React Hooks

slides at https://github.com/mvolkmann/talks

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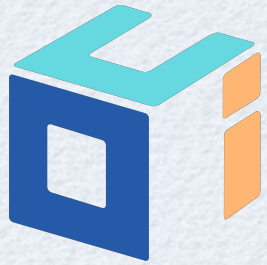

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Hooks Overview

- Feature **added in React 16.7.0-alpha.0**
- **Ready** for production use **in 16.8** released in February 2019
- **Enables implementing stateful components with functions instead of classes**
- No plans to remove existing ways of implementing components
- Hooks provide new way that most developers will find easier to understand
- Components that use hooks can be used together with class-based components
- Existing apps can gradually incorporate hooks or never use them
- Makes React the only major web framework that supports **implementing an entire app with only functions**

Hook Caveats

- There are some lifecycle methods whose functionality cannot yet be implemented using hooks
  - `componentDidCatch`
  - `getSnapshotBeforeUpdate`
- These are rarely used

Hook Benefits

- Implementing components with functions removes need to
  - understand **`this`** keyword
  - understand **`bind`** and when to use it
- Easier to work with component state and context
- Easier to reuse state logic between multiple components
- Removes most needs for higher-order components and render props
  - these require increased levels of code nesting
- Uses "effects" in place of lifecycle methods
  - makes it possible to better organize related code such as adding/removing event listeners and opening/closing resources
- Easier to optimize function component code than class component code
  - refers to minifying, hot reloading, and tree shaking

Hook Function Rules

- Names should start with **`use`**
  - allows linting rules to check for proper use of hooks
  - provides clue that the function may access state
- Can only be called in function-based components and in custom hooks
- Cannot be called conditionally
  - means they cannot be called in **`if`**/**`else`** blocks, loops, or nested functions
  - ensures that for any component, the **same hooks are invoked in the same order on every render**

ESLint

- React provides ESLint rules to detect hook rule violations
  - see https://www.npmjs.com/package/eslint-plugin-react-hooks
- Currently a single rule named "**`react-hooks/rules-of-hooks`**"
  - should configure with value "**`error`**"
  - assumes any function whose name begins with "**`use`**" followed by an uppercase letter is a hook
  - verifies hooks are only called from function components (name starts uppercase) or custom hook functions
  - verifies that hooks will be called in the same order on every render

Provided Hooks

- Implemented as functions exported by **`react`** package
  - ex. `import {useState, useEffect} from 'react';`
- Described on following slides,
  somewhat ordered based on
  how frequently they are expected to be used

State Hook ...

- `useState` provides a way to add state to function components
  - allows components to use state without using `this` keyword
  - takes initial value of state
  - returns array containing current value and a function to change it
- The following can appear inside a function that defines a component

```
const [petName, setPetName] = useState('Dasher');
const [petBreed, setPetBreed] = useState('Whippet');
```

  - `petName` holds current value of state
  - `setPetName` is a function that can be called to change value
- "set" functions
  - can be passed a new value or
    a function that will be passed current value and returns new value
  - **calls to them trigger the component to be re-rendered if the value has changed**

... State Hook ...

- State is often a primitive value, but can also be an object or array (also an object)
- When an object is used
  - calls to corresponding set function must pass entire value
  - set functions do not merge top level properties of the object passed to them with the current value as is done by the `Component` `setState` method
- `useState` calls are made every time the component is rendered
  - to obtain current value for each piece of state
  - initial values are only be applied in first render

... State Hook ...

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

export default function Pet() {
  const [petName, setPetName] = useState('Dasher');
  const [petBreed, setPetBreed] = useState('Whippet');
  const changeBreed = e => setPetBreed(e.target.value);
  const changeName = e => setPetName(e.target.value);
  return (
    <div>
      <label htmlFor="name">
        Name
        <input id="name" onChange={changeName} value={petName} />
      </label>
      <br />
      <label htmlFor="breed">
        Breed
        <select id="breed" onChange={changeBreed} value={petBreed}>
          <option>Greyhound</option>
          <option>Italian Greyhound</option>
          <option>Whippet</option>
        </select>
      </label>
      <div>{petName} is a {petBreed}.</div>
    </div>
  );
}
```

... State Hook

- Not necessary to understand how this works, but it's interesting
- State values for a component are stored in a **linked list**
- Each call to **`useState`** associates a state value with a different node in the linked list
- In previous example
  - **`petName`** is stored in first node
  - **`petBreed`** is stored in second node

top-state-hook

- But what if you wanted to share state between multiple components?
- Custom hook `useTopState` adds state outside components
  - takes state name (any string) and initial value
  - returns current value and a function for changing it, just like `useState`

```
const [petName, setPetName] = useTopState('petName', 'Dasher');
```

- Can be shared with any number of other components
  - only first component to use a given state name initializes it
- If any component changes the state,
  all components that use it are re-rendered
- See https://www.npmjs.com/package/top-state-hook

Effect Hook ...

- `useEffect` provides an alternative to some lifecycle methods in function components
  - `componentDidMount`
  - `componentDidUpdate`
  - `componentWillUnmount`
- Effects have two phases, setup and cleanup
  - think of setup as being performed when a class component would call `componentDidMount` or `componentDidUpdate`, which is after React updates the DOM
  - think of cleanup as being performed when a class component would call `componentWillUnmount`
- Example use
  - move focus to a particular input - demonstrated in "Ref Hook" section later

... Effect Hook ...

- Setup functionality examples
  - registering an event listener
  - opening a network connection
  - starting a timeout or interval
  - fetching data (ex. calling a REST service)
- Cleanup functionality examples
  - unregistering an event listener
  - closing a network connection
  - clearing a timeout or interval

... Effect Hook ...

- Function passed to **`useEffect`** performs setup
- If no cleanup is needed, this function returns nothing
- If cleanup is need, this function returns another that performs cleanup
- For example

```
useEffect(() => {
  console.log('performing setup');
  return () => {
    console.log('performing cleanup');
  };
});
```

- **`useEffect`** can be called any number of times
  inside a function component
- Typically called once for each distinct kind of effect
  rather than combining code for multiple effects in a single call

... Effect Hook ...

- **In first render** of a component, order of execution is

  1. all code in component function
  2. setup code in all effects in order defined

- **In subsequent renders**, order of execution is

  1. all code in component function
  2. cleanup code in all effects in order defined (not reverse)
  3. setup code in all effects in order defined

… Effect Hook

- **To prevent cleanup/setup code from running in every subsequent render**
  - supply second argument to `useEffect` that is an array of variables
  - cleanup/setup code is only run again if any of these variable values have changed since last call
  - to only run on first render, pass empty array

Context Hook ...

- `useContext` provides an alternative way to consume context state in function components
- Does not change how context providers are implemented
  - still implemented by creating a class that extends from `React.Component` and renders a `Provider`
  - for details, see https://reactjs.org/docs/context.html
- Example
  - suppose a context provider has been implemented in component `SomeContext`
  - `useContext` can be used in another component to access its state

```
import {SomeContext} from './some-context';

export default MyComponent() {
  const context = useContext(SomeContext);
  return <div>{context.someData}</div>;
}
```

… Context Hook

- `context` variable is set to an object that provides
  - read-only access to state properties of the context
  - ability to call methods defined on it
- Directly setting properties on `context`
  affects the local object, but not context state
  - doing this is not flagged as an error
- Context methods can provide a way for
  context consumers to modify context state
- Calling `useContext` also
  subscribes the component to context state updates
  - whenever context state changes, the component is re-rendered
- To avoid re-rendering the component on every context state change,
  wrap returned JSX in a call to `useCallback` described next

context-easy

- A great use of `useContext` is in conjunction with the npm package "context-easy"
  - implements a Context API `Provider` that can manage all the state in an application, like a Redux store
  - highly generic, making it suitable for any application
  - can get and set state data at dot-separated paths
    - ex. `user.address.city`
  - provides context methods `set`, `transform`, `delete`, `push`, `map`, `filter`, `increment`, `decrement`, and `toggle`
- See https://www.npmjs.com/package/context-easy

Callback Hook ...

- `useCallback` takes an expression and
  an array of variables that affect the result
- Returns a memoized value
- Often the input expression is a function
- Can be used to avoid recreating callback functions
  defined in function components
  every time they are rendered
- Such functions are often used as DOM event handlers

... Callback Hook ...

- For example, consider the difference between these

```
<input onChange={e => processInput(e, color, size)}>

<input onChange={useCallback(e => processInput(e, color, size), [color, size]}>
```

- Same functionality, but second line
  only creates a new function for the **`onChange`** prop ...
  - on first render
  - on subsequent renders only if value of **`color`** or **`size`** has changed since last render
- Avoiding creation of new callback functions
  allows the React reconciliation process to correctly
  determine whether the component needs to be re-rendered
- Provides a performance benefit

... Callback Hook ...

- If callback function does not depend on any variables, pass an empty array for second argument
  - causes `useCallback` to always return same function
- If second argument is omitted, a new function will be returned on every call which defeats the purpose

Why doesn't `useCallback` treat omitting the second argument the same as passing an empty array?

… Callback Hook

- **useCallback** can also serve as a substitute for the lifecycle method **shouldComponentUpdate** available in class components
- For example, suppose **v1** and **v2** are variables whose values come from calls to **useState** or **useContext** and these are used in the calculation of JSX to be rendered
- To only calculate new JSX if one or both of them have changed since the last render, pass the JSX as the first argument to **useCallback**
- For example

```
return useCallback(
  <div>
    component JSX goes here
  </div>,
  [v1, v2]
);
```

Memo Hook ...

- `useMemo` takes a function and
  an array of variables that affect the result
- Memoizes the function and returns its current result
- For example, suppose `x` and `y` are variables
  whose values come from calls to `useState` or `useContext`
  and we need to compute a value based on these
- The following code reuses the previous result
  if the values of `x` and `y` have not changed

```
const hypot = useMemo(
  () => {
    console.log('calculating hypotenuse');
    return Math.sqrt(x * x + y * y);
  },
  [x, y]
);
```

... Memo Hook

- Only remembers result for last set of input values,
  not all past unique calculations

- Note difference between `useCallback` and `useMemo`
- While both provide memoization,
  `useCallback` returns a value (which can be a function) and
  `useMemo` returns the result of calling a function

`React.memo` Function ...

- A function, not a hook
- Added in React 16.6
- Memoizes a function component so
  it is only re-rendered if at least one of its **props** has changed
- Does what class components do when they
  extend from `PureComponent` instead of `Component`
- For example, the following defines a `Percent` component
  that renders the percentage a count represents of a total

percent.js

```
import React from 'react';

const Percent = React.memo(({count, total}) => {
  console.log('Percent rendering'); // to verify when this happens
  const percent = total === 0 ? 0 : (count / total) * 100;
  return <span>{percent.toFixed(2)}%</span>;
});

export default Percent;
```

... `React.memo` Function

- By default, performs a shallow compare of ALL props
- To customize comparison
  - pass a function as second argument
  - will be passed two objects containing the previous and next props
  - return **`true`** to skip render

percent.js

```
import React from 'react';

function skipRender(prevProps, nextProps) {
  return (
    prevProps.count === nextProps.count &&
    prevProps.total === nextProps.total
  );
}

const Percent = React.memo(({count, total, symbol}) => {
  console.log('Percent rendering'); // to verify when this happens
  const percent = total === 0 ? 0 : (count / total) * 100;
  return <span>{percent.toFixed(2)}{symbol}</span>;
}, skipRender);

export default Percent;
```

Reducer Hook ...

- `useReducer` supports implementing components whose state is updated by dispatching actions that are handled by a reducer function
  - patterned after Redux
  - takes reducer function and initial state
- Example
  - very simple todo app with a single component, `TodoList`
  - uses Sass for styling (nested rules)
  - calls `useReducer` to obtain `state` and `dispatch` function
  - calls `dispatch` in event handling functions
  - only re-renders when calls to `dispatch` result in a state change

... Reducer Hook ...

todo-list.scss

```
.todo-list {
  .delete-btn {
    background-color: transparent;
    border: none;
    color: red;
    font-weight: bold;
  }

  .done-true {
    color: gray;
    text-decoration: line-through;
  }

  form {
    margin-bottom: 10px;
  }

  .todo {
    margin-bottom: 0;
  }
}
```

... Reducer Hook ...

todo-list.js

```
import React, {useCallback, useReducer} from 'react';
import './todo-list.scss';

const initialState = {
  text: '',
  todos: []
  // objects in this have id, text, and done properties.
};

let lastId = 0;

// prevents form submit
const handleSubmit = e => e.preventDefault();
```

... Reducer Hook ...

todo-list.js

```
function reducer(state, action) {
  const {text, todos} = state;
  const {payload, type} = action;
  switch (type) {
    case 'add-todo': { // doesn't use payload
      const newTodos = todos.concat({id: ++lastId, text, done: false});
      return {...state, text: '', todos: newTodos};
    }
    case 'change-text':
      return {...state, text: payload};
    case 'delete-todo': {
      const id = payload;
      const newTodos = todos.filter(todo => todo.id !== id);
      return {...state, todos: newTodos};
    }
    case 'toggle-done': {
      const id = payload;
      const newTodos = todos.map(
        todo => (todo.id === id ? {...todo, done: !todo.done} : todo)
      );
      return {...state, todos: newTodos};
    }
    default:
      return state;
  }
}
```

... Reducer Hook ...

todo-list.js

```
export default function TodoList() {
  const [state, dispatch] = useReducer(reducer, initialState);

  const handleAdd = useCallback(
    () => dispatch({type: 'add-todo'}),
    []);

  const handleDelete = useCallback(
    id => dispatch({type: 'delete-todo', payload: id}),
    []
  );

  const handleText = useCallback(
    e => dispatch({type: 'change-text', payload: e.target.value}),
    []
  );

  const handleToggleDone = useCallback(
    id => dispatch({type: 'toggle-done', payload: id}),
    []
  );
```

want same event handling function in each render, so second argument to `useCallback` is empty array

… Reducer Hook

todo-list.js

```
  return (
    <div className="todo-list">
      <h2>Todos</h2>
      <form onSubmit={handleSubmit}>
        <label htmlFor="text">
          <input
            placeholder="todo text"
            onChange={handleText}
            value={state.text}
          />
        </label>
        <button onClick={handleAdd}>+</button>
      </form>
      {state.todos.map(todo => (
        <div className="todo" key={todo.id}>
          <input
            type="checkbox"
            checked={todo.done}
            onChange={() => handleToggleDone(todo.id)}
         />
          <span className={`done-${todo.done}`}>{todo.text}</span>
          <button className="delete-btn" onClick={() => handleDelete(todo.id)}>
            X
          </button>
        </div>
      ))}
    </div>
  );
}
```

bb

- `useRef` provides an alternative to
  using class component instance variables
  in function components
- Refs persist across renders
- Differ from capturing data with `useState`
  in that changes to their values do not
  trigger the component to re-render
- `useRef` optionally takes an initial value and
  returns an object whose `current` property holds current value
- **Common use** is to capture references to DOM nodes

... Ref Hook ...

- For example, in Todo app above we can automatically move focus to text input
- To do this

1. import `useEffect` and `useRef` hooks

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

2. create ref inside function

```
const inputRef = useRef();
```

3. add an effect to move focus

```
useEffect(() => inputRef.current.focus(), []);
```

executes only in first render

4. set ref using `input` element `ref` prop

```
<input
  placeholder="todo text"
  onChange={handleText}
  ref={inputRef}
  value={state.text}
/>;
```

... Ref Hook

- Ref values are not required to be DOM nodes
- For example, suppose we wanted to log the number of todos that have been deleted every time one is deleted
- To do this

1. create ref inside function to hold count
2. increment ref value every time a todo is deleted
3. log current ref value

```
const deleteCountRef = useRef(0); // initial value is zero

// Modified version of handleDelete function above.
const handleDelete = useCallback(
  id => {
    dispatch({type: 'delete-todo', payload: id});
    deleteCountRef.current++;
    console.log('You have deleted', deleteCountRef.current, 'todos.');
  },
  [] // want same function on every render
);
```

Imperative Handle Hook

- `useImperativeHandle` modifies
  the instance value parent components will see
  if they obtain a ref to the current component
- One use is to add methods to the instance
  that parent components can call
- Example
  - suppose current component contains multiple inputs
  - it could use this hook to add a method to its instance value
    that parent components can call to move focus to a specific input

Layout Effect Hook

- `useLayoutEffect` is used to query and modify the DOM
- Similar to `useEffect`,
  but differs in that the function passed to it
  is invoked after every DOM mutation in the component
- DOM modifications are applied synchronously
- One use is to implement **animations**

Custom Hooks ...

- A function whose name begins with "`use`"
  and calls one more hook functions
- Typically return an array or object
  that contains state data and
  functions that can be called to modify the state
  - like provided `useState` hook
- Useful for extracting hook functionality from a function component
  so it can be reused in multiple function components

... Custom Hooks ...

- For example, Dan Abramov demonstrated a custom hook that watches the browser window width

```
function useWindowWidth() {
  const [width, setWidth] = useState(window.innerWidth);
  useEffect(() => {
    // setup steps
    const handleResize = () => setWidth(window.innerWidth);
    window.addEventListener('resize', handleResize);
    return () => {
      // cleanup steps using using component is unmounted
      window.removeEventListener('resize', handleResize);
    };
  }, []); // only runs on first render
  return width;
}
```

maintains this state separately for each component that calls this function

- To use this in a function component

```
  const width = useWindowWidth();
```

- Using components will be re-rendered every time the window width changes and will be given the width

... Custom Hooks

- Another example Dan Abramov demonstrated simplifies associating a state value with a form input

assumes the state does not need to be maintained in an using component

```
function useFormInput(initialValue) {
  const [value, setValue] = useState(initialValue);
  const onChange = e => setValue(e.target.value);
  // Returning these values in an object instead of an array
  // allows it to be spread into the props of an HTML input.
  return {onChange, value};
}
```

- For example, to use this in a function component that renders an **`input`** element for entering a name

```
  const nameProps = useFormInput('');
  // current value is in nameProps.value
  return (
    <input {...nameProps} />
  );
```

- Removes need for custom event handling!

Use Debug Value Hook ...

- Provided hook `useDebugValue` displays a primitive value after a custom hook name in React DevTools when a component that uses the hook is selected
- Can pass a different value in each hook invocation
- Only displays last value passed
- Useful for debugging

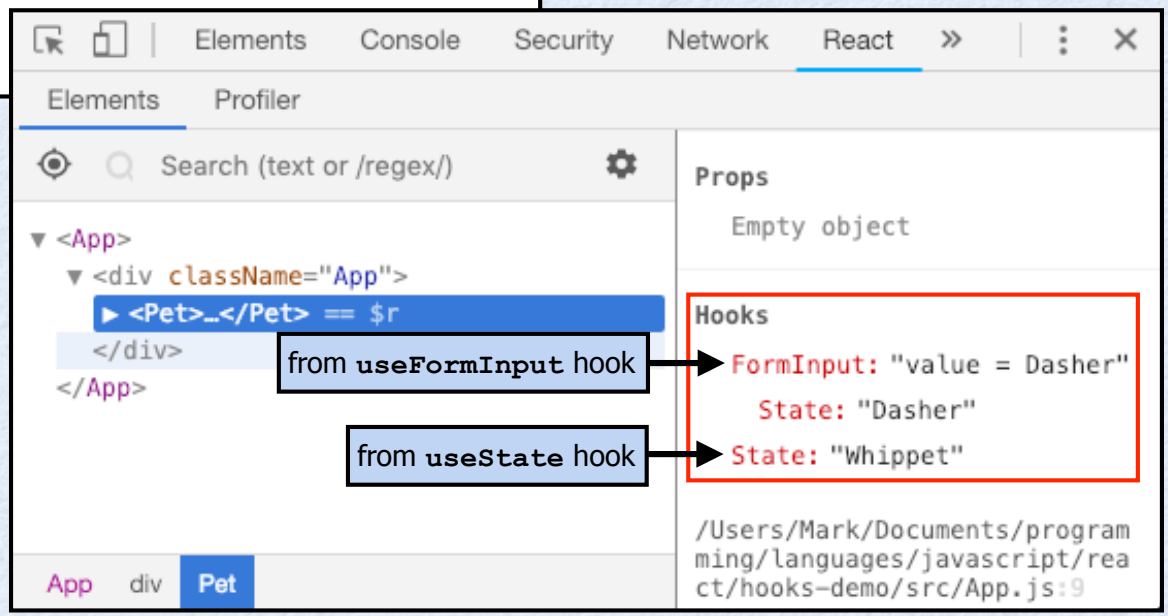
... Use Debug Hook

- Example

```
import {useDebugValue} from 'react';

function useFormInput(initialValue) {
  const [value, setValue] = useState(initialValue);
  useDebugValue('value = ' + value);
  const onChange = e => setValue(e.target.value);
  return {onChange, value};
}
```

same as previous code except for use of `useDebugValue`



Third Party Hooks

- The React community is busy creating and sharing additional hooks
- Many are listed at https://nikgraf.github.io/react-hooks
- Mine are
  - **top-state-hook** - for sharing state between function components
  - **context-easy** - for managing all app state in a single context

Wrap Up

- Hooks are a great addition to React!
- They make implementing components much easier
- They also likely spell the end of implementing React components with classes
- Over time we will see much less use of higher-order components and render props
- Make it simpler!

Resources

- "Introducing Hooks" official docs in 8 parts
  - https://reactjs.org/docs/hooks-intro.html
- "React Today and Tomorrow and 90% Cleaner React" talk at React Conf 2018 by Sophie Alpert, Dan Abramov, and Ryan Florence
  - https://www.youtube.com/watch?v=dpw9EHDh2bM&t=2792s
- egghead.io videos by Kent Dodds
  - https://egghead.io/lessons/react-use-the-usestate-react-hook
- These slides
  - https://github.com/mvolkmann/talks/blob/master/react-hooks.key.pdf