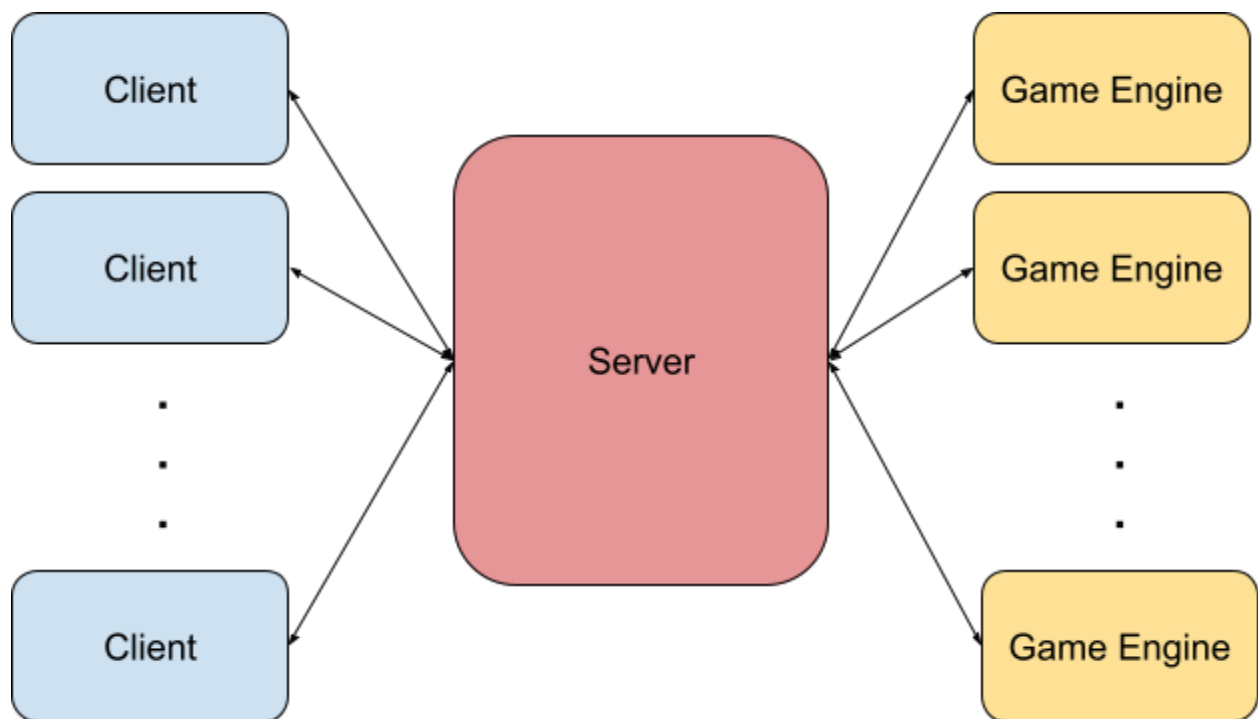


1- Project Structure:

The project has 3 main components, server, client, and game-engine. The way they communicate with each other is shown in the below diagram:



Now we will describe each component completely:

1- Server:

It is the core of our project. We will use socket programming to have our client-server architecture. First, we create our server socket and bind it to the 8080 port on the local machine. Then the server will create a thread to check our waiting list each 5 seconds. Then, in a while loop it will check for new connections and create a new thread for each new client and send them to the game lobby.

The waiting list will contain information about all clients which are waiting for another player for each available table size (3, 4, 5). The server puts players in this list and the `waiting_list_checker` checks which of the table size waiting list arrays has at least two players and then matches them together. The waiting list array is shared between the server thread and waiting list checker thread. To use it properly, we will use one mutex lock called `waiting_list_lock`. There is also another shared memory called `client_status` which both server

and waiting list check have access to (There is also another mutex lock called `client_status_lock`). The `waiting_list_checker` will change the matched clients' status from `GAME_LOBBY` to `IN_GAME`, assign a new `game_engine` for matched players, assign their turn order according to which of them connected sooner, and remove them from the `waiting_list` array.

Each player will stay at `GAME_LOBBY` status after they choose their table size until their status changes to `IN_GAME`. After that, they will receive start game notification and then the `run_game` function for them.

In the `run_game` function, the server will get the active player action, then update the corresponding game engine table. Then, the server will change the `game_engine` active player and continue this until the game is finished. If a player makes a mistake, the active player won't be changed and that player will again choose an action.

When the `game_engine.is_game_finished` function returns `True`, we will exit the game loop and send the players appropriate end game message according to the game status (win, lose, draw).

There are some shared things between server and client code. '#' character stands for active player message start. '\$' character stands for end game message. These two will be used in client code to specify the player status.

Also, we will use some delays in our server code to make socket pipes work properly.

2- Clients:

In the client side, we will use lightweight code. First, we create a socket to connect to the server socket on port 8080 local host. After we get the acknowledge from the server, we will get the `table_size` from standard input. Then, we will send to the server and again, waiting for the acknowledge.

After that, we will wait for server to match the client with another player. After the server sends the acknowledge for game start, we will enter a while loop. In each iteration, we will wait for the server to send the `turn_ack_message`.

If the `turn_ack_message` starts with the '#' character which is the active player character, it means that it is the client's turn. Then, we will get client action, and send it to the server. Again, we will wait for the server acknowledge. If the `turn_ack_message` starts with '\$' character which is the end game character, it means that the game is finished, and we will print the final message and exit the program. If the message does not start with '\$' or '#', it means that the client should for the other player to perform their action.

About the player action, Each client will enter the coordinate that they want to be marked with their sign in X Y format (1-based). Then, the client program encodes this actions into $(x - 1) \times \text{tablesize} + (y - 1)$ and sends it to the server. Then the server will decode it, and perform the appropriate action in the game engine.

3- Game Engine:

The game-engine is responsible for all tic-tac-toe game functionalities. The server will assign a new game engine for each paired players. The game-engine class has this structure:

```
class GameEngine:
    def __init__(self, table_size):
        self.table_size = table_size
        self.cur_player = FIRST_PLAYER
        self.table = [[EMPTY_SIGN for i in range(table_size)] for j in
range(table_size)]
        self.player_signs = {FIRST_PLAYER: FIRST_PLAYER_SIGN, SECOND_PLAYER:
SECOND_PLAYER_SIGN}
        self.win_length = self.initialize_win_length(table_size)
```

- table_size variable stands for game table size
- cur_player variable stands for cur active player
- table variable stands for the table of the game
- player_signs variables stands for the signs that we want to use for the first and second player which have put 'X' and 'O' characters in this implementation.
- win_length variable stands for the appropriate lengths of same signs which leads to victory. (3 for table_size = 3,4 and 4 for table_size=5)

The main functions of game_engine class are:

1. Is_game_finished: In this function we will check all win conditions game including table rows, table columns, table main diagonals and table anti diagonals. Also, if there is no win condition, we will check for draw state. For draw, state we simply check whether the table is full or not.
2. update_table: In this function, we will decode the encoded message that the client has sent to the server, and put the active player sign into the appropriate place on the table. If the chosen place was out of the table or the chosen place was not empty, we will return WRONG_MOVE status. Otherwise, we will update the table and return CORRECT_MOVE status.
3. update_active_player: In this function, we will change the cur_player variable with FIRST_PLAYER or SECOND_PLAYER according to the previous value of cur_player variable.

2- Requirements:

We only use the thread6 library and we have put it in requirements.txt file.

3- Runtime Examples:

In this section, we will put some examples of our project with different table sizes:

1. table_size=3:

```
(.venv) alireza@Alirezas-MacBook-Pro-3 MaryamOS % python server.py
Server socket has been created...
Before: [[], [], []]
After: [[], [], []]
Before: [[], [], []]
After: [[], [], []]
Before: [[], [], []]
After: [[], [], []]
Before: [[], [], []]
After: [[], [], []]
Before: [[], [], []]
After: [[], [], []]
```

```
(.venv) alireza@Alirezas-MacBook-Pro-3 MaryamOS % python client.py
Welcome to the Tic-Tac-Toe Server

Choose your table size: 3
Table size=3

Waiting for the game to start...
```

```
(.venv) alireza@Alirezas-MacBook-Pro-3 MaryamOS % python client.py
Welcome to the Tic-Tac-Toe Server

Choose your table size: 3
Table size=3

Waiting for the game to start...
Your game will start shortly...

Your game has started and You are the second player; your sign is O
- | - | -
- | - | -
- | - | -

Waiting for the other player...
```

```
(.venv) alireza@Alirezas-MacBook-Pro-3 MaryamOS % python client.py
Welcome to the Tic-Tac-Toe Server

Choose your table size: 3
Table size=3

Waiting for the game to start...
Your game will start shortly...

Your game has started and You are the first player; your sign is X

- | - | -
- | - | -
- | - | -

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 1 1
X | - | -
- | - | -
- | - | -
Marked Successfully!

Waiting for the other player...
```

```
Choose your table size: 3
Table size=3

Waiting for the game to start...
Your game will start shortly...

Your game has started and You are the second player; your sign is O
- | - | -
- | - | -
- | - | -

Waiting for the other player...

X | - | -
- | - | -
- | - | -

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 2 2
X | - | -
- | O | -
- | - | -
Marked Successfully!

Waiting for the other player...
```

```

- | - | -
- | - | -
- | - | -

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 1 1
X | - | -
- | - | -
- | - | -
Marked Successfully!

Waiting for the other player...

X | - | -
- | 0 | -
- | - | -

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 2 1
X | - | -
X | 0 | -
- | - | -
Marked Successfully!

Waiting for the other player...

```

```

X | - | -
- | - | -
- | - | -

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 2 2
X | - | -
- | 0 | -
- | - | -
Marked Successfully!

Waiting for the other player...

X | - | -
X | 0 | -
- | - | -

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 3 1
X | - | -
X | 0 | -
0 | - | -
Marked Successfully!

Waiting for the other player...

```

```

Enter the place you want to mark position X,Y: 2 1
X | - | -
X | 0 | -
- | - | -
Marked Successfully!

Waiting for the other player...

X | - | -
X | 0 | -
0 | - | -

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 3 1
X | - | -
X | 0 | -
0 | - | -
Wrong Move!

X | - | -
X | 0 | -
0 | - | -

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 

```

```

X | 0 | -
- | - | -

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 3 1
X | - | -
X | 0 | -
0 | - | -
Marked Successfully!

Waiting for the other player...

X | X | -
X | 0 | -
0 | - | -

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 1 3
X | X | 0
X | 0 | -
0 | - | -
Marked Successfully!

You won...

(.venv) alireza@Alirezas-MacBook-Pro-3 MaryamOS %

```

```

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 3 1
X | - | -
X | 0 | -
0 | - | -
Wrong Move!

X | - | -
X | 0 | -
0 | - | -

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 1 2
X | X | -
X | 0 | -
0 | - | -
Marked Successfully!

Waiting for the other player...

X | X | 0
X | 0 | -
0 | - | -
You just lost the game...

(.venv) alireza@Alirezas-MacBook-Pro-3 MaryamOS %

```

2. table_size=4:

```

(.venv) alireza@Alirezas-MacBook-Pro-3 MaryamOS % python client.py
Welcome to the Tic-Tac-Toe Server

Choose your table size: 4
Table size=4

Waiting for the game to start...
Your game will start shortly...

Your game has started and You are the first player; your sign is X

- | - | - | -
- | - | - | -
- | - | - | -
- | - | - | -

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y:

```



```
(.venv) alireza@Alirezas-MacBook-Pro-3 MaryamOS % python client.py
Welcome to the Tic-Tac-Toe Server

Choose your table size: 4
Table size=4

Waiting for the game to start...
Your game will start shortly...

Your game has started and You are the second player; your sign is 0
- | - | - | -
- | - | - | -
- | - | - | -
- | - | - | -

Waiting for the other player...
```

```
(.venv) alireza@Alirezas-MacBook-Pro-3 MaryamOS % python client.py
Welcome to the Tic-Tac-Toe Server

Choose your table size: 4
Table size=4

Waiting for the game to start...
Your game will start shortly...

Your game has started and You are the first player; your sign is X

- | - | - | -
- | - | - | -
- | - | - | -
- | - | - | -

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 2 2
- | - | - | -
- | X | - | -
- | - | - | -
- | - | - | -

Marked Successfully!

Waiting for the other player...
```

```
Waiting for the game to start...
Your game will start shortly...

Your game has started and You are the second player; your sign is 0
- | - | - | -
- | - | - | -
- | - | - | -
- | - | - | -

Waiting for the other player...

- | - | - | -
- | X | - | -
- | - | - | -
- | - | - | -

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 3 3
- | - | - | -
- | X | - | -
- | - | 0 | -
- | - | - | -

Marked Successfully!

Waiting for the other player...
```


Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 2 2

```
- | - | - | -  
- | X | - | -  
- | - | - | -  
- | - | - | -
```

Marked Successfully!

Waiting for the other player...

```
- | - | - | -  
- | X | - | -  
- | - | O | -  
- | - | - | -
```

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 3 1

```
- | - | - | -  
- | X | - | -  
X | - | O | -  
- | - | - | -
```

Marked Successfully!

Waiting for the other player...

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 3 3

```
- | - | - | -  
- | X | - | -  
- | - | O | -  
- | - | - | -
```

Marked Successfully!

Waiting for the other player...

```
- | - | - | -  
- | X | - | -  
X | - | O | -  
- | - | - | -
```

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 2 3

```
- | - | - | -  
- | X | O | -  
X | - | O | -  
- | - | - | -
```

Marked Successfully!

Waiting for the other player...

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 3 1

```
- | - | - | -  
- | X | - | -  
X | - | O | -  
- | - | - | -
```

Marked Successfully!

Waiting for the other player...

```
- | - | - | -  
- | X | O | -  
X | - | O | -  
- | - | - | -
```

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 1 1

```
X | - | - | -  
- | X | O | -  
X | - | O | -  
- | - | - | -
```

Marked Successfully!

Waiting for the other player...

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 2 3

```
- | - | - | -  
- | X | O | -  
X | - | O | -  
- | - | - | -
```

Marked Successfully!

Waiting for the other player...

```
X | - | - | -  
- | X | O | -  
X | - | O | -  
- | - | - | -
```

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 1 3

```
X | - | O | -  
- | X | O | -  
X | - | O | -  
- | - | - | -
```

Marked Successfully!

You won...

```
X | - | O | -  
- | - | - | -
```

Marked Successfully!

Waiting for the other player...

```
- | - | - | -  
- | X | O | -  
X | - | O | -  
- | - | - | -
```

Its your turn! Enter the place you want to mark...

Enter the place you want to mark position X,Y: 1 1

```
X | - | - | -  
- | X | O | -  
X | - | O | -  
- | - | - | -
```

Marked Successfully!

Waiting for the other player...

```
X | - | O | -  
- | X | O | -  
X | - | O | -  
- | - | - | -
```

You just lost the game...