Web Development and API Design

Lesson 10:
Online Multi-Player Game

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Goals

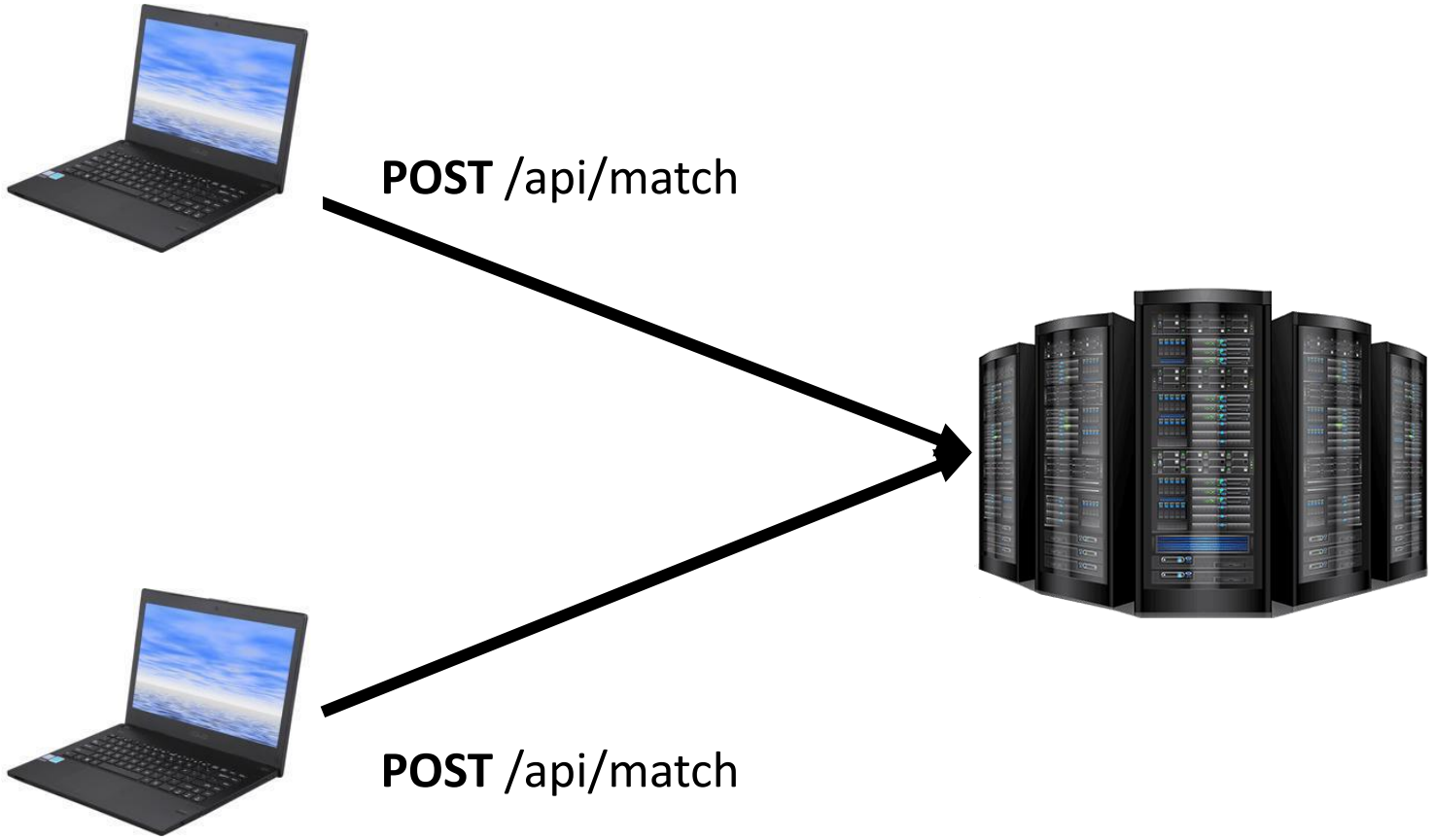
- See a full working example of a non-trivial, multi-player, online game based on what learned so far in class
- Learn how to deploy your app on a cloud provider
- Some discussions on databases…

Online Game

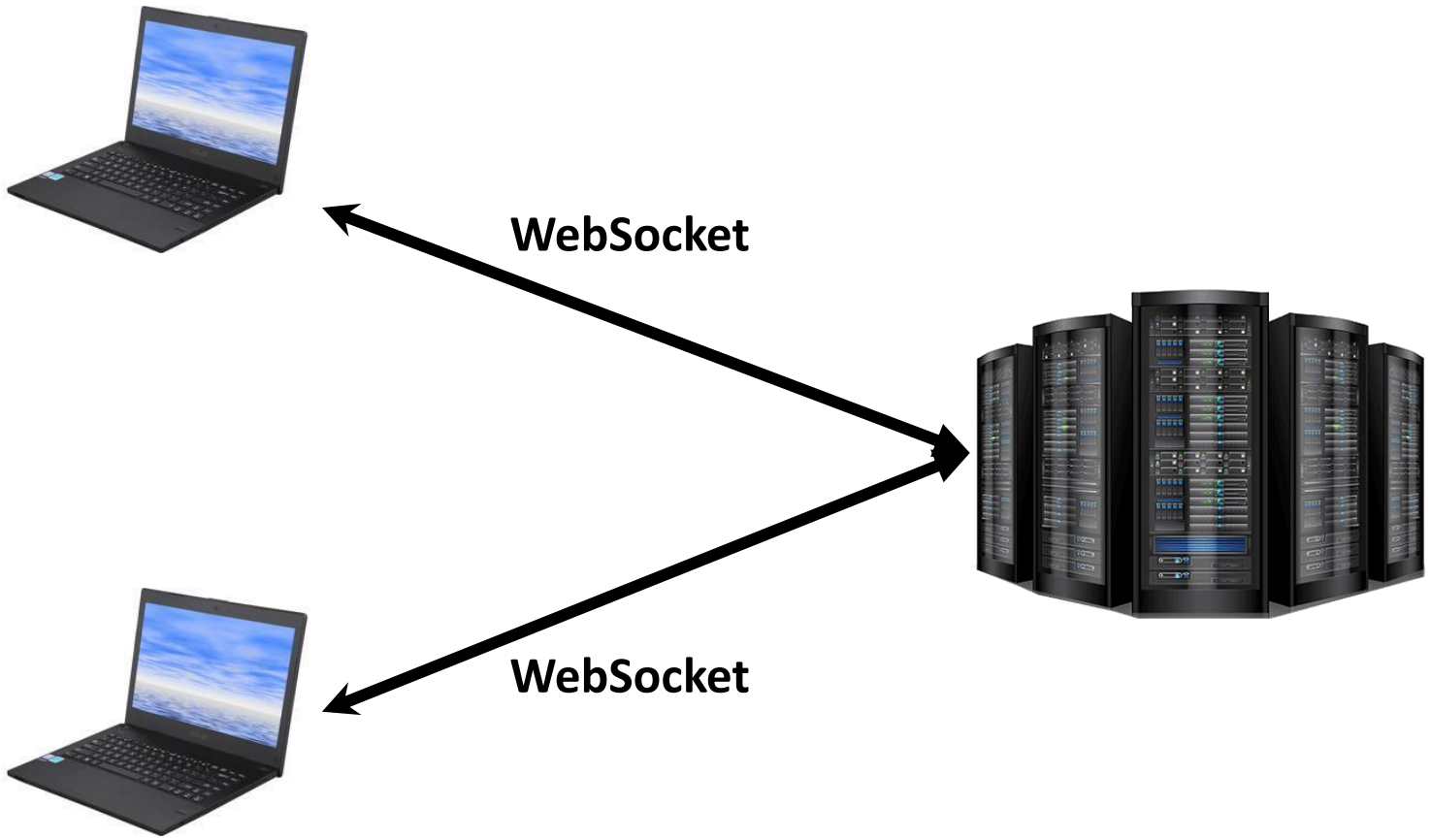
Multi-player Connect4

- Turn-based, but need *WebSockets* to get informed when opponent has done his/her move
- How to pair players on different machines?
- How to prevent cheating?
- etc.

- REST API call to start match, same endpoint (IP:port)
- Put on queue until at least 2 players



- When match starts, **each player** creates a *WebSocket* toward the server
- To avoid cheating, the **state** of the match is on server, the players only see a **view** of it (recall users can do whatever on his/her browser…)
- Match state: **board** plus 2 *WebSockets* for the 2 players
- At each state change on server, opponent gets informed via *WebSocket*
- Actions out of sequence must be discarded (possible cheater)



WebSocket Security

- Assume match with id **X** between players **A** and **B**
- How does server know that incoming *WebSocket* request for player **A** on match **X** is actually made by player **A**???
- At least 2 options
  1. As first WS message is in HTTP, can use same auth
  2. Create a **unique, one-time-use random token** in a **secured** way for **A** (eg authed REST endpoint), associate such token to **A** on server, auth the WS when such token is provided
     - This is a more general approach, not tied to implementation details of how the WS is established
     - Recall that WS is for a single user (own TCP socket), so need auth only once, and not like on every single request like in HTTP (eg using cookies)

WebSocket Cost

- WSs are **EXPENSIVE**, as TCP sockets are OS resources
- Need to keep open a TCP socket **for each** WS
- In HTTP, if running out of ports, can close TCP after resolving each incoming request
  - Recall a TCP connection is defined by 4 coordinates: IP and port of client, and IP and port of server
  - Ie, in HTTP keeping a TCP on after a request is only for performance reasons, eg if expecting other following requests
    - See also: "*Connection: Keep-Alive*" HTTP header

WebSocket Topics

- There can be different types of communications between a client and server over WS
  - eg many different functionalities and operations
- Too expensive to open a different TCP socket for each operation
- **Must re-use same WS** for each different kind of operation
- (Simple) Solution: wrap JSON data into an object defining a discriminating "*topic*" field, which identifies the operation
  - Note: there are more sophisticated message protocols like STOMP
- Server will decide what to execute based on topic's field value

Example

```
{
  “topic”: “...”
   “data”: {...}
}
```

```
{
  “topic”: “update”
   “data”: {
            “matchId”: 42,
            “boardDto”: {…},
            “isX”: true,
            “opponentId”: 1234
}
```

Cloud Deployment

Cloud Deployment

- Different companies provide cloud hosting solutions for your applications, which frees you from hardware issues, but for a price
- *Amazon Web Services* (AWS) is perhaps the most famous/used one
  - eg, *Netflix* runs on AWS
- *Automated scaling*: if you need more load, automatically rent more nodes, and automatically scale down if less load
  - this is also good for applications targeting a specific country (eg Norway), in which you will not get much load during the night

Definition of “Cloud”

Heroku

- One of the main cloud providers
- At the time of this writing, it provides *easy* to use *free* hosting
  - note, this might change at any time
- Supporting NodeJS applications
  - and many others

Using Heroku

- First you need to create an account at www.heroku.com
- Most instructions on Heroku shows how to deploy with Git, but *I do not like it*… we will use a CLI
  - however, you can use whatever you like…
- Install *Heroku CLI*, which allows you to interact with Heroku from command line
- On the web interface, create an "app" with a name of your choice. In these slides, I will use "*pg6300-c4*"
  - as names are unique, you will need to choose a different name

From Command Line (CLI)

- **heroku plugins:install heroku-builds**
  - need to be run only once, to install the "*builds*" plugin
- **heroku login**
  - will setup credential for the other commands.
  - note: if using Windows, this might not work on GitBash, and need to do this command once from a regular Terminal
- **heroku builds:create -a pg6300-c4**
  - zip all your files in current folder, and deploy them in the app
  - note: use "*.gitignore*" to specify what to exclude

Settings

- Can have extra settings in "*engines*" under *package.json*, but not compulsory
  - eg., version of Node and YARN to use to run/build your app
- Your app MUST bind to a port specified by **process.env.PORT**
  - otherwise, Heroku will not know how to reverse-proxy to it
- Your app will be automatically built by Heroku with "*yarn build*", and started with "*yarn start*"

https://pg6300-c4.herokuapp.com/

Cloud and WebSockets

- WebSockets are expensive resources
- Free-tier cloud options might allow only small number of WS
- Might shut them down automatically if inactive for even short period, e.g. 30-60 seconds
  - could implement some auto-reconnect when sockets are forcibly closed…

Databases

Why Databases?

- Need to store your data somewhere
- If in memory, lose everything as soon as the app restarts
- For a full app, you need a database
  - cloud providers like Heroku give you databases as well
- We are not going to see databases in this course, but need to briefly discuss them

The 3 Rules of Choosing a Database

1. New project or unsure what to do? **Choose Postgres**
2. If you are already using *MySQL* and migration to *Postgres* would be too expensive, can stick with *MySQL*
3. If you have a long experience with databases, know exactly what you are doing, and can measure objectively the performance benefits of different tradeoffs compared to just using *Postgres*, then, *and only then*, choose best database for the *specific* problem you are facing

Example: *MySQL*

- Open source, but own (and mainly developed) by *Oracle*… and let's not forget that one of its main commercial products is *Oracle Database*…
  - so, yes, in theory those 2 databases are competitors…
- For most use cases, *MySQL* is on par with *Postgres,* but usually slower at adding new advanced features
  - eg support for NoSQL features like JSON data type, or SQL compliance

Example: *MongoDB*

- Most famous *NoSQL* database
  - very, very popular in tutorials… especially in NodeJS
- Meant for *documents*, not for data with *relations*
  - Usually documents are in JSON format, where the only relations are hierarchical, eg nested objects
- Can be *fast* and *easy* to set up…
- … but you need to *sacrifice ACID* for it…
  - eg, when you “save” some data, can be just cached, and not actually saved…
  - ACID transactions added in v4.0, in 2018…
- *Postgres/MySQL* can save JSON fields, and be very fast at it
  - eg, in 2014, Postgres was actually faster than MongoDB in benchmarks at dealing with JSON

MongoDB Cont.

- Might start with JSON *documents*… but then one day you need to add relations between data: *you are screwed*
  - “screwed” meaning ending up implementing JOINs at application level, which is a nightmare and very inefficient… and/or duplicate data, which need to be kept always in sync…
- Or even worse, choosing *MongoDB* even when you deal with relational data, just because of *hype*…
- …or when you do not really deal with the amount of data of Google/Amazon/etc…

But… MongoDB is “Web Scale”!

- https://www.youtube.com/watch?v=b2F-DItXtZs
- http://www.sarahmei.com/blog/2013/11/11/why-you-should-never-use-mongodb/
- **echo "MongoDB is Web Scale!" > /dev/null**
- Note: video is from 2010. At that time MongoDB was total “*rubbish*”. Today is better
  - eg ACID transactions added in 2018