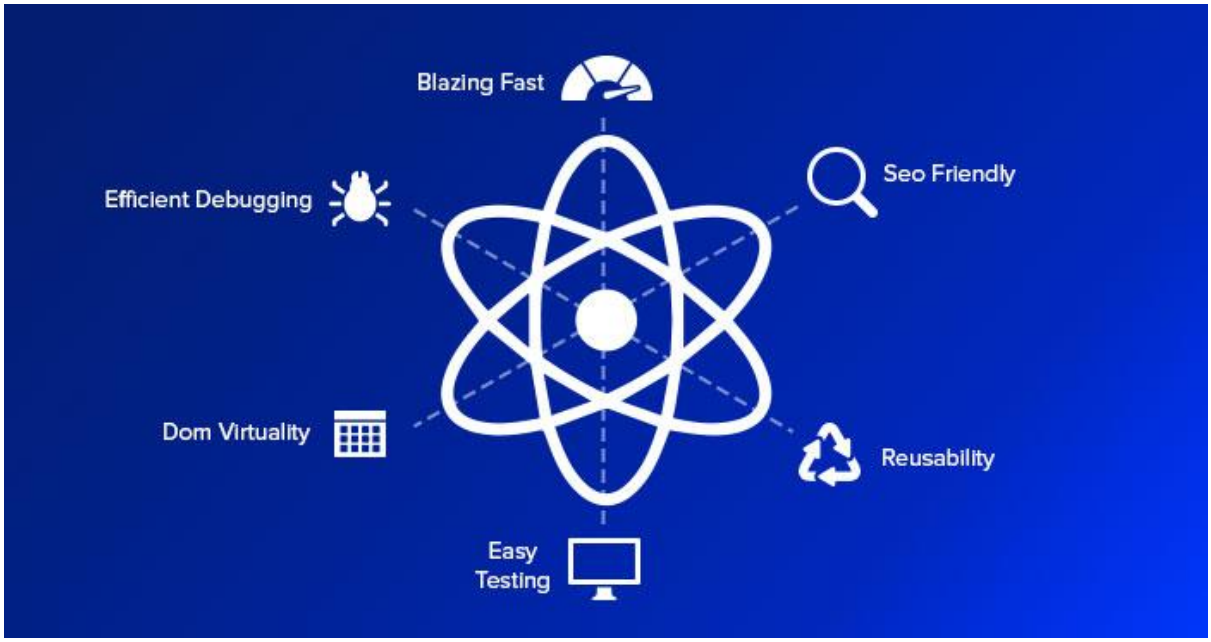
MAIN CONCEPT OF REACT JS



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1.Hello World

The smallest React example looks like this:

```
ReactDOM.render(
  <h1>Hello, world!</h1>,
  document.getElementById('root')
);
```

It displays a heading saying “Hello, world!” on the page.
Try it on CodePen

Click the link above to open an online editor. Feel free to make some changes, and see how they affect the output. Most pages in this guide will have editable examples like this one.

How to Read This Guide

In this guide, we will examine the building blocks of React apps: elements and components. Once you master them, you can create complex apps from small reusable pieces.
Tip
This guide is designed for people who prefer **learning concepts step by step**. If you prefer to learn by doing, check out our practical tutorial. You might find this guide and the tutorial complementary to each other.

This is the first chapter in a step-by-step guide about main React concepts. You can find a list of all its chapters in the navigation sidebar. If you’re reading this from a mobile device, you can access the navigation by pressing the button in the bottom right corner of your screen.
Every chapter in this guide builds on the knowledge introduced in earlier chapters. **You can learn most of React by reading the “Main Concepts” guide chapters in the order they appear in the sidebar.** For example, “Introducing JSX” is the next chapter after this one.

Knowledge Level Assumptions

React is a JavaScript library, and so we’ll assume you have a basic understanding of the JavaScript language. **If you don’t feel very confident, we recommend going through a JavaScript tutorial to check your knowledge**

level and enable you to follow along this guide without getting lost. It might take you between 30 minutes and an hour, but as a result you won't have to feel like you're learning both React and JavaScript at the same time.

Note

This guide occasionally uses some newer JavaScript syntax in the examples. If you haven't worked with JavaScript in the last few years, these three points should get you most of the way.

2.Introducing JSX

Consider this variable declaration:

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

This funny tag syntax is neither a string nor HTML.

It is called JSX, and it is a syntax extension to JavaScript. We recommend using it with React to describe what the UI should look like. JSX may remind you of a template language, but it comes with the full power of JavaScript.
JSX produces React "elements". We will explore rendering them to the DOM in the next section. Below, you can find the basics of JSX necessary to get you started.

Why JSX?

React embraces the fact that rendering logic is inherently coupled with other UI logic: how events are handled, how the state changes over time, and how the data is prepared for display.
Instead of artificially separating *technologies* by putting markup and logic in separate files, React separates *concerns* with loosely coupled units called "components" that contain both. We will come back to components in a further section, but if you're not yet comfortable putting markup in JS, this talk might convince you otherwise.
React doesn't require using JSX, but most people find it helpful as a visual aid when working with UI inside the JavaScript code. It also allows React to show more useful error and warning messages.

With that out of the way, let's get started!

Embedding Expressions in JSX

In the example below, we declare a variable called `name` and then use it inside JSX by wrapping it in curly braces:

```
const name = 'Josh Perez';const element = <h1>Hello, {name}</h1>;
ReactDOM.render(
  element,
  document.getElementById('root')
);
```

You can put any valid JavaScript expression inside the curly braces in JSX. For example, `2 + 2`, `user.firstName`, or `formatName(user)` are all valid JavaScript expressions.

In the example below, we embed the result of calling a JavaScript function, `formatName(user)`, into an `<h1>` element.

```
function formatName(user) {
  return user.firstName + ' ' + user.lastName;
}

const user = {
  firstName: 'Harper',
  lastName: 'Perez'
};

const element = (
  <h1>
    Hello, {formatName(user)}!  </h1>
);

ReactDOM.render(
  element,
  document.getElementById('root')
);
```

Try it on CodePen

We split JSX over multiple lines for readability. While it isn't required, when doing this, we also recommend wrapping it in parentheses to avoid the pitfalls of automatic semicolon insertion.

JSX is an Expression Too

After compilation, JSX expressions become regular JavaScript function calls and evaluate to JavaScript objects.

This means that you can use JSX inside of `if` statements and `for` loops, assign it to variables, accept it as arguments, and return it from functions:

```
function getGreeting(user) {
  if (user) {
    return <h1>Hello, {formatName(user)}!</h1>;  }
  return <h1>Hello, Stranger.</h1>;}
```

Specifying Attributes with JSX

You may use quotes to specify string literals as attributes:

```
const element = <div tabIndex="0"></div>;
```

You may also use curly braces to embed a JavaScript expression in an attribute:

```
const element = <img src={user.avatarUrl}></img>;
```

Don't put quotes around curly braces when embedding a JavaScript expression in an attribute. You should either use quotes (for string values) or curly braces (for expressions), but not both in the same attribute.

Warning:
Since JSX is closer to JavaScript than to HTML, React DOM uses `camelCase` property naming convention instead of HTML attribute names.
For example, `class` becomes `className` in JSX, and `tabindex` becomes `tabIndex`.

Specifying Children with JSX

If a tag is empty, you may close it immediately with `/>`, like XML:

```
const element = <img src={user.avatarUrl} />;
```

JSX tags may contain children:

```
const element = (
  <div>
    <h1>Hello!</h1>
    <h2>Good to see you here.</h2>
  </div>
);
```

JSX Prevents Injection Attacks

It is safe to embed user input in JSX:

```
const title = response.potentiallyMaliciousInput;
// This is safe:
const element = <h1>{title}</h1>;
```

By default, React DOM escapes any values embedded in JSX before rendering them. Thus it ensures that you can never inject anything that's not explicitly written in your application. Everything is converted to a string before being rendered. This helps prevent XSS (cross-site-scripting) attacks.

JSX Represents Objects

Babel compiles JSX down to `React.createElement()` calls.

These two examples are identical:

```
const element = (
  <h1 className="greeting">
```

```
    Hello, world!
  </h1>
);
const element = React.createElement(
  'h1',
  {className: 'greeting'},
  'Hello, world!'
);
```

`React.createElement()` performs a few checks to help you write bug-free code but essentially it creates an object like this:

```
// Note: this structure is simplified
const element = {
  type: 'h1',
  props: {
    className: 'greeting',
    children: 'Hello, world!'
  }
};
```

These objects are called “React elements”. You can think of them as descriptions of what you want to see on the screen. React reads these objects and uses them to construct the DOM and keep it up to date.
We will explore rendering React elements to the DOM in the next section.

Tip:
We recommend using the “Babel” language definition for your editor of choice so that both ES6 and JSX code is properly highlighted.

3.Rendering Elements

Elements are the smallest building blocks of React apps.

An element describes what you want to see on the screen:

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

Unlike browser DOM elements, React elements are plain objects, and are cheap to create. React DOM takes care of updating the DOM to match the React elements.

Note:

One might confuse elements with a more widely known concept of "components". We will introduce components in the next section. Elements are what components are "made of", and we encourage you to read this section before jumping ahead.

Rendering an Element into the DOM

Let's say there is a `<div>` somewhere in your HTML file:

```
<div id="root"></div>
```

We call this a "root" DOM node because everything inside it will be managed by React DOM.

Applications built with just React usually have a single root DOM node. If you are integrating React into an existing app, you may have as many isolated root DOM nodes as you like.

To render a React element into a root DOM node, pass both to `ReactDOM.render()`:

```
const element = <h1>Hello, world</h1>;
ReactDOM.render(element, document.getElementById('root'));
```

Try it on CodePen

It displays "Hello, world" on the page.

Updating the Rendered Element

React elements are immutable. Once you create an element, you can't change its children or attributes. An element is like a single frame in a movie: it represents the UI at a certain point in time.
With our knowledge so far, the only way to update the UI is to create a new element, and pass it to `ReactDOM.render()`.

Consider this ticking clock example:

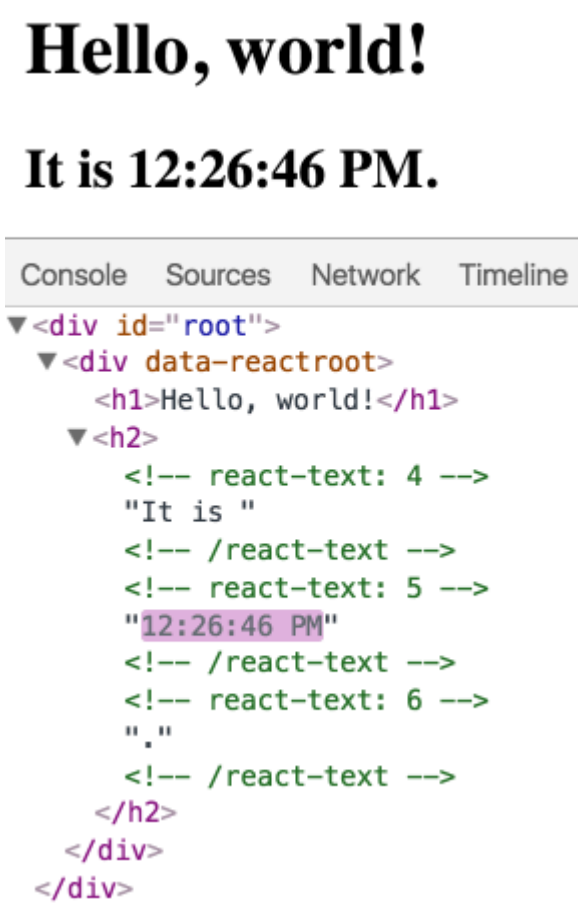
```
function tick() {
  const element = (
    <div>
      <h1>Hello, world!</h1>
      <h2>It is {new Date().toLocaleTimeString()}.</h2>
    </div>
  );
  ReactDOM.render(element, document.getElementById('root'));}

setInterval(tick, 1000);
```

Try it on CodePen
It calls `ReactDOM.render()` every second from a `setInterval()` callback.
Note:
In practice, most React apps only call `ReactDOM.render()` once. In the next sections we will learn how such code gets encapsulated into stateful components.

We recommend that you don't skip topics because they build on each other.

React Only Updates What's Necessary

React DOM compares the element and its children to the previous one, and only applies the DOM updates necessary to bring the DOM to the desired state.
You can verify by inspecting the last example with the browser tools:



Even though we create an element describing the whole UI tree on every tick, only the text node whose contents have changed gets updated by React DOM.

In our experience, thinking about how the UI should look at any given moment, rather than how to change it over time, eliminates a whole class of bugs.

4. Components and Props

Components let you split the UI into independent, reusable pieces, and think about each piece in isolation. This page provides an introduction to the idea of components. You can find a detailed component API reference here.

Conceptually, components are like JavaScript functions. They accept arbitrary inputs (called "props") and return React elements describing what should appear on the screen.

Function and Class Components

The simplest way to define a component is to write a JavaScript function:

```
function Welcome(props) {
  return <h1>Hello, {props.name}</h1>;
}
```

This function is a valid React component because it accepts a single "props" (which stands for properties) object argument with data and returns a React element. We call such components "function components" because they are literally JavaScript functions.
You can also use an ES6 class to define a component:

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

The above two components are equivalent from React's point of view.
Function and Class components both have some additional features that we will discuss in the next sections.

Rendering a Component

Previously, we only encountered React elements that represent DOM tags:

```
const element = <div />;
```

However, elements can also represent user-defined components:

```
const element = <Welcome name="Sara" />;
```

When React sees an element representing a user-defined component, it passes JSX attributes and children to this component as a single object. We call this object "props".

For example, this code renders "Hello, Sara" on the page:

```
function Welcome(props) {  return <h1>Hello, {props.name}</h1>;
}

const element = <Welcome name="Sara" />;ReactDOM.render(
  element,
  document.getElementById('root')
);
```

Try it on CodePen

Let's recap what happens in this example:

1. We call `ReactDOM.render()` with the `<Welcome name="Sara" />` element.
2. React calls the `Welcome` component with `{name: 'Sara'}` as the props.
3. Our `Welcome` component returns a `<h1>Hello, Sara</h1>` element as the result.
4. React DOM efficiently updates the DOM to match `<h1>Hello, Sara</h1>`.

Note: Always start component names with a capital letter.

React treats components starting with lowercase letters as DOM tags. For example, `<div />` represents an HTML div tag, but `<Welcome />` represents a component and requires `Welcome` to be in scope.

To learn more about the reasoning behind this convention, please read JSX In Depth.

Composing Components

Components can refer to other components in their output. This lets us use the same component abstraction for any level of detail. A button, a form, a dialog, a screen: in React apps, all those are commonly expressed as components.
For example, we can create an `App` component that renders `Welcome` many times:

```
function Welcome(props) {
  return <h1>Hello, {props.name}</h1>;
}

function App() {
  return (
    <div>
      <Welcome name="Sara" />      <Welcome name="Cahal" />      <Welcome
name="Edite" />    </div>
  );
}

ReactDOM.render(
  <App />,
  document.getElementById('root')
);
```

Try it on CodePen
Typically, new React apps have a single `App` component at the very top. However, if you integrate React into an existing app, you might start bottom-up with a small component like `Button` and gradually work your way to the top of the view hierarchy.

Extracting Components

Don’t be afraid to split components into smaller components.
For example, consider this `Comment` component:

```
function Comment(props) {
  return (
    <div className="Comment">
      <div className="UserInfo">
        <img className="Avatar"
          src={props.author.avatarUrl}
          alt={props.author.name}
        />
        <div className="UserInfo-name">
          {props.author.name}
        </div>
      </div>
```

```
      <div className="Comment-text">
        {props.text}
      </div>
      <div className="Comment-date">
        {formatDate(props.date)}
      </div>
    </div>
  );
}
```

Try it on CodePen

It accepts `author` (an object), `text` (a string), and `date` (a date) as props, and describes a comment on a social media website.

This component can be tricky to change because of all the nesting, and it is also hard to reuse individual parts of it. Let's extract a few components from it.

First, we will extract `Avatar`:

```
function Avatar(props) {
  return (
    <img className="Avatar"      src={props.user.avatarUrl}
alt={props.user.name}    />  );
}
```

The `Avatar` doesn't need to know that it is being rendered inside a `Comment`. This is why we have given its prop a more generic name: `user` rather than `author`.

We recommend naming props from the component's own point of view rather than the context in which it is being used.

We can now simplify `Comment` a tiny bit:

```
function Comment(props) {
  return (
    <div className="Comment">
      <div className="UserInfo">
        <Avatar user={props.author} />        <div className="UserInfo-name">
          {props.author.name}
        </div>
      </div>
      <div className="Comment-text">
        {props.text}
      </div>
      <div className="Comment-date">
        {formatDate(props.date)}
      </div>
    </div>
```

```
  );
}
```

Next, we will extract a `UserInfo` component that renders an `Avatar` next to the user's name:

```
function UserInfo(props) {
  return (
    <div className="UserInfo">      <Avatar user={props.user} />      <div
className="UserInfo-name">        {props.user.name}      </div>    </div>  );
}
```

This lets us simplify `Comment` even further:

```
function Comment(props) {
  return (
    <div className="Comment">
      <UserInfo user={props.author} />      <div className="Comment-text">
        {props.text}
      </div>
      <div className="Comment-date">
        {formatDate(props.date)}
      </div>
    </div>
  );
}
```

Try it on CodePen

Extracting components might seem like grunt work at first, but having a palette of reusable components pays off in larger apps. A good rule of thumb is that if a part of your UI is used several times (`Button`, `Panel`, `Avatar`), or is complex enough on its own (`App`, `FeedStory`, `Comment`), it is a good candidate to be extracted to a separate component.

Props are Read-Only

Whether you declare a component as a function or a class, it must never modify its own props. Consider this `sum` function:

```
function sum(a, b) {
  return a + b;
}
```

Such functions are called "pure" because they do not attempt to change their inputs, and always return the same result for the same inputs.

In contrast, this function is impure because it changes its own input:

```
function withdraw(account, amount) {
  account.total -= amount;
```

```
}
```

React is pretty flexible but it has a single strict rule:

All React components must act like pure functions with respect to their props.

Of course, application UIs are dynamic and change over time. In the next section, we will introduce a new concept of "state". State allows React components to change their output over time in response to user actions, network responses, and anything else, without violating this rule.

5. State and Lifecycle

This page introduces the concept of state and lifecycle in a React component. You can find a detailed component API reference here.

Consider the ticking clock example from one of the previous sections.

In Rendering Elements, we have only learned one way to update the UI. We call `ReactDOM.render()` to change the rendered output:

```
function tick() {
  const element = (
    <div>
      <h1>Hello, world!</h1>
      <h2>It is {new Date().toLocaleTimeString()}.</h2>
    </div>
  );
  ReactDOM.render(    element,    document.getElementById('root')  );}

setInterval(tick, 1000);
```

Try it on CodePen

In this section, we will learn how to make the `Clock` component truly reusable and encapsulated. It will set up its own timer and update itself every second.

We can start by encapsulating how the clock looks:

```
function Clock(props) {
  return (
    <div>      <h1>Hello, world!</h1>      <h2>It is
{props.date.toLocaleTimeString()}.</h2>    </div>  );
}

function tick() {
  ReactDOM.render(
    <Clock date={new Date()} />,    document.getElementById('root')
  );
}

setInterval(tick, 1000);
```

Try it on CodePen

However, it misses a crucial requirement: the fact that the `Clock` sets up a timer and updates the UI every second should be an implementation detail of the `Clock`.

Ideally we want to write this once and have the `Clock` update itself:

```
ReactDOM.render(
  <Clock />,  document.getElementById('root')
);
```

To implement this, we need to add "state" to the `Clock` component.

State is similar to props, but it is private and fully controlled by the component.

Converting a Function to a Class

You can convert a function component like `Clock` to a class in five steps:

1. Create an ES6 class, with the same name, that extends `React.Component`.
2. Add a single empty method to it called `render()`.
3. Move the body of the function into the `render()` method.
4. Replace `props` with `this.props` in the `render()` body.
5. Delete the remaining empty function declaration.

```
class Clock extends React.Component {
  render() {
    return (
      <div>
        <h1>Hello, world!</h1>
        <h2>It is {this.props.date.toLocaleTimeString()}.</h2>
      </div>
    );
  }
}
```

Try it on CodePen

`Clock` is now defined as a class rather than a function.
The `render` method will be called each time an update happens, but as long as we render `<Clock />` into the same DOM node, only a single instance of the `Clock` class will be used. This lets us use additional features such as local state and lifecycle methods.

Adding Local State to a Class

We will move the `date` from props to state in three steps:

1. Replace `this.props.date` with `this.state.date` in the `render()` method:

```
class Clock extends React.Component {
  render() {
    return (
      <div>
```

```
        <h1>Hello, world!</h1>
        <h2>It is {this.state.date.toLocaleTimeString()}.</h2>      </div>
    );
  }
}
```

2. Add a class constructor that assigns the initial `this.state`:

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

  render() {
    return (
      <div>
        <h1>Hello, world!</h1>
        <h2>It is {this.state.date.toLocaleTimeString()}.</h2>
      </div>
    );
  }
}
```

Note how we pass `props` to the base constructor:

```
  constructor(props) {
    super(props);    this.state = {date: new Date()};
  }
```

Class components should always call the base constructor with `props`.

3. Remove the `date` prop from the `<Clock />` element:

```
ReactDOM.render(
  <Clock />,  document.getElementById('root')
);
```

We will later add the timer code back to the component itself.

The result looks like this:

```
class Clock extends React.Component {
  constructor(props) {    super(props);    this.state = {date: new Date()};  }
  render() {
    return (
      <div>
        <h1>Hello, world!</h1>
        <h2>It is {this.state.date.toLocaleTimeString()}.</h2>      </div>
    );
  }
```

```
}

ReactDOM.render(
  <Clock />,  document.getElementById('root')
);
```

Try it on CodePen

Next, we'll make the `Clock` set up its own timer and update itself every second.

Adding Lifecycle Methods to a Class

In applications with many components, it's very important to free up resources taken by the components when they are destroyed.

We want to set up a timer whenever the `Clock` is rendered to the DOM for the first time. This is called "mounting" in React.

We also want to clear that timer whenever the DOM produced by the `Clock` is removed. This is called "unmounting" in React.

We can declare special methods on the component class to run some code when a component mounts and unmounts:

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

  componentDidMount() {  }
  componentWillUnmount() {  }
  render() {
    return (
      <div>
        <h1>Hello, world!</h1>
        <h2>It is {this.state.date.toLocaleTimeString()}.</h2>
      </div>
    );
  }
}
```

These methods are called "lifecycle methods".

The `componentDidMount()` method runs after the component output has been rendered to the DOM. This is a good place to set up a timer:

```
  componentDidMount() {
    this.timerID = setInterval(      () => this.tick(),      1000    );  }
```

Note how we save the timer ID right on `this` (`this.timerID`).
While `this.props` is set up by React itself and `this.state` has a special meaning, you are free to add additional fields to the class manually if you need to store something that doesn't participate in the data flow (like a timer ID).
We will tear down the timer in the `componentWillUnmount()` lifecycle method:

```
  componentWillUnmount() {
    clearInterval(this.timerID);  }
```

Finally, we will implement a method called `tick()` that the `Clock` component will run every second.
It will use `this.setState()` to schedule updates to the component local state:

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

  componentDidMount() {
    this.timerID = setInterval(
      () => this.tick(),
      1000
    );
  }

  componentWillUnmount() {
    clearInterval(this.timerID);
  }

  tick() {    this.setState({      date: new Date()    });  }
  render() {
    return (
      <div>
        <h1>Hello, world!</h1>
        <h2>It is {this.state.date.toLocaleTimeString()}.</h2>
      </div>
    );
  }
}

ReactDOM.render(
  <Clock />,
  document.getElementById('root')
);
```

Try it on CodePen

Now the clock ticks every second.

Let's quickly recap what's going on and the order in which the methods are called:

1. When `<Clock />` is passed to `ReactDOM.render()`, React calls the constructor of the `Clock` component. Since `Clock` needs to display the current time, it initializes `this.state` with an object including the current time. We will later update this state.
2. React then calls the `Clock` component's `render()` method. This is how React learns what should be displayed on the screen. React then updates the DOM to match the `Clock`'s render output.
3. When the `Clock` output is inserted in the DOM, React calls the `componentDidMount()` lifecycle method. Inside it, the `Clock` component asks the browser to set up a timer to call the component's `tick()` method once a second.
4. Every second the browser calls the `tick()` method. Inside it, the `Clock` component schedules a UI update by calling `setState()` with an object containing the current time. Thanks to the `setState()` call, React knows the state has changed, and calls the `render()` method again to learn what should be on the screen. This time, `this.state.date` in the `render()` method will be different, and so the render output will include the updated time. React updates the DOM accordingly.
5. If the `Clock` component is ever removed from the DOM, React calls the `componentWillUnmount()` lifecycle method so the timer is stopped.

Using State Correctly

There are three things you should know about `setState()`.

Do Not Modify State Directly

For example, this will not re-render a component:

```
// Wrong
this.state.comment = 'Hello';
```

Instead, use `setState()`:

```
// Correct
this.setState({comment: 'Hello'});
```

The only place where you can assign `this.state` is the constructor.

State Updates May Be Asynchronous

React may batch multiple `setState()` calls into a single update for performance. Because `this.props` and `this.state` may be updated asynchronously, you should not rely on their values for calculating the next state.

For example, this code may fail to update the counter:

```
// Wrong
this.setState({
  counter: this.state.counter + this.props.increment,
});
```

To fix it, use a second form of `setState()` that accepts a function rather than an object. That function will receive the previous state as the first argument, and the props at the time the update is applied as the second argument:

```
// Correct
this.setState((state, props) => ({
  counter: state.counter + props.increment
}));
```

We used an arrow function above, but it also works with regular functions:

```
// Correct
this.setState(function(state, props) {
  return {
    counter: state.counter + props.increment
  };
});
```

State Updates are Merged

When you call `setState()`, React merges the object you provide into the current state.

For example, your state may contain several independent variables:

```
  constructor(props) {
    super(props);
    this.state = {
      posts: [],      comments: []    };
  }
```

Then you can update them independently with separate `setState()` calls:

```
  componentDidMount() {
    fetchPosts().then(response => {
      this.setState({
        posts: response.posts      });
    });
```

```
    fetchComments().then(response => {
      this.setState({
        comments: response.comments      });
    });
  }
```

The merging is shallow,
so `this.setState({comments})` leaves `this.state.posts` intact, but completely replaces `this.state.comments`.

The Data Flows Down

Neither parent nor child components can know if a certain component is stateful or stateless, and they shouldn't care whether it is defined as a function or a class.

This is why state is often called local or encapsulated. It is not accessible to any component other than the one that owns and sets it.

A component may choose to pass its state down as props to its child components:

```
<FormattedDate date={this.state.date} />
```

The `FormattedDate` component would receive the `date` in its props and wouldn't know whether it came from the `Clock`'s state, from the `Clock`'s props, or was typed by hand:

```
function FormattedDate(props) {
  return <h2>It is {props.date.toLocaleTimeString()}.</h2>;
}
```

Try it on CodePen

This is commonly called a "top-down" or "unidirectional" data flow. Any state is always owned by some specific component, and any data or UI derived from that state can only affect components "below" them in the tree.

If you imagine a component tree as a waterfall of props, each component's state is like an additional water source that joins it at an arbitrary point but also flows down.
To show that all components are truly isolated, we can create an `App` component that renders three `<Clock>`s:

```
function App() {
  return (
    <div>
      <Clock />      <Clock />      <Clock />    </div>
  );
}

ReactDOM.render(
  <App />,
  document.getElementById('root')
);
```

Try it on CodePen

Each `Clock` sets up its own timer and updates independently.

In React apps, whether a component is stateful or stateless is considered an implementation detail of the component that may change over time. You can use stateless components inside stateful components, and vice versa.

6.Handling Events

Handling events with React elements is very similar to handling events on DOM elements. There are some syntax differences:

- React events are named using camelCase, rather than lowercase.
- With JSX you pass a function as the event handler, rather than a string.

For example, the HTML:

```
<button onclick="activateLasers()">
  Activate Lasers
</button>
```

is slightly different in React:

```
<button onClick={activateLasers}>  Activate Lasers
</button>
```

Another difference is that you cannot return `false` to prevent default behavior in React. You must call `preventDefault` explicitly. For example, with plain HTML, to prevent the default form behavior of submitting, you can write:

```
<form onsubmit="console.log('You clicked submit.'); return false">
  <button type="submit">Submit</button>
</form>
```

In React, this could instead be:

```
function Form() {
  function handleSubmit(e) {
    e.preventDefault();    console.log('You clicked submit.');
  }

  return (
    <form onSubmit={handleSubmit}>
      <button type="submit">Submit</button>
    </form>
  );
}
```

Here, `e` is a synthetic event. React defines these synthetic events according to the W3C spec, so you don't need to worry about cross-browser compatibility.

React events do not work exactly the same as native events. See the `SyntheticEvent` reference guide to learn more.
When using React, you generally don't need to call `addEventListener` to add listeners to a DOM element after it is created. Instead, just provide a listener when the element is initially rendered.
When you define a component using an ES6 class, a common pattern is for an event handler to be a method on the class. For example, this `Toggle` component renders a button that lets the user toggle between "ON" and "OFF" states:

```
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>
    );
  }
}

ReactDOM.render(
  <Toggle />,
  document.getElementById('root')
);
```

Try it on CodePen

You have to be careful about the meaning of `this` in JSX callbacks. In JavaScript, class methods are not bound by default. If you forget to bind `this.handleClick` and pass it to `onClick`, `this` will be `undefined` when the function is actually called.
This is not React-specific behavior; it is a part of how functions work in JavaScript. Generally, if you refer to a method without `()` after it, such as `onClick={this.handleClick}`, you should bind that method.

If calling `bind` annoys you, there are two ways you can get around this. If you are using the experimental public class fields syntax, you can use class fields to correctly bind callbacks:

```
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>
    );
  }
}
```

This syntax is enabled by default in Create React App.
If you aren't using class fields syntax, you can use an arrow function in the callback:

```
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>
    );
  }
}
```

The problem with this syntax is that a different callback is created each time the `LoggingButton` renders. In most cases, this is fine. However, if this callback is passed as a prop to lower components, those components might do an extra re-rendering. We generally recommend binding in the constructor or using the class fields syntax, to avoid this sort of performance problem.

Passing Arguments to Event Handlers

Inside a loop, it is common to want to pass an extra parameter to an event handler. For example, if `id` is the row ID, either of the following would work:

```
<button onClick={(e) => this.deleteRow(id, e)}>Delete Row</button>
```

```
<button onClick={this.deleteRow.bind(this, id)}>Delete Row</button>
```

The above two lines are equivalent, and use arrow functions and `Function.prototype.bind` respectively.
In both cases, the `e` argument representing the React event will be passed as a second argument after the ID. With an arrow function, we have to pass it explicitly, but with `bind` any further arguments are automatically forwarded.

7. Conditional Rendering

In React, you can create distinct components that encapsulate behavior you need. Then, you can render only some of them, depending on the state of your application.

Conditional rendering in React works the same way conditions work in JavaScript. Use JavaScript operators like `if` or the conditional operator to create elements representing the current state, and let React update the UI to match them.

Consider these two components:

```
function UserGreeting(props) {
  return <h1>Welcome back!</h1>;
}

function GuestGreeting(props) {
  return <h1>Please sign up.</h1>;
}
```

We'll create a `Greeting` component that displays either of these components depending on whether a user is logged in:

```
function Greeting(props) {
  const isLoggedIn = props.isLoggedIn;
  if (isLoggedIn) {    return <UserGreeting />;  }  return <GuestGreeting />;}
ReactDOM.render(
  // Try changing to isLoggedIn={true}:
  <Greeting isLoggedIn={false} />,  document.getElementById('root'));
```

Try it on CodePen

This example renders a different greeting depending on the value of `isLoggedIn` prop.

Element Variables

You can use variables to store elements. This can help you conditionally render a part of the component while the rest of the output doesn't change.

Consider these two new components representing Logout and Login buttons:

```
function LoginButton(props) {
  return (
    <button onClick={props.onClick}>
```

```
      Login
    </button>
  );
}

function LogoutButton(props) {
  return (
    <button onClick={props.onClick}>
      Logout
    </button>
  );
}
```

In the example below, we will create a stateful component called `LoginControl`.

It will render either `<LoginButton />` or `<LogoutButton />` depending on its current state. It will also render a `<Greeting />` from the previous example:

```
class LoginControl extends React.Component {
  constructor(props) {
    super(props);
    this.handleLoginClick = this.handleLoginClick.bind(this);
    this.handleLogoutClick = this.handleLogoutClick.bind(this);
    this.state = {isLoggedIn: false};
  }

  handleLoginClick() {
    this.setState({isLoggedIn: true});
  }

  handleLogoutClick() {
    this.setState({isLoggedIn: false});
  }

  render() {
    const isLoggedIn = this.state.isLoggedIn;
    let button;
    if (isLoggedIn) {      button = <LogoutButton
onClick={this.handleLogoutClick} />;    } else {      button = <LoginButton
onClick={this.handleLoginClick} />;    }
    return (
      <div>
        <Greeting isLoggedIn={isLoggedIn} />        {button}      </div>
    );
  }
}
```

```
ReactDOM.render(
  <LoginControl />,
  document.getElementById('root')
);
```

Try it on CodePen

While declaring a variable and using an `if` statement is a fine way to conditionally render a component, sometimes you might want to use a shorter syntax. There are a few ways to inline conditions in JSX, explained below.

Inline If with Logical && Operator

You may embed expressions in JSX by wrapping them in curly braces. This includes the JavaScript logical `&&` operator. It can be handy for conditionally including an element:

```
function Mailbox(props) {
  const unreadMessages = props.unreadMessages;
  return (
    <div>
      <h1>Hello!</h1>
      {unreadMessages.length > 0 &&        <h2>          You have
{unreadMessages.length} unread messages.        </h2>      }    </div>
  );
}

const messages = ['React', 'Re: React', 'Re:Re: React'];
ReactDOM.render(
  <Mailbox unreadMessages={messages} />,
  document.getElementById('root')
);
```

Try it on CodePen

It works because in JavaScript, `true && expression` always evaluates to `expression`, and `false && expression` always evaluates to `false`. Therefore, if the condition is `true`, the element right after `&&` will appear in the output. If it is `false`, React will ignore and skip it.

Note that returning a falsy expression will still cause the element after `&&` to be skipped but will return the falsy expression. In the example below, `<div>0</div>` will be returned by the render method.

```
render() {
  const count = 0;  return (
    <div>
      { count && <h1>Messages: {count}</h1>}    </div>
  );
}
```

Inline If-Else with Conditional Operator

Another method for conditionally rendering elements inline is to use the JavaScript conditional operator `condition ? true : false`.

In the example below, we use it to conditionally render a small block of text.

```
render() {
  const isLoggedIn = this.state.isLoggedIn;
  return (
    <div>
      The user is <b>{isLoggedIn ? 'currently' : 'not'}</b> logged in.
</div>
  );
}
```

It can also be used for larger expressions although it is less obvious what's going on:

```
render() {
  const isLoggedIn = this.state.isLoggedIn;
  return (
    <div>
      {isLoggedIn        ? <LogoutButton onClick={this.handleLogoutClick} />
        : <LoginButton onClick={this.handleLoginClick} />      }
    </div>  );
}
```

Just like in JavaScript, it is up to you to choose an appropriate style based on what you and your team consider more readable. Also remember that whenever conditions become too complex, it might be a good time to extract a component.

Preventing Component from Rendering

In rare cases you might want a component to hide itself even though it was rendered by another component. To do this return `null` instead of its render output.

In the example below, the `<WarningBanner />` is rendered depending on the value of the prop called `warn`. If the value of the prop is `false`, then the component does not render:

```
function WarningBanner(props) {
  if (!props.warn) {    return null;  }
  return (
    <div className="warning">
      Warning!
    </div>
```

```
  );
}

class Page extends React.Component {
  constructor(props) {
    super(props);
    this.state = {showWarning: true};
    this.handleToggleClick = this.handleToggleClick.bind(this);
  }

  handleToggleClick() {
    this.setState(state => ({
      showWarning: !state.showWarning
    }));
  }

  render() {
    return (
      <div>
        <WarningBanner warn={this.state.showWarning} />        <button
onClick={this.handleToggleClick}>
          {this.state.showWarning ? 'Hide' : 'Show'}
        </button>
      </div>
    );
  }
}

ReactDOM.render(
  <Page />,
  document.getElementById('root')
);
```

Try it on CodePen

Returning `null` from a component's `render` method does not affect the firing of the component's lifecycle methods. For instance `componentDidUpdate` will still be called.

8.Lists and Keys

First, let's review how you transform lists in JavaScript.

Given the code below, we use the `map()` function to take an array of `numbers` and double their values. We assign the new array returned by `map()` to the variable `doubled` and log it:

```
const numbers = [1, 2, 3, 4, 5];
const doubled = numbers.map((number) => number * 2);console.log(doubled);
```

This code logs `[2, 4, 6, 8, 10]` to the console.

In React, transforming arrays into lists of elements is nearly identical.

Rendering Multiple Components

You can build collections of elements and include them in JSX using curly braces `{}`.

Below, we loop through the `numbers` array using the JavaScript `map()` function. We return a `<li>` element for each item. Finally, we assign the resulting array of elements to `listItems`:

```
const numbers = [1, 2, 3, 4, 5];
const listItems = numbers.map((number) =>  <li>{number}</li>);
```

We include the entire `listItems` array inside a `<ul>` element, and render it to the DOM:

```
ReactDOM.render(
  <ul>{listItems}</ul>,  document.getElementById('root')
);
```

Try it on CodePen

This code displays a bullet list of numbers between 1 and 5.

Basic List Component

Usually you would render lists inside a component.

We can refactor the previous example into a component that accepts an array of `numbers` and outputs a list of elements.

```
function NumberList(props) {
  const numbers = props.numbers;
  const listItems = numbers.map((number) =>    <li>{number}</li>  );  return (
    <ul>{listItems}</ul>  );
}

const numbers = [1, 2, 3, 4, 5];
ReactDOM.render(
  <NumberList numbers={numbers} />,  document.getElementById('root')
```

```
);
```

When you run this code, you'll be given a warning that a key should be provided for list items. A "key" is a special string attribute you need to include when creating lists of elements. We'll discuss why it's important in the next section.

Let's assign a `key` to our list items inside `numbers.map()` and fix the missing key issue.

```
function NumberList(props) {
  const numbers = props.numbers;
  const listItems = numbers.map((number) =>
    <li key={number.toString()}>      {number}
    </li>
  );
  return (
    <ul>{listItems}</ul>
  );
}

const numbers = [1, 2, 3, 4, 5];
ReactDOM.render(
  <NumberList numbers={numbers} />,
  document.getElementById('root')
);
```

Try it on CodePen

Keys

Keys help React identify which items have changed, are added, or are removed. Keys should be given to the elements inside the array to give the elements a stable identity:

```
const numbers = [1, 2, 3, 4, 5];
const listItems = numbers.map((number) =>
  <li key={number.toString()}>    {number}
  </li>
);
```

The best way to pick a key is to use a string that uniquely identifies a list item among its siblings. Most often you would use IDs from your data as keys:

```
const todoItems = todos.map((todo) =>
  <li key={todo.id}>    {todo.text}
  </li>
```

```
);
```

When you don't have stable IDs for rendered items, you may use the item index as a key as a last resort:

```
const todoItems = todos.map((todo, index) =>
  // Only do this if items have no stable IDs  <li key={index}>    {todo.text}
  </li>
);
```

We don't recommend using indexes for keys if the order of items may change. This can negatively impact performance and may cause issues with component state. Check out Robin Pokorny's article for an in-depth explanation on the negative impacts of using an index as a key. If you choose not to assign an explicit key to list items then React will default to using indexes as keys.
Here is an in-depth explanation about why keys are necessary if you're interested in learning more.

Extracting Components with Keys

Keys only make sense in the context of the surrounding array.
For example, if you extract a `ListItem` component, you should keep the key on the `<ListItem />` elements in the array rather than on the `<li>` element in the `ListItem` itself.

Example: Incorrect Key Usage

```
function ListItem(props) {
  const value = props.value;
  return (
    // Wrong! There is no need to specify the key here:    <li
key={value.toString()}>      {value}
    </li>
  );
}

function NumberList(props) {
  const numbers = props.numbers;
  const listItems = numbers.map((number) =>
    // Wrong! The key should have been specified here:    <ListItem
value={number} />  );
  return (
    <ul>
      {listItems}
    </ul>
  );
}
```

```
const numbers = [1, 2, 3, 4, 5];
ReactDOM.render(
  <NumberList numbers={numbers} />,
  document.getElementById('root')
);
```

Example: Correct Key Usage

```
function ListItem(props) {
  // Correct! There is no need to specify the key here:  return
<li>{props.value}</li>;}

function NumberList(props) {
  const numbers = props.numbers;
  const listItems = numbers.map((number) =>
    // Correct! Key should be specified inside the array.    <ListItem
key={number.toString()} value={number} />  );
  return (
    <ul>
      {listItems}
    </ul>
  );
}

const numbers = [1, 2, 3, 4, 5];
ReactDOM.render(
  <NumberList numbers={numbers} />,
  document.getElementById('root')
);
```

Try it on CodePen

A good rule of thumb is that elements inside the `map()` call need keys.

Keys Must Only Be Unique Among Siblings

Keys used within arrays should be unique among their siblings. However, they don't need to be globally unique. We can use the same keys when we produce two different arrays:

```
function Blog(props) {
  const sidebar = (    <ul>
      {props.posts.map((post) =>
        <li key={post.id}>          {post.title}
        </li>
      )}
    </ul>
  );
  const content = props.posts.map((post) =>    <div key={post.id}>
<h3>{post.title}</h3>
```

```
      <p>{post.content}</p>
    </div>
  );
  return (
    <div>
      {sidebar}      <hr />
      {content}    </div>
  );
}

const posts = [
  {id: 1, title: 'Hello World', content: 'Welcome to learning React!'},
  {id: 2, title: 'Installation', content: 'You can install React from npm.'}
];
ReactDOM.render(
  <Blog posts={posts} />,
  document.getElementById('root')
);
```

Try it on CodePen

Keys serve as a hint to React but they don't get passed to your components. If you need the same value in your component, pass it explicitly as a prop with a different name:

```
const content = posts.map((post) =>
  <Post
    key={post.id}    id={post.id}    title={post.title} />
);
```

With the example above, the `Post` component can read `props.id`, but not `props.key`.

Embedding map() in JSX

In the examples above we declared a separate `listItems` variable and included it in JSX:

```
function NumberList(props) {
  const numbers = props.numbers;
  const listItems = numbers.map((number) =>    <ListItem
key={number.toString()}              value={number} />  );  return (
    <ul>
      {listItems}
    </ul>
  );
}
```

JSX allows embedding any expression in curly braces so we could inline the `map()` result:

```
function NumberList(props) {
  const numbers = props.numbers;
  return (
    <ul>
      {numbers.map((number) =>         <ListItem key={number.toString()}
value={number} />       )}    </ul>
  );
}
```

Try it on CodePen

Sometimes this results in clearer code, but this style can also be abused. Like in JavaScript, it is up to you to decide whether it is worth extracting a variable for readability. Keep in mind that if the `map()` body is too nested, it might be a good time to extract a component.

9.Forms

HTML form elements work a bit differently from other DOM elements in React, because form elements naturally keep some internal state. For example, this form in plain HTML accepts a single name:

```
<form>
  <label>
    Name:
    <input type="text" name="name" />
  </label>
  <input type="submit" value="Submit" />
</form>
```

This form has the default HTML form behavior of browsing to a new page when the user submits the form. If you want this behavior in React, it just works. But in most cases, it's convenient to have a JavaScript function that handles the submission of the form and has access to the data that the user entered into the form. The standard way to achieve this is with a technique called "controlled components".

Controlled Components

In HTML, form elements such as `<input>`, `<textarea>`, and `<select>` typically maintain their own state and update it based on user input. In React, mutable state is typically kept in the state property of components, and only updated with `setState()`.

We can combine the two by making the React state be the "single source of truth". Then the React component that renders a form also controls what happens in that form on subsequent user input. An input form element whose value is controlled by React in this way is called a "controlled component".

For example, if we want to make the previous example log the name when it is submitted, we can write the form as a controlled component:

```
class NameForm extends React.Component {
  constructor(props) {
    super(props);
    this.state = {value: ''};
```

```
    this.handleChange = this.handleChange.bind(this);
    this.handleSubmit = this.handleSubmit.bind(this);
  }

  handleChange(event) {    this.setState({value: event.target.value});  }
  handleSubmit(event) {
    alert('A name was submitted: ' + this.state.value);
    event.preventDefault();
  }

  render() {
    return (
      <form onSubmit={this.handleSubmit}>        <label>
          Name:
          <input type="text" value={this.state.value}
onChange={this.handleChange} />        </label>
        <input type="submit" value="Submit" />
      </form>
    );
  }
}
```

Try it on CodePen

Since the `value` attribute is set on our form element, the displayed value will always be `this.state.value`, making the React state the source of truth. Since `handleChange` runs on every keystroke to update the React state, the displayed value will update as the user types.

With a controlled component, the input's value is always driven by the React state. While this means you have to type a bit more code, you can now pass the value to other UI elements too, or reset it from other event handlers.

The textarea Tag

In HTML, a `<textarea>` element defines its text by its children:

```
<textarea>
  Hello there, this is some text in a text area
</textarea>
```

In React, a `<textarea>` uses a `value` attribute instead. This way, a form using a `<textarea>` can be written very similarly to a form that uses a single-line input:

```
class EssayForm extends React.Component {
  constructor(props) {
    super(props);
```

```
    this.state = {      value: 'Please write an essay about your favorite DOM element.'    };
    this.handleChange = this.handleChange.bind(this);
    this.handleSubmit = this.handleSubmit.bind(this);
  }

  handleChange(event) {    this.setState({value: event.target.value});  }
  handleSubmit(event) {
    alert('An essay was submitted: ' + this.state.value);
    event.preventDefault();
  }

  render() {
    return (
      <form onSubmit={this.handleSubmit}>
        <label>
          Essay:
          <textarea value={this.state.value} onChange={this.handleChange} />
</label>
        <input type="submit" value="Submit" />
      </form>
    );
  }
}
```

Notice that `this.state.value` is initialized in the constructor, so that the text area starts off with some text in it.

The select Tag

In HTML, `<select>` creates a drop-down list. For example, this HTML creates a drop-down list of flavors:

```
<select>
  <option value="grapefruit">Grapefruit</option>
  <option value="lime">Lime</option>
  <option selected value="coconut">Coconut</option>
  <option value="mango">Mango</option>
</select>
```

Note that the Coconut option is initially selected, because of the `selected` attribute. React, instead of using this `selected` attribute, uses a `value` attribute on the root `select` tag. This is more convenient in a controlled component because you only need to update it in one place. For example:

```
class FlavorForm extends React.Component {
  constructor(props) {
    super(props);
```

```
    this.state = {value: 'coconut'};
    this.handleChange = this.handleChange.bind(this);
    this.handleSubmit = this.handleSubmit.bind(this);
  }

  handleChange(event) {    this.setState({value: event.target.value});  }
  handleSubmit(event) {
    alert('Your favorite flavor is: ' + this.state.value);
    event.preventDefault();
  }

  render() {
    return (
      <form onSubmit={this.handleSubmit}>
        <label>
          Pick your favorite flavor:
          <select value={this.state.value} onChange={this.handleChange}>
<option value="grapefruit">Grapefruit</option>
            <option value="lime">Lime</option>
            <option value="coconut">Coconut</option>
            <option value="mango">Mango</option>
          </select>
        </label>
        <input type="submit" value="Submit" />
      </form>
    );
  }
}
```

Try it on CodePen

Overall, this makes it so that `<input type="text">`, `<textarea>`, and `<select>` all work very similarly - they all accept a `value` attribute that you can use to implement a controlled component.

Note

You can pass an array into the `value` attribute, allowing you to select multiple options in a `select` tag:

```
<select multiple={true} value={['B', 'C']}>
```

The file input Tag

In HTML, an `<input type="file">` lets the user choose one or more files from their device storage to be uploaded to a server or manipulated by JavaScript via the File API.

```
<input type="file" />
```

Because its value is read-only, it is an **uncontrolled** component in React. It is discussed together with other uncontrolled components later in the documentation.

Handling Multiple Inputs

When you need to handle multiple controlled `input` elements, you can add a `name` attribute to each element and let the handler function choose what to do based on the value of `event.target.name`.

For example:

```
class Reservation extends React.Component {
  constructor(props) {
    super(props);
    this.state = {
      isGoing: true,
      numberOfGuests: 2
    };

    this.handleInputChange = this.handleInputChange.bind(this);
  }

  handleInputChange(event) {
    const target = event.target;
    const value = target.type === 'checkbox' ? target.checked : target.value;
    const name = target.name;
    this.setState({
      [name]: value    });
  }

  render() {
    return (
      <form>
        <label>
          Is going:
          <input
            name="isGoing"            type="checkbox"
            checked={this.state.isGoing}
            onChange={this.handleInputChange} />
        </label>
        <br />
        <label>
          Number of guests:
          <input
            name="numberOfGuests"            type="number"
```

```
            value={this.state.numberOfGuests}
            onChange={this.handleInputChange} />
        </label>
      </form>
    );
  }
}
```

Try it on CodePen

Note how we used the ES6 computed property name syntax to update the state key corresponding to the given input name:

```
this.setState({
  [name]: value});
```

It is equivalent to this ES5 code:

```
var partialState = {};
partialState[name] = value;this.setState(partialState);
```

Also, since `setState()` automatically merges a partial state into the current state, we only needed to call it with the changed parts.

Controlled Input Null Value

Specifying the value prop on a controlled component prevents the user from changing the input unless you desire so. If you've specified a `value` but the input is still editable, you may have accidentally
set `value` to `undefined` or `null`.

The following code demonstrates this. (The input is locked at first but becomes editable after a short delay.)

```
ReactDOM.render(<input value="hi" />, mountNode);

setTimeout(function() {
  ReactDOM.render(<input value={null} />, mountNode);
}, 1000);
```

Alternatives to Controlled Components

It can sometimes be tedious to use controlled components, because you need to write an event handler for every way your data can change and pipe all of the input state through a React component. This can become particularly annoying when you are converting a preexisting codebase to React, or integrating a React application with a non-React library. In these situations,

you might want to check out uncontrolled components, an alternative technique for implementing input forms.

Fully-Fledged Solutions

If you're looking for a complete solution including validation, keeping track of the visited fields, and handling form submission, Formik is one of the popular choices. However, it is built on the same principles of controlled components and managing state — so don't neglect to learn them.

10. Lifting State Up

Often, several components need to reflect the same changing data. We recommend lifting the shared state up to their closest common ancestor. Let's see how this works in action.

In this section, we will create a temperature calculator that calculates whether the water would boil at a given temperature.
We will start with a component called `BoilingVerdict`. It accepts the `celsius` temperature as a prop, and prints whether it is enough to boil the water:

```
function BoilingVerdict(props) {
  if (props.celsius >= 100) {
    return <p>The water would boil.</p>;  }
  return <p>The water would not boil.</p>;}
```

Next, we will create a component called `Calculator`. It renders an `<input>` that lets you enter the temperature, and keeps its value in `this.state.temperature`.
Additionally, it renders the `BoilingVerdict` for the current input value.

```
class Calculator extends React.Component {
  constructor(props) {
    super(props);
    this.handleChange = this.handleChange.bind(this);
    this.state = {temperature: ''};  }

  handleChange(e) {
    this.setState({temperature: e.target.value});  }

  render() {
    const temperature = this.state.temperature;    return (
      <fieldset>
        <legend>Enter temperature in Celsius:</legend>
        <input          value={temperature}
onChange={this.handleChange} />        <BoilingVerdict
celsius={parseFloat(temperature)} />      </fieldset>
    );
  }
}
```

Try it on CodePen

Adding a Second Input

Our new requirement is that, in addition to a Celsius input, we provide a Fahrenheit input, and they are kept in sync.
We can start by extracting a `TemperatureInput` component from `Calculator`. We will add a new `scale` prop to it that can either be `"c"` or `"f"`:

```
const scaleNames = {  c: 'Celsius',  f: 'Fahrenheit'};
class TemperatureInput extends React.Component {
  constructor(props) {
    super(props);
    this.handleChange = this.handleChange.bind(this);
    this.state = {temperature: ''};
  }

  handleChange(e) {
    this.setState({temperature: e.target.value});
  }

  render() {
    const temperature = this.state.temperature;
    const scale = this.props.scale;    return (
      <fieldset>
        <legend>Enter temperature in {scaleNames[scale]}:</legend>
<input value={temperature}
               onChange={this.handleChange} />
      </fieldset>
    );
  }
}
```

We can now change the `Calculator` to render two separate temperature inputs:

```
class Calculator extends React.Component {
  render() {
    return (
      <div>
        <TemperatureInput scale="c" />        <TemperatureInput scale="f" />
</div>
    );
  }
}
```

Try it on CodePen

We have two inputs now, but when you enter the temperature in one of them, the other doesn't update. This contradicts our requirement: we want to keep them in sync.
We also can't display the `BoilingVerdict` from `Calculator`. The `Calculator` doesn't know the current temperature because it is hidden inside the `TemperatureInput`.

Writing Conversion Functions

First, we will write two functions to convert from Celsius to Fahrenheit and back:

```
function toCelsius(fahrenheit) {
  return (fahrenheit - 32) * 5 / 9;
}

function toFahrenheit(celsius) {
  return (celsius * 9 / 5) + 32;
}
```

These two functions convert numbers. We will write another function that takes a string `temperature` and a converter function as arguments and returns a string. We will use it to calculate the value of one input based on the other input.
It returns an empty string on an invalid `temperature`, and it keeps the output rounded to the third decimal place:

```
function tryConvert(temperature, convert) {
  const input = parseFloat(temperature);
  if (Number.isNaN(input)) {
    return '';
  }
  const output = convert(input);
  const rounded = Math.round(output * 1000) / 1000;
  return rounded.toString();
}
```

For example, `tryConvert('abc', toCelsius)` returns an empty string, and `tryConvert('10.22', toFahrenheit)` returns `'50.396'`.

Lifting State Up

Currently, both `TemperatureInput` components independently keep their values in the local state:

```
class TemperatureInput extends React.Component {
  constructor(props) {
    super(props);
```

```
    this.handleChange = this.handleChange.bind(this);
    this.state = {temperature: ''};  }

  handleChange(e) {
    this.setState({temperature: e.target.value});  }

  render() {
    const temperature = this.state.temperature;    // ...
```

However, we want these two inputs to be in sync with each other. When we update the Celsius input, the Fahrenheit input should reflect the converted temperature, and vice versa.
In React, sharing state is accomplished by moving it up to the closest common ancestor of the components that need it. This is called "lifting state up". We will remove the local state from the `TemperatureInput` and move it into the `Calculator` instead.
If the `Calculator` owns the shared state, it becomes the "source of truth" for the current temperature in both inputs. It can instruct them both to have values that are consistent with each other. Since the props of both `TemperatureInput` components are coming from the same parent `Calculator` component, the two inputs will always be in sync.

Let's see how this works step by step.
First, we will replace `this.state.temperature` with `this.props.temperature` in the `TemperatureInput` component. For now, let's pretend `this.props.temperature` already exists, although we will need to pass it from the `Calculator` in the future:

```
  render() {
    // Before: const temperature = this.state.temperature;
    const temperature = this.props.temperature;    // ...
```

We know that props are read-only. When the `temperature` was in the local state, the `TemperatureInput` could just call `this.setState()` to change it. However, now that the `temperature` is coming from the parent as a prop, the `TemperatureInput` has no control over it.
In React, this is usually solved by making a component "controlled". Just like the DOM `<input>` accepts both a `value` and an `onChange` prop, so can the custom `TemperatureInput` accept both `temperature` and `onTemperatureChange` props from its parent `Calculator`.
Now, when the `TemperatureInput` wants to update its temperature, it calls `this.props.onTemperatureChange`:

```
  handleChange(e) {
    // Before: this.setState({temperature: e.target.value});
    this.props.onTemperatureChange(e.target.value);    // ...
```

Note:
There is no special meaning to either `temperature` or `onTemperatureChange` prop names in custom components. We could have called them anything else, like name them `value` and `onChange` which is a common convention.

The `onTemperatureChange` prop will be provided together with the `temperature` prop by the parent `Calculator` component. It will handle the change by modifying its own local state, thus re-rendering both inputs with the new values. We will look at the new `Calculator` implementation very soon. Before diving into the changes in the `Calculator`, let's recap our changes to the `TemperatureInput` component. We have removed the local state from it, and instead of reading `this.state.temperature`, we now read `this.props.temperature`. Instead of calling `this.setState()` when we want to make a change, we now call `this.props.onTemperatureChange()`, which will be provided by the `Calculator`:

```
class TemperatureInput extends React.Component {
  constructor(props) {
    super(props);
    this.handleChange = this.handleChange.bind(this);
  }

  handleChange(e) {
    this.props.onTemperatureChange(e.target.value);  }

  render() {
    const temperature = this.props.temperature;    const scale =
this.props.scale;
    return (
      <fieldset>
        <legend>Enter temperature in {scaleNames[scale]}:</legend>
        <input value={temperature}
               onChange={this.handleChange} />
      </fieldset>
    );
  }
}
```

Now let's turn to the `Calculator` component.
We will store the current input's `temperature` and `scale` in its local state. This is the state we "lifted up" from the inputs, and it will serve as the "source of truth" for both of them. It is the minimal representation of all the data we need to know in order to render both inputs.

For example, if we enter 37 into the Celsius input, the state of the `Calculator` component will be:

```
{
  temperature: '37',
  scale: 'c'
}
```

If we later edit the Fahrenheit field to be 212, the state of the `Calculator` will be:

```
{
  temperature: '212',
  scale: 'f'
}
```

We could have stored the value of both inputs but it turns out to be unnecessary. It is enough to store the value of the most recently changed input, and the scale that it represents. We can then infer the value of the other input based on the current `temperature` and `scale` alone.

The inputs stay in sync because their values are computed from the same state:

```
class Calculator extends React.Component {
  constructor(props) {
    super(props);
    this.handleCelsiusChange = this.handleCelsiusChange.bind(this);
    this.handleFahrenheitChange = this.handleFahrenheitChange.bind(this);
    this.state = {temperature: '', scale: 'c'};  }

  handleCelsiusChange(temperature) {
    this.setState({scale: 'c', temperature});  }

  handleFahrenheitChange(temperature) {
    this.setState({scale: 'f', temperature});  }

  render() {
    const scale = this.state.scale;    const temperature =
this.state.temperature;    const celsius = scale === 'f' ?
tryConvert(temperature, toCelsius) : temperature;    const fahrenheit = scale
=== 'c' ? tryConvert(temperature, toFahrenheit) : temperature;
    return (
      <div>
        <TemperatureInput
          scale="c"
          temperature={celsius}
onTemperatureChange={this.handleCelsiusChange} />        <TemperatureInput
          scale="f"
```

```
          temperature={fahrenheit}
onTemperatureChange={this.handleFahrenheitChange} />        <BoilingVerdict
          celsius={parseFloat(celsius)} />      </div>
    );
  }
}
```

Try it on CodePen

Now, no matter which input you edit, `this.state.temperature` and `this.state.scale` in the `Calculator` get updated. One of the inputs gets the value as is, so any user input is preserved, and the other input value is always recalculated based on it.

Let's recap what happens when you edit an input:

- React calls the function specified as `onChange` on the DOM `<input>`. In our case, this is the `handleChange` method in the `TemperatureInput` component.
- The `handleChange` method in the `TemperatureInput` component calls `this.props.onTemperatureChange()` with the new desired value. Its props, including `onTemperatureChange`, were provided by its parent component, the `Calculator`.
- When it previously rendered, the `Calculator` had specified that `onTemperatureChange` of the Celsius `TemperatureInput` is the `Calculator`'s `handleCelsiusChange` method, and `onTemperatureChange` of the Fahrenheit `TemperatureInput` is the `Calculator`'s `handleFahrenheitChange` method. So either of these two `Calculator` methods gets called depending on which input we edited.
- Inside these methods, the `Calculator` component asks React to re-render itself by calling `this.setState()` with the new input value and the current scale of the input we just edited.
- React calls the `Calculator` component's `render` method to learn what the UI should look like. The values of both inputs are recomputed based on the current temperature and the active scale. The temperature conversion is performed here.
- React calls the `render` methods of the individual `TemperatureInput` components with their new props specified by the `Calculator`. It learns what their UI should look like.
- React calls the `render` method of the `BoilingVerdict` component, passing the temperature in Celsius as its props.

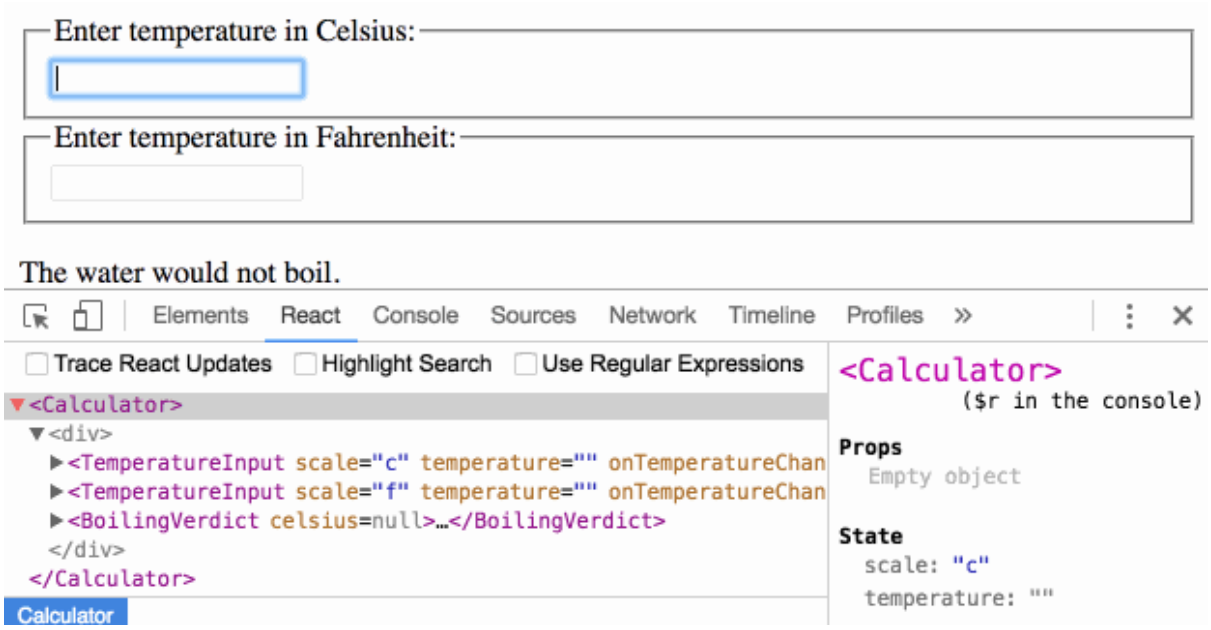
- React DOM updates the DOM with the boiling verdict and to match the desired input values. The input we just edited receives its current value, and the other input is updated to the temperature after conversion.

Every update goes through the same steps so the inputs stay in sync.

Lessons Learned

There should be a single "source of truth" for any data that changes in a React application. Usually, the state is first added to the component that needs it for rendering. Then, if other components also need it, you can lift it up to their closest common ancestor. Instead of trying to sync the state between different components, you should rely on the top-down data flow.

Lifting state involves writing more "boilerplate" code than two-way binding approaches, but as a benefit, it takes less work to find and isolate bugs. Since any state "lives" in some component and that component alone can change it, the surface area for bugs is greatly reduced. Additionally, you can implement any custom logic to reject or transform user input.
If something can be derived from either props or state, it probably shouldn't be in the state. For example, instead of storing both `celsiusValue` and `fahrenheitValue`, we store just the last edited `temperature` and its `scale`. The value of the other input can always be calculated from them in the `render()` method. This lets us clear or apply rounding to the other field without losing any precision in the user input.
When you see something wrong in the UI, you can use React Developer Tools to inspect the props and move up the tree until you find the component responsible for updating the state. This lets you trace the bugs to their source:


Enter temperature in Celsius:
Enter temperature in Fahrenheit:
The water would not boil.
Elements
React
Console
Sources
Network
Timeline
Profiles
Trace React Updates
Highlight Search
Use Regular Expressions
<Calculator>

<TemperatureInput scale="c" temperature="" onTemperatureChan
<TemperatureInput scale="f" temperature="" onTemperatureChan
<BoilingVerdict celsius=null>…</BoilingVerdict>

</Calculator>
Calculator
<Calculator>
($r in the console)
Props
Empty object
State
scale: "c"
temperature: ""

11. Composition vs Inheritance

React has a powerful composition model, and we recommend using composition instead of inheritance to reuse code between components.

In this section, we will consider a few problems where developers new to React often reach for inheritance, and show how we can solve them with composition.

Containment

Some components don't know their children ahead of time. This is especially common for components like `Sidebar` or `Dialog` that represent generic "boxes". We recommend that such components use the special `children` prop to pass children elements directly into their output:

```
function FancyBorder(props) {
  return (
    <div className={'FancyBorder FancyBorder-' + props.color}>
      {props.children}    </div>
  );
}
```

This lets other components pass arbitrary children to them by nesting the JSX:

```
function WelcomeDialog() {
  return (
    <FancyBorder color="blue">
      <h1 className="Dialog-title">        Welcome      </h1>      <p
className="Dialog-message">        Thank you for visiting our spacecraft!
</p>    </FancyBorder>
  );
}
```

Try it on CodePen

Anything inside the `<FancyBorder>` JSX tag gets passed into the `FancyBorder` component as a `children` prop.

Since `FancyBorder` renders `{props.children}` inside a `<div>`, the passed elements appear in the final output.

While this is less common, sometimes you might need multiple "holes" in a component. In such cases you may come up with your own convention instead of using `children`:

```jsx
function SplitPane(props) {
  return (
    <div className="SplitPane">
      <div className="SplitPane-left">
        {props.left}      </div>
      <div className="SplitPane-right">
        {props.right}      </div>
    </div>
  );
}

function App() {
  return (
    <SplitPane
      left={
        <Contacts />      }
      right={
        <Chat />      } />
  );
}
```

Try it on CodePen

React elements like `<Contacts />` and `<Chat />` are just objects, so you can pass them as props like any other data. This approach may remind you of "slots" in other libraries but there are no limitations on what you can pass as props in React.

Specialization

Sometimes we think about components as being "special cases" of other components. For example, we might say that a `WelcomeDialog` is a special case of `Dialog`.

In React, this is also achieved by composition, where a more "specific" component renders a more "generic" one and configures it with props:

```jsx
function Dialog(props) {
  return (
    <FancyBorder color="blue">
      <h1 className="Dialog-title">
        {props.title}      </h1>
      <p className="Dialog-message">
        {props.message}      </p>
    </FancyBorder>
  );
}
```

```
function WelcomeDialog() {
  return (
    <Dialog      title="Welcome"      message="Thank you for visiting our
spacecraft!" />  );
}
```

Try it on CodePen

Composition works equally well for components defined as classes:

```
function Dialog(props) {
  return (
    <FancyBorder color="blue">
      <h1 className="Dialog-title">
        {props.title}
      </h1>
      <p className="Dialog-message">
        {props.message}
      </p>
      {props.children}    </FancyBorder>
  );
}

class SignUpDialog extends React.Component {
  constructor(props) {
    super(props);
    this.handleChange = this.handleChange.bind(this);
    this.handleSignUp = this.handleSignUp.bind(this);
    this.state = {login: ''};
  }

  render() {
    return (
      <Dialog title="Mars Exploration Program"
              message="How should we refer to you?">
        <input value={this.state.login}
onChange={this.handleChange} />        <button onClick={this.handleSignUp}>
Sign Me Up!        </button>      </Dialog>
    );
  }

  handleChange(e) {
    this.setState({login: e.target.value});
  }

  handleSignUp() {
    alert(`Welcome aboard, ${this.state.login}!`);
```

```
  }
}
```

Try it on CodePen

So What About Inheritance?

At Facebook, we use React in thousands of components, and we haven't found any use cases where we would recommend creating component inheritance hierarchies.

Props and composition give you all the flexibility you need to customize a component's look and behavior in an explicit and safe way. Remember that components may accept arbitrary props, including primitive values, React elements, or functions.

If you want to reuse non-UI functionality between components, we suggest extracting it into a separate JavaScript module. The components may import it and use that function, object, or a class, without extending it.

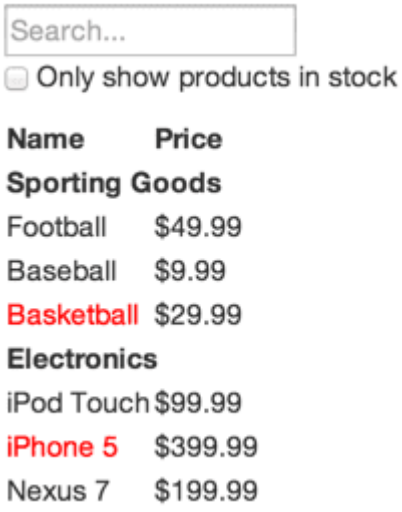
Thinking in React

React is, in our opinion, the premier way to build big, fast Web apps with JavaScript. It has scaled very well for us at Facebook and Instagram.

One of the many great parts of React is how it makes you think about apps as you build them. In this document, we'll walk you through the thought process of building a searchable product data table using React.

Start With A Mock

Imagine that we already have a JSON API and a mock from our designer. The mock looks like this:



Our JSON API returns some data that looks like this:

```
[
  {category: "Sporting Goods", price: "$49.99", stocked: true, name:
"Football"},
  {category: "Sporting Goods", price: "$9.99", stocked: true, name:
"Baseball"},
  {category: "Sporting Goods", price: "$29.99", stocked: false, name:
"Basketball"},
  {category: "Electronics", price: "$99.99", stocked: true, name: "iPod
Touch"},
```

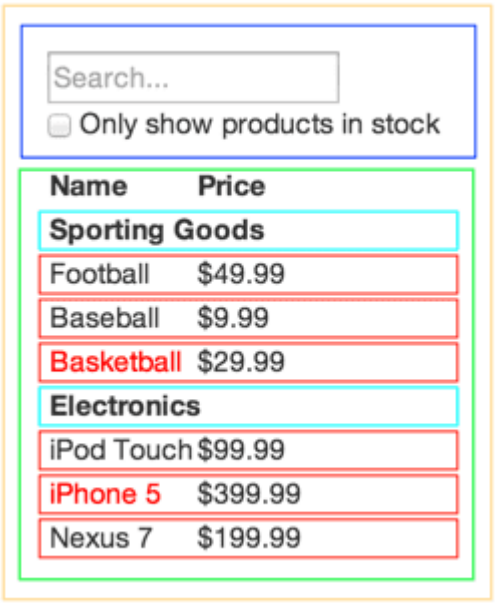
```
  {category: "Electronics", price: "$399.99", stocked: false, name: "iPhone
5"},
  {category: "Electronics", price: "$199.99", stocked: true, name: "Nexus 7"}
];
```

Step 1: Break The UI Into A Component Hierarchy

The first thing you'll want to do is to draw boxes around every component (and subcomponent) in the mock and give them all names. If you're working with a designer, they may have already done this, so go talk to them! Their Photoshop layer names may end up being the names of your React components!

But how do you know what should be its own component? Use the same techniques for deciding if you should create a new function or object. One such technique is the single responsibility principle, that is, a component should ideally only do one thing. If it ends up growing, it should be decomposed into smaller subcomponents.

Since you're often displaying a JSON data model to a user, you'll find that if your model was built correctly, your UI (and therefore your component structure) will map nicely. That's because UI and data models tend to adhere to the same *information architecture*. Separate your UI into components, where each component matches one piece of your data model.



You'll see here that we have five components in our app. We've italicized the data each component represents.

1. **`FilterableProductTable` (orange):** contains the entirety of the example
2. **`SearchBar` (blue):** receives all *user input*
3. **`ProductTable` (green):** displays and filters the *data collection* based on *user input*
4. **`ProductCategoryRow` (turquoise):** displays a heading for each *category*
5. **`ProductRow` (red):** displays a row for each *product*

If you look at `ProductTable`, you'll see that the table header (containing the "Name" and "Price" labels) isn't its own component. This is a matter of preference, and there's an argument to be made either way. For this example, we left it as part of `ProductTable` because it is part of rendering the *data collection* which is `ProductTable`'s responsibility. However, if this header grows to be complex (e.g., if we were to add affordances for sorting), it would certainly make sense to make this its own `ProductTableHeader` component.

Now that we've identified the components in our mock, let's arrange them into a hierarchy. Components that appear within another component in the mock should appear as a child in the hierarchy:

- `FilterableProductTable`
    - `SearchBar`
    - `ProductTable`
        - `ProductCategoryRow`
        - `ProductRow`

Step 2: Build A Static Version in React

See the Pen Thinking In React: Step 2 on CodePen.

Now that you have your component hierarchy, it's time to implement your app. The easiest way is to build a version that takes your data model and renders the UI but has no interactivity. It's best to decouple these processes because building a static version requires a lot of typing and no thinking, and adding interactivity requires a lot of thinking and not a lot of typing. We'll see why.

To build a static version of your app that renders your data model, you'll want to build components that reuse other components and pass data using *props*. *props* are a way of passing data from parent to child. If you're familiar with the concept of *state*, **don't use state at all** to build this static

version. State is reserved only for interactivity, that is, data that changes over time. Since this is a static version of the app, you don't need it.
You can build top-down or bottom-up. That is, you can either start with building the components higher up in the hierarchy (i.e. starting with `FilterableProductTable`) or with the ones lower in it (`ProductRow`). In simpler examples, it's usually easier to go top-down, and on larger projects, it's easier to go bottom-up and write tests as you build.
At the end of this step, you'll have a library of reusable components that render your data model. The components will only have `render()` methods since this is a static version of your app. The component at the top of the hierarchy (`FilterableProductTable`) will take your data model as a prop. If you make a change to your underlying data model and call `ReactDOM.render()` again, the UI will be updated. You can see how your UI is updated and where to make changes. React's **one-way data flow** (also called *one-way binding*) keeps everything modular and fast.
Refer to the React docs if you need help executing this step.

A Brief Interlude: Props vs State

There are two types of "model" data in React: props and state. It's important to understand the distinction between the two; skim the official React docs if you aren't sure what the difference is. See also FAQ: What is the difference between state and props?

Step 3: Identify The Minimal (but complete) Representation Of UI State

To make your UI interactive, you need to be able to trigger changes to your underlying data model. React achieves this with **state**.
To build your app correctly, you first need to think of the minimal set of mutable state that your app needs. The key here is DRY: *Don't Repeat Yourself*. Figure out the absolute minimal representation of the state your application needs and compute everything else you need on-demand. For example, if you're building a TODO list, keep an array of the TODO items around; don't keep a separate state variable for the count. Instead, when you want to render the TODO count, take the length of the TODO items array.

Think of all the pieces of data in our example application. We have:

- The original list of products
- The search text the user has entered
- The value of the checkbox
- The filtered list of products

Let's go through each one and figure out which one is state. Ask three questions about each piece of data:

1. Is it passed in from a parent via props? If so, it probably isn't state.
2. Does it remain unchanged over time? If so, it probably isn't state.
3. Can you compute it based on any other state or props in your component? If so, it isn't state.

The original list of products is passed in as props, so that's not state. The search text and the checkbox seem to be state since they change over time and can't be computed from anything. And finally, the filtered list of products isn't state because it can be computed by combining the original list of products with the search text and value of the checkbox.

So finally, our state is:

- The search text the user has entered
- The value of the checkbox

Step 4: Identify Where Your State Should Live

See the Pen Thinking In React: Step 4 on CodePen.
OK, so we've identified what the minimal set of app state is. Next, we need to identify which component mutates, or *owns*, this state.
Remember: React is all about one-way data flow down the component hierarchy. It may not be immediately clear which component should own what state. **This is often the most challenging part for newcomers to understand,** so follow these steps to figure it out:

For each piece of state in your application:

- Identify every component that renders something based on that state.
- Find a common owner component (a single component above all the components that need the state in the hierarchy).
- Either the common owner or another component higher up in the hierarchy should own the state.
- If you can't find a component where it makes sense to own the state, create a new component solely for holding the state and add it somewhere in the hierarchy above the common owner component.

Let's run through this strategy for our application:

- `ProductTable` needs to filter the product list based on state and `SearchBar` needs to display the search text and checked state.
- The common owner component is `FilterableProductTable`.
- It conceptually makes sense for the filter text and checked value to live in `FilterableProductTable`

Cool, so we've decided that our state lives in `FilterableProductTable`. First, add an instance property `this.state = {filterText: '', inStockOnly: false}` to `FilterableProductTable`'s `constructor` to reflect the initial state of your application. Then,
pass `filterText` and `inStockOnly` to `ProductTable` and `SearchBar` as a prop. Finally, use these props to filter the rows in `ProductTable` and set the values of the form fields in `SearchBar`.
You can start seeing how your application will behave:
set `filterText` to `"ball"` and refresh your app. You'll see that the data table is updated correctly.

Step 5: Add Inverse Data Flow

See the Pen Thinking In React: Step 5 on CodePen.
So far, we've built an app that renders correctly as a function of props and state flowing down the hierarchy. Now it's time to support data flowing the other way: the form components deep in the hierarchy need to update the state in `FilterableProductTable`.

React makes this data flow explicit to help you understand how your program works, but it does require a little more typing than traditional two-way data binding.

If you try to type or check the box in the current version of the example, you'll see that React ignores your input. This is intentional, as we've set the `value` prop of the `input` to always be equal to the `state` passed in from `FilterableProductTable`.

Let's think about what we want to happen. We want to make sure that whenever the user changes the form, we update the state to reflect the user input. Since components should only update their own state, `FilterableProductTable` will pass callbacks to `SearchBar` that will fire whenever the state should be updated. We can use the `onChange` event on the inputs to be notified of it. The callbacks passed by `FilterableProductTable` will call `setState()`, and the app will be updated.

And That's It

Hopefully, this gives you an idea of how to think about building components and applications with React. While it may be a little more typing than you're used to, remember that code is read far more than it's written, and it's less difficult to read this modular, explicit code. As you start to build large libraries of components, you'll appreciate this explicitness and modularity, and with code reuse, your lines of code will start to shrink. :)