Socket Programming for Network Communication

an introduction to network clients and servers

I've chosen a number between 1 and 100. Can you guess it?

The Goal

Develop a network-based system that implements a number guessing game.

For starters, lets just focus on the **server** side of things. We can use the `telnet` program for our client, testing, and validation of our server.

The Game

The game is to guess a number between 1 and 100. After a player connects, the server will silently choose a random number and give higher/lower hints to the player as they try to guess the chosen number. When they are successful, the game ends and the connection terminates.

With a Partner, Play a Few Rounds of the Guessing Game

Question

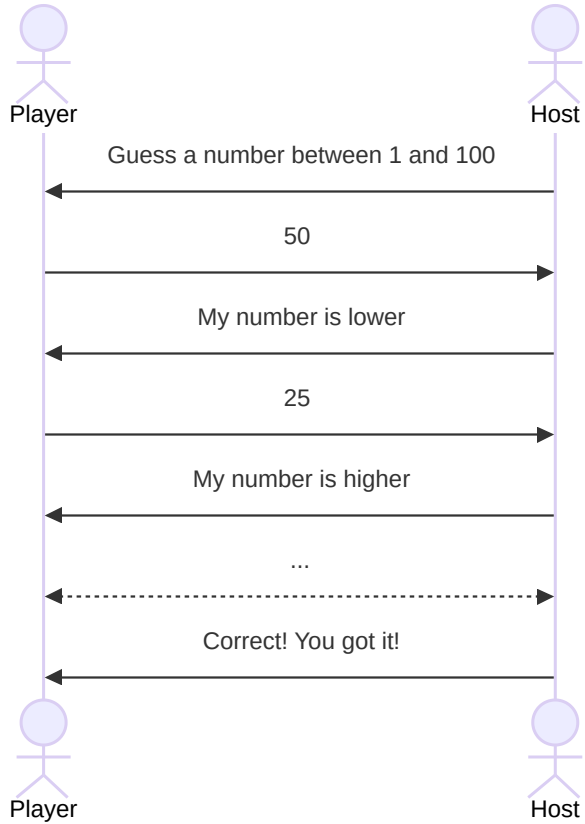
Write down the sequence of play

- How do you start?
- What do you do if they give a bad response?
- How do you end?

07:00

▶ Start

The Guessing Game Protocol v1



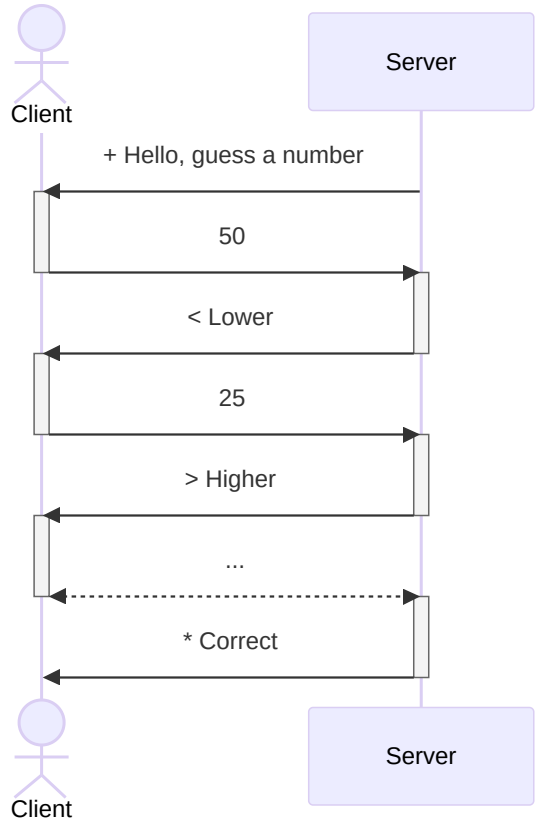
Player and **Host** are the two actors in our game.

The game progresses through a formal set of exchanges:

1. The **Host** starts by asking the **Player** to guess a number.
2. The **Player** announces a number guess.
3. The **Host** tells them if the number is too high, too low, or the correct number

Steps 2-3 continue until the **Player** has guessed the correct number, the **Host** tells them it is correct and the game ends.

The Guessing Game Protocol v2



Client and **Server** replace **Player** and **Host**.

The **first character** of each line the server sends distinguish the type of message.

- `+` indicates the start of the game
- `!` indicates invalid number was received
- `*` indicates the correct number was guessed
- `<` indicates the guess was too high
- `>` indicates the guess was too low

The **Client** only sends numbers.

The Guessing Game Protocol v3

Guessing Game Server (Java)

An excellent starting place for **Java** is the Java Tutorial. Which includes a lesson All About Sockets. This example is from that tutorial.

```
try (
    ServerSocket serverSocket = new ServerSocket(portNumber);
    Socket clientSocket = serverSocket.accept();
    PrintWriter out =
        new PrintWriter(clientSocket.getOutputStream(), true);
    BufferedReader in = new BufferedReader(
        new InputStreamReader(clientSocket.getInputStream()));
) {
    ...
    out.println("+ Hello, guess a number...");
    while ((inputLine = in.readLine()) != null) {
        outputLine = responseForGuess(inputLine);
        out.println(outputLine);
        ...
    }
```

Note

You will need to add a loop to continue accepting new connections (with `accept()`) after this one closes.

Guessing Game Server (Python)

An excellent starting place for **Python** is the Python Documentation. The Socket Programming HOWTO is very good and walks through an object-oriented approach to socket programming in Python. This is a much simpler example.

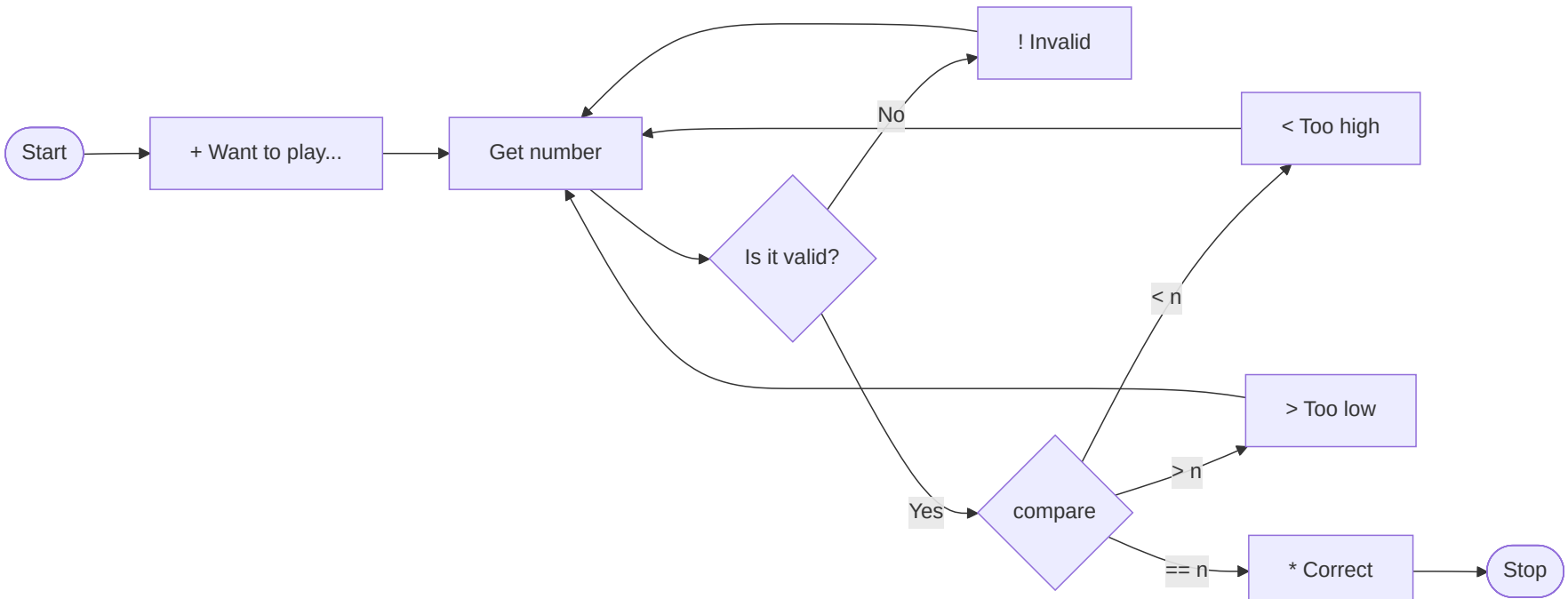
```python
import socket

s = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
s.bind(('localhost', 2222))
s.listen(10)
conn, addr = s.accept()
conn.send('hello'.encode('utf-8'))
while True:
    data = conn.recv(1024)
    line = data.decode('utf-8')
    response = response_for_guess(line)
    conn.send(response.encode('utf-8'))

s.close()
```

Note

You will need to add a loop to continue accepting new connections (with `accept()`) after this one closes.

Guessing Game Flow

What does the server's **response for guess** do?



Guessing Game Server

Requirements

The server must

- Accept network connections on a configurable port number (>1024)
- Send the `welcome` message at the start of the communication.
- Read a line of data (terminated by newline).
- If the input is not a number or not 1, 100, send the `invalid` message. Otherwise, send either the `higher`, `lower`, or `correct` message.
- Loop until a correct guess or the connection terminates.
- Accept new connections after one terminates.
- Choose a **new** random number for the next game.

Guessing Game Server

Requirements

Non-Requirements

The server must not

- Accept guesses via the terminal or shell where it was started.
- Display a graphical interface. This is a **server**. Servers run in the background and have **no user interface**.
- Terminate unexpectedly on invalid input or sudden connection loss. It should be reasonably resillient.

All player interaction is over the network

- If you need diagnostics, you **may** print them to `stdout` of the server program.

Guessing Game Server

Requirements

Non-Requirements

Your Code

The Programming Part

- Use any programming language you want; Java, Python, C, Go, Rust...
- Use the **socket** library, do not use a higher-level library.
- You should be using functions like `accept()`, `send()`, `receive()`, `read()`, `write()`.
- You only have to handle one connection (client) at a time.
- If you are able to handle multiple clients at once, you will be ready for Project 2. This typically requires multi-threading of some sort.
- Read the specification included with the assignment. It provides all the details you need to be successful!

Guessing Game Server

Other Programming Languages

Most other modern and general purpose programming languages provide for **socket programming** in some way. If you use a different language, you will have to find your own introduction materials.

You should also be aware that, **I need to be able to compile and run your code**.

You should choose a language that is available on the CS Lab UNIX/Linux systems. That is where I will test your code.

Known working languages: Python, Java, Rust, C/C++. Talk to me if you are thinking of using something other than these.

Example Interaction with Game

We don’t have a proper client program at this point and you don’t have to write one for the assignment.

This example uses the `telnet` program as a client to connect to the server and play the game. You could use a program like `Putty` on Windows to do the same thing.

```
$ telnet localhost 2222
+ Hello. I’m thinking of a number between 1 and 100. Can you guess it?
50
< My number is lower.
25
> Higher.
Go go gadget guesser!
! Invalid input, please enter only numbers between 1 and 100.
35
> Higher.
42
* That’s it. Good job. It took you 3 guesses. Thanks for playing.
$
```

`telnet` is a simple text-based communication program that allows you to connect to a compatible server then send and receive text-based messages.

Socket Programming for Network Communication

The End