Web Development and API Design

Lesson 03: SPA Components

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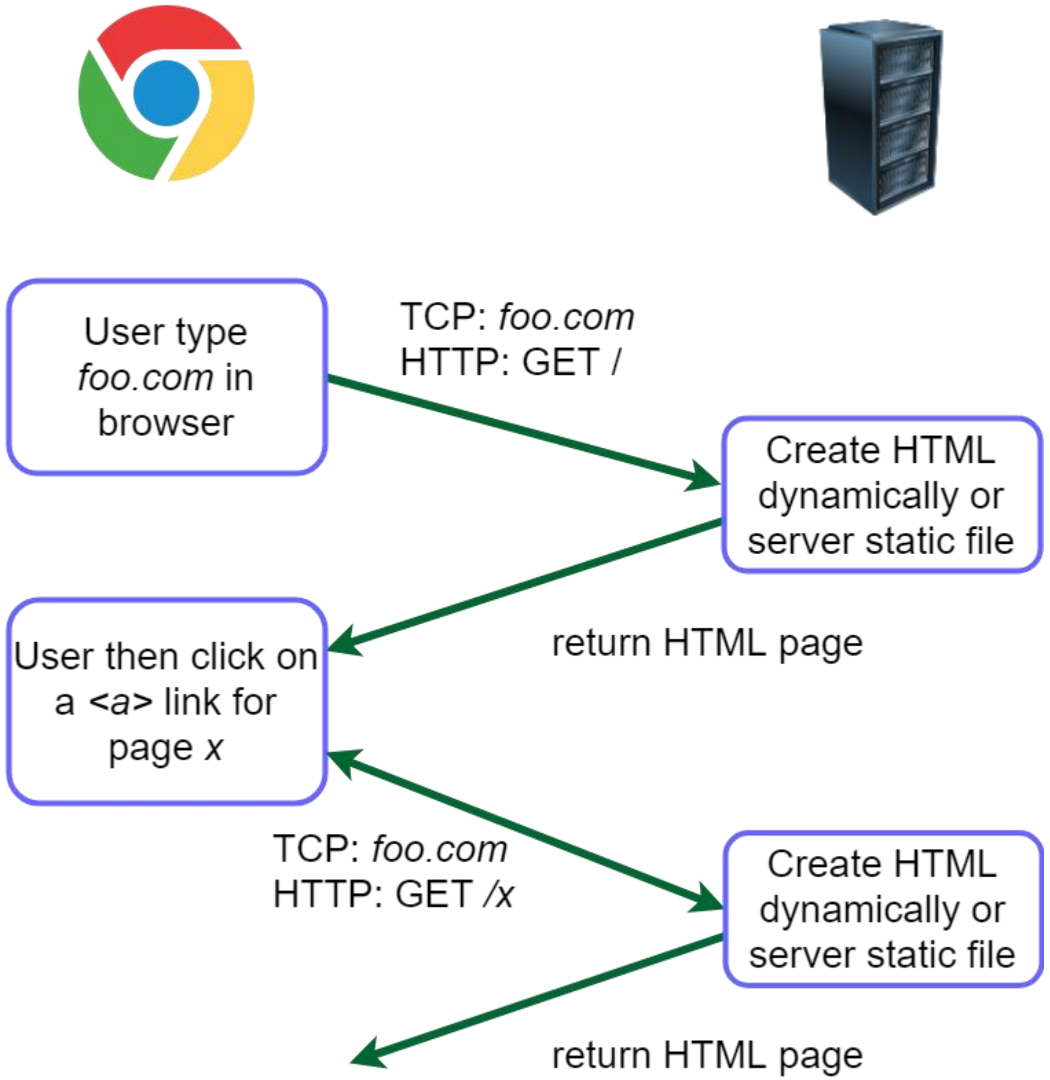
Goals

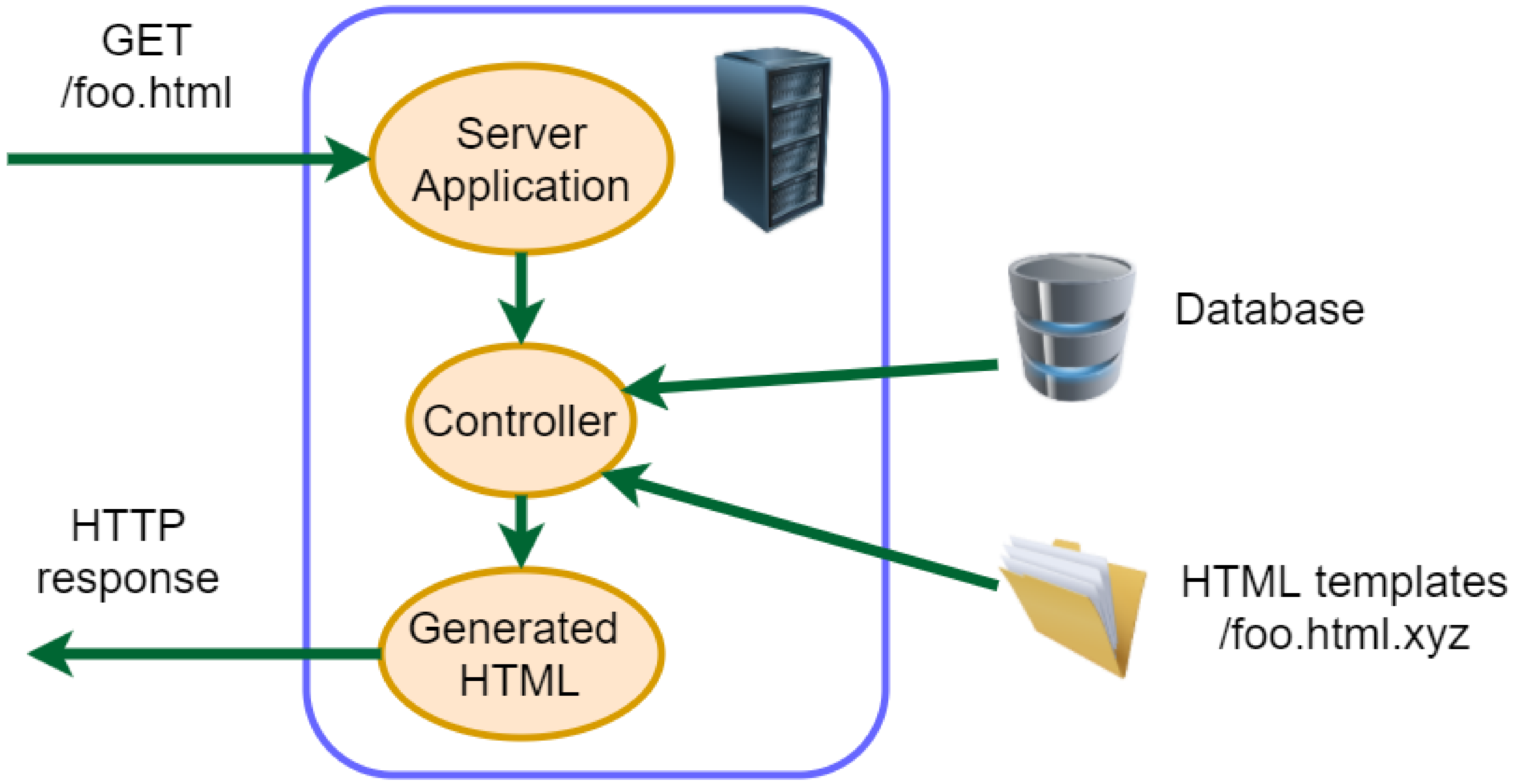
- Learn the main concepts behind *Single-Page-Applications* (SPA)
- Understand why direct DOM manipulation is not-recommended, and a library/framework should be rather used
- Understanding the need for *Components* in SPAs
- Introduction to *React*

Traditional Web Applications


User type *foo.com* in browser
TCP: *foo.com*
HTTP: GET /
Create HTML dynamically or server static file
return HTML page
User then click on a <*a*> link for page *x*
TCP: *foo.com*
HTTP: GET /*x*
Create HTML dynamically or server static file
return HTML page

- Navigation with HTML tags like **<a>** and **<form>**
- Each request is a HTTP message, eg GET or POST
- Get a full HTML page (could be dynamically generated server side)

Server-Side-Rendering



Single-Page-Applications (SPA)

- There is only one single HTML file, with no content
- All the HTML content is **dynamically generated on the browser** with JavaScript
  - ie, by manipulating the DOM
- **Navigation between pages is simulated** by modifying the GUI on the fly (including changing the URL in the address bar)

Fetching New Data

- Even if HTML is generated on browser with JS, we still need to communicate with server
  - to save/load data
- We will **NOT** get any new HTML file
- Just data in JSON format
  - *JavaScript Object Notation*
- JS will update DOM based on JSON data
- *Web Servers* will provide the JSON data
  - in rest of the course, we will see REST and GrahpQL APIs

SPA Complexity

- Now we can have a LOT of JS code in the frontend
- *Manually* updating the DOM at each *state change*, and at each *browser event* is not scalable
  - Can be done, but it quickly becomes a mess
- We need design patterns and tool support to handle such complexity

Libraries/Frameworks

- Frontend technologies vary very quickly
- As this time of writing, there are 3 main ones, all *open-source*
- **React**: made by Facebook
  - the one we use in this course
  - most popular, widely used in many Norwegian companies
- **Angular**: made by Google
  - whole framework, heavy-weight
  - still widely used, but losing popularity
- **Vue**: one main developer/author
  - very popular in Asia
  - bus factor…

React Components

- Define components (e.g., like objects) with a **state**, and a way to **render** HTML based on such state
- Web page represented with a root component, with children components, in a *tree* structure
  - each component has its own state, and only knows how to render itself
- We will NOT call the rendering directly
- We just change the state of the component, and *React* will automatically re-render what needed

Rendering Optimizations

- There can be many events in a browser (user clicks, mouse movements, etc)
- React can *automatically* optimize when HTML needs to be re-rendered
  - eg, squashing together several updates that happen within few milliseconds
- Virtual-DOM
  - Even if a component’s state is changed, it might be that only small parts of its HTML is now different, if any at all
  - React does not naively re-render the whole HTML, but just what is actually needed to be modified
  - It keeps a Virtual DOM in memory, and only updates the actual GUI in browser in what it differs from the VDOM

JSX

- A React Component will generate HTML code via its *render()* function
- Handling HTML as JS strings is too error-prone
  - e.g., lack of static validation of HTML grammar
- **JSX**: a file format for *React* in which you can **mix JS and HTML together**
- Browsers have NO clue of JSX… you need to use *Babel* to transform JSX into JS
- Note: we will use "*.jsx*" suffix to represent JSX files… but it is possible to use "*.js*" as well, although it is arguably a bad practice

WebPack with Babel

- Include libraries in *devDependencies* of *package.json*
- Need to modify *webpack.config.js* to tell *WP* to use *Babel* on all JSX files, but not the ones under "*node_modules*" folder

```
module: {
    rules: [
        {
            test: /\.jsx$/,
            exclude: /node_modules/,
            use: {
                loader: "babel-loader"
            }
        }
    ]
},
```

React.Component Class

- eg, "*class App extends React.Component*"
- **constructor(props)**
  - always call **super(props);**
  - can set initial state directly with "**this.state = …**"
- **render()**: override to create HTML based on state and props
- **setState(newState)**: called to modify the state
  - the change is asynchronous, ie **this.state** is not modified immediately
  - use version **setState(prev => newState)** when **newState** is computed from the previous state, eg **setState(prev => ({x: prev.x+1}))**

Lifecycle Methods

- **componentDidMount()**: override to execute code after constructor and first **render()** is executed
  - useful for expensive initialization code, eg AJAX calls to backend, which would slow down the app if done in the constructor
- **componentWillUnmount()**: override to execute code once the component is removed from the DOM
- **componentDidUpdate()**: override to execute code after method has been re-rendered due to a state/props update

JavaScript Woes

- What if you type **componenDidMount()** instead of **componentDidMount()**???
- That would be just another method in your class that is never called, as ignored by *React*
- JS classes are just syntactic sugar… no way to specify that a method is overriding one from superclass (and throw exception if misspelled)
- *Happy debugging!!!*
  - some IDEs like *WebStorm* can issue warning if a method is never used…

React Hooks

- *Hooks* were introduced later than class components (2019)
- Enable to write components as *functions with state*
- Have some advantages, eg when need to re-use stateful logic
- *Hooks* are currently the recommended approach to write *React* components
- But I prefer classes…
- We ll see *Hooks* just in this class, but you can use them (eg in exam) if you prefer them