event that we wanted to make. As we started programming, we found out that it was easier to just put everything into the Client and Server classes. It was also easier and more efficient to not make objects for the messages, and just print them to all the clients’ GUIs using the *synchronized* keyword (which means it does the same thing for all of the Client objects at the same time). These classes may not be used by the time we finish the project, but our initial ideas from these classes will be implemented in some way, shape, or form in the final build. We decided to leave these classes in to show our thought process throughout the development. In terms of what we need to properly run this project, it needs to implement a specified port, as well as a “server” and “clients” to work. We also need a testbench to run it (ex. Eclipse running on a Windows 10 PC).

As mentioned above, we initially designed the components to all be separate objects. This was initially thought to be easier, but along the way we found out we can just merge all the components into two classes and to not make them into objects, but to just run the same code at the same time to all the Client objects’ GUIs. A new construct that we ran into when we were researching Java libraries was the *synchronized* keyword in Java, which we have never seen or used before. According to Baeldung.com, the Java *synchronized* keyword is used in a multi-threaded environment because, “a race condition occurs when two or more threads attempt to update mutable shared data at the same time. Java offers a mechanism to avoid race conditions by synchronizing thread access to shared data. A piece of logic marked with synchronized becomes a synchronized block, allowing only one thread to execute at any given time.” So, with the *synchronized* keyword, it is possible to perform the same exact piece of code at the same exact time for all users. An example of this is when, in our chat room, a user says “Hi” to all the other chat users. The time stamp printed to all the users is the exact same timestamp, to the millisecond, for everyone. This is because the process of printing to each client’s GUI is being performed as the same exact process.

In terms of general option, we do not have much on the front end, since we spent most of our time on the back end to get the program working. In terms of the front end of the project, we use two mechanics: the console and a GUI. The console is a read-only field that used for the output of the Server side of the program. For example, the port the server is connected to, the timestamp it connected on, and the number of Clients in the chat room (which updates for every entry and departure) are some of the prints that the console receives. Next is the GUI. We decided to use GUIs because Java already has a JFrame class for GUIs, and they natively work very well in Eclipse. All you need is a line to initialize it, a few mandatory fields (like adding a text field and making it visible), and some customization. All in all, this is about 15 lines of code. Also, a GUI was used because Eclipse does not like to show multiple consoles for different programs running at the same time. We can create different console windows, but they all print the same thing. Also, they all update every time one of the programs running has an output, meaning they all cannot show different outputs anyway. Using a GUI, it is easier to give each user a distinct menu for their chatting purposes.

For the pseudocode, the entire program itself is about 100 lines of code spread across two classes. First is the Server class. This class must run before the Client class, so the Client class has something to connect to. First, we import the necessary IO classes, network classes, Execution classes (for executing multithreading), and Exception classes to suppress the exceptions in the console. We start with sets of created clients and sets of clients in the chat room. Next, we create an object that allows our program to perform multithreading, which is required to use the chat room simultaneously with other users. A port is specified, and now we begin the main() method. All this method does it create a multithreaded pool, connect to the specified port on our PC using UDP socketing, and executes the Handler() class. All this Handler() class (which implements Runnable() because we are using CPU threads in this program) does is read the socket we specified and tells the server to connect to that socket. The most important function we now run is, intentionally, called run() (required to use this name by the Handler() class) contains many different *try-catch* blocks, a *try-catch-finally* block, and even a *synchronized* keyword. The *try-catch* blocks try a block of code and catch any exceptions that may occur, in which it stops what it is doing to prevent the program from catching. This is used when we try to set up the client into the chat room, so the server does not crash because of a client-end mistake. The *try-catch-finally* block does the same thing, except when an Exception is found, it runs the *finally* block of code to keep the program going; we put a remove() method in here so if a client causes issues, we remove them to prevent further damage to the server-side of the program. Lastly is the *synchronized* keyword, which I have described in more detail in a previous section of this report. This keyword makes sure all the code for all the clients is executed at the same time.

Next is the Client class. We imported the necessary JFrame classes, IO classes, customization classes, and Exception classes to suppress exceptions in the console that users create when they leave the chat room. The Client is given a default IP address then a JFrame object is created for them. Now we connect the Client to the Server. This is where the JFrame GUI becomes visible (because it would not make sense to have it visible beforehand) and prompts an input for the unique username. Once that is received, the Client is connected to the Server. The Client can send messages and receives messages from other users. When the Client wants to leave, they can X out of the window or type “!quit” in the chat (without “”). They are then removed from the chat room. Their window then becomes nonvisible again.

Testing

In terms of the requirements, we have completed everything there is for the project. When talking about the server side of things, the Client receives a “Welcome to the Chat Room!” message when they first join, as well as all other clients that were already connected are informed that there is a new client that joined. When a client leaves the room, not only does the console update to tell us that someone has left the room, but all clients receive the notifications in their message log. When a client sends a message, we can see that message pop up on all the GUIs of all the other clients’ logs as well. Also, when a specific client sends a message, their name is tied to it (it is sent within their own GUI instance), so all other users know which other client has sent the message (plus, there is a timestamp attached to it for easier distinguishability). All these properties are handled by the Server in order to manage all the clients.

All the behaviors of the client side of the project are complete as well. When we click “Run As” on the Client class, we are greeted to a new GUI and a welcome message. When the client wants to leave the chat room, they can either X out of the window, or type “!quit” into the chat bar. In our code, this caused a NoSuchElementException, because when the server-side code would loop back to the beginning, it did not know why its client count is less, so it throws this error. We added a *try-catch* block to suppress this because the program still works as intended, it just throws an error every time. Next, when the client types a message, the server then receives the message. The server executes the code written for the Client object which allows it to broadcast to all the other clients in the chat room (thanks to that *synchronized* keyword). Next, we implemented a while loop with the condition of (true) for Client connection to the server. This means it executes forever until it is interrupted (in this case, when the Client object is destroyed and is garbage collected). This way, it will always stay connected, wait for messages, and will always be able to send messages. Therefore, each Client should do these two things at the same time, which fulfills the final behavior requirement: they all wait for user input and sending the message out, and they all wait to receive messages and print the message on the standard output.

Conclusion

Overall, we had a lot of fun working on this project. We were a little hesitant at first because we both knew nothing on socket programming. (Kyle) After watching a multitude of sample videos on YouTube, how to implement this in our code, what the *synchronized* keyword was and how to implement it, and the weeks of trial and error, I am very pleased how this turned out. I am glad that Jeff and I were able to fulfill all the requirements and I also feel that we have split up the work about evenly. Jeff was grinding away for the past few weeks on the initial foundation of the project because he became more familiar with socket programming because that was an area he was also working on for Senior Project. While he was working on the foundation, I was reading up and watching YouTube examples of how this project can be completed. Once he worked out a lot of his Java classes, I started helping with optimizations, customizations, and commenting of the code. When the code was mostly complete, I started to work on this project report so Jeff would not be overwhelmed with most of the project load. After this project writeup, we will start to work on the video demonstration of how the Chat Room works.

Group Description

Jeff- initial code write, project report review, demo video review

Kyle- code review, project report write, demo video recorded

Sources Used

Java multithreading:

https://www.tutorialspoint.com/java/java\_multithreading.htm https://www.geeksforgeeks.org/multithreading-in-java/

Java *synchronized* keyword:

https://www.baeldung.com/java-synchronized

Socket Programming:

https://www.keil.com/pack/doc/mw/Network/html/group\_\_net\_u\_d\_p\_\_\_func.html