Five in a row

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Introduction

- **Five in a row** is an abstract strategy game, also called Gomoku. It is traditionally played with black and white stones on a board with 15x15 or 19x19 intersections.

- We developed the "five in a row" game as a client and server architecture web application (written in Javascript/HTML), so that one player can go to the game website and play against another player remotely.

- We applied the Websocket (RFC 6455) protocol to created the real-time client-server-communication.

Introduction

- **Node.js** is an open-source, cross-platform runtime environment for developing server-side web applications.
  Node.js contains a built-in library to allow applications to act as a stand-alone web server.

- **Socket.IO** is a JavaScript library that enables real-time, bi-directional communication between web clients and servers.
  It primarily uses the **WebSocket** protocol. It provides many features, such as broadcasting to multiple sockets, storing data associated with each client, and asynchronous I/O.

Design
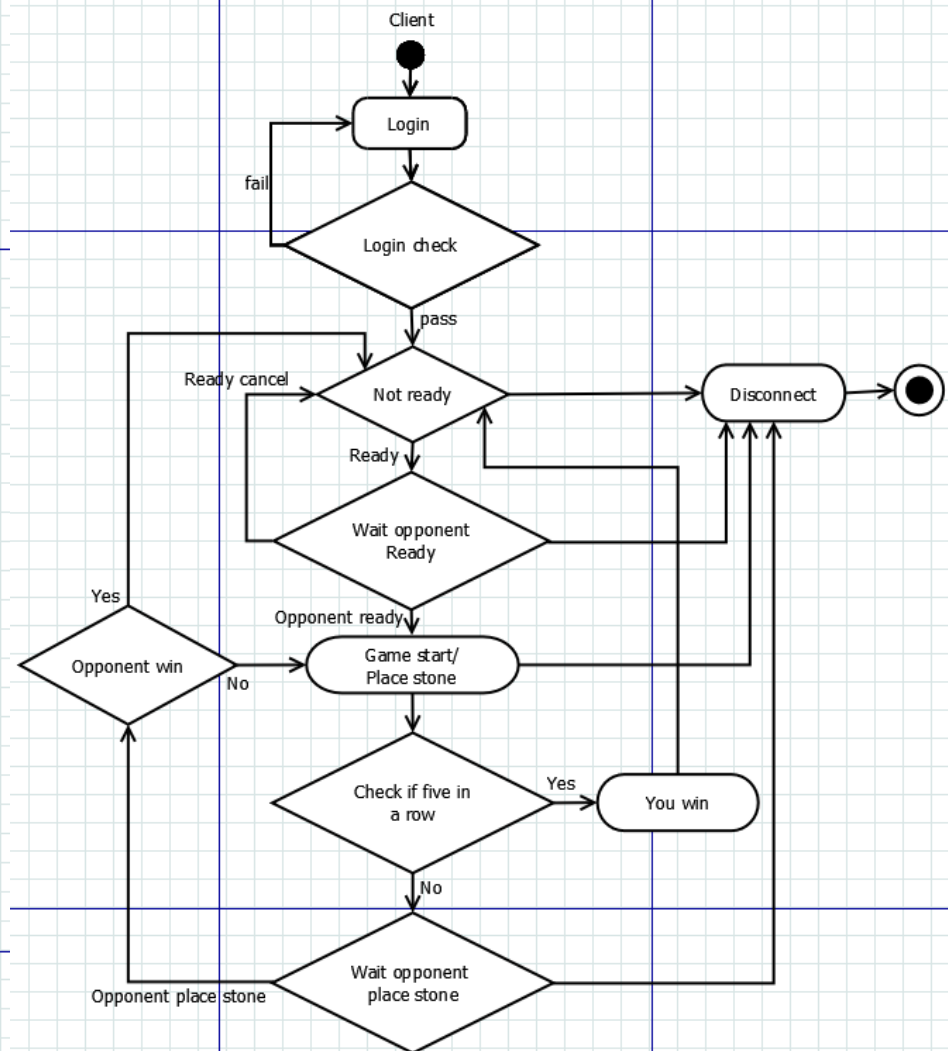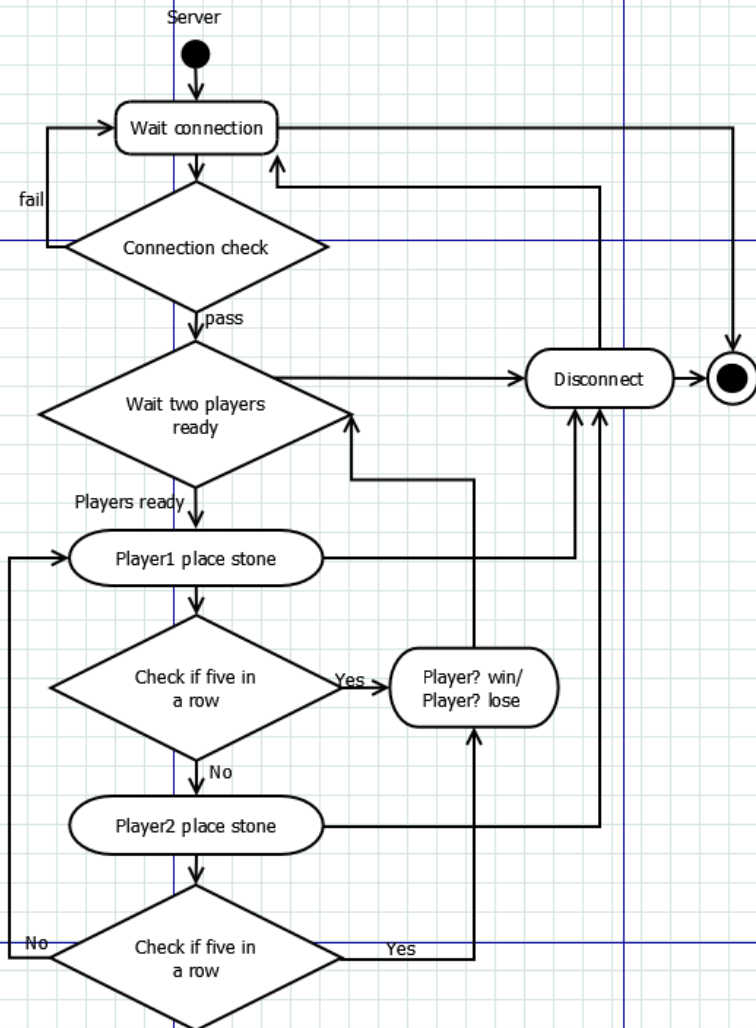
Design

Design
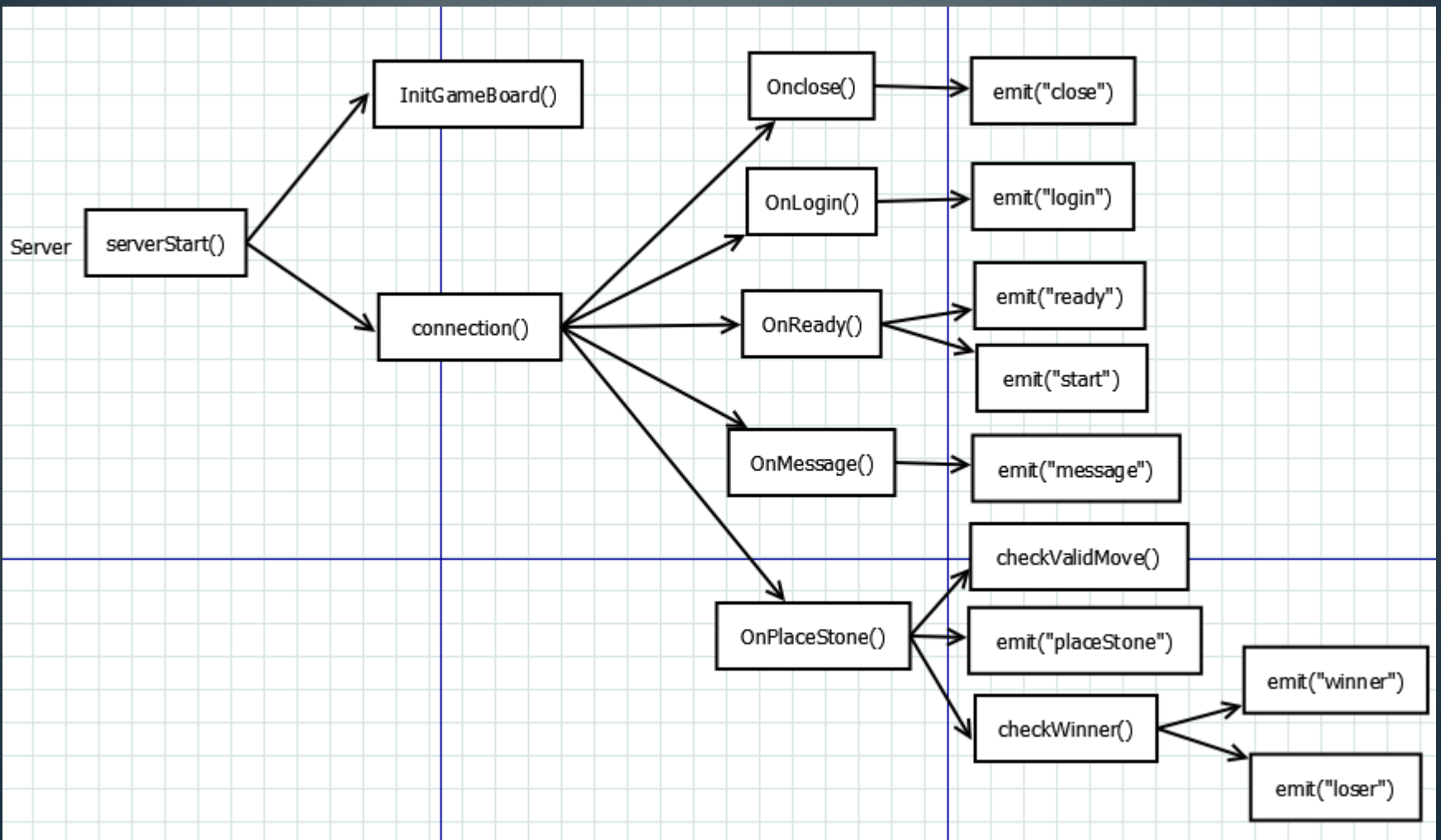
Implementing snapshot
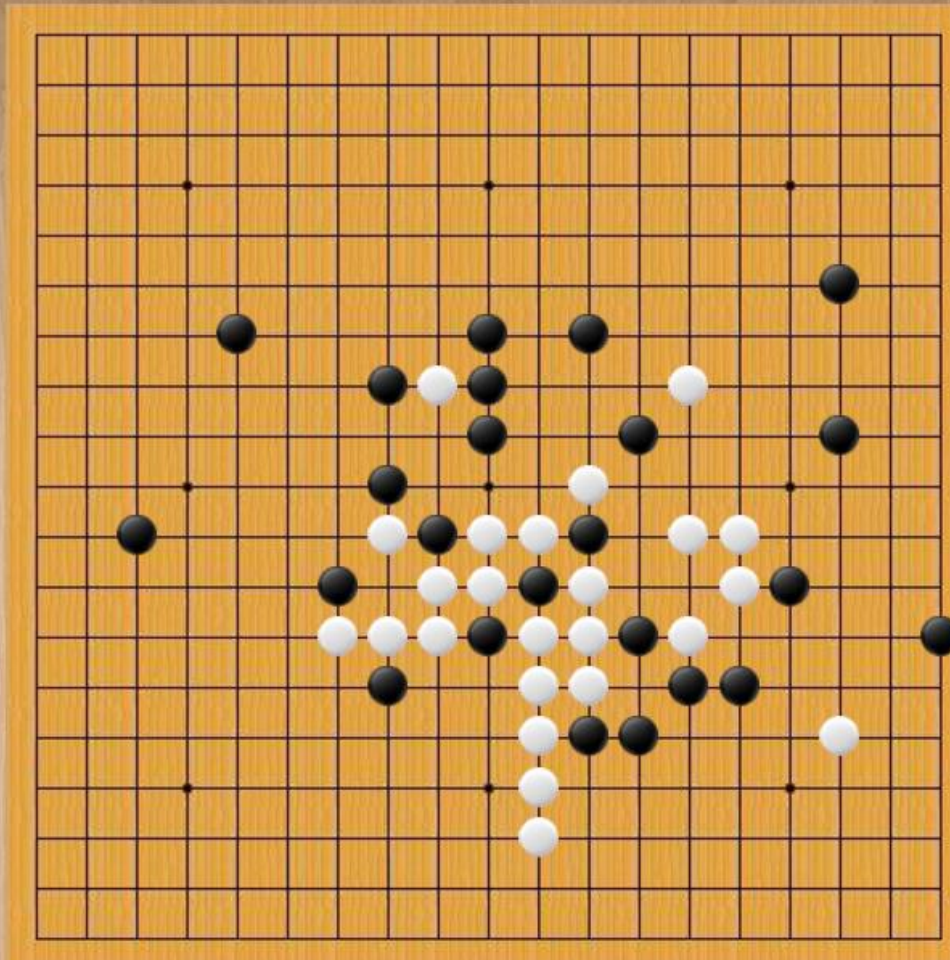
Network Analysis

- Server: 192.168.1.79
- Clients: 192.168.1.79 (Player1) and 192.168.1.73 (Player2)

HTTP Request

- Clients open the webpage and login

```
232 43.856705 192.168.1.73   192.168.1.79   HTTP   424 GET /socket.io/?EIO=3&transport=polling&t=1449705003407-3&sid=SLcb2MuuPiUg6StrAAAB HTTP/1.1
233 43.856754 192.168.1.79   192.168.1.73   TCP     66 8080 → 51250 [ACK] Seq=1 Ack=359 Win=131392 Len=0 TSval=780012350 TSecr=477196082
234 43.857770 192.168.1.79   192.168.1.73   HTTP   304 HTTP/1.1 200 OK  (text/html)
235 43.859118 192.168.1.79   192.168.1.73   HTTP   477 HTTP/1.1 200 OK  (application/octet-stream)
236 43.860842 192.168.1.73   192.168.1.79   TCP     66 51249 → 8080 [ACK] Seq=468 Ack=138 Win=131616 Len=0 TSval=477196083 TSecr=780012349
237 43.863357 192.168.1.73   192.168.1.79   TCP     66 51246 → 8080 [ACK] Seq=1454 Ack=939 Win=130832 Len=0 TSval=477196087 TSecr=780012351
238 43.863705 192.168.1.73   192.168.1.79   TCP     66 51250 → 8080 [ACK] Seq=359 Ack=412 Win=131344 Len=0 TSval=477196087 TSecr=780012352
```

Player 1 is Ready

260 48.673403 192.168.1.79   192.168.1.73   WebSocket   136 WebSocket Text [FIN]

```
    .... .... ...0 = Fin: Not set
    [TCP Flags: *******AP***]
  Window size value: 4102
  [Calculated window size: 131264]
  [Window size scaling factor: 32]
▼ Checksum: 0x682f [validation disabled]
    [Good Checksum: False]
    [Bad Checksum: False]
  Urgent pointer: 0
▼ Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps
  ▼ No-Operation (NOP)
    ▼ Type: 1
        0... .... = Copy on fragmentation: No
        .00. .... = Class: Control (0)
        ...0 0001 = Number: No-Operation (NOP) (1)
  ▼ No-Operation (NOP)
    ▼ Type: 1
        0... .... = Copy on fragmentation: No
        .00. .... = Class: Control (0)
        ...0 0001 = Number: No-Operation (NOP) (1)
  ▼ Timestamps: TSval 780017160, TSecr 477197368
      Kind: Time Stamp Option (8)
      Length: 10
      Timestamp value: 780017160
      Timestamp echo reply: 477197368
▼ [SEQ/ACK analysis]
    [iRTT: 0.002789000 seconds]
    [Bytes in flight: 70]
  [PDU Size: 70]
▼ WebSocket
    1... .... = Fin: True
    .000 .... = Reserved: 0x00
    .... 0001 = Opcode: Text (1)
    0... .... = Mask: False
    .100 0100 = Payload length: 68
    Payload
▼ Line-based text data
    42["ready",{"id":"G1ogZtnCvy4mgohhAAAA","nickname":"p1","status":1}]
```

Player 2 is Ready

```
268 51.199678 192.168.1.73        192.168.1.79      WebSocket      86 WebSocket Text [FIN] [MASKED]
    Window size value: 8222
    [Calculated window size: 131552]
    [Window size scaling factor: 16]
 ▼ Checksum: 0x22d2 [validation disabled]
        [Good Checksum: False]
        [Bad Checksum: False]
    Urgent pointer: 0
 ▼ Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps
    ▼ No-Operation (NOP)
        ▼ Type: 1
            0... .... = Copy on fragmentation: No
            .00. .... = Class: Control (0)
            ...0 0001 = Number: No-Operation (NOP) (1)
    ▼ No-Operation (NOP)
        ▼ Type: 1
            0... .... = Copy on fragmentation: No
            .00. .... = Class: Control (0)
            ...0 0001 = Number: No-Operation (NOP) (1)
    ▼ Timestamps: TSval 477203342, TSecr 780017160
            Kind: Time Stamp Option (8)
            Length: 10
            Timestamp value: 477203342
            Timestamp echo reply: 780017160
 ▼ [SEQ/ACK analysis]
        [iRTT: 0.002789000 seconds]
        [Bytes in flight: 20]
    [PDU Size: 20]
 WebSocket
    1... .... = Fin: True
    .000 .... = Reserved: 0x00
    .... 0001 = Opcode: Text (1)
    1... .... = Mask: True
    .000 1110 = Payload length: 14
    Masking-Key: b0f3c577
    Masked payload
    Payload
 Line-based text data
    42["ready",""]
```

Start and Play Game


```
271 51.202094 192.168.1.79      192.168.1.73      WebSocket      110 WebSocket Text [FIN]

▼ Checksum: 0x72b5 [validation disabled]
    [Good Checksum: False]
    [Bad Checksum: False]
  Urgent pointer: 0
▼ Options: (12 bytes), No-Operation (NOP), No-Operation (NOP), Timestamps
  ▼ No-Operation (NOP)
    ▼ Type: 1
        0... .... = Copy on fragmentation: No
        .00. .... = Class: Control (0)
        ...0 0001 = Number: No-Operation (NOP) (1)
  ▼ No-Operation (NOP)
    ▼ Type: 1
        0... .... = Copy on fragmentation: No
        .00. .... = Class: Control (0)
        ...0 0001 = Number: No-Operation (NOP) (1)
  ▼ Timestamps: TSval 780019684, TSecr 477203342
      Kind: Time Stamp Option (8)
      Length: 10
      Timestamp value: 780019684
      Timestamp echo reply: 477203342
▼ [SEQ/ACK analysis]
    [iRTT: 0.002789000 seconds]
    [Bytes in flight: 114]
  [PDU Size: 44]
WebSocket
  1... .... = Fin: True
  .000 .... = Reserved: 0x00
  .... 0001 = Opcode: Text (1)
  0... .... = Mask: False
  .010 1010 = Payload length: 42
  Payload
Line-based text data
  42["start",{"color":2,"allowPlace":false}]
```

289	57.681924	192.168.1.79	192.168.1.73	WebSocket	136 WebSocket Text [FIN]
299	60.006419	192.168.1.73	192.168.1.79	WebSocket	113 WebSocket Text [FIN] [MASKED]
301	60.007855	192.168.1.79	192.168.1.73	WebSocket	137 WebSocket Text [FIN]
306	61.611952	192.168.1.79	192.168.1.73	WebSocket	137 WebSocket Text [FIN]
316	63.592744	192.168.1.73	192.168.1.79	WebSocket	113 WebSocket Text [FIN] [MASKED]
320	63.594856	192.168.1.79	192.168.1.73	WebSocket	137 WebSocket Text [FIN]
346	65.792222	192.168.1.79	192.168.1.73	WebSocket	137 WebSocket Text [FIN]
352	67.176348	192.168.1.73	192.168.1.79	WebSocket	113 WebSocket Text [FIN] [MASKED]
354	67.177541	192.168.1.79	192.168.1.73	WebSocket	137 WebSocket Text [FIN]
359	70.130909	192.168.1.79	192.168.1.73	WebSocket	138 WebSocket Text [FIN]
365	72.091472	192.168.1.73	192.168.1.79	WebSocket	73 WebSocket Text [FIN] [MASKED]
367	72.092069	192.168.1.79	192.168.1.73	WebSocket	69 WebSocket Text [FIN]
369	72.398180	192.168.1.73	192.168.1.79	WebSocket	112 WebSocket Text [FIN] [MASKED]
371	72.399296	192.168.1.79	192.168.1.73	WebSocket	136 WebSocket Text [FIN]
381	74.839639	192.168.1.79	192.168.1.73	WebSocket	136 WebSocket Text [FIN]
390	76.492074	192.168.1.73	192.168.1.79	WebSocket	112 WebSocket Text [FIN] [MASKED]
392	76.493660	192.168.1.79	192.168.1.73	WebSocket	136 WebSocket Text [FIN]

```
        Kind: Time Stamp Option (8)
        Length: 10
        Timestamp value: 780026155
        Timestamp echo reply: 477203412
    ▼ [SEQ/ACK analysis]
        [iRTT: 0.002789000 seconds]
        [Bytes in flight: 70]
      [PDU Size: 70]
WebSocket
    1... .... = Fin: True
    .000 .... = Reserved: 0x00
    .... 0001 = Opcode: Text (1)
    0... .... = Mask: False
    .100 0100 = Payload length: 68
    Payload
Line-based text data
    42["placeStone",{"color":1,"x":9,"y":8,"id":"G1ogZtnCvy4mgohhAAAA"}]
```

Player 1 Wins


```
393 76.495261 192.168.1.79      192.168.1.73      WebSocket      83 WebSocket Text [FIN]
    ▼ Timestamps: TSval 780044917, TSecr 477228578
        Kind: Time Stamp Option (8)
        Length: 10
        Timestamp value: 780044917
        Timestamp echo reply: 477228578
 ▼ [SEQ/ACK analysis]
     [iRTT: 0.002789000 seconds]
     [Bytes in flight: 87]
    [PDU Size: 17]
WebSocket
    1... .... = Fin: True
    .000 .... = Reserved: 0x00
    .... 0001 = Opcode: Text (1)
    0... .... = Mask: False
    .000 1111 = Payload length: 15
    Payload
Line-based text data
    42["winner",""]
```