SENG 365 Week 9

React: Event Handling, Hooks, Global State

This week

- Event handling
- Hooks
- Global storage
- Routing
- Debugging React apps

Event handling and hooks

Event handling

- Event handling in a component is similar to DOM events but with some differences
  - Camel case notation: `onClick`, `onSubmit`, etc.
  - Pass a function as the event handler
- The function can be a method in the component class but cannot be called unless `this` is explicitly bound.

Digression: function binding

```
const module = {
  x: 42,
  getX: function() {
    return this.x;
  }
};

const unboundGetX = module.getX;
console.log(unboundGetX()); // The function gets invoked at the global scope
// expected output: undefined

const boundGetX = unboundGetX.bind(module);
console.log(boundGetX());
// expected output: 42
```

Accessing a component method for an event (option 1)

```
class Toggle extends React.Component {
  constructor(props) {
    super(props);
    this.state = {isToggleOn: true};

    // This binding is necessary to make `this` work in the callback
    this.handleClick = this.handleClick.bind(this);
  }

  handleClick() {
    this.setState(prevState => ({
      isToggleOn: !prevState.isToggleOn
    }));
  }

  render() {
    return (
      <button onClick={this.handleClick}>
        {this.state.isToggleOn ? 'ON' : 'OFF'}
      </button>
    );
  }
}
```

Bind `this` in the component constructor.

Accessing a component method for an event (option 2)

```
class LoggingButton extends React.Component {
  // This syntax ensures `this` is bound within handleClick.
  // Warning: this is *experimental* syntax.
  handleClick = () => {
    console.log('this is:', this);
  }

  render() {
    return (
      <button onClick={this.handleClick}>
        Click me
      </button>
    );
  }
}
```

Use public class fields syntax

This syntax is experimental but enabled by default by Create React App

Accessing a component method for an event (option 3)

```
class LoggingButton extends React.Component {
  handleClick() {
    console.log('this is:', this);
  }

  render() {
    // This syntax ensures `this` is bound within handleClick
    return (
      <button onClick={() => this.handleClick()}>
        Click me
      </button>
    );
  }
}
```

Use arrow function in callback

Not as performant because creates new function with each render

Function components with state

- Function components have been around in React for a long time for simple components
- Stateless before React 16.8
- Hooks were added in React 16.8
- Now most of what you could do with class components can be done with function components
- Syntax much lighter, easier to read code

Hooks in Function Components

```
import React, { useState } from 'react';

function Example() {
  // Declare a new state variable, which we'll call "count"
  const [count, setCount] = useState(0);

  return (
    <div>
      <p>You clicked {count} times</p>
      <button onClick={() => setCount(count + 1)}>
        Click me
      </button>
    </div>
  );
}
```

Import `useState` hook

`count` is assigned the initial value which is zero.

`setCount` is assigned to a function used to modify the state.

Note: must use arrow function notation, otherwise if we execute `setCount(count + 1)` in the return statement it will get in an endless render loop.

Hooks in Function Components

```
const App = () => {
  const [ counter, setCounter ] = useState(0)

  const increaseByOne = () => setCounter(counter + 1)

  const setToZero = () => setCounter(0)

  return (
    <div>
      <div>{counter}</div>
      <button onClick={increaseByOne}>
        plus
      </button>
      <button onClick={setToZero}>
        zero
      </button>
    </div>
  )
}
```

If we don't want to use an arrow function in the render, declare a `const` set equal to the arrow function in the component body.

(Note in this example App component function is also using the `const` function expression form, instead of `function` keyword)

Accessing previous state explicitly in setter function

```
function Counter({ initialCount }) {
 const [count, setCount] = useState(initialCount);
 return (
   <div>
     Count: {count}
     <button onClick={() => setCount(initialCount)}>Reset</button>
     <button onClick={() => setCount((prevCount) => prevCount - 1)}>-
</button>
     <button onClick={() => setCount((prevCount) => prevCount + 1)}>+
</button>
   </div>
 );
}
```

`useState` can be used to set multiple state variables

```
function App() {
 const [sport, setSport] = useState('basketball');
 const [points, setPoints] = useState(31);
 const [hobbies, setHobbies] = useState([]);
}
```

Compare with `this.state` in class components.
Updating a state variable *replaces* the variable, in contrast to merging as in `this.setState()`

useReducer

```
const initialState = {count: 0};

function reducer(state, action) {
  switch (action.type) {
    case 'increment':
      return {count: state.count + 1};
    case 'decrement':
      return {count: state.count - 1};
    default:
      throw new Error();
  }
}

function Counter() {
  const [state, dispatch] = useReducer(reducer, initialState);
  return (
    <>
      Count: {state.count}
      <button onClick={() => dispatch({type: 'decrement'})}>-</button>
      <button onClick={() => dispatch({type: 'increment'})}>+</button>
    </>
  );
}
```

Pass in a reducer of type `(state, action) => newState`

Returns state and a dispatch method that can be used to trigger different actions.

Useful to maintain state of complex objects

In React source `useState` is just a special case of the `useReducer` hook

`useEffect` hook

```
import React, { useState, useEffect } from 'react';

function Example() {
  const [count, setCount] = useState(0);

  // Similar to componentDidMount and componentDidUpdate:
  useEffect(() => {
    // Update the document title using the browser API
    document.title = `You clicked ${count} times`;
  });

  return (
    <div>
      <p>You clicked {count} times</p>
      <button onClick={() => setCount(count + 1)}>
        Click me
      </button>
    </div>
  );
}
```

Creates side effects in components

Tells component that it needs to do something *after* render

Guarantees DOM has been updated

Allows similar functionality to lifecycle methods in a class component

`useEffect` optimization

Second parameter is a dependency array: specifies what state variables must change to execute side effect

```
useEffect(() => {
  document.title = `You clicked ${count} times`;
}, [count]); // Only re-run the effect if count changes
```

Rules for Hooks

- Only call at Top Level (not inside loops, conditions, etc.)
- Only call from React functions **or** custom hooks (next slide)

- Many more pre-defined hooks: https://reactjs.org/docs/hooks-reference.html

Custom hooks

```
import { useState, useEffect } from 'react';

function useFriendStatus(friendID) {
  const [isOnline, setIsOnline] = useState(null);

  useEffect(() => {
    function handleStatusChange(status) {
      setIsOnline(status.isOnline);
    }

    ChatAPI.subscribeToFriendStatus(friendID, handleStatusChange);
    return () => {
      ChatAPI.unsubscribeFromFriendStatus(friendID, handleStatusChange);
    };
  });

  return isOnline;
}
```

JS function name starts with `use`

Must follow Rules of Hooks (from previous slide)

Using custom hooks

```
function FriendStatus(props) {
  const isOnline = useFriendStatus(props.friend.id);

  if (isOnline === null) {
    return 'Loading...';
  }
  return isOnline ? 'Online' : 'Offline';
}
```

```
function FriendListItem(props) {
  const isOnline = useFriendStatus(props.friend.id);

  return (
    <li style={{ color: isOnline ? 'green' : 'black' }}>
      {props.friend.name}
    </li>
  );
}
```

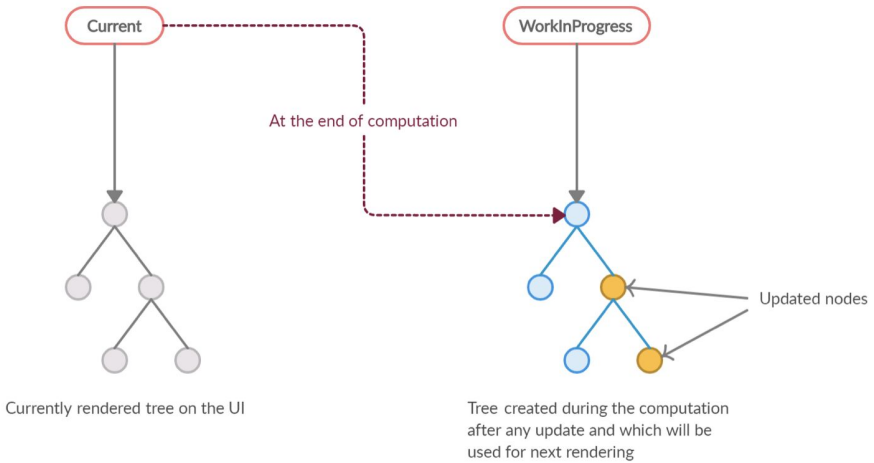
Two different components using the same hook **do not** share state

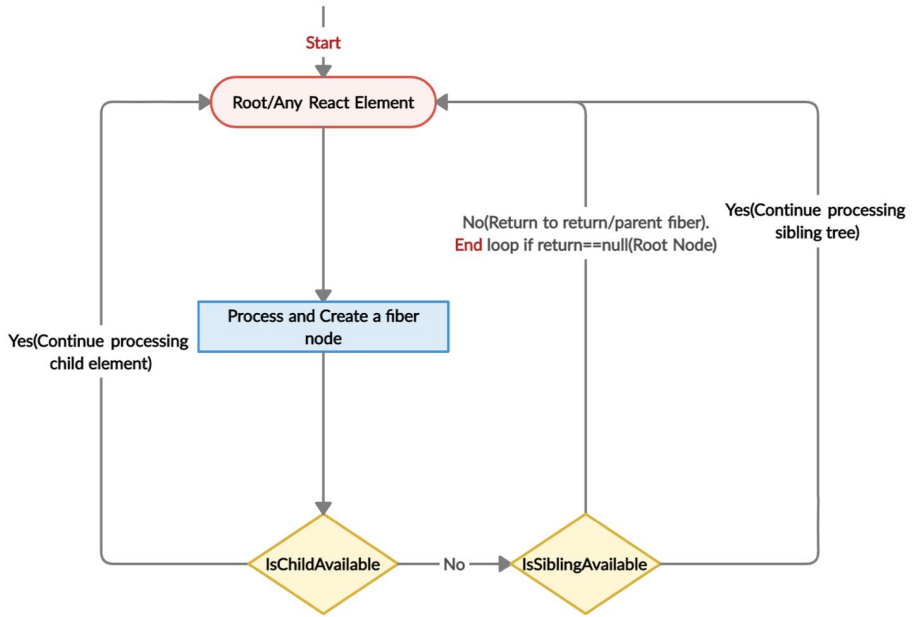
How do Hooks work under the hood?

- In React, **reconciliation** and **render** are two different phases
- **Reconciliation** is the tree diffing algorithm in React used to say what changed (virtual DOM)
- **Render** uses that info to update the app
- Reconciliation is implemented using **fibers**
  - a JavaScript object that contains information about a component, its input, and its output
  - a kind of virtual stack frame

More info: https://blog.logrocket.com/deep-dive-react-fiber/

Fiber tree traversal





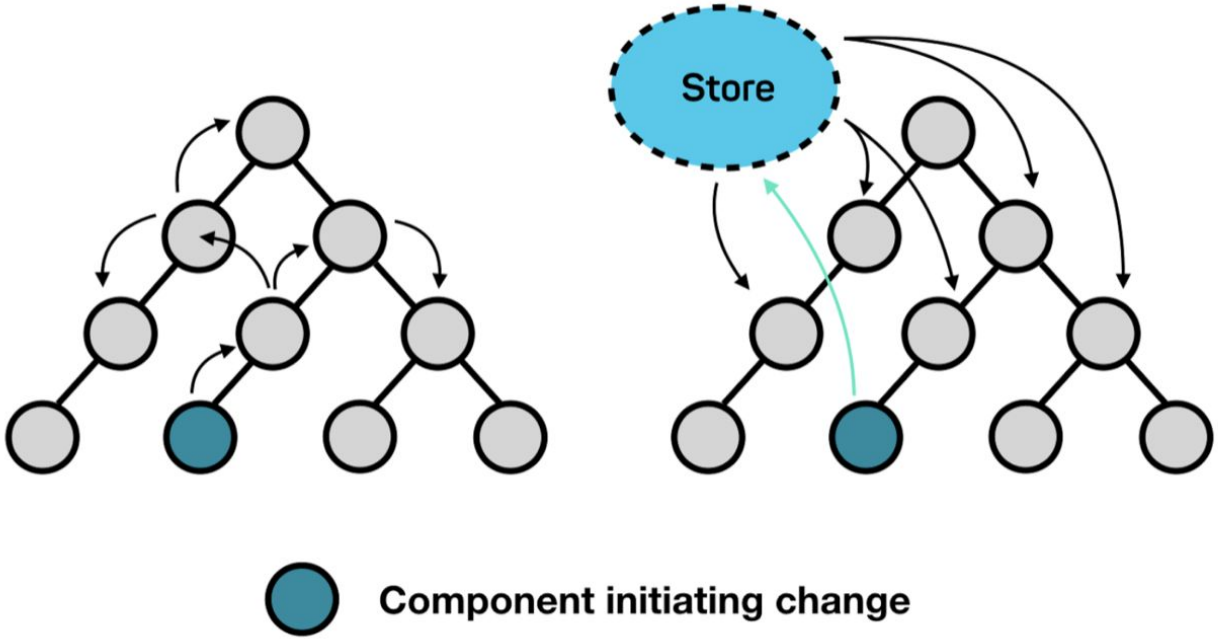
Hooks are called in render

- Hooks use a “dispatcher” object
- When you call useState, useEffect, … it passes the call to the dispatcher object
- The renderer is what executes the component function (based on the result of reconciliation)
- The renderer knows the context of the component and works through linked list of hooks

State and props revisited

- In React, state is internal to components
- props are used to pass information from parents to children
- Children can pass information to parents, by passing a parent setter function as a prop in a child element
- But what about complex apps with shared state across components not in parent-child relationship?

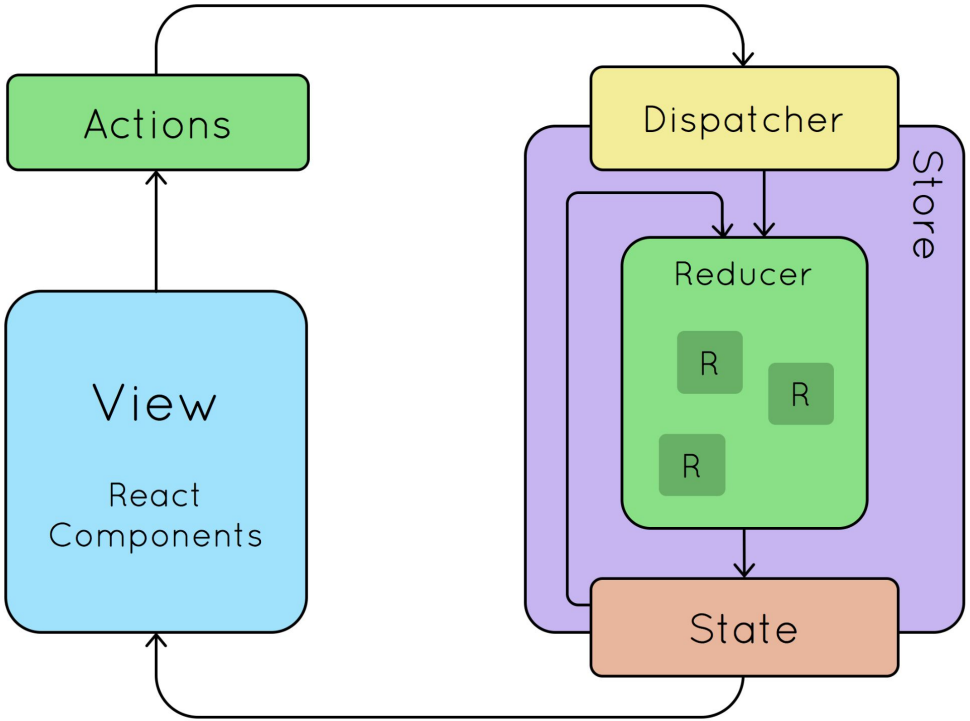
Global state



Global state management

- Several libraries exist to manage global state
- Define actions to update the state, can be async functions (e.g., including a data fetch from server)
- Redux is the most popular
  - Verbose, lots of boilerplate
  - Best to use Redux-Toolkit for React >16.8 with function components and hooks
- We use Zustand in the labs
- `useContext` hook is useful for sharing global variables such as CSS themes, but can be inefficient for large apps (triggering updates of all components)

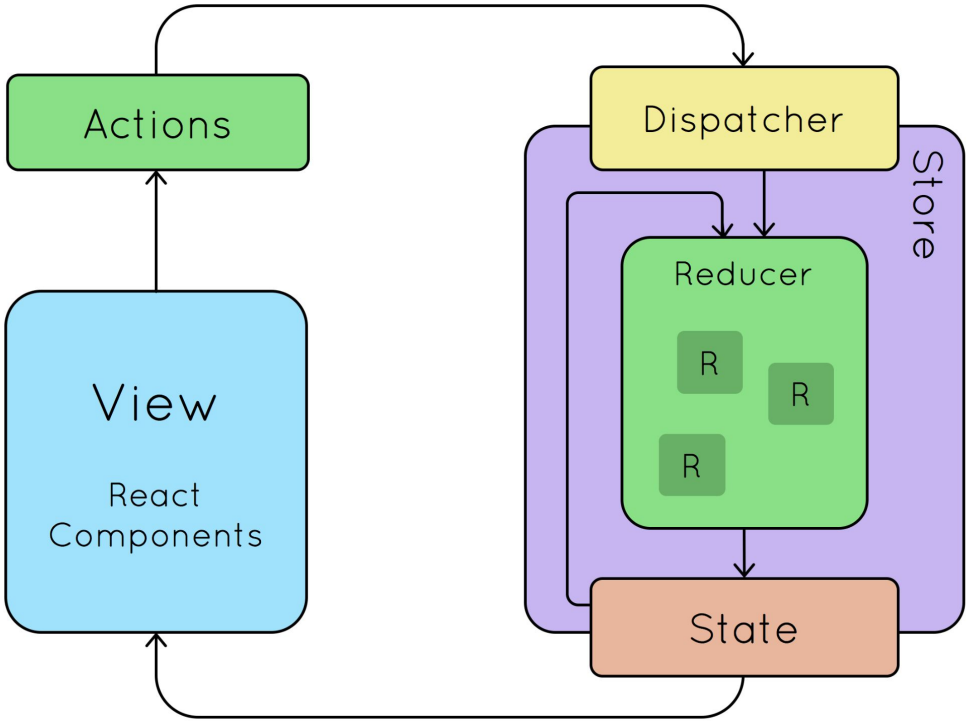
Redux model



Actions = JavaScript objects that *describe* the action to be taken

```
//action to add a todo item
{ type: 'ADD_TODO', text: 'This is a new todo' }
//action that pass a login payload
{ type: 'LOGIN', payload: { username: 'foo', password: 'bar' }}
```

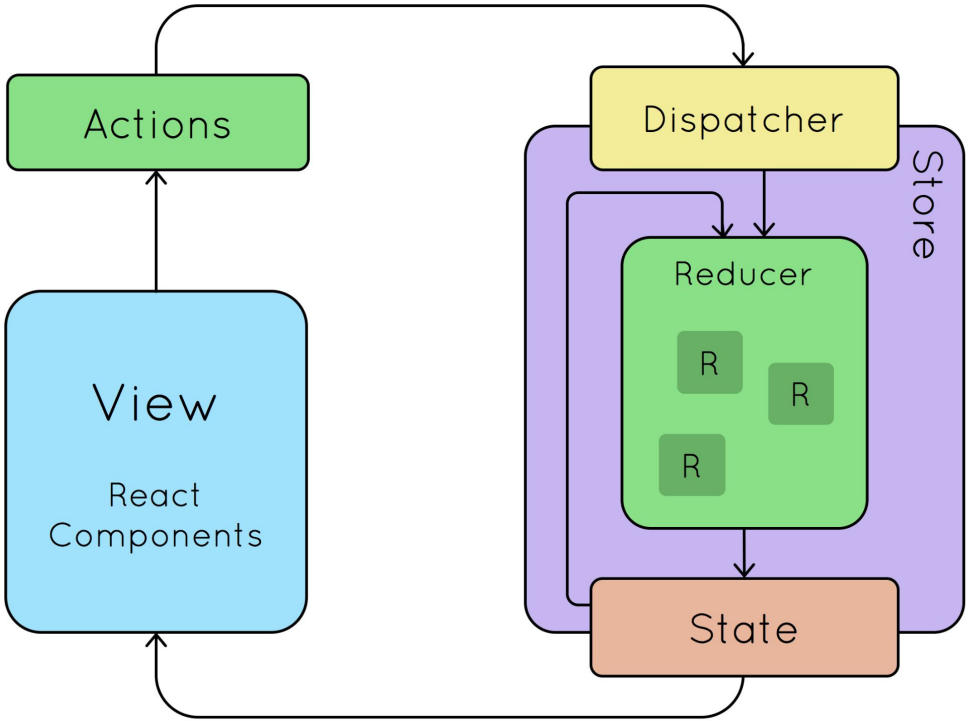
Redux model



Reducer = *pure functions* that take an action and update the state

```
//takes in the current state and action
//updates the value based on the action's type
function counterReducer(state = { value: 0 }, action) {
  switch (action.type) {
    case 'INCREASE':
      return { value: state.value + 1 }
    case 'DECREASE':
      return { value: state.value - 1 }
    default:
      return state
  }
}
```

Redux model



Redux-toolkit: slices combines all this to create less boilerplate code

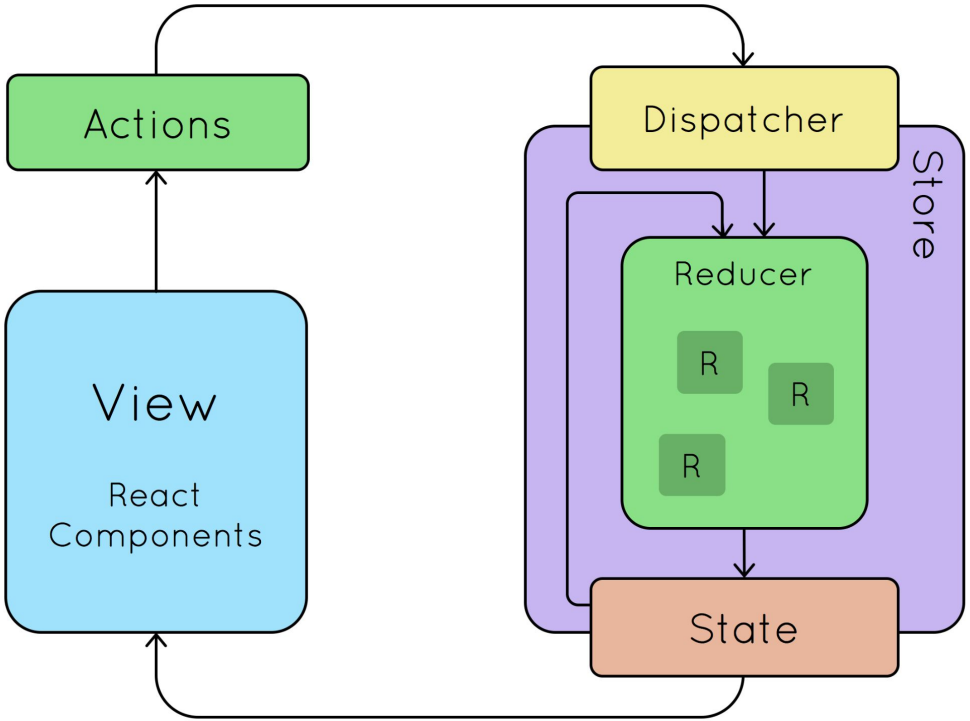
```
import { createSlice } from '@reduxjs/toolkit'

export const counterSlice = createSlice({
  name: 'counter',
  initialState: {
    value: 0
  },
  reducers: {
    increase: state => {
      state.value += 1
    },
    decrease: state => {
      state.value -= 1
    }
  }
})

// each case under reducers becomes an action
export const { increase, decrease } = counterSlice.actions

export default counterSlice.reducer
```

Redux model



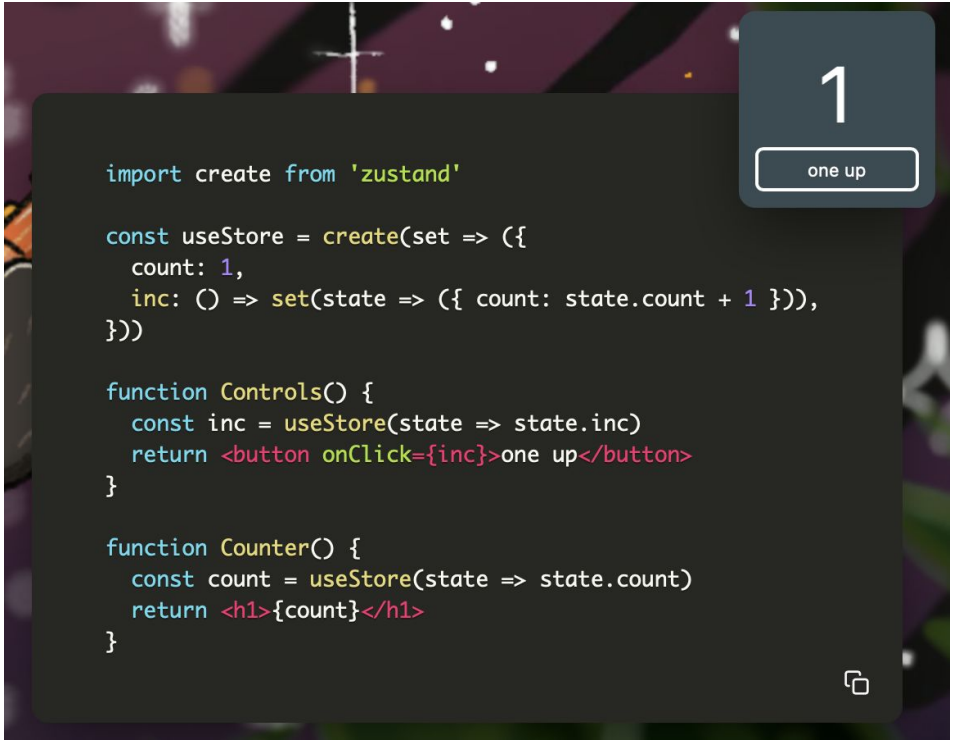
Redux-toolkit: useSelector and useDispatch hooks are used in the component

```
export function Counter() {
  const count = useSelector(state => state.counter.value)
  // in our slice, we provided the name property as 'counter'
  // and the initialState with a 'value' property
  // thus to read our data, we need useSelector to return the state.counter

  const dispatch = useDispatch()
  // gets the dispatch function to dispatch our actions

  return (
    <div>
        <button onClick={() => dispatch(increase())}>
          Increase
        </button>
        <p>{count}<p>
        <button onClick={() => dispatch(decrease())}>
          Decrease
        </button>
    </div>
  )
}
```

Zustand


1
one up
import create from 'zustand'
const useStore = create(set => ({
count: 1,
inc: () => set(state => ({ count: state.count + 1 })),
}))
function Controls() {
const inc = useStore(state => state.inc)
return <button onClick={inc}>one up</button>
}
function Counter() {
const count = useStore(state => state.count)
return <h1>{count}</h1>
}

useContext

1. Create a context object

```
const UserContext = createContext()
```

`useContext`

1. Create a context object
2. Wrap components in context Provider (`user` is a state variable)

```
const UserContext = createContext()

<UserContext.Provider value={user}>
  <h1>{`Hello ${user}!`}</h1>
  <Component2 user={user} />
</UserContext.Provider>
```

useContext

1. Create a context object
2. Wrap components in context Provider, and pass state variable (e.g. `user`) as value
3. In child component access the variable with `useContext`

```
const UserContext = createContext()

<UserContext.Provider value={user}>
  <h1>{`Hello ${user}!`}</h1>
  <Component2 user={user} />
</UserContext.Provider>

const user = useContext(UserContext);

return (
  <>
    <h1>Component 5</h1>
    <h2>{`Hello ${user} again!`}</h2>
  </>
);
```

Routing

Routing basics

- In a traditional non-SPA website, when you navigate to a new route (e.g. by clicking a link) it loads a new page from the server
- In SPA:
  - The page is not re-loaded
  - The link is intercepted and any new content needed from the server is made by client-side code
  - Do not need to re-render entire page, including framework JS (e.g. React), potentially saving data transfer/time.
  - Bonus: can update the page dynamically, e.g. using CSS transitions

React Router basic concepts

URL – URL is address bar

Location – object based on window.location

History – object that subscribes to the browser's history stack

The history stack is changed via POP, PUSH, REPLACE operations

Client-side routing – programmatically changing the history stack without making a server request

Route match – when the URL matches a pattern a specific route is rendered

Location object

`pathname`, `search` and `hash` come from the url

`state` is the current top of the history stack

`key` is a unique key (useful for client-side caching etc.)

```
{
  pathname: "/bbq/pig-pickins",
  search: "?campaign=instagram",
  hash: "#menu",
  state: null,
  key: "aefz24ie"
}
```

Route config and matching

```
<Routes>
  <Route path="/" element={<App />}>
    <Route index element={<Home />} />
    <Route path="teams" element={<Teams />}>
      <Route path=":teamId" element={<Team />} />
      <Route path=":teamId/edit" element={<EditTeam />} />
      <Route path="new" element={<NewTeamForm />} />
      <Route index element={<LeagueStandings />} />
    </Route>
  </Route>
  <Route element={<PageLayout />}>
    <Route path="/privacy" element={<Privacy />} />
    <Route path="/tos" element={<Tos />} />
  </Route>
  <Route path="contact-us" element={<Contact />} />
</Routes>
```

- The route config is a tree of route elements.
- Matches can be exact or dynamic (e.g. `:teamId`)
- `path` prop defines the match
- `element` prop defines the component to be rendereds

Higher-order Components

```
class Welcome extends React.Component {
  render() {
    return (
      <div>Welcome {this.props.user}</div>
    );
  }
}

const withUser = (WrappedComponent) => {
  return class extends React.Component {
    render() {
      if (this.props.user) {
        return (
          <WrappedComponent { ...this.props} />
        )
      }
      return <div>Welcome Guest!</div>
    }
  }
}

export default withUser(Welcome);
```

Wrapping components with props proxy

Higher-order Components

Wrapping components with inheritance inversion

```
class Welcome extends React.Component {
  render() {
    return (
      <div>Welcome {this.props.user}</div>
    );
  }
}

const withUser = (WrappedComponent) => {
  return class extends React.Component {
    render() {
      if (this.props.user) {
        return (
          <WrappedComponent { ...this.props} />
        )
      }
      return <div>Welcome Guest!</div>
    }
  }
}

const withLoader = (WrappedComponent) => {
  return class extends WrappedComponent {
    render() {
      const { isLoaded } = this.props;
      if (!isLoaded) {
        return <div>Loading...</div>;
      }
      return super.render();
    }
  }
}

export default withLoader(withUser(Welcome));
```

Debugging React Apps

Tips on debugging

- When you run in dev hot reloading is enabled
- Keep browser open with web page (e.g. `localhost:3000`) and console visible while developing
- Sometimes when it crashes (shows error message in browser) you need to reload the page

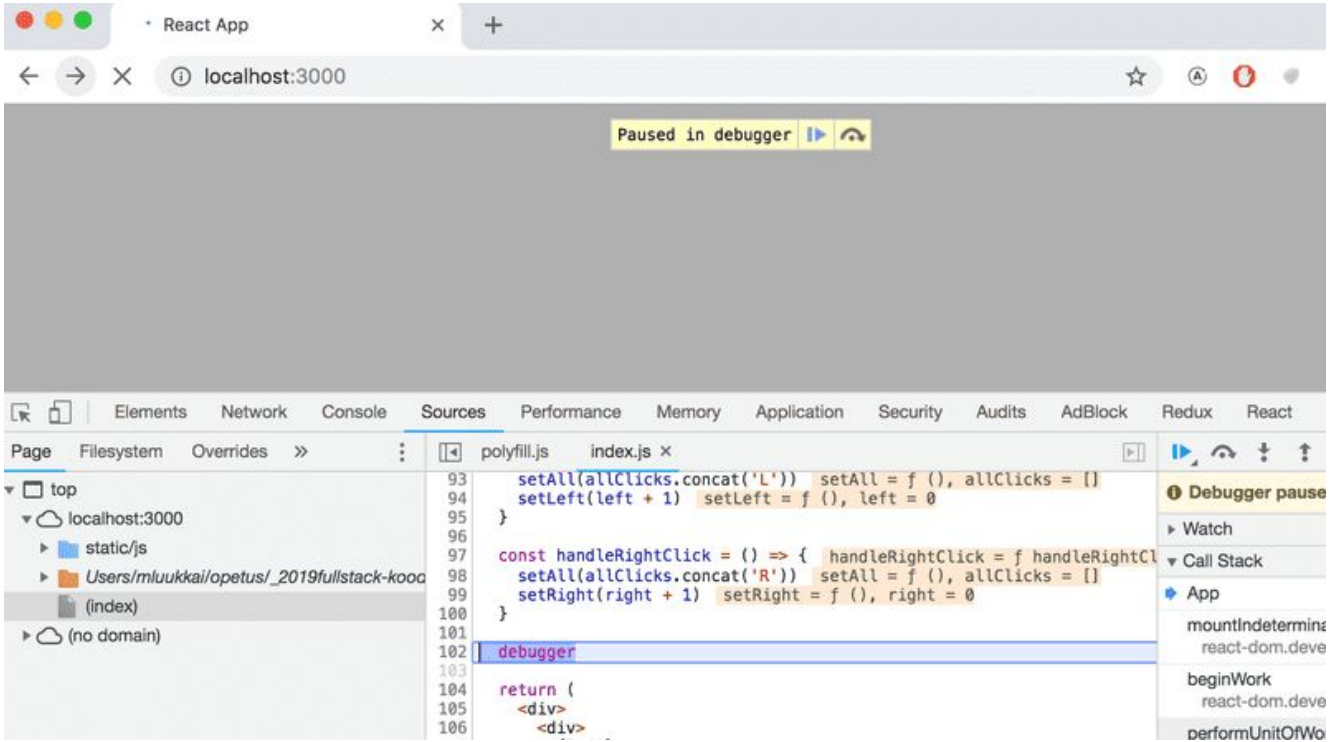
console.log

- `console.log` is still a great way to view the state of variables when components load
- Remember to remove these before production, though!

```
console.log('props value is', props)
```

Use comma, not + when concatenating complex objects to strings

debugger in Chrome developer

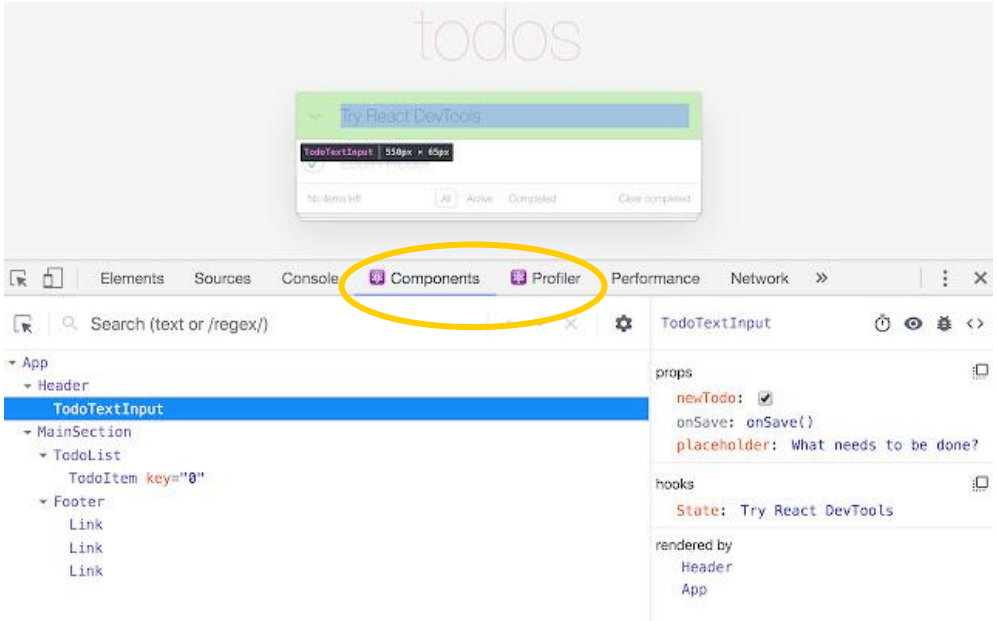


Can also set breakpoints manually.

Once it has stopped you can use the console to view the value of various variables.

React developer tools

https://chrome.google.com/webstore/detail/react-developer-tools/fmkadmapgofadopljbjfkapdkoienihi

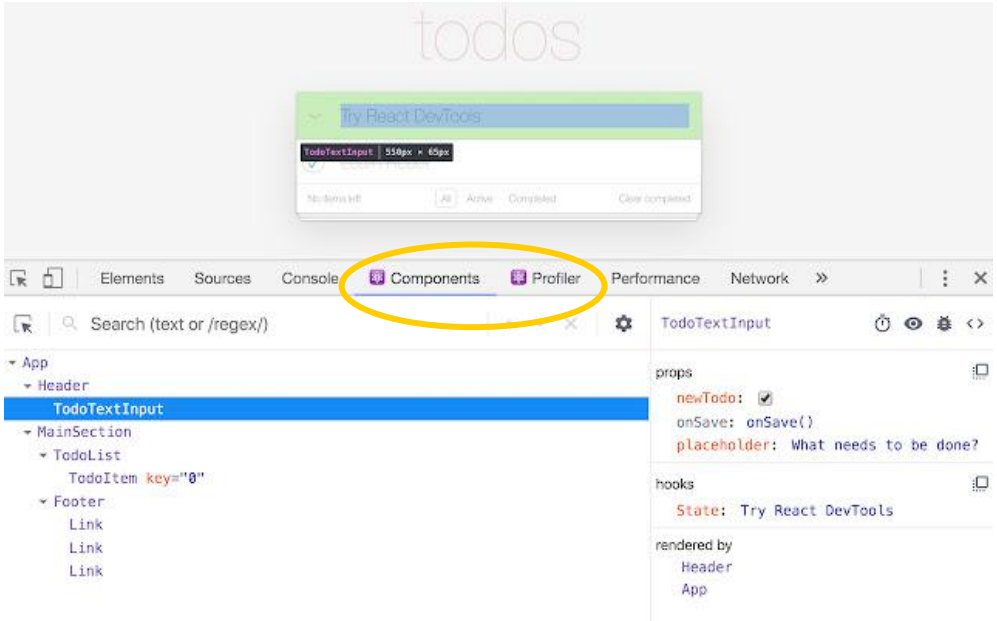


Adds a Components tab to the developer console

Can view component state and props, and hooks in order of definition

React developer tools

https://chrome.google.com/webstore/detail/react-developer-tools/fmkadmapgofadopljbjfkapdkoienihi



Adds a Components and Profiler tabs to the developer console

Can view component state and props, and hooks in order of definition

Profiler allows you to test performance of components