Building User Interfaces

React 1
An Introduction

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Adapted from Prof. Mutlu's slides

Disclaimer

As with JS, this is not a comprehensive introduction to React, so below are links to great additional resources:

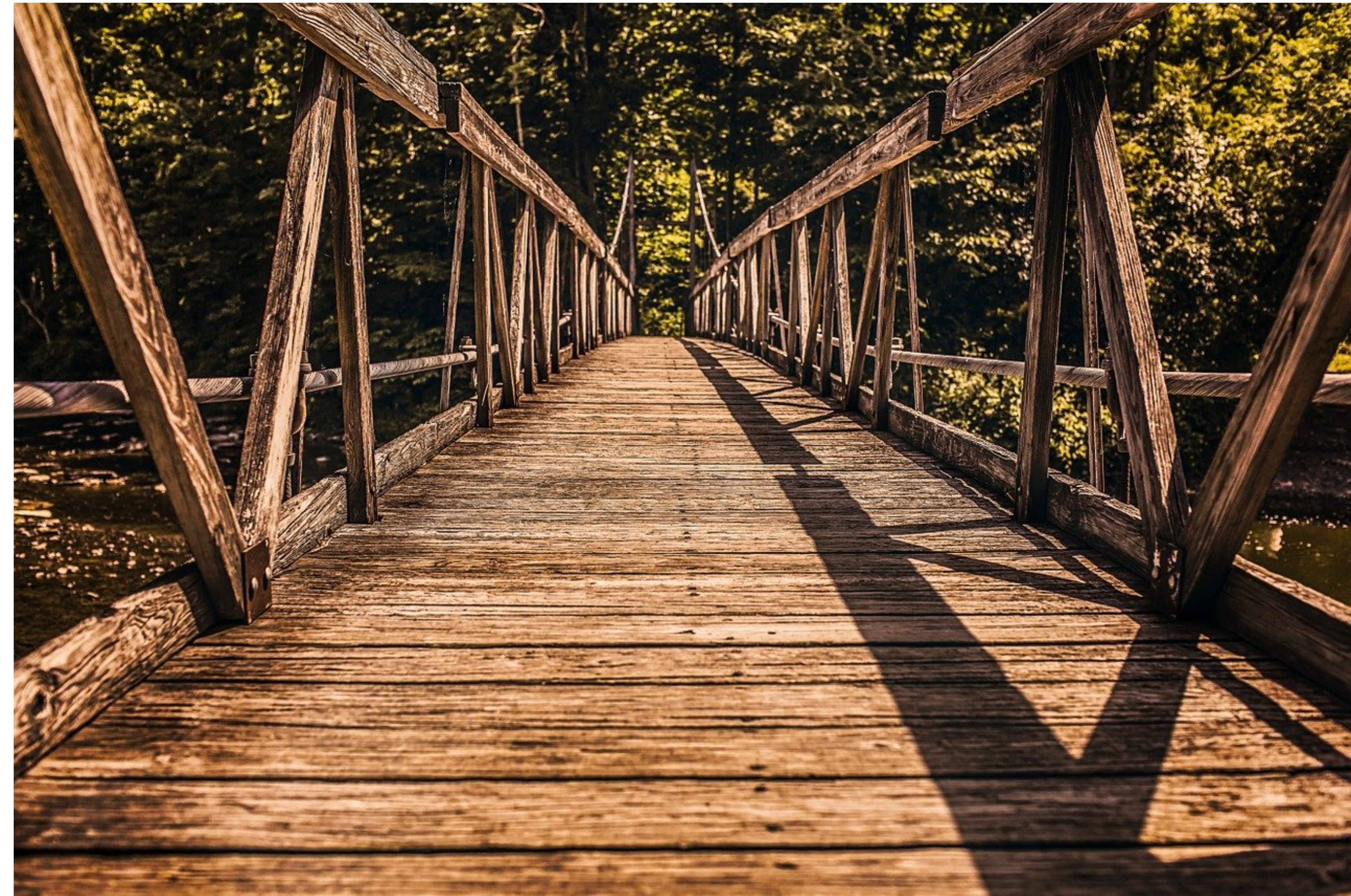
- ReactJS.org
- W3 Schools
- Build with React
- Tania Rascia's React Overview and Walkthrough

Another Disclaimer[1]

If this is your first $CS - 5**$ class, be prepared to:

- Work on more open-ended problems
- Know that there are likely more than one "correct" solution
- Find alternative ways of implementing ideas (check whether they are approved)

These are great skills to build!



[1] Image source

What we will learn today?

- History and overview of React
- Overview of building blocks
- Setting up a React project

Why should we use React?

What is React?[2]

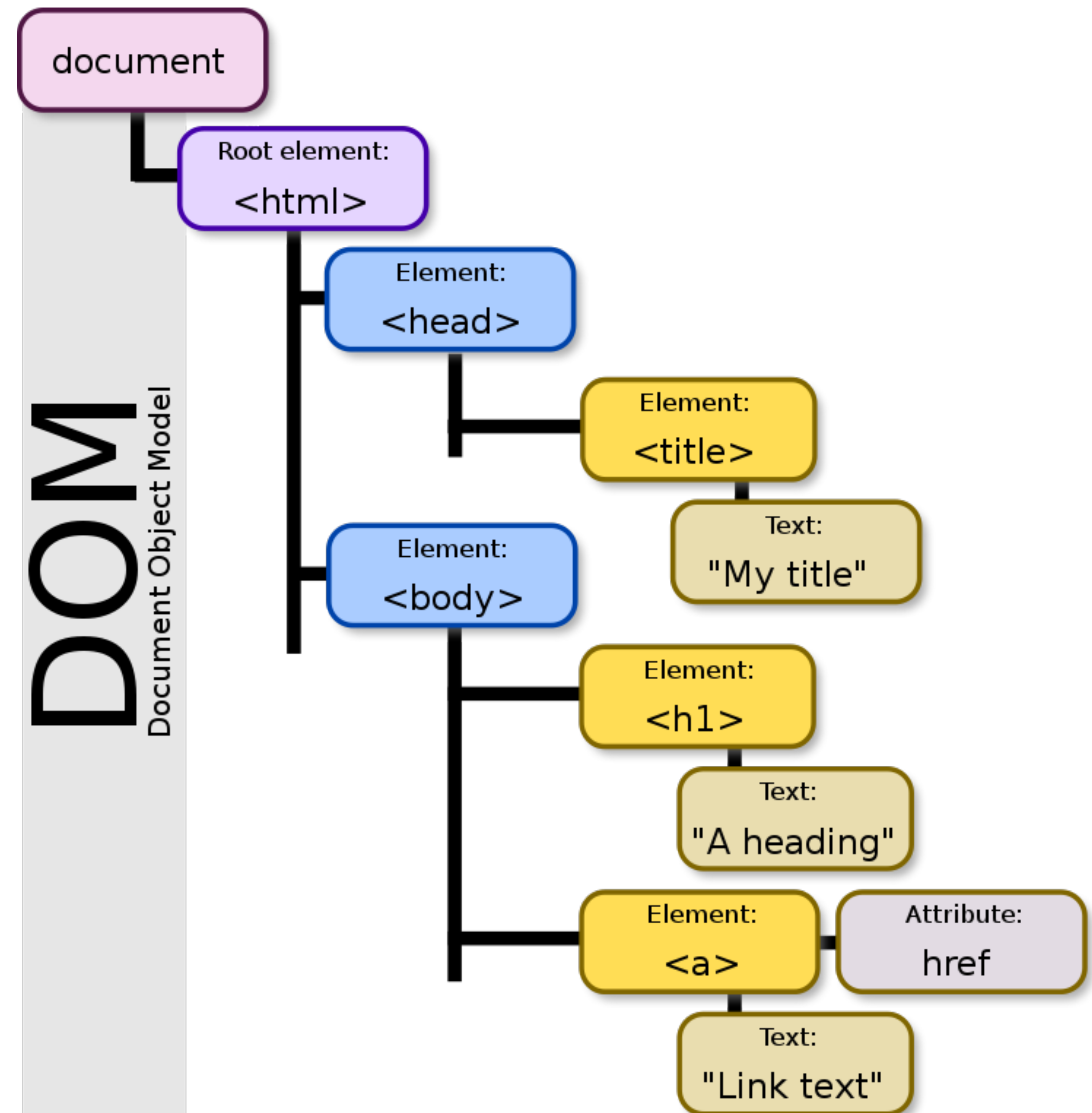
Definition: Also called ReactJS, React is a JS library for building user interfaces.

- Developed by Facebook, dating back to 2010.
- Started as an internal development tool, then open-sourced in 2013.

[2] More on the history of React

Refresher: Document Object Model[3]

Definition: Document Object Model (DOM) translates an HTML or XML document into a tree structure where each node represents an object on the page.



[3] Wikipedia: DOM

Refresher: DOM Programming Interface

- **Objects**: HTML elements, such as a paragraph of text.
- **Property**: Value that we can get or set, such as the `id` of an element.
- **Method**: An action we can take, such as adding or deleting an HTML element.

For JS to interact with user-facing elements, we first need to access them...

Refresher: Accessing HTML elements

Most common way of accessing content is `getElementById()`.

```
<p id="userName"></p>

<script>
    document.getElementById("userName").innerHTML = "Cole Nelson";
</script>
```

We can also find elements using tag name, class name, CSS selectors, and HTML object collections.

Refresher: Manipulating HTML elements

Changing content:

```
document.getElementById("userName").innerHTML = "Cole Nelson";
```

Changing attributes:

```
document.getElementById("userImage").src = "Headshot.png";
document.getElementById("userName").style.color = "red";
```

Refresher: DOM Events

DOM provides access to HTML events, such as `onclick`, `onload`, `onunload`, `onchange`, `onmouseover`, `onmouseout`, `onmousedown`, `onmouseup`, `formaction`.

We can register functions to events using *inline event handlers*, *DOM on-event handlers*, and *using event listeners*.

What's wrong with this approach?[4][5]

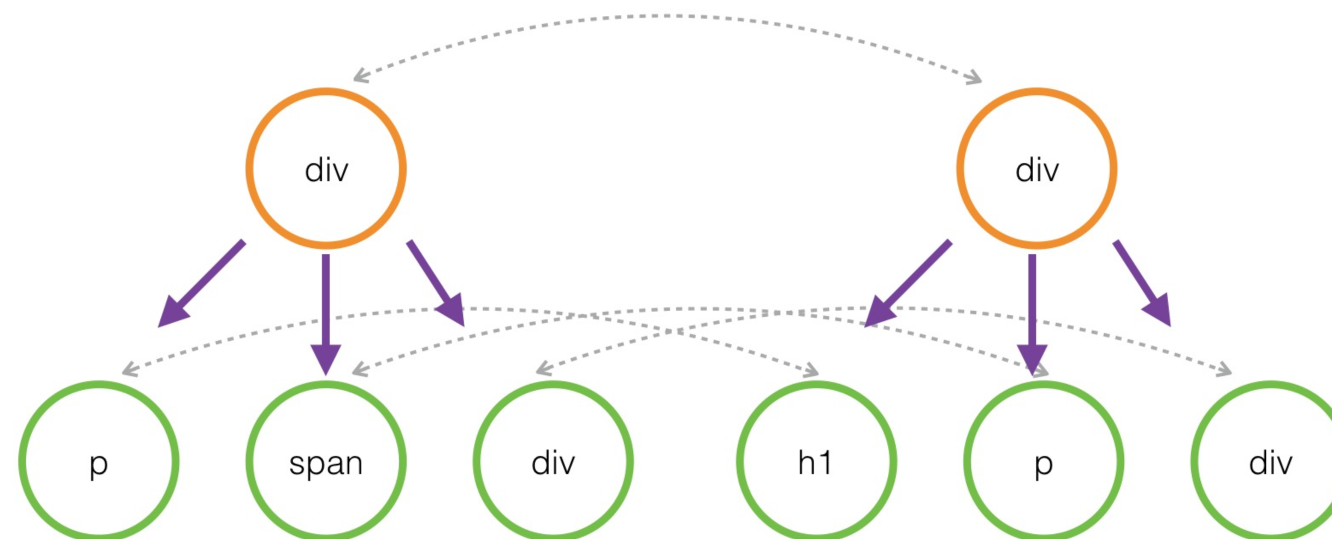
- Working with HTML DOM is slow
  - The DOM for *single-page applications (SPAs)* can be huge
  - Interactive applications require a large number of and frequent updates on DOM elements
  - Inefficient updating

[4] React Kung Fu

[5] Image source

Solution: The *Virtual DOM*[6]

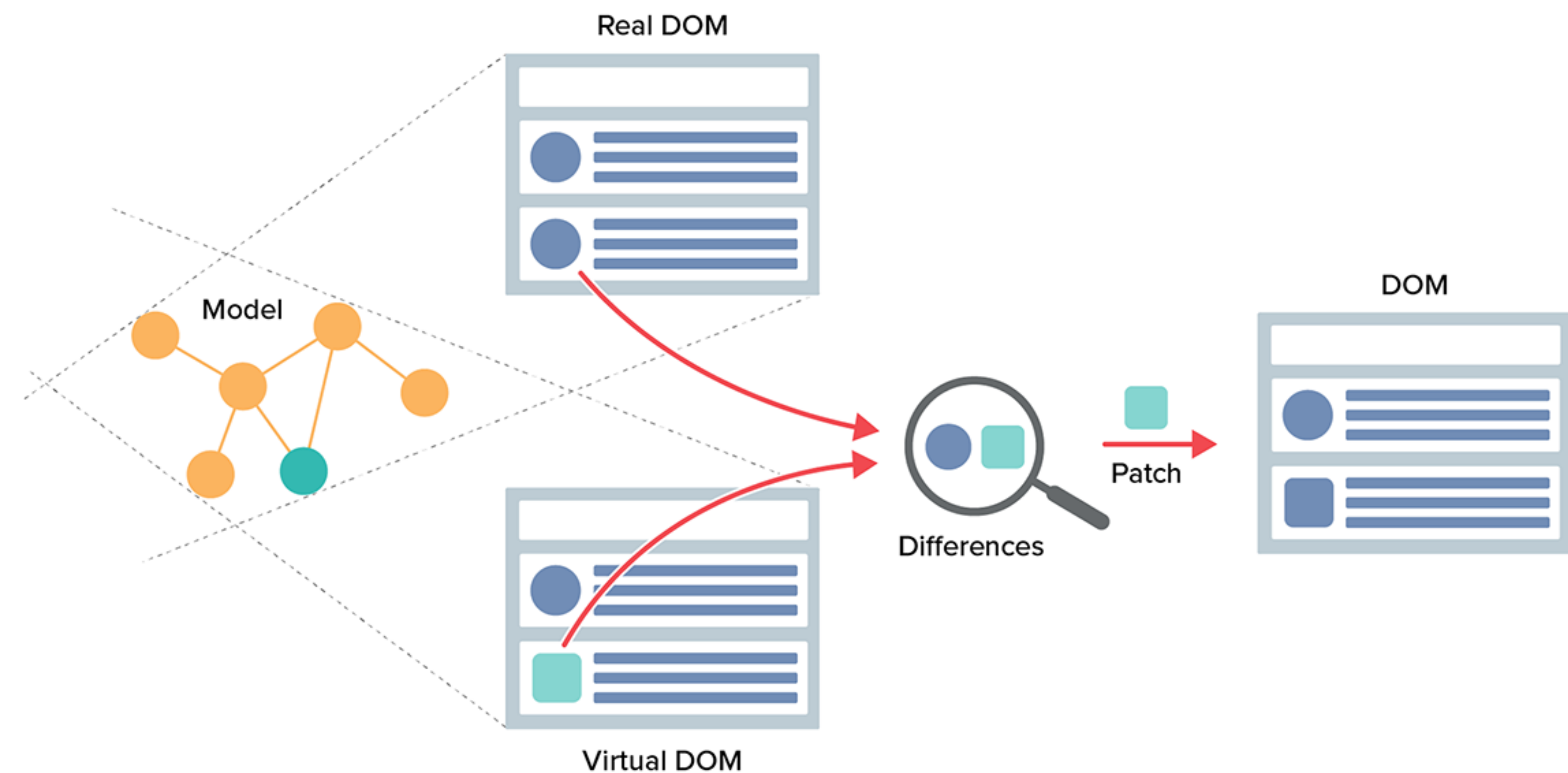
Definition: The virtual DOM is a *virtual* representation of the user-facing elements that are kept in memory and synced with the real DOM when DOM elements are updated.



[6] Image source

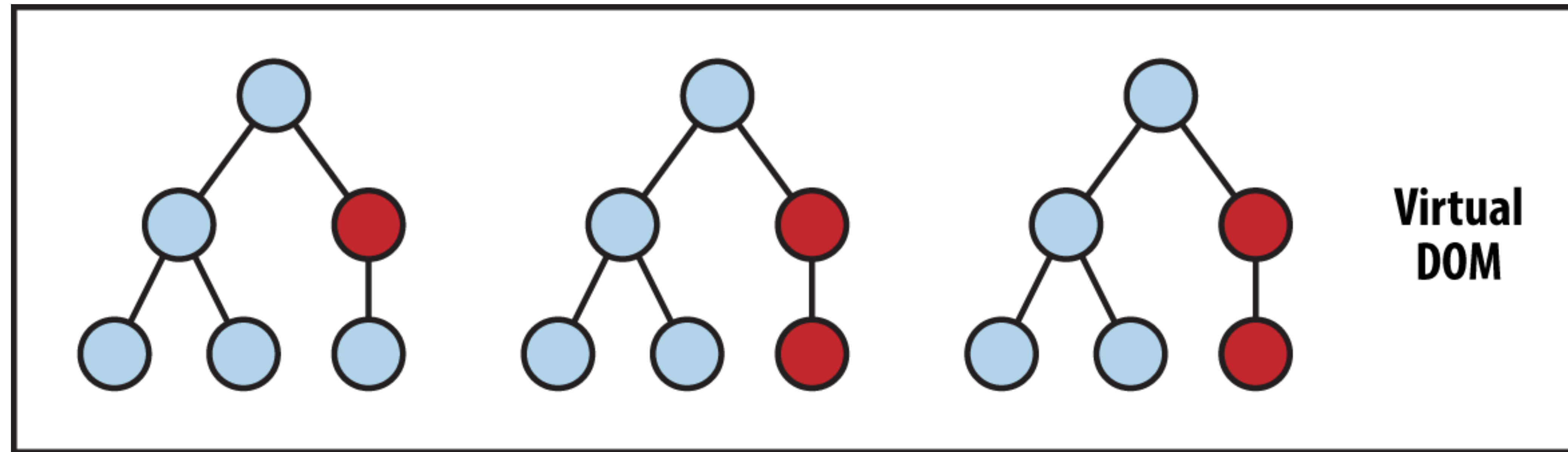
More on the solution: *Reconciliation*[7]

Definition: *Reconciliation* is the process of *diffing* and syncing the virtual and real DOM to render changes for the user.

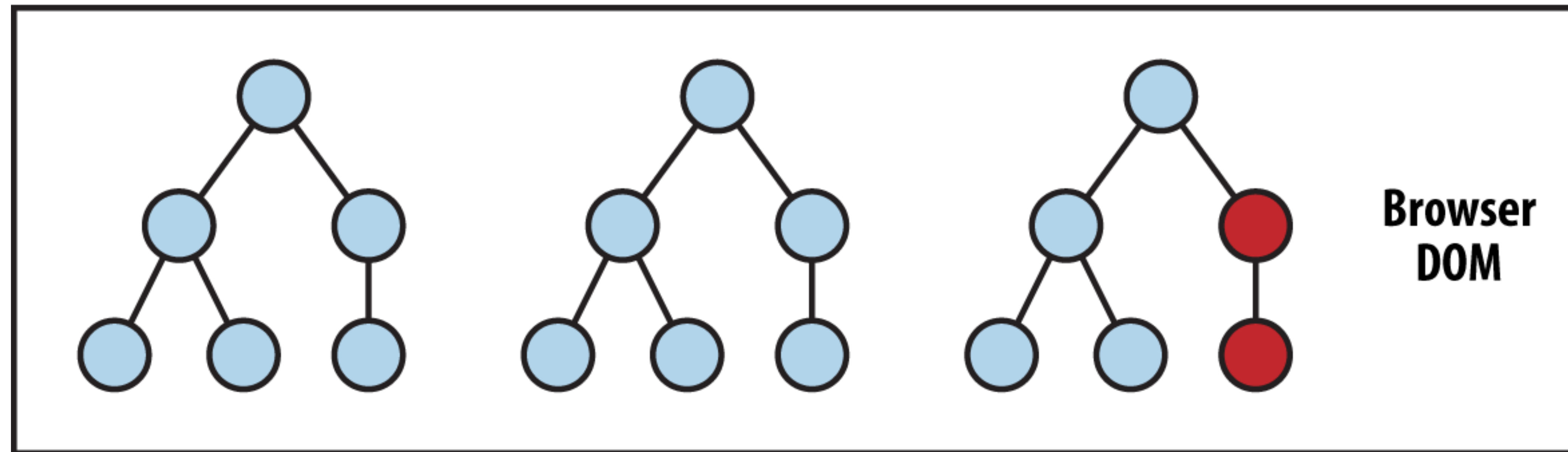


[7] Image source

[8]



State Change → Compute Diff → Re-render



[8] Source

What are the benefits?

- Incredibly fast, as only what is updated in the Virtual DOM is updated in the real DOM
- Abstracts away interactions with DOM: *declarative programming*

Detour: Declarative vs. imperative programming

Definition: *Imperative programming* expresses how the computation must flow.
- Programming how to get the outcome we want.

Definition: *Declarative programming* expresses the logic of a computation without describing its flow.
- Programming what we want the outcome to be.

Imperative example:[9]

```
var ages = [32, 45, 16, 67];
function checkEligibility() {
  for (i = 0; i < ages.length; i++) {
    if (ages[i] < 18 || ages[i] > 65) {
      console.log('Every one is not eligible');
      return false; } }
  console.log('Every one is eligible');
  return true; }
```

Declarative example:

```
var ages = [32, 45, 16, 67];
function checkEligibility() {
  console.log(ages.every(age => age >= 18 && age <= 65)
      ? 'Every one is eligible' : 'Every one is not eligible'); }
```

[9] See working example in CodePen

Detour: What are advantages of imperative/declarative programming?

Imperative

- Easier to debug
- Open to customization

Declarative

- More abstraction/ Modular
- More concise and readable
- Quicker to code
- Dense code

Let's get back to React

- React assumes declarative programming
  - We only care about the outcome we want to see
- The `ReactDOM` library takes care of reconciliation and updating user-facing content under the hood

Let's look at this again visually

Credit: Maggie Appleton[10]

[10] Image sources: next two slides

React's VIRTUAL DOM?

One of the reasons React is so darn *fast** at updating changes to our app is that it uses a VIRTUAL DOM

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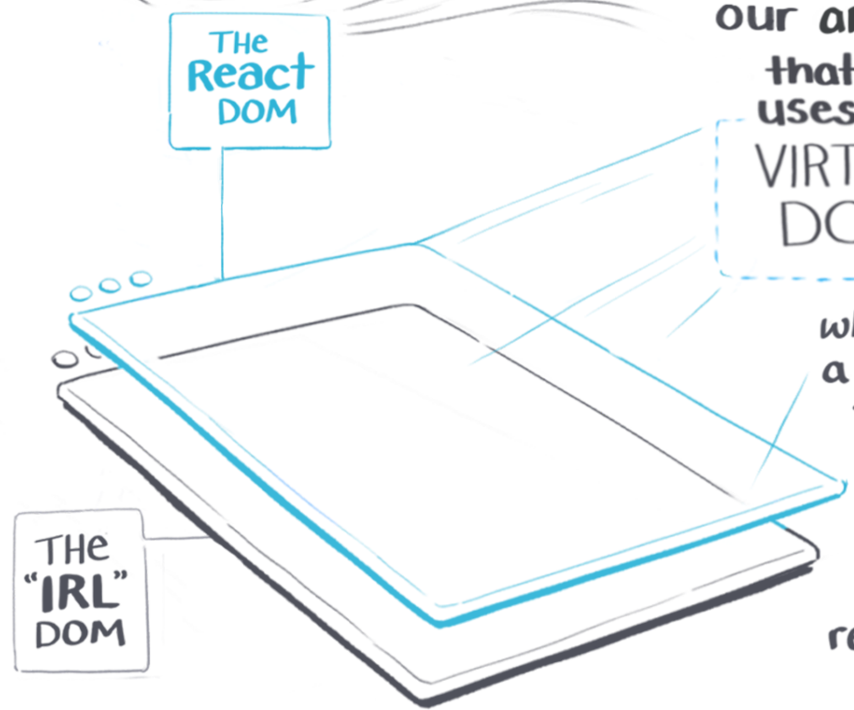
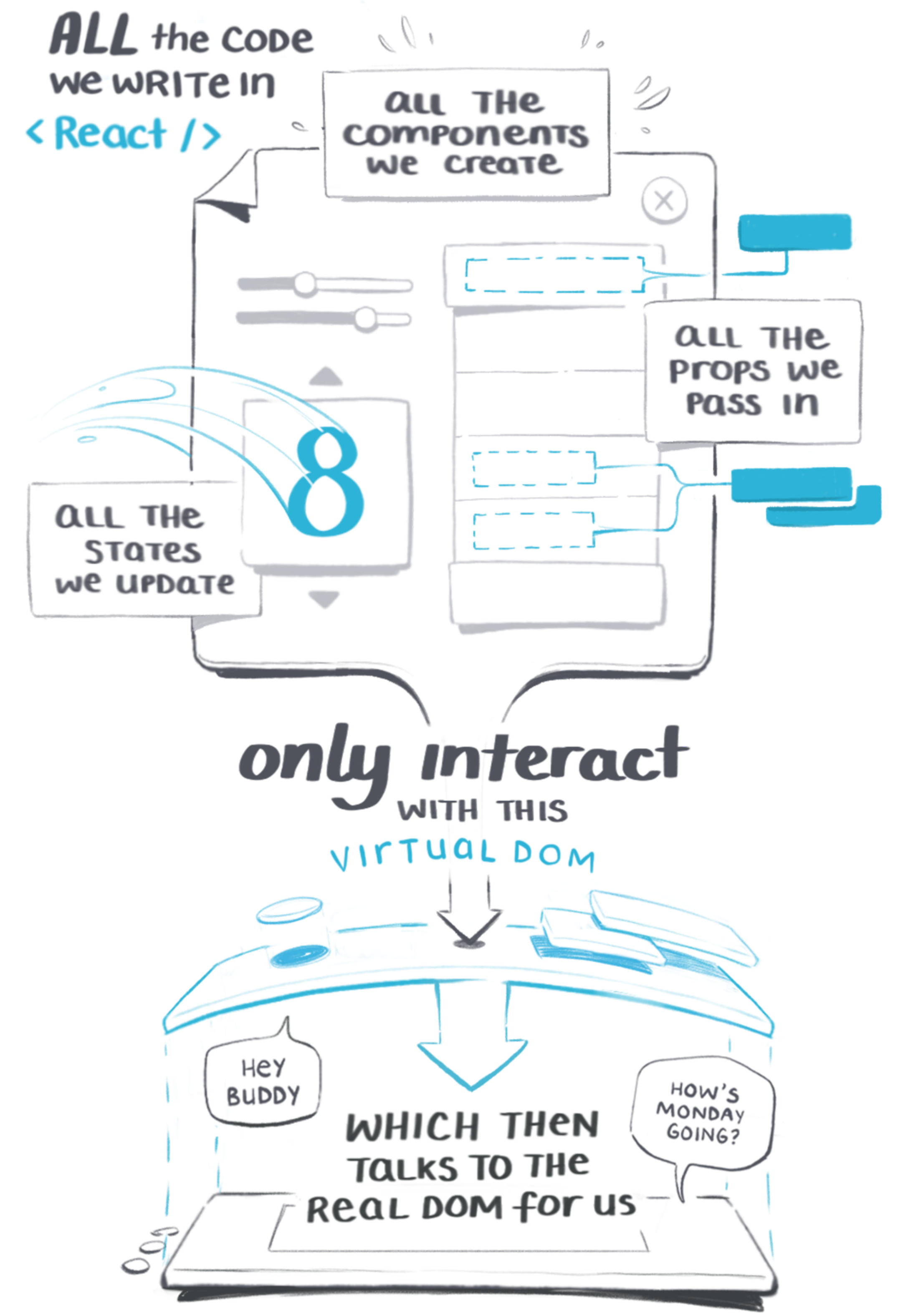
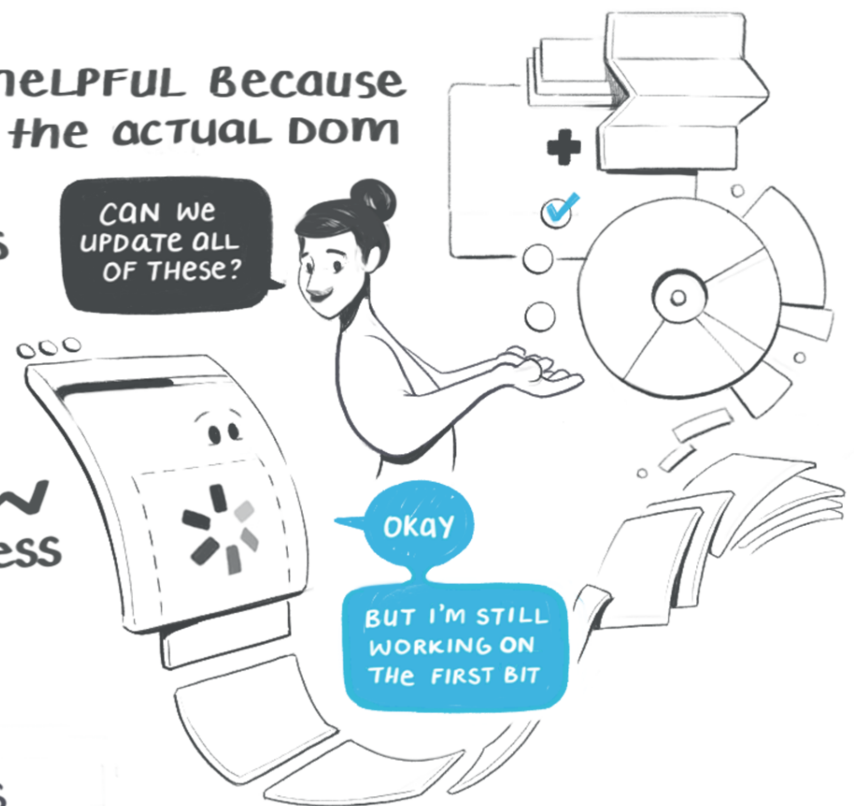
2

which is like a *floating* SECOND LAYER on top of the real DOM.



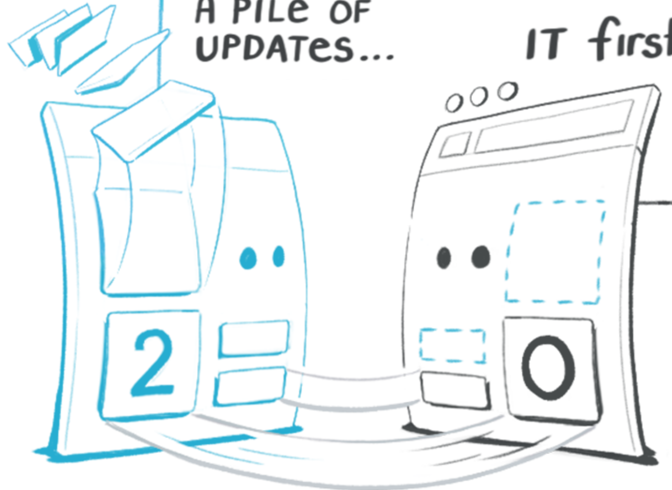


This is helpful because passing the actual DOM lots of changes to our app's state is a SLOW process



Whereas, when we pass THE VIRTUAL DOM

A pile of updates...



IT first compares it's own version of the DOM to THE REAL DOM and notes all the changes

and then it runs a "diffing algorithm"

to calculate how to relay those changes in the most EFFICIENT way possible...

WITH the least number of REQUESTS

Our 1,000 updates

(this process of syncing up your app's state with the real DOM is called **reconciliation**)

Handy dev buzzword

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* I know React's speed is a hotly debated point. To clarify: The *virtual* DOM doesn't speed up our initial render. It's only quicker at rendering changes to state, compared to the bog-standard, unoptimised DOM. It's also not the *absolute fastest* solution to the issue of slow DOMs.

Ok, that's why we should use React!

The name comes from *react*ing to events.

Building Blocks

Core Components

React `elements` and `components` are the two fundamental building blocks React uses to represent and change all user-facing context and events.

Definition: A React element is a light, stateless, immutable, virtual representation of a DOM Element.

React elements are JS objects, thus browser-independent, until they are rendered. Once they are rendered, they become DOM elements.[11]

```
var root = React.createElement('div');
ReactDOM.render(root, document.getElementById('example'));
```

[11] List of ReactElements

If React elements are immutable, how do we update the page?

Think of an element as a single frame of a movie, which represents the page at a certain point in time. To update the page, we create and render a new element.

React.Component

Definition: A React `component` is a function or class that accepts an input and returns a React `element`.

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

React.Component, Continued

Components work like JS functions; they accept `props` and return React elements that correspond to what will be rendered in the DOM.

Each component is encapsulated (one component per file) and can operate independently, affording modularity.

`render()`

Definition: `render()` returns a React element to be displayed on the page. Think of what you would like to see on the screen to determine what should go in `render()`.

There are two `render()` methods in React: `ReactDOM.render()` and `Component.render()`.

`ReactDOM.render()`[12]

`ReactDOM.render(element, container)` mounts the declared `element` as a child to the specified `container` in the DOM.

```
const element = <h1>Welcome to React</h1>;
ReactDOM.render(element, document.getElementById('root'));
```

[12] See in CodePen

`Component.render()`[13]

`Component.render()` creates the virtual DOM representation of the contents of the React component. And then, we call `ReactDOM.render()` to mount the elements on the DOM.

```
class App extends React.Component {
  render() {
    return (
      <div>
          <h1 className="App-title">Welcome to React</h1>
      </div>
    );
  }
}
ReactDOM.render(<App />, document.getElementById("root"));
```

[13] See in CodePen

`props` and `states`

Definition: `props`, or properties, are the arbitrary input provided into React components that utilize them to render content.

Components should never modify `props`; they are read-only and immutable.

Definition: `state` is similar to `props`, but they are fully private and controlled by the component.

`state` is what helps us keep track of changes in data.

Usage: `props`[14]

Props are passed into functions as arguments, e.g.:

```
function Welcome(props) {
  return <h1>Hello, {props.name}</h1>;
}
const element = <Welcome name="Professor Zhao" />;
ReactDOM.render(element, document.getElementById('root'));
```

Reference using `this.props` within the component.

[14] See in CodePen

Usage: `state`[15]

States are defined and manipulated within components, e.g.:

```
class Welcome extends React.Component {
  constructor(props) {
    super(props);
    this.state = {date: new Date()};
  }
}
```

The `state` can be referenced using `this.state` and changed using `this.setState()`. More on this later...

[15] See in CodePen

JSX

Definition: A syntax extension to Javascript, that adds XML syntax to JavaScript. JSX declarations produce React elements.

```
<div className="red">Text</div>;
```

... is compiled into ...

```
React.createElement("div", { className: "red" }, "Text");
```

Babel[16] is the preprocessor that compiles JSX into JS.

[16] See example in Babel REPL

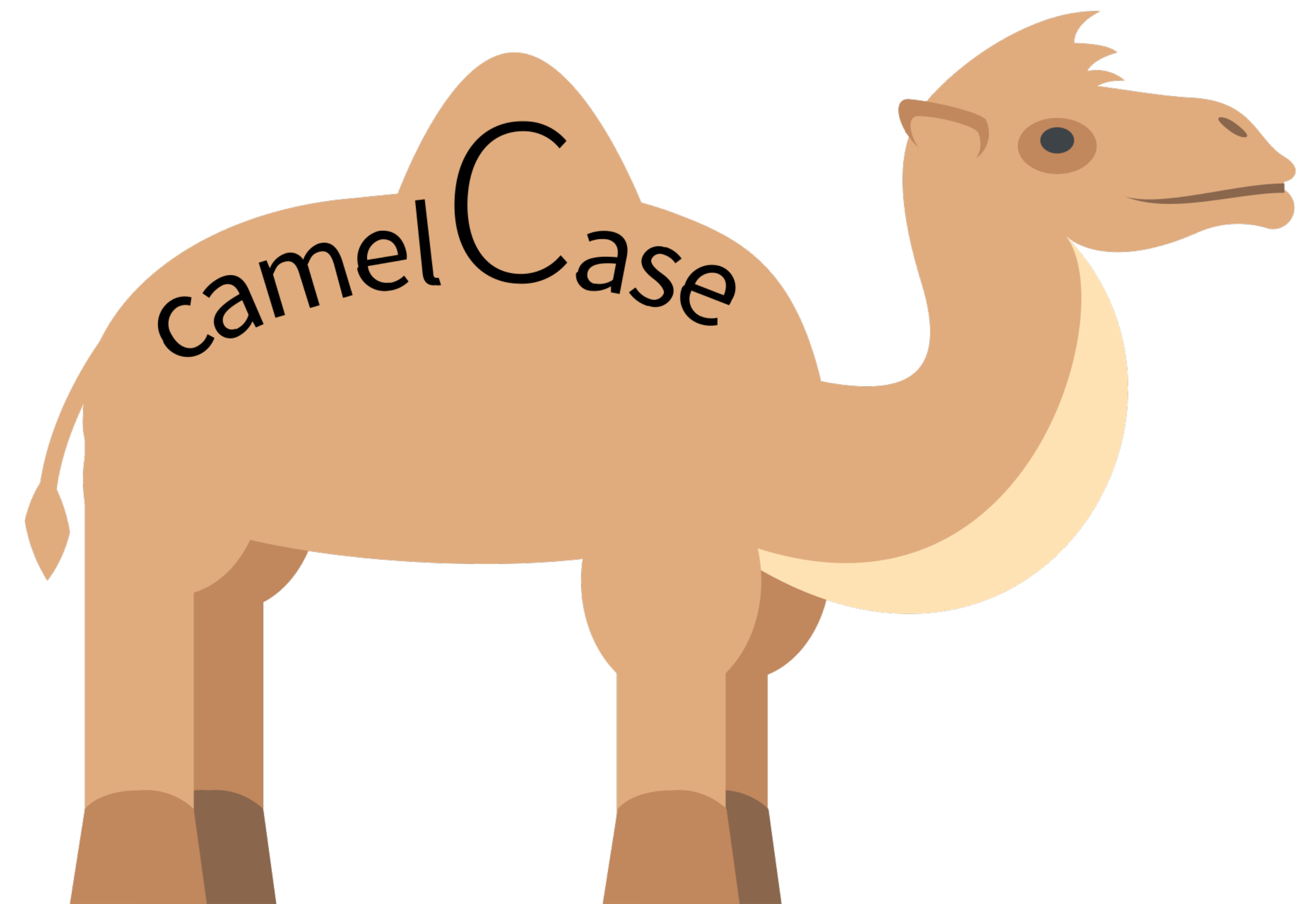
JSX, *Continued*

- JSX is not required, but makes React programming extremely effective

Detour: Naming Conventions[17]

Definition: `camelCase` involves writing phrases such that each word begins capitalized with no spaces/punctuation.

Definition: `hyphen-case` (aka *kebab-case*) involves writing phrases in lower case and using a hyphen as a separator.



[17] Wikipedia

Detour: Naming Conventions, *Continued*

Definition: `PascalCase` capitalizes all words with no spaces/punctuation.

— ReactDOM and JSX use `camelCase`

— React components use `PascalCase`

Setting up a React project

Setting up a React project

In the development environment

What you will need: *terminal*, *coding environment*, *Node.js*

```
npm install -g create-react-app

npx create-react-app <your-app-name>
cd <your-app-name>
npm start
```

Setting up a React project

In a sandbox

Simple React application:[18]

1. set sandbox settings to `Babel` preprocessor
2. import `react` and `react-dom` CDNs

React project:

— Create a project using a template / upload your project

[18] See example in CodePen

What did we learn today?

- History and overview of React
- Overview of building blocks
- Setting up a React project

4 Quizzes

Complete the Canvas quiz.