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# CSE 331

# Software Design & Implementation

Fall 2020

“Section 8” – HW8: React Canvas + Common Bugs

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# Agenda

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- Overview of HW8 – “Connect the Dots”
- Canvas HTML object
  - how to use from React
- Common React bugs & how to fix them

# HW8

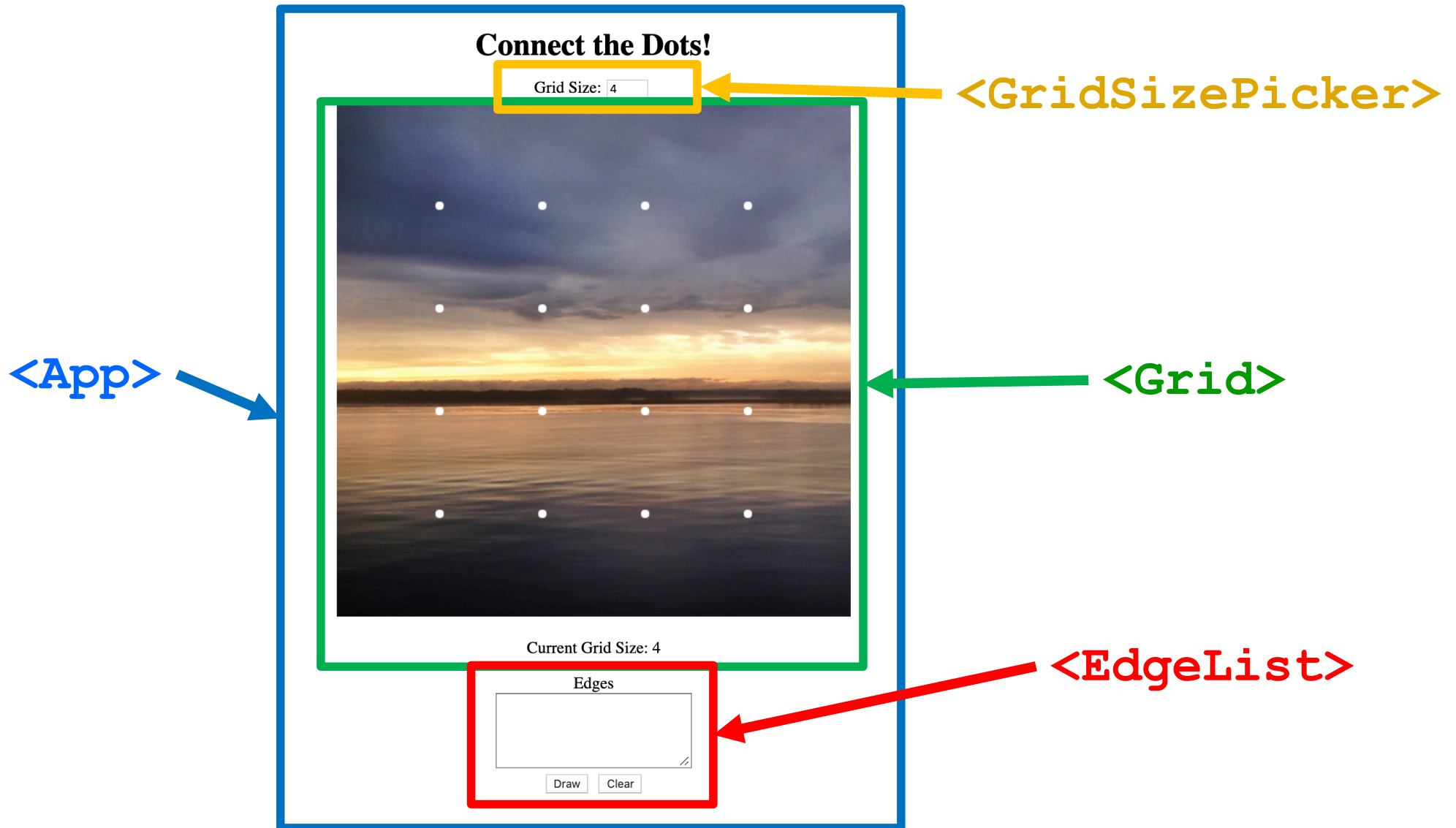
# HW8 Overview

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- Starter code has (most of) the pieces, but not much functionality.
  - Lots of hard-coded values, placeholders (console.log instead of actually doing stuff), etc..
- Your job: "wire all the pieces together"
  - Accept user input
  - Process/parse the data
  - Error check – users do weird stuff, make sure you can't crash
  - Move data between components as necessary
  - Add the actual functionality in response to user input.
- Structure:
  - Top-level <App> component, with three child components.

# HW8 Component Structure

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# Running a React App

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**npm:** Similar to gradle, but we need to install manually the first time.

In the terminal, change directory until you're in the same place as the "**package.json**" file for the project you want to run.

To Install (first time): **npm install**

To Run (every time): **npm start**

Once started, you can edit and save files and the page will automatically reload – no need to restart. Use Control-C to shut down when you're done developing.

**CANVAS**

Example 2:

# Drawing on a Canvas

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- `<canvas>` tag: creates a blank drawing surface that you can “draw” on with JS
  - Create lines, shapes, draw images.
  - Has `width` and `height` attributes to determine the size of the drawing surface.
- We’re using `<canvas>` in HW8 and HW9 to draw lines/paths on top of images (like a map of campus!)
- Javascript is going to need some kind of Canvas object in order to call functions and draw pictures.
  - How do we get this object?



# Example 2 Code

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```
<html>
  <head>
    <title>2. HTML5 Canvas</title>
  </head>
  <body>
    <script type="text/javascript">
      function drawSomething() {
        let canvas = document.getElementById("theCanvas");
        let context = canvas.getContext("2d");
        context.fillStyle = "teal";
        context.fillRect(50, 50, 150, 100);
      }
    </script>
    <button onclick="drawSomething()">Draw Something Cool</button>
    <br />
    <canvas id="theCanvas" width="500" height="500"></canvas>
  </body>
</html>
```

Example 4:

# React Canvas

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Our previous canvas code from Example 2 converted to use React!

1. Need to get a canvas object to draw like last time.  
This is different in React.
  - a. It's React's job to manage the HTML for us, grabbing something with an ID defeats that purpose and can cause bugs.
  - b. In React, we use "Ref" objects instead of ID strings, but they work similarly.
2. Write an `updateCanvasImage()` method to draw a rectangle on the canvas like before.
3. Use `componentDidMount()` to find out when React is ready for us to start drawing things, then call `updateCanvasImage()`

# Component Life-Cycle

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## Creation of a component:

1. `constructor` (passed props) — create initial state
2. `render` — produce the HTML
3. `componentDidMount` — anything you need to do after HTML exists in the DOM

## Update of component (after `setState`):

1. `render`
2. `componentDidUpdate`

## Removal of component (after parent's `re-render` removes child):

1. `componentWillUnmount`

Example 8:

# Stateful Example

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Add some more components:

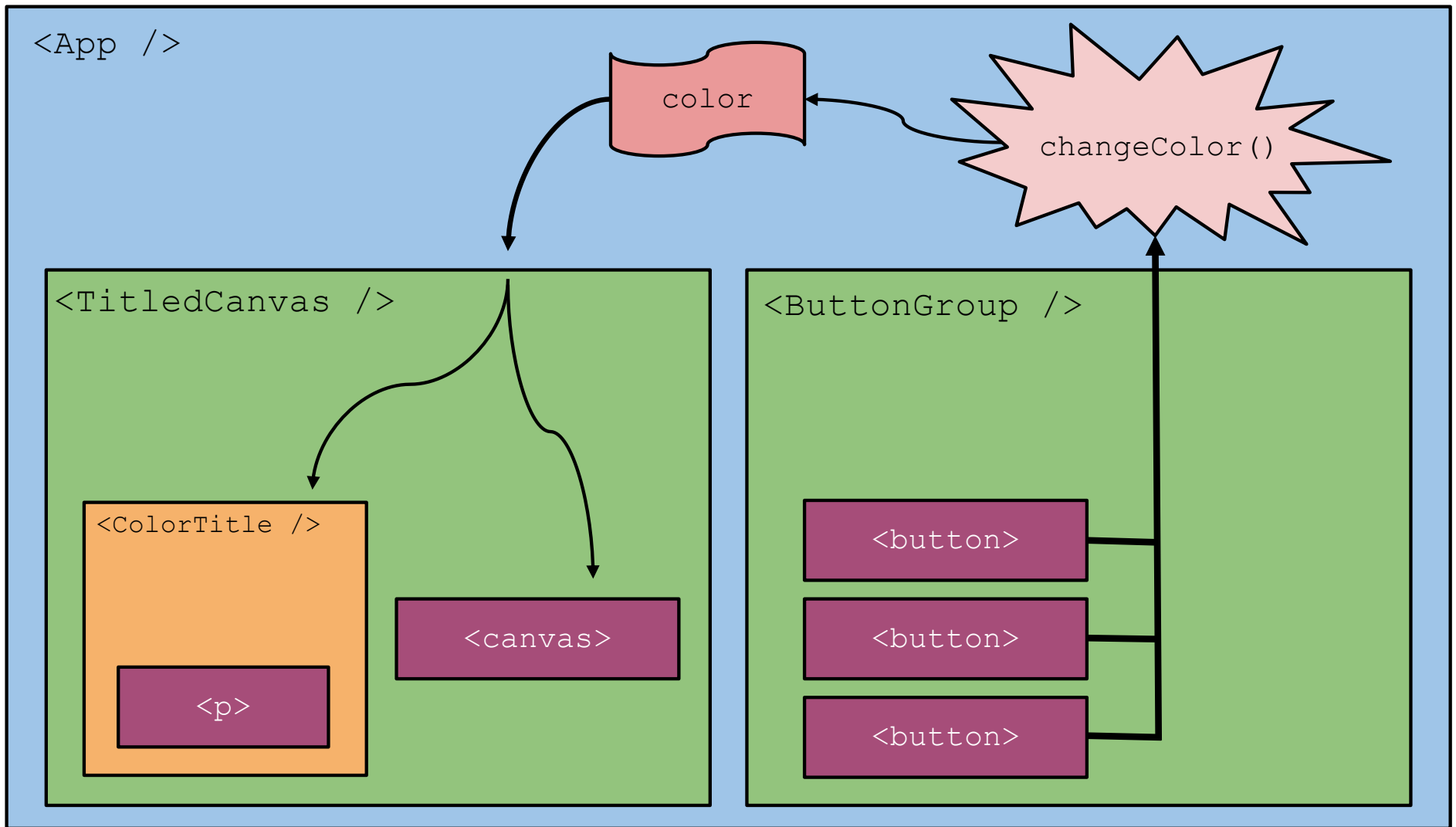
- New component to choose a color (red, green, blue)
- New component that puts a title above the canvas

Add state:

- `App` stores a current color
  - passed to child components in `props`
  - `ButtonGroup` uses a callback to notify `App` that a new color has been chosen
    - callback is passed in via `props` also
  - `App` calls `setState`, which causes a re-render
    - React re-creates or updates the children as necessary

# The Flow

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# Summary

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- Components are reusable blocks of code that allow modular design and proper cohesion.
- Components contain other components and HTML tags to determine how they appear on a webpage.
  - React is responsible for managing the underlying webpage.
- Data owned/controlled by a component is stored in that component's state.
- Data flows *down* from parent to child through props.
- Data flows *up* from child to parent through callbacks from the child into the parent's code.
- React notifies components of changes to their data through lifecycle methods, like `componentDidUpdate`

# EVENT HANDLERS

# Passing Methods as Event Handlers

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- Remember that JS only passes “`this`” to a method call if the function is invoked using the “`obj.method(...)`” syntax.
- In lecture, we saw two ways to fix this:

```
onClick={this.handleClick.bind(this)}
```

```
onClick={evt => this.handleClick(evt)}
```

which create functions where “`this`” is already bound in place

- This code shows a third way...



# Passing Methods as Event Handlers

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- Instead of declaring a handler like this

```
handleClick(evt) { ... }
```

you can declare it like this

```
handleClick = (evt) => { ... };
```

- The latter `handleClick` is actually a *field*, not a regular method.
- It defines a field whose value is a bound method, i.e., a function with the “`this`” already set correctly.

# Passing Methods as Event Handlers

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- If you define your event handlers like this

```
handleClick = (evt) => { ... };
```

then you can pass them directly as event handlers:

```
onClick={this.handleClick}
```

- It's up to you, which of these 3 approaches you want to use.
- They all work correctly.

# REACT BUGS

# Common React Bugs

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- Most common bugs in React are:
  - Reading from React state before the data has been populated.
  - Not properly understanding the React life cycle (the order that things happen within your app).
- This is because of specific **asynchronous updates** to React's internal representation of the webpage.
  - **Note:** There may be a very slight delay to updating your React components.
- **IMPORTANT:** You need to be careful when updating your React component's state and trying to access data!

# Debugging React Strategies

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When you hit a bug...

1. Walk step by step through the order that your code runs, checking how the state should be populated.
  - Use documentation about the React lifecycle to help you figure out which things happen in which order.
2. Put a `console.log()` in your methods if needed, and in `componentDidUpdate()` to check when your state was updated.
3. **Last resort:** Googling may be useful! Be very careful about this.

# Bug 1 – “Read before Write”

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Expected Functionality:

- Adds a canvas to the page and displays a blue rectangle immediately.

Current Functionality:

- **TypeError** when the page is loaded.

# Bug 1 –The Problem

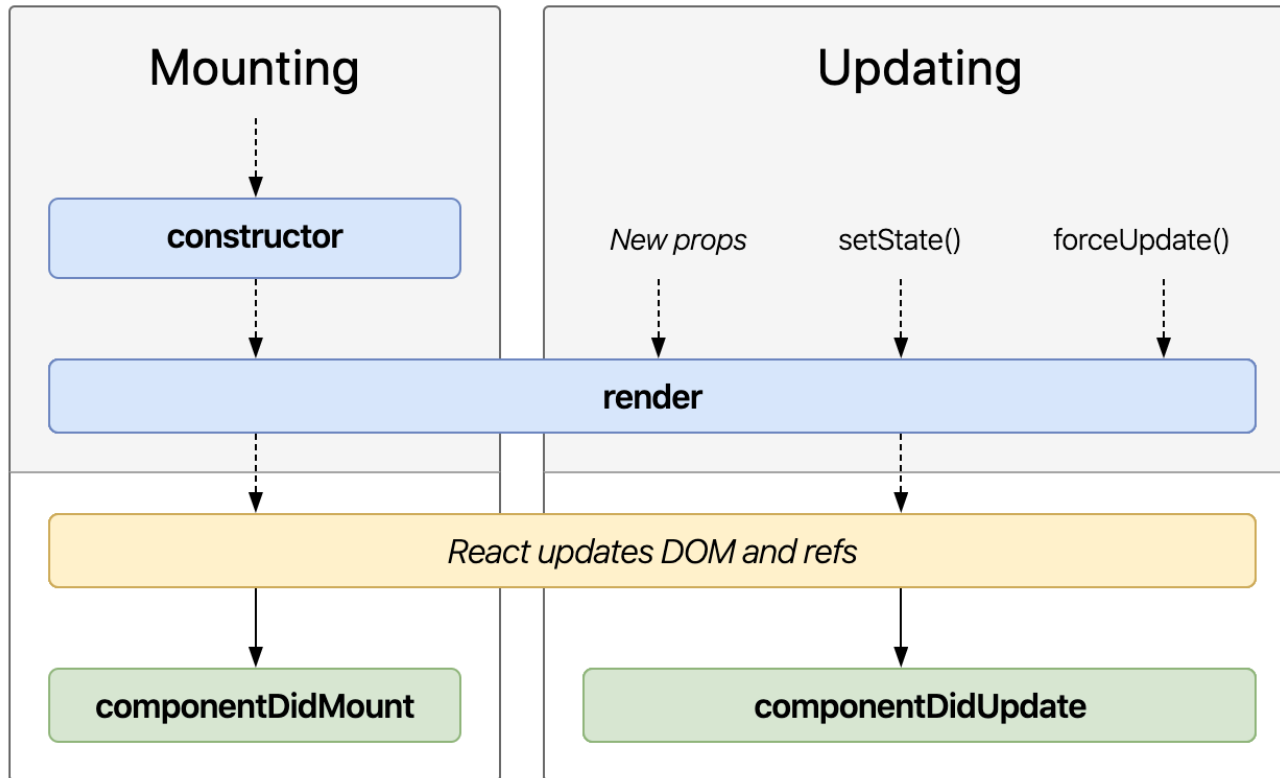
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It seems like `this.canvasRef.current` is null, when it's supposed to be our Canvas object.

- Why doesn't the Canvas object exist yet? Let's think about how the `<canvas>` is eventually inserted into the page...
  1. Our component is created and inserted into the page (in this case by `ReactDOM.render()`)
  2. React constructs the component and then calls the component's `render()` to get the HTML tags we want.
  3. React inserts those tags into the webpage **and then** sets up all the reference objects.

# Bug 1 – “Read before Write”

## (Part of) The React Lifecycle



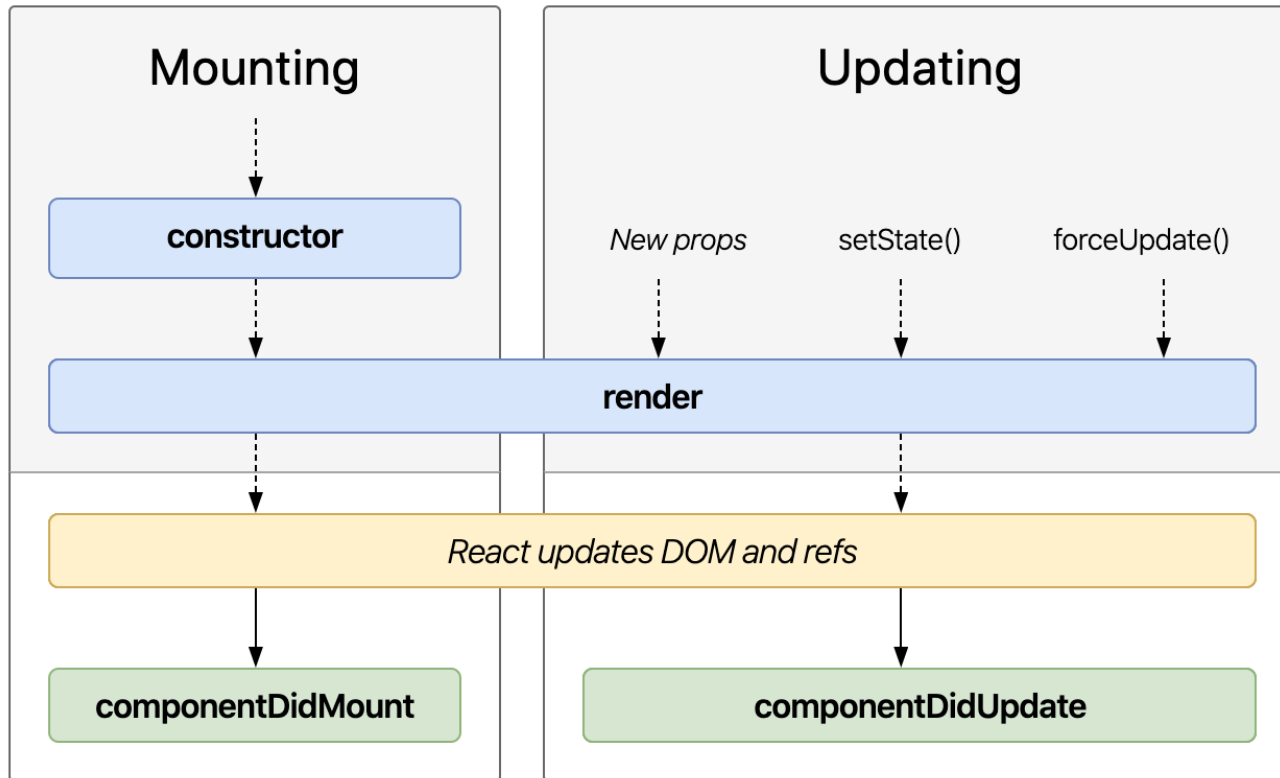
- Order that React calls methods.
- We're accessing the reference during the constructor
- React doesn't update the refs (yellow box) until after `render()` – so they don't exist when the constructor is running!

Image: <http://projects.wojtekmaj.pl/react-lifecycle-methods-diagram/>



# Bug 1 – The Fix

## (Part of) The React Lifecycle



## Solution

### Override

`componentDidMount`:  
called when React is done  
inserting all the DOM  
nodes and updating refs.

In `componentDidMount`,  
we know it's safe to use  
the ref (the “read”), since  
it's guaranteed to happen  
after the updating the refs  
(the “write”) has finished.

Image: <http://projects.wojtekmaj.pl/react-lifecycle-methods-diagram/>

# Bug 1 – The Fix

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- Move the `updateCanvasImage` call into `componentDidMount`
  - Still called during the component "mounting" phase – so we're able to set up the "first look" of the canvas like we wanted.
  - Happens after React sets up our refs, so we know we'll have a valid Canvas object to work with.
- Common idea in React:
  - Set something up (like the `<canvas>` tag) and give it to React (by returning from `render`)
  - Some time later, React will do its job.
  - React makes a *callback* (like `componentDidMount`) to let us know that it's done and we can use whatever we set up (like accessing the Canvas through its ref).

# Bug 2 – “React Doesn’t Know”

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## Expected Functionality:

- When the button is clicked, the message on the page changes to "I've been clicked!"

## Current Functionality:

- The message on the page never changes.
- We know that the button event is working because the `console.log()` inside the listener is being run, so the bug must be somewhere else.

# Bug 2 – The Problem

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- The `this.clicked` variable is being updated correctly
  - You can print it out to double check, if you'd like.
- The only place we can modify what text is being put in the `<p>` is during the `render()` method – we need to return a different `<p>` element to change what's on the page.
  - But React doesn't know it's supposed to call `render` again!
  - More accurately: React doesn't know that the contents of the `this.clicked` variable matters for `render`.

# Bug 2 – The Solution?

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- React has a special place for variables that affect how a component renders: `this.state`.
  - Store an object ( `{...}` ) inside `this.state`, put whatever properties we want in that object to track the data we need.
  - Instead of `this.clicked`, we write `this.state.clicked`
- "clicked" isn't a special name here – just a variable name. Could easily call it `"this.state.pizza"`
- "state" **is** a special name: part of the React convention, React code expects that you store your state variables in `this.state`
- Not quite a fix yet, but a step in the right direction.

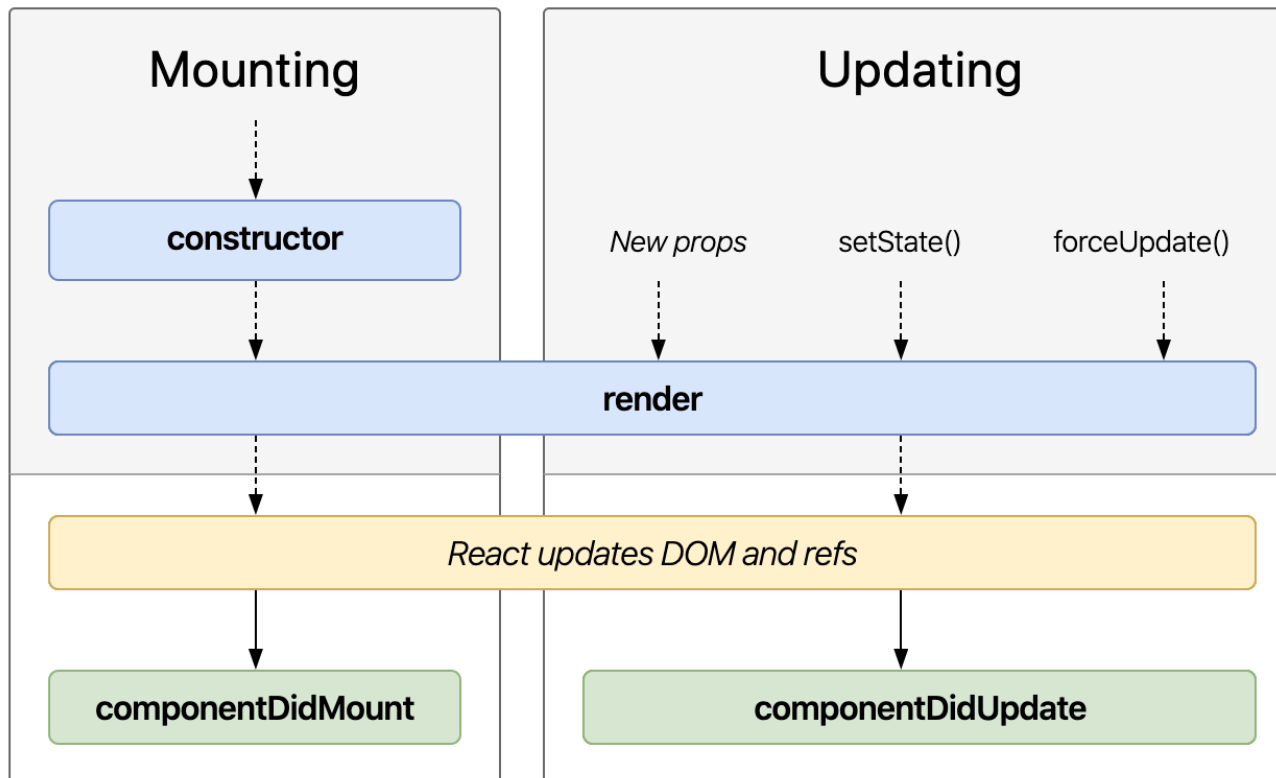
## Bug 2 – The *New* Problem

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- We're now storing our data in the right place, but we still aren't telling React when we change it.
  - React requires that you notify it when you *want* to change the data, *instead* of changing it yourself.
  - This is why we get a TypeScript compiler error when we try to change it manually.
- To request a state change, call `this.setState` and pass it an object representing *the changes you want to make*.
  - You should never directly modify the contents of `this.state` (except for constructor initialization). (Impossible with TS).
- Since you use `this.setState` (which is React code) to update the state, React knows that you'll need things to be updated based on what changed. (So, React will re-do the render).

# Bug 2 – The Fix

## (Part of) The React Lifecycle



### Solution

By calling `setState` to update our state, we trigger a "component update cycle". During an update, React will change the state and then re-call `render()`. In `render()`, we can return the new text to be displayed on the page.

# Bug 3 – “Read before Write (is done)”

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## Expected Functionality:

- When a button is clicked, a square of that color appears in the canvas.
- The current color is displayed in the text above the buttons.

## Current Functionality:

- The text above the buttons seems to be working correctly.
- The canvas is lagging behind one click – displays the color from two clicks ago instead of the most recent click.



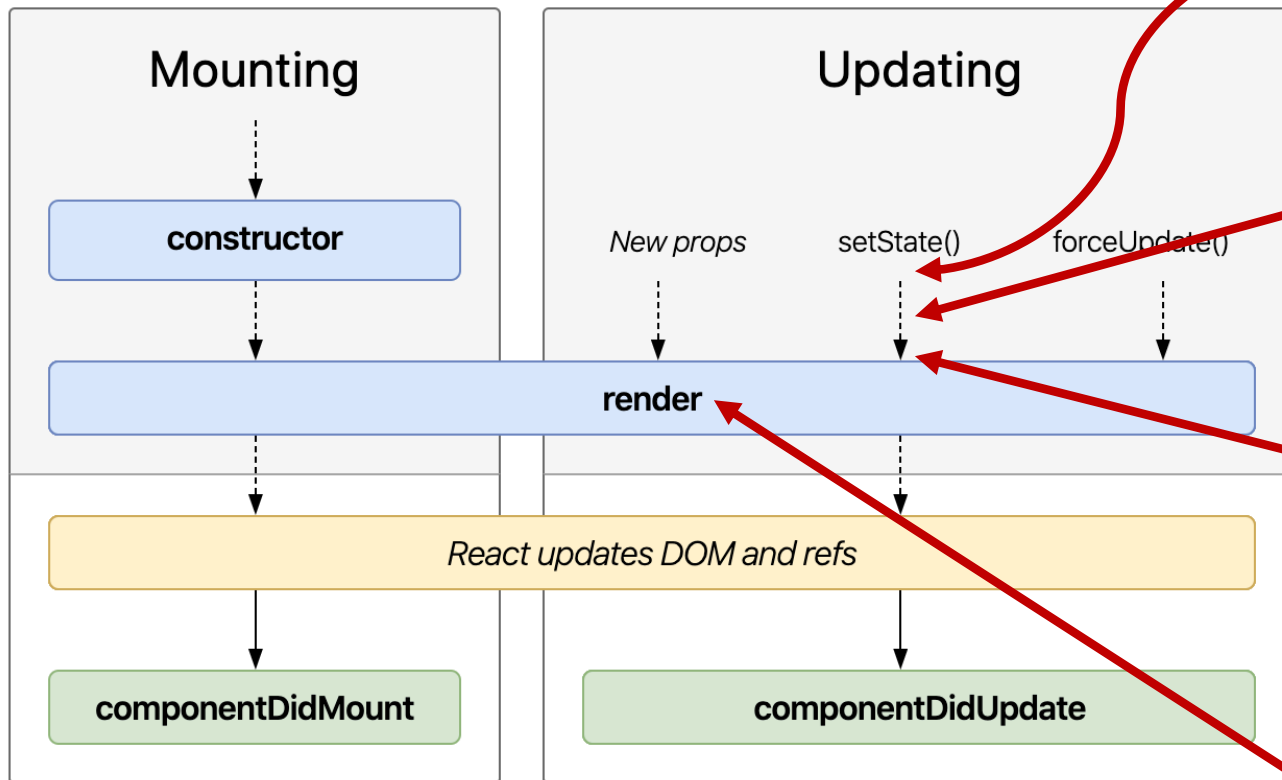
# Bug 3 – The Problem

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- Remember that, in React, `setState` is a *request* for a *future change* to state. **When `setState` returns, the state has not yet been updated.**
  - React delays state changes for performance reasons.
  - Means we need to be careful about reading state: when do we know that it's guaranteed to be up-to-date?
- The problem is that we're trying to access the state immediately after calling `setState` – React hasn't gotten around to updating the state yet, so we're seeing the old value.
  - This is why the canvas is "lagging behind" by one: when we draw the canvas, we're seeing the value of state from the previous button press.

# Bug 3 – What's Actually Happening

## (Part of) The React Lifecycle



`setState` returns,  
our code keeps going

Our code calls  
`this.drawSquare`,  
which sees the old value  
still in `this.state`

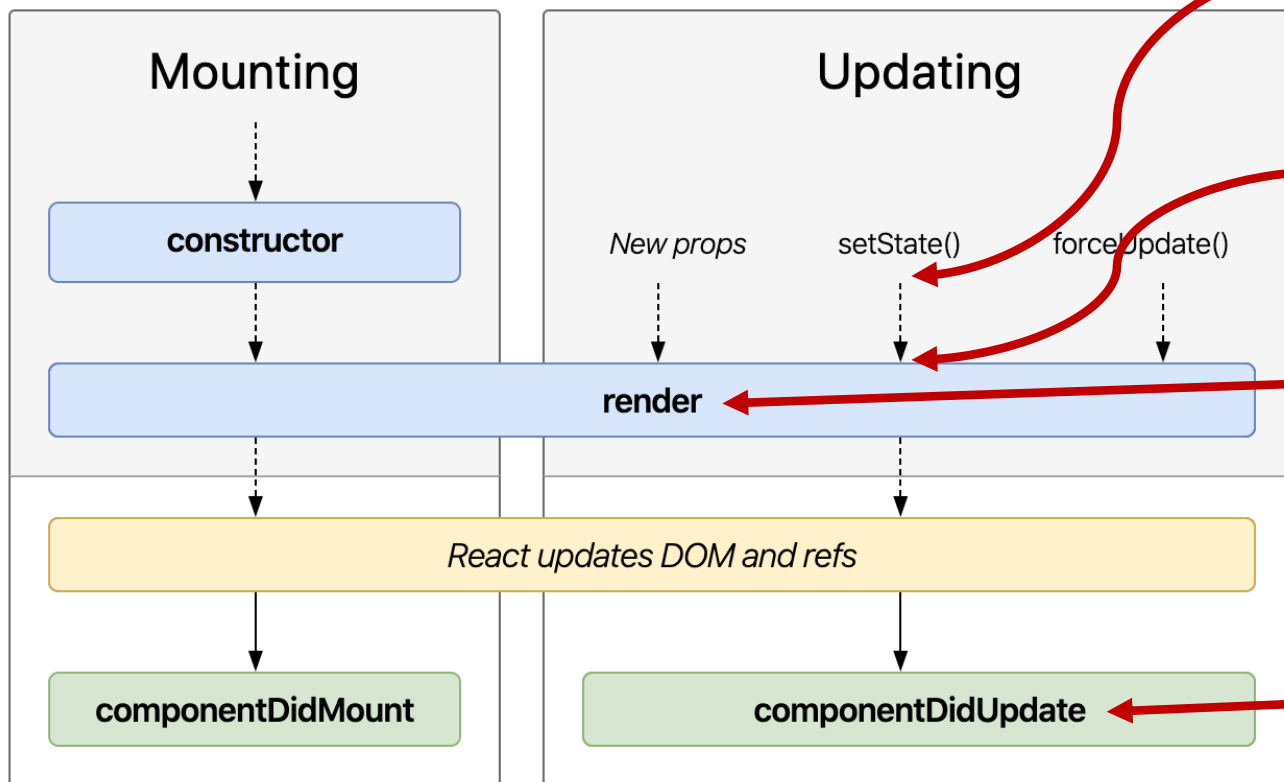
`this.state` gets  
changed later (by React)

The `<p>` gets updated  
here, which is why it sees  
the correct state (state is  
guaranteed to be updated  
before render is called)

Image: <http://projects.wojtekmaj.pl/react-lifecycle-methods-diagram/>

# Bug 3 – The Fix

## (Part of) The React Lifecycle



`setState` returns,  
our code keeps going

`this.state` gets  
changed later (by React)

`<p>` gets updated here, so  
it sees the correct state

### Solution

Should call `drawSquare`,  
here, since it is  
guaranteed to happen  
after the `this.state`  
value has been updated.