# Optimizing Performance

Internally, React uses several clever techniques to minimize the number of costly DOM operations required to update the UI. For many applications, using React will lead to a fast user interface without doing much work to specifically optimize for performance. Nevertheless, there are several ways you can speed up your React application.

Use the Production Build

If you're benchmarking or experiencing performance problems in your React apps, make sure you're testing with the minified production build.

By default, React includes many helpful warnings. These warnings are very useful in development. However, they make React larger and slower so you should make sure to use the production version when you deploy the app.

If you aren't sure whether your build process is set up correctly, you can check it by installing React Developer Tools for Chrome. If you visit a site with React in production mode, the icon will have a dark background:
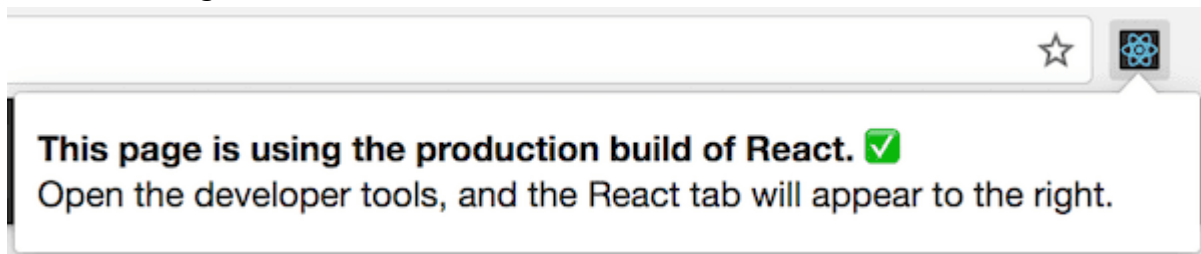
If you visit a site with React in development mode, the icon will have a red background:

> Note that the development build is not suitable for production. Make sure to use the production build before deployment.

It is expected that you use the development mode when working on your app, and the production mode when deploying your app to the users.

You can find instructions for building your app for production below.

Create React App

If your project is built with Create React App, run:

```
npm run build
```

This will create a production build of your app in the `build/` folder of your project.

Remember that this is only necessary before deploying to production. For normal development, use `npm start`.

Single-File Builds

We offer production-ready versions of React and React DOM as single files:

```
<script src="https://unpkg.com/react@16/umd/react.production.min.js"></script>
<script src="https://unpkg.com/react-dom@16/umd/react-dom.production.min.js"></script>
```

Remember that only React files ending with `.production.min.js` are suitable for production.

Brunch

For the most efficient Brunch production build, install the `terser-brunch` plugin:

```
# If you use npm
npm install --save-dev terser-brunch

# If you use Yarn
yarn add --dev terser-brunch
```

Then, to create a production build, add the `-p` flag to the `build` command:

```
brunch build -p
```

Remember that you only need to do this for production builds. You shouldn't pass the `-p` flag or apply this plugin in development, because it will hide useful React warnings and make the builds much slower.

Browserify

For the most efficient Browserify production build, install a few plugins:

```
# If you use npm
npm install --save-dev envify terser uglifyify

# If you use Yarn
yarn add --dev envify terser uglifyify
```
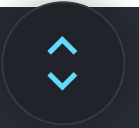
To create a production build, make sure that you add these transforms **(the order matters)**:

- The `envify` transform ensures the right build environment is set. Make it global (`-g`).

- The `uglifyify` transform removes development imports. Make it global too (`-g`).

- Finally, the resulting bundle is piped to `terser` for mangling (read why).

For example:

```
browserify ./index.js \
  -g [ envify --NODE_ENV production ] \
  -g uglifyify \
  | terser --compress --mangle > ./bundle.js
```

Remember that you only need to do this for production builds. You shouldn't apply these plugins in development because they will hide useful React warnings, and make the builds much slower.

Rollup

For the most efficient Rollup production build, install a few plugins:

```
# If you use npm
npm install --save-dev rollup-plugin-commonjs rollup-plugin-replace rollup-plugin-terser

# If you use Yarn
yarn add --dev rollup-plugin-commonjs rollup-plugin-replace rollup-plugin-terser
```

To create a production build, make sure that you add these plugins **(the order matters)**:

- The `replace` plugin ensures the right build environment is set.
- The `commonjs` plugin provides support for CommonJS in Rollup.
- The `terser` plugin compresses and mangles the final bundle.

```
plugins: [
  // ...
  require('rollup-plugin-replace')({
    'process.env.NODE_ENV': JSON.stringify('production')
  }),
  require('rollup-plugin-commonjs')(),
  require('rollup-plugin-terser')(),
  // ...
]
```

For a complete setup example see this gist.

Remember that you only need to do this for production builds. You shouldn't apply the `terser` plugin or the `replace` plugin with `'production'` value in development because they will hide useful React warnings, and make the builds much slower.
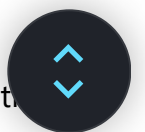
webpack

Webpack v4+ will minify your code by default in production mode.

```
const TerserPlugin = require('terser-webpack-plugin');

module.exports = {
  mode: 'production',
  optimization: {
    minimizer: [new TerserPlugin({ /* additional options here */ })],
  },
};
```

You can learn more about this in webpack documentation.

Remember that you only need to do this for production builds. You shouldn't apply `TerserPlugin` in development because it will hide useful React warnings, and make the builds much slower.

Profiling Components with the Chrome Performance Tab

In the **development** mode, you can visualize how components mount, update, and unmount, using the performance tools in supported browsers. For example:
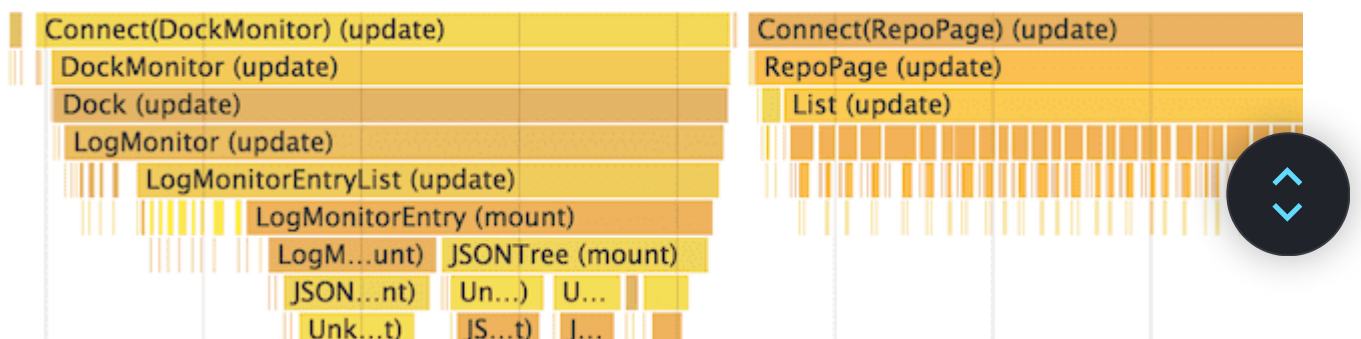
To do this in Chrome:

1. Temporarily **disable all Chrome extensions, especially React DevTools**. They can significantly skew the results!

2. Make sure you're running the application in the development mode.

3. Open the Chrome DevTools **Performance** tab and press **Record**.

4. Perform the actions you want to profile. Don't record more than 20 seconds or Chrome might hang.

5. Stop recording.

6. React events will be grouped under the **User Timing** label.

For a more detailed walkthrough, check out this article by Ben Schwarz.

Note that **the numbers are relative so components will render faster in production**. Still, this should help you realize when unrelated UI gets updated by mistake, and how deep and how often your UI updates occur.

Currently Chrome, Edge, and IE are the only browsers supporting this feature, but we use the standard User Timing API so we expect more browsers to add support for it.

Profiling Components with the DevTools Profiler

`react-dom` 16.5+ and `react-native` 0.57+ provide enhanced profiling capabilities in DEV mode with the React DevTools Profiler. An overview of the Profiler can be found in the blog post "Introducing the React Profiler". A video walkthrough of the profiler is also available on YouTube.

If you haven't yet installed the React DevTools, you can find them here:

- Chrome Browser Extension

- Firefox Browser Extension
- Standalone Node Package

> **Note**
>
> A production profiling bundle of `react-dom` is also available as `react-dom/profiling`. Read more about how to use this bundle at fb.me/react-profiling

Virtualize Long Lists

If your application renders long lists of data (hundreds or thousands of rows), we recommended using a technique known as "windowing". This technique only renders a small subset of your rows at any given time, and can dramatically reduce the time it takes to re-render the components as well as the number of DOM nodes created.

react-window and react-virtualized are popular windowing libraries. They provide several reusable components for displaying lists, grids, and tabular data. You can also create your own windowing component, like Twitter did, if you want something more tailored to your application's specific use case.

Avoid Reconciliation

React builds and maintains an internal representation of the rendered UI. It includes the React elements you return from your components. This representation lets React avoid creating DOM nodes and accessing existing ones beyond necessity, as that can be slower than operations on JavaScript objects. Sometimes it is referred to as a "virtual DOM", but it works the same way on React Native.

When a component's props or state change, React decides whether an actual DOM update is necessary by comparing the newly returned element with the previously rendered one. When
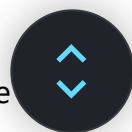
they are not equal, React will update the DOM.

Even though React only updates the changed DOM nodes, re-rendering still takes some time. In many cases it's not a problem, but if the slowdown is noticeable, you can speed all of this up by overriding the lifecycle function `shouldComponentUpdate`, which is triggered before the re-rendering process starts. The default implementation of this function returns `true`, leaving React to perform the update:

```
shouldComponentUpdate(nextProps, nextState) {
  return true;
}
```

If you know that in some situations your component doesn't need to update, you can return `false` from `shouldComponentUpdate` instead, to skip the whole rendering process, including calling `render()` on this component and below.

In most cases, instead of writing `shouldComponentUpdate()` by hand, you can inherit from `React.PureComponent`. It is equivalent to implementing `shouldComponentUpdate()` with a shallow comparison of current and previous props and state.

---

shouldComponentUpdate In Action

Here's a subtree of components. For each one, `SCU` indicates what `shouldComponentUpdate` returned, and `vDOMEq` indicates whether the rendered React elements were equivalent. Finally, the circle's color indicates whether the component had to be reconciled or not.
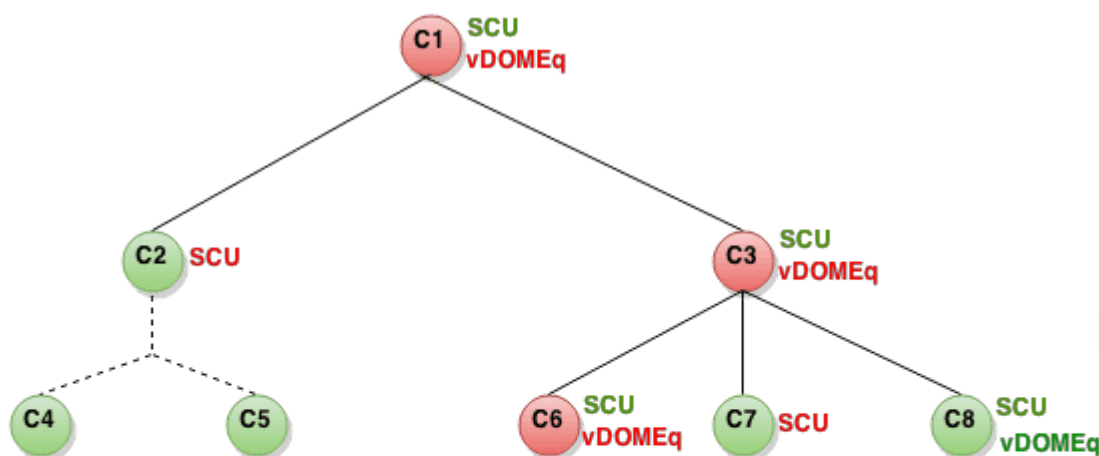
No Reconciliation needed

Reconciliation needed

SCU
SCU
shouldComponentUpdate?

vDOMEq
vDOMEq
are virtual DOMs equivalent?

Since `shouldComponentUpdate` returned `false` for the subtree rooted at C2, React did not attempt to render C2, and thus didn't even have to invoke `shouldComponentUpdate` on C4 and C5.

For C1 and C3, `shouldComponentUpdate` returned `true`, so React had to go down to the leaves and check them. For C6 `shouldComponentUpdate` returned `true`, and since the rendered elements weren't equivalent React had to update the DOM.

The last interesting case is C8. React had to render this component, but since the React elements it returned were equal to the previously rendered ones, it didn't have to update the DOM.

Note that React only had to do DOM mutations for C6, which was inevitable. For C8, it bailed out by comparing the rendered React elements, and for C2's subtree and C7, it didn't even have to compare the elements as we bailed out on `shouldComponentUpdate`, and `render` was not called.

Examples

If the only way your component ever changes is when the `props.color` or the `state.count` variable changes, you could have `shouldComponentUpdate` check that:

```
class CounterButton extends React.Component {
  constructor(props) {
    super(props);
    this.state = {count: 1};
  }

  shouldComponentUpdate(nextProps, nextState) {
    if (this.props.color !== nextProps.color) {
```
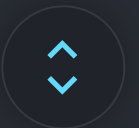
```
      return true;
    }
    if (this.state.count !== nextState.count) {
      return true;
    }
    return false;
  }

  render() {
    return (
      <button
        color={this.props.color}
        onClick={() => this.setState(state => ({count: state.count + 1}))}>
        Count: {this.state.count}
      </button>
    );
  }
}
```

In this code, `shouldComponentUpdate` is just checking if there is any change in `props.color` or `state.count`. If those values don't change, the component doesn't update. If your component got more complex, you could use a similar pattern of doing a "shallow comparison" between all the fields of `props` and `state` to determine if the component should update. This pattern is common enough that React provides a helper to use this logic - just inherit from `React.PureComponent`. So this code is a simpler way to achieve the same thing:

```
class CounterButton extends React.PureComponent {
  constructor(props) {
    super(props);
    this.state = {count: 1};
  }

  render() {
    return (
      <button
        color={this.props.color}
        onClick={() => this.setState(state => ({count: state.count + 1}))}>
        Count: {this.state.count}
      </button>
    );
  }
}
```

Most of the time, you can use `React.PureComponent` instead of writing your own `shouldComponentUpdate`. It only does a shallow comparison, so you can't use it if the props or state may have been mutated in a way that a shallow comparison would miss.

This can be a problem with more complex data structures. For example, let's say you want a `ListOfWords` component to render a comma-separated list of words, with a parent `WordAdder` component that lets you click a button to add a word to the list. This code does *not* work correctly:

```
class ListOfWords extends React.PureComponent {
  render() {
    return <div>{this.props.words.join(',')}</div>;
  }
}

class WordAdder extends React.Component {
  constructor(props) {
    super(props);
    this.state = {
      words: ['marklar']
    };
    this.handleClick = this.handleClick.bind(this);
  }

  handleClick() {
    // This section is bad style and causes a bug
    const words = this.state.words;
    words.push('marklar');
    this.setState({words: words});
  }

  render() {
    return (
      <div>
        <button onClick={this.handleClick} />
        <ListOfWords words={this.state.words} />
      </div>
    );
  }
}
```

The problem is that `PureComponent` will do a simple comparison between the old and new values of `this.props.words`. Since this code mutates the `words` array in the `handleClick`
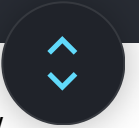
method of `WordAdder`, the old and new values of `this.props.words` will compare as equal, even though the actual words in the array have changed. The `ListOfWords` will thus not update even though it has new words that should be rendered.

The Power Of Not Mutating Data

The simplest way to avoid this problem is to avoid mutating values that you are using as props or state. For example, the `handleClick` method above could be rewritten using `concat` as:

```
handleClick() {
  this.setState(state => ({
    words: state.words.concat(['marklar'])
  }));
}
```

ES6 supports a spread syntax for arrays which can make this easier. If you're using Create React App, this syntax is available by default.

```
handleClick() {
  this.setState(state => ({
    words: [...state.words, 'marklar'],
  }));
};
```

You can also rewrite code that mutates objects to avoid mutation, in a similar way. For example, let's say we have an object named `colormap` and we want to write a function that changes `colormap.right` to be `'blue'`. We could write:

```
function updateColorMap(colormap) {
  colormap.right = 'blue';
}
```

To write this without mutating the original object, we can use Object.assign method:

```
function updateColorMap(colormap) {
  return Object.assign({}, colormap, {right: 'blue'});
}
```

updateColorMap now returns a new object, rather than mutating the old one. Object.assign is in ES6 and requires a polyfill.

There is a JavaScript proposal to add object spread properties to make it easier to update objects without mutation as well:

```
function updateColorMap(colormap) {
  return {...colormap, right: 'blue'};
}
```

If you're using Create React App, both Object.assign and the object spread syntax are available by default.

When you deal with deeply nested objects, updating them in an immutable way can feel convoluted. If you run into this problem, check out Immer or immutability-helper. These libraries let you write highly readable code without losing the benefits of immutability.

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