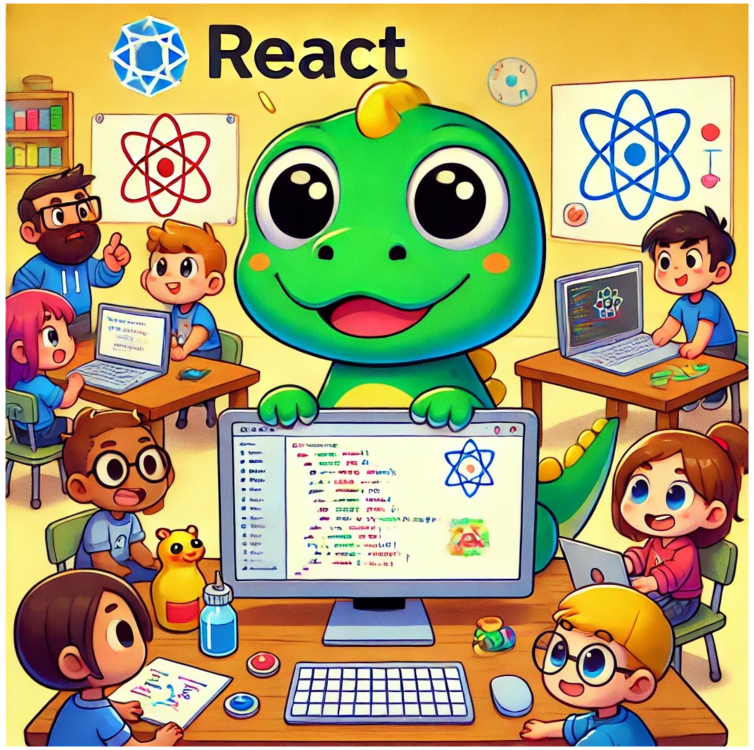

# React

CSC309

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UNIVERSITY OF TORONTO

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## This session

- Begins (or resumes) our front-end journey

- Modern client-side JavaScript
  - React, JSX

- React application
  - Props
  - Events
  - State

# Classic web applications

- A backend server listens for HTTP requests

- Requests come from browser
  - GET requests by entering a URL or clicking on a link
  - POST requests by filling out forms
  - Typically request a specific page

- Server returns a HTTP response with HTML body

- Browser renders the HTML page

# Modern web applications

- A backend server listens for HTTP requests

- Requests come from browser, mobile apps, postman, …
  - Typically request a specific CRUD operation
  - GET requests for queries, POST for data manipulation

- Server returns a HTTP response with JSON body

# Modern web applications

- Client processes the response accordingly

- In the rest of this course, we will focus on web clients
  - Sending requests through a web browser (on desktop, tablet, or phone)

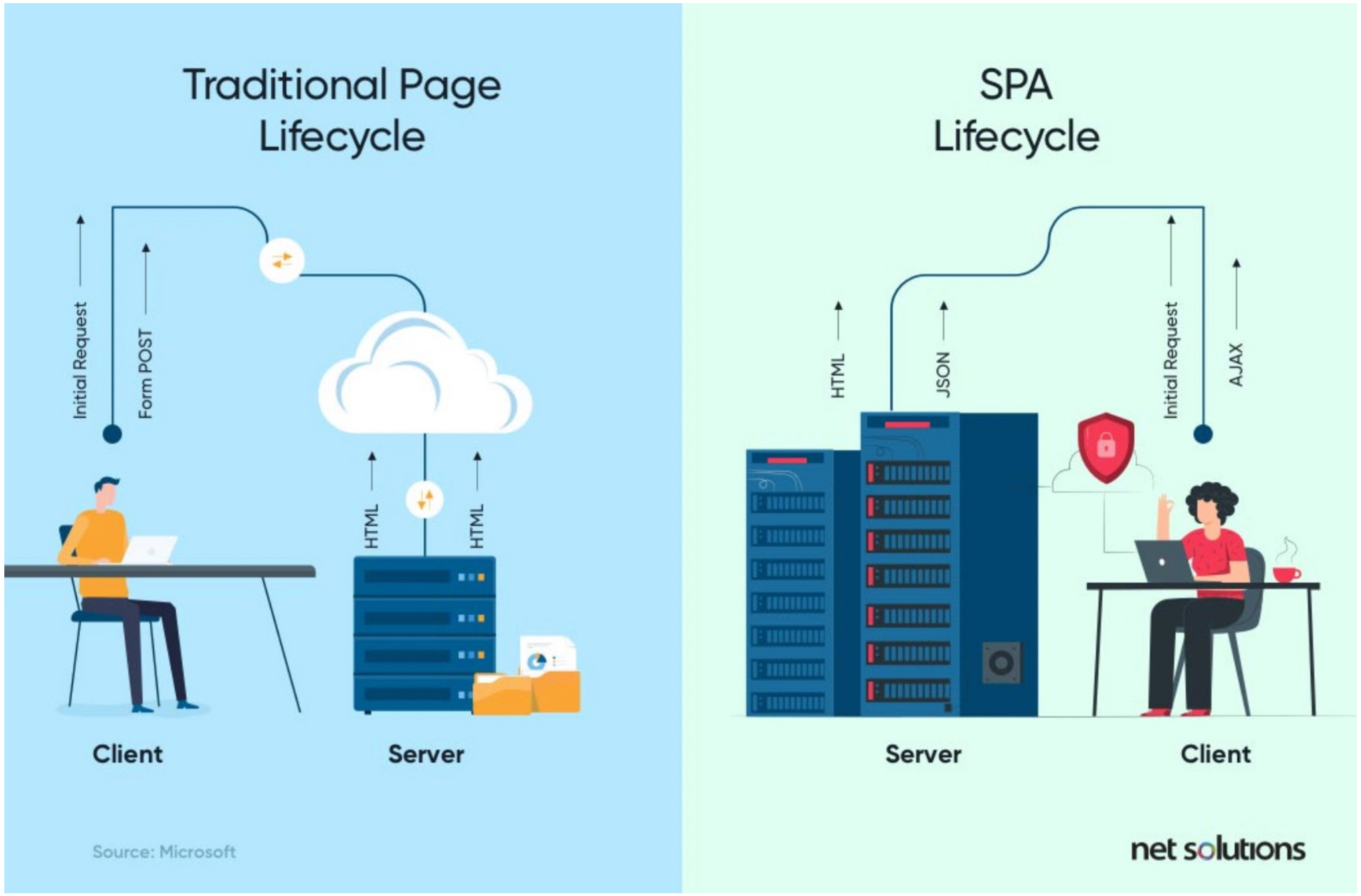
- We use JavaScript to make changes to the webpage
  - Also known as Single Page Applications

# Single-page applications

- Seamless user experience
  - No reloads, no refreshes
  - Everything does not get reset every time
  - More control over the user experience

- Efficiency
  - The whole page does not get updated

- Faster load time
  - The initial load (when nothing is there) takes less time



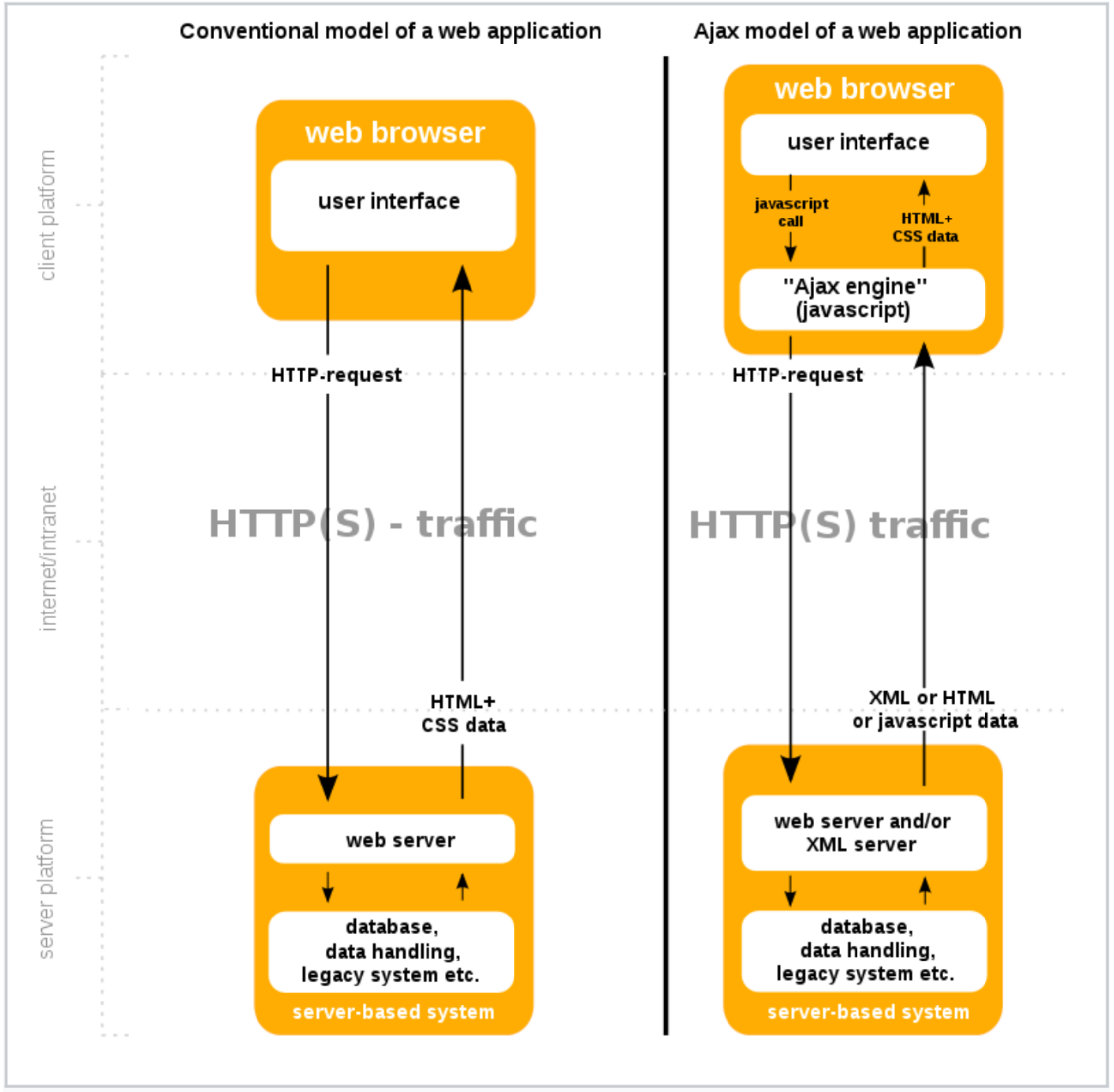
Source: https://www.netsolutions.com/insights/single-page-application/

## Technology

- Single page applications use a technology called Asynchronous JavaScript and XML (Ajax)

- Browser sends the request in background
  - Does not block the main thread
  - Further changes are made to the document

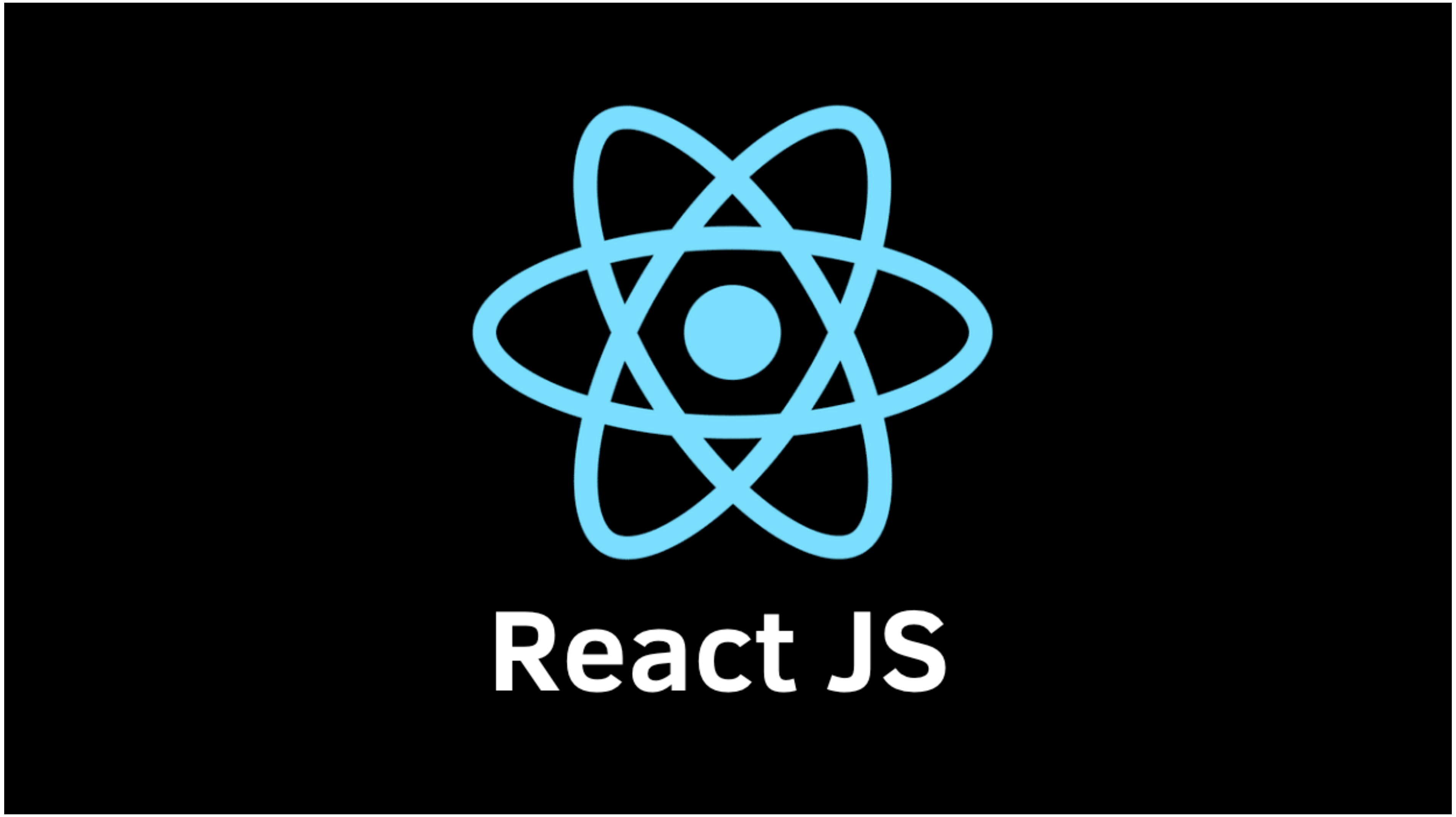
# Ajax model



Source: https://en.wikipedia.org/wiki/Ajax_(programming)

## Creating a single-page application

- Nobody does that with pure Ajax
- Many frameworks are out there to help you
- Another advantage: backend/frontend separation
  - Lecture 3 recap: Front-end merits an independent project
  - More on that next week
- Examples: React, Angular, Vue


React JS

## React

- Released by Facebook in 2013

- A JS library for building interactive user interfaces

- React takes charge of re-rendering when something changes
    - You no longer need to manipulate elements manually

## React

- Creates a virtual DOM in memory
- When something changes, React re-renders its own DOM
    - More about the "something" later
- Compares the new and old DOMs and finds out what has been updated
- Updates the specific elements of the browser's DOM

# What's the point

- Updating and re-rendering the actual DOM is expensive
- Not feasible to re-render the entire page on every change
- This way, React only changes what really needs to change

## JSX

- React uses a special variation of JavaScript that allows for merging HTML and JS together

- Example:

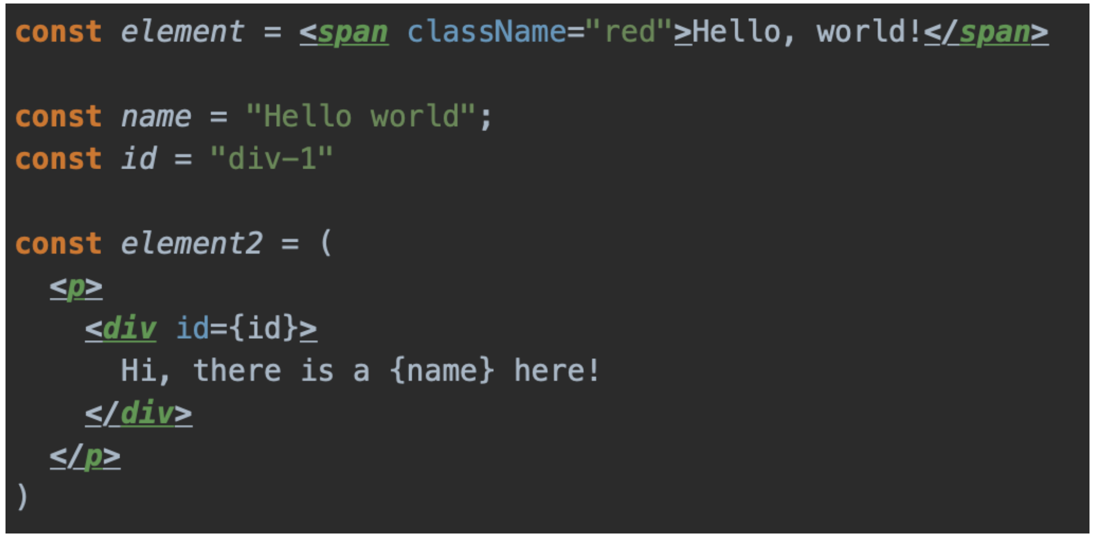
```
const element = <h1>Hello, world!</h1>;
```

- Browsers do not understand this syntax
    - Should be translated before execution

# Translation

Visit https://babeljs.io/

JSX

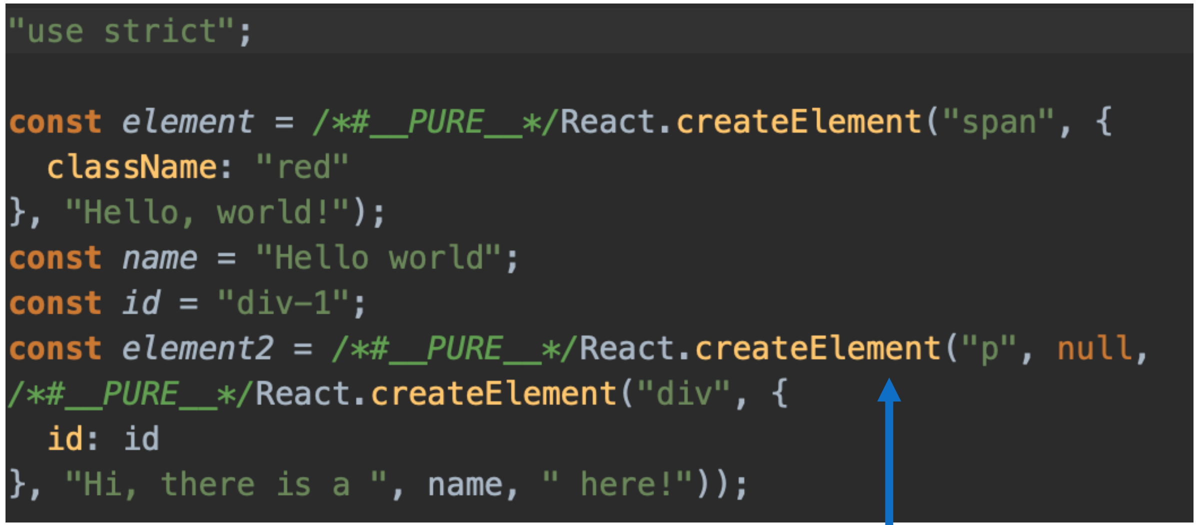


```
const element = <span className="red">Hello, world!</span>

const name = "Hello world";
const id = "div-1"

const element2 = (
  <p>
    <div id={id}>
      Hi, there is a {name} here!
    </div>
  </p>
)
```

JS



```
"use strict";

const element = /*#__PURE__*/React.createElement("span", {
  className: "red"
}, "Hello, world!");
const name = "Hello world";
const id = "div-1";
const element2 = /*#__PURE__*/React.createElement("p", null,
/*#__PURE__*/React.createElement("div", {
  id: id
}, "Hi, there is a ", name, " here!"));
```

Note: these are React elements, not real JS elements

## Make it real

- Import React and Babel (JSX) scripts to your HTML

```
<script src="https://unpkg.com/react/umd/react.production.min.js"></script>
<script src="https://unpkg.com/react-dom/umd/react-dom.production.min.js"></script>
<script src="https://unpkg.com/@babel/standalone/babel.min.js"></script>
```

- Render your element in an actual JS element

```
<script type="text/babel">

  const element = <h1>Hello World!</h1>;
  ReactDOM.render(element, document.body)

</script>
```

## Components

- Key concept in React
- Allows you to make your elements reusable
- It’s a function or class that returns a React element
- Can be re-used like a known tag

## Function components

- Example:

```
function SayHello() {
  return <h1>Hello world!</h1>;
}
```

- How to re-use it

```
ReactDOM.render(<SayHello />,
              document.getElementById("root")
)
```

- You can put any JS statement inside the {} in JSX
- Singular tags must always end with />
- Components' names should always be capitalized
  - Lowercase names are reserved for built-in elements: p, h1, div, etc.
- A JSX element must be wrapped in one enclosing tag
  - If more than one, wrap them in a React fragment

```
<>
   <p>
      <div id={id}>
         Hi, there is a {name} here!
      </div>
   </p>
   <img src="http://test.com/img.jpg" />
</>
```

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## Props

- React mimics JS attributes via props
  - Read-only data coming from the parent element

- A dictionary containing attributes

```
function Text(props) {
  return <h4>{props.value}</h4>
}
```

- To pass props:

```
<Text value="John" />
```

- Styles and classes are handled a bit differently in JSX

- Example:

```
function Text(props) {
 return(
   <h4 className="text" style={{fontSize: props.size}}>
     {props.value}
   </h4>
   )
}
```

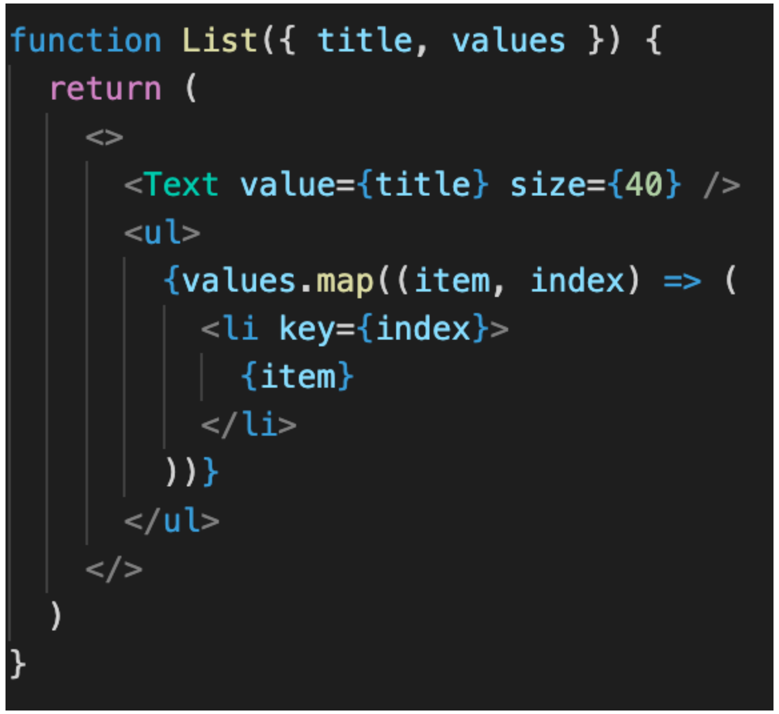
- To pass props:

```
<Text value="Cars" size={30} />
```

- Can you think of a way to simplify the above component?
  - Hint: Use destructuring

# A more sophisticated example

- Elements created in a loop must have a unique key prop
- Identifies which item has changed, is added, or is removed
- Otherwise, React will have to re-render the whole list if something changes



```
function List({ title, values }) {
  return (
    <>
      <Text value={title} size={40} />
      <ul>
        {values.map((item, index) => (
          <li key={index}>
            {item}
          </li>
        ))}
      </ul>
    </>
  )
}
```

## Paired tag

- You can use your component as a paired tag
- What put inside tags will be passed as the children prop

```
function Wrapper({ children }) {
  return <div className="col">
  { children }
  </div>;
}

const wrapped = (
   <Wrapper>
         <List values={[1, 2, 3, "my cat"]} />
   </Wrapper>
)
```

## Re-rendering and updates

# Class components

- Another way to define a component
- Extends `React.Component`
  - Should implement the `render` method
- Props passed to constructor
- Example:

```
class Welcome extends React.Component {
  render() {
    return <h1>Hello, {this.props.name}</h1>;
  }
}
```

## State

- Exhibits the real power of React!

- Components have a built-in state
    - An object initialized in the constructor

- Once the state changes, component re-renders

## State

- Initialize the state object in the constructor

```
class Counter extends React.Component {
  constructor(props){
    super(props)
    this.state = { counter: 0, }
  }
}
```

- State values can be accessed via `this.state`

```
render(){
  return <h3>{this.state.counter}</h3>
}
```

## Updating the state

- React states should never be mutated
  - Breaks the underlying assumptions of React

- To update the state, call the `setState` method
  - Other approaches will not trigger re-render

- Never assign state other than in the constructor

## Updating the state

- Wrong way #1:
```
this.state.counter += 1
```

- Wrong way #2:
```
this.state = {
  counter: this.state.counter + 1
}
```

- Correct way:
```
this.setState({
  counter: this.state.counter + 1
)}
```

# Events

- React has the same set of events as plain JS
- React events are written in camelCase
    - `onClick` vs `onclick`
- The action must be a function, not any statement
    - `onClick={() => alert()}` vs `onclick="alert()"`

# Events

- You can define the event handler as a method inside the class

- Example:

```
increment(){
  this.setState({counter: this.state.counter + 1})
}
```

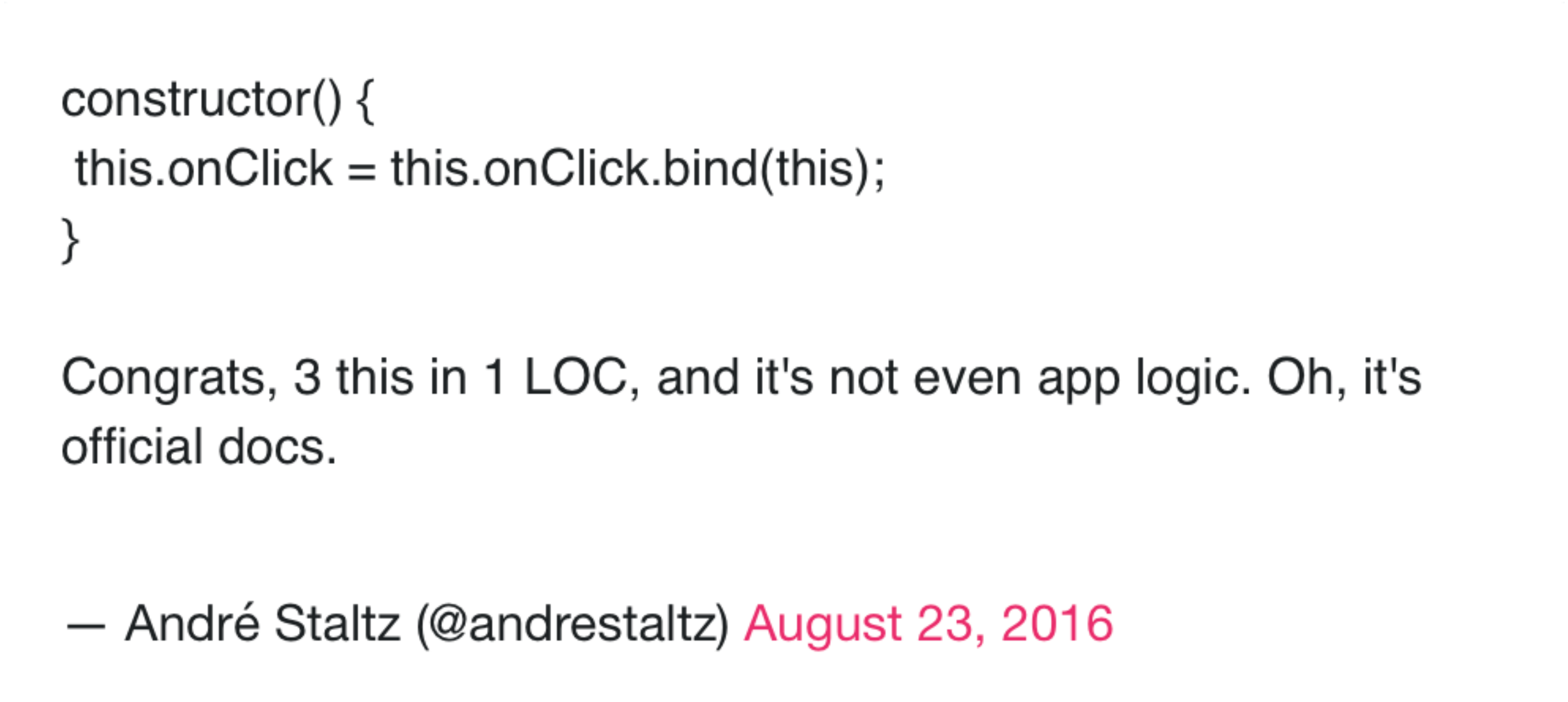
- Usage

```
<button onClick={this.increment}> Click me </button>
```

## This won't work!

- Remember the previous discussion about this
- Each JS function has its own this, which is the caller object
- The object that calls the event handler is not your component object

# Solution



```
constructor() {
 this.onClick = this.onClick.bind(this);
}
```

Congrats, 3 this in 1 LOC, and it's not even app logic. Oh, it's official docs.

— André Staltz (@andrestaltz) August 23, 2016

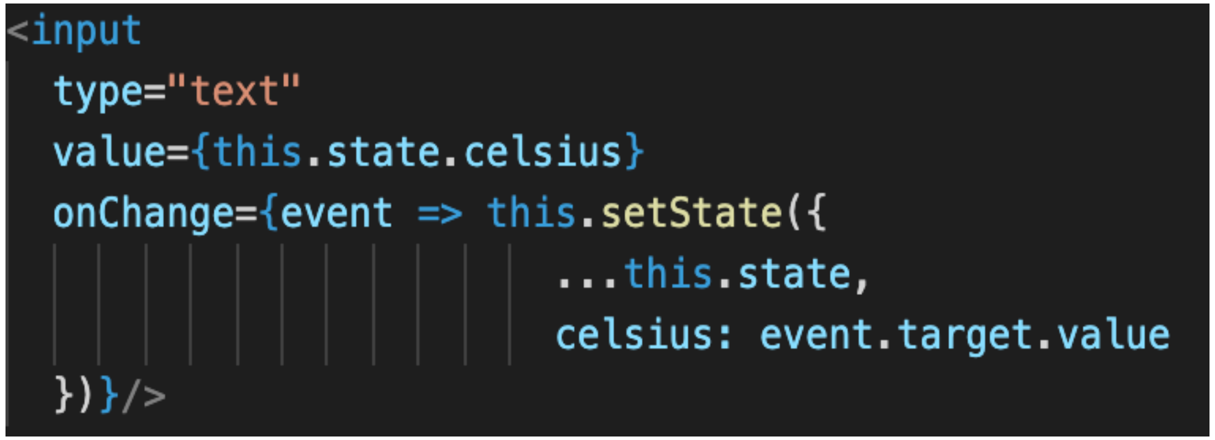
## Another solution

- Recap: arrow functions do not introduce their own this
- Instead, they capture this from the outer scope
- Fortunately, the class body has the proper this
- Therefore, arrow functions work!

## Example: a two-way Celsius to Fahrenheit converter

## Notes

- To store and use input’s value:
  - Add it to state
  - Read it from state as well
- Read the new value from `event.target.value`



```
<input
  type="text"
  value={this.state.celsius}
  onChange={event => this.setState({
                    ...this.state,
                    celsius: event.target.value
  })}/>
```

## Lift the state up!

Visit: https://reactjs.org/docs/lifting-state-up.html

- To pass a shared state between components, move it to their common ancestor
- Define the state in the common ancestor
- Pass it as props to the original components
- Pass a setter function as change handler

## Next session

- Monorepo: React in Next.js
- Enhanced function components
  - Hooks
- API calls