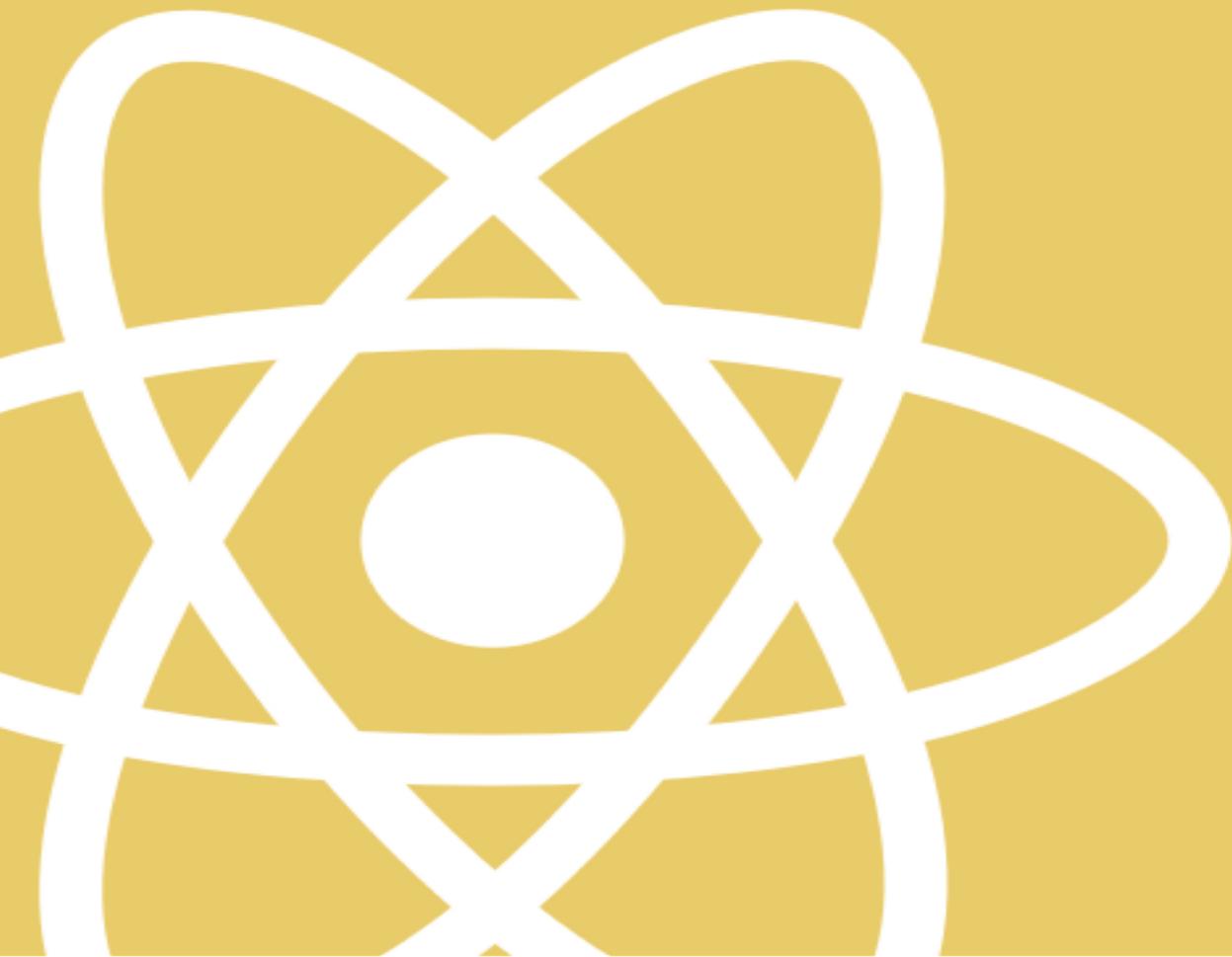


by robin wieruch

# the Road to learn React



# The Road to learn React

Robin Wieruch

This book is for sale at <http://leanpub.com/the-road-to-learn-react>

This version was published on 2017-03-10



Leanpub

This is a [Leanpub](#) book. Leanpub empowers authors and publishers with the Lean Publishing process. [Lean Publishing](#) is the act of publishing an in-progress ebook using lightweight tools and many iterations to get reader feedback, pivot until you have the right book and build traction once you do.

© 2016 - 2017 Robin Wieruch

# Tweet This Book!

Please help Robin Wieruch by spreading the word about this book on [Twitter!](#)

The suggested tweet for this book is:

I just bought *The Road to learn React* by [@rwieruch](#) [#ReactJs](#) [#JavaScript](#)

The suggested hashtag for this book is [#ReactJs](#) [#JavaScript](#).

Find out what other people are saying about the book by clicking on this link to search for this hashtag on Twitter:

[https://twitter.com/search?q=#ReactJs #JavaScript](https://twitter.com/search?q=#ReactJs%20#JavaScript)

# Contents

Foreword . . . . .	i
FAQ . . . . .	ii
Change Log . . . . .	iii
How to read it? . . . . .	iv
What you can expect (so far..) . . . . .	v
<b>Introduction to React . . . . .</b>	<b>1</b>
Hi, my name is React. . . . .	2
Requirements . . . . .	4
node and npm . . . . .	5
Installation . . . . .	7
Zero-Configuration Setup . . . . .	8
Introduction to JSX . . . . .	11
ES6 const and let . . . . .	14
ReactDOM . . . . .	16
Hot Module Reloading . . . . .	17
Complex JavaScript in JSX . . . . .	19
ES6 Arrow Functions . . . . .	23
ES6 Classes . . . . .	25
<b>Basics in React . . . . .</b>	<b>28</b>
Internal Component State . . . . .	29
ES6 Object_INITIALIZER . . . . .	31
Unidirectional Data Flow . . . . .	33
Interactions with Forms and Events . . . . .	37
ES6 Destructuring . . . . .	44
Controlled Components . . . . .	46
Split Up Components . . . . .	48
Composeable Components . . . . .	51
Reusable Components . . . . .	53
Component Declarations . . . . .	56

## CONTENTS

Styling Components . . . . .	59
<b>Getting Real with an API . . . . .</b>	<b>66</b>
Lifecycle Methods . . . . .	67
Fetching Data . . . . .	69
ES6 Spread Operators . . . . .	73
Conditional Rendering . . . . .	76
Client- or Server-side Search . . . . .	79
Paginated Fetch . . . . .	83
Client Cache . . . . .	87
<b>Code Organization and Testing . . . . .</b>	<b>95</b>
ES6 Modules: Import and Export . . . . .	96
Code Organization with ES6 Modules . . . . .	100
Component Interface with PropTypes . . . . .	105
Snapshot Tests with Jest . . . . .	109
Unit Tests with Enzyme . . . . .	114
<b>Advanced React Components . . . . .</b>	<b>117</b>
Ref a DOM Element . . . . .	118
Loading ... . . . .	122
Higher Order Components . . . . .	126
Advanced Sorting . . . . .	130
<b>State Management in React and beyond . . . . .</b>	<b>144</b>
Lifting State . . . . .	145
Revisited: setState() . . . . .	152
Taming the State . . . . .	157
<b>Final Steps to Production . . . . .</b>	<b>159</b>
Eject . . . . .	160
Deploy your App . . . . .	161
<b>Final Words . . . . .</b>	<b>162</b>

# Foreword

I love to teach, even though I am no expert. I learn every day and I have the fortune to have great mentors. After all not everyone has the opportunity to learn from mentors and peers. The book is my attempt to give something back. It might help people to get started and advance in React.

**But why me?** In the past I have written a large tutorial to implement a [SoundCloud Client in React + Redux](#)<sup>1</sup>. I never expected the overwhelming reaction. I learned a lot during the process of writing. But even more by getting your feedback. It was my first attempt to teach people in programming.

It also taught me to do better. I realized the SoundCloud tutorial is suited for advanced developers. It uses several tools to bootstrap your application and dives quickly into Redux. Still it helped a lot of people to get started. In my opinion it is a great tutorial to get a bigger picture of React + Redux. I use every free minute to improve the material, but it is time consuming.

In the Road to learn React I want to offer a foundation before you start to dive into the broader React ecosystem. It has less tooling and less external state management, but a lot of information around React. It explains general concepts, patterns and best practices.

You will learn to build your own Hacker News application. It covers real world features like pagination, client-side caching and interactions like searching and sorting. Additionally you will transition from JavaScript ES5 to JavaScript ES6 on the way. In conclusion, the book should give you a solid foundation in React before you dive into more advanced topics like Redux. I hope this book captures my enthusiasm for React and JavaScript and helps you to get started.

---

<sup>1</sup><https://www.robinwieruch.de/the-soundcloud-client-in-react-redux>

# FAQ

**How do I get updates?** You can [subscribe](#)<sup>2</sup> to my Newsletter or follow me on [Twitter](#)<sup>3</sup> to get updates. It keeps me motivated to continue. Once you have a copy of the book, it will stay updated. But you have to download the copy again when an update is announced. I will notify everyone by a [Newsletter](#)<sup>4</sup> and [Twitter](#)<sup>5</sup>.

**Does it cover Redux?** It doesn't. The book should give you a solid foundation before you dive into advanced topics. Still the implementation in the book will show you that you don't need Redux to build an application. After you have read the book, you should be able to implement a solid application without Redux. You can pre-order my next book to support me: [The Road to learn Redux](#)<sup>6</sup>.

**Does it use JavaScript ES6?** Yes. But don't worry. You will be fine if you are familiar with JavaScript ES5. All JavaScript ES6 features I describe on the journey to learn React will transition from ES5 to ES6 in the book. Every feature along the way will be explained. The book does not only teach React, but also all useful JavaScript ES6 features for React.

**Why is the book pay what you want?** I have put a lot of effort into this and will do so in the future. My desire is to reach as many people as possible. Everyone should be enabled to learn React. Still you could pay - if you can afford it - because it already took me a lot of my time to write and improve the book.

**Will you add more chapters in the future?** You can have a look at the Change Log chapter for major updates that already happened. There will be unannounced improvements in between all the time. In general it depends on the community whether I continue to work on the book. If there is an acceptance for the book, I will deliver more chapters and improve the old material. I will keep the content up to date with recent best practices, concepts and patterns. I would love to hear your thoughts about possible chapters to improve and enrich the learning experience.

**Can I help to improve it?** Yes. You can have a direct impact with your thoughts and [contributions on GitHub](#)<sup>7</sup>. I don't claim to be an expert nor to write in native English. I would appreciate your help very much.

**What are the reading formats?** In addition to the .pdf, .epub, and .mobi formats, you can read it in pure markdown on [GitHub](#)<sup>8</sup>. In general, I recommend reading it on a suitable format, otherwise the code snippets will have ugly line breaks.

---

<sup>2</sup><https://www.getrevue.co/profile/rwieruch>

<sup>3</sup><https://twitter.com/rwieruch>

<sup>4</sup><https://www.getrevue.co/profile/rwieruch>

<sup>5</sup><https://twitter.com/rwieruch>

<sup>6</sup><https://gumroad.com/products/uwiyl>

<sup>7</sup><https://github.com/rwieruch/the-road-to-learn-react>

<sup>8</sup><https://github.com/rwieruch/the-road-to-learn-react>

# Change Log

## 10. January 2017:

- [v2 Pull Request](#)<sup>9</sup>
- even more beginner friendly
- 37% more content
- 30% improved content
- 13 improved and new chapters
- 140 pages of learning material
- + [interactive course of the book on educative.io](#)<sup>10</sup>

## 08. March 2017:

- [v3 Pull Request](#)<sup>11</sup>
- 20% more content
- 25% improved content
- 9 new chapters
- 170 pages of learning material

---

<sup>9</sup><https://github.com/rwieruch/the-road-to-learn-react/pull/18>

<sup>10</sup><https://www.educative.io/collection/5740745361195008/5676830073815040>

<sup>11</sup><https://github.com/rwieruch/the-road-to-learn-react/pull/34>

# How to read it?

The book is my attempt to teach React while you will write an application. It is a practical guide to learn React and not a reference work about React. You will write a Hacker News application that interacts with a real world API. Among several interesting topics, it covers state management in React, caching and interactions (sorting and searching). On the way you will learn best practices and patterns in React.

In addition, the book gives you a transition from JavaScript ES5 to JavaScript ES6. React embraces a lot of JavaScript ES6 features and I want to show you how you can use them.

In general each chapter of the book will build up on the previous chapter. Each chapter will teach you something new. Don't rush through the book. You should internalize each step. You could apply your own implementations and read more about the topic. After each chapter I give you some reading material and exercises. If you really want to learn React, I highly recommend to read the extra material and do some hands on exercises. After you have read a chapter, make yourself comfortable with the learnings before you continue.

In the end you will have a complete React application in production. I am very keen to see your results, so please text me when you have finished the book. The final chapter of the book will give you a handful of options to continue your React journey. In general you will find a lot of React related topics on [my personal website](#)<sup>12</sup>.

Since you are reading the book, I guess you are new to React. That's perfect. In the end I hope to get your feedback to improve the material to enable everyone to learn React. You can have a direct impact on [GitHub](#)<sup>13</sup> or text me on [Twitter](#)<sup>14</sup>.

---

<sup>12</sup><https://www.robinwieruch.de/>

<sup>13</sup><https://github.com/rwieruch/the-road-to-learn-react>

<sup>14</sup><https://twitter.com/rwieruch>

# What you can expect (so far...)

- [Hacker News App in React<sup>15</sup>](#)
- no complicated configurations
- create-react-app to bootstrap your application
- efficient lightweight code
- only React setState as state management (so far...)
- transition from JavaScript ES5 to ES6 along the way
- the React API with setState and lifecycle methods
- interaction with a real world API (Hacker News)
- advanced user interactions
  - client-sided sorting
  - client-sided filtering
  - server-sided searching
- implementation of client-side caching
- higher order functions and higher order components
- snapshot test components with Jest
- unit test components with Enzyme
- neat libraries along the way
- exercises and more readings along the way
- internalize and reinforce your learnings
- deploy your application to production

---

<sup>15</sup><https://intense-refuge-78753.herokuapp.com/>

# Introduction to React

The chapter gives you an introduction to React. You may ask yourself: Why should I learn React in the first place? The chapter might give you the answer to that question. Afterward you will dive into the ecosystem by bootstrapping your first React application. Along the way you will get an introduction to JSX and ReactDOM. Be prepared for your first React component.

## Hi, my name is React.

**Why should you bother to learn React?** In recent years single page applications (SPA<sup>16</sup>) have become popular. Frameworks like Angular, Ember and Backbone helped JavaScript developers to build modern web applications beyond the usage of jQuery. The list is not exhaustive. There exists a wide range of SPA frameworks. When you consider the release dates, most of them are among the first generation of SPAs: Angular 2010, Backbone 2010, Ember 2011.

The initial React release was 2013 by Facebook. React is not an SPA framework but a view library. It is the V in the MVC<sup>17</sup> (model view controller). It only enables you to render components as viewable elements in a browser. Yet the whole ecosystem around React makes it possible to build single page applications.

But why should you consider using React over the first generation of SPA frameworks? While the first generation of frameworks tried to solve a lot of things at once, React only helps you to build your view layer. It's a library and not a framework. The idea behind it: Your view is a hierarchy of composable components.

In React you can focus on your view before you introduce more aspects to your application. Every other aspect is another building block for your SPA. These building blocks are essential to build a mature application. They come with two advantages.

First you can learn the building blocks step by step. You don't have to worry about understanding them altogether. It is different from a framework that gives you every building block from the start. This book focuses on React as the first building block. More building blocks follow eventually.

Second all building blocks are interchangeable. It makes the ecosystem around React such an innovative place. Multiple solutions are competing with each other. You can pick the most appealing solution for you and your use case.

The first generation of SPA frameworks arrived at an enterprise level. They are more rigid. React stays innovative and gets adopted by multiple tech thought leader companies like [Airbnb](#), [Netflix](#) and of course [Facebook](#)<sup>18</sup>. All of them invest in the future of React and are content with React and the ecosystem itself.

React is probably one of the best choices for building single page applications nowadays. It only delivers the view layer, but the React ecosystem is a whole flexible and interchangeable framework. React has a slim API, an amazing ecosystem and a great community. You can read about my experiences [why I moved from Angular to React](#)<sup>19</sup>. I highly recommend to have an understanding why you would choose React over another framework or library. After all everyone is keen to experience where React will lead us in 2017 and beyond.

---

<sup>16</sup>[https://en.wikipedia.org/wiki/Single-page\\_application](https://en.wikipedia.org/wiki/Single-page_application)

<sup>17</sup>[https://de.wikipedia.org/wiki/Model\\_View\\_Controller](https://de.wikipedia.org/wiki/Model_View_Controller)

<sup>18</sup><https://github.com/facebook/react/wiki/Sites-Using-React>

<sup>19</sup><https://www.robinwieruch.de/reasons-why-i-moved-from-angular-to-react/>

## Exercises

- read about [why I moved from Angular to React](https://www.robinwieruch.de/reasons-why-i-moved-from-angular-to-react/)<sup>20</sup>

---

<sup>20</sup><https://www.robinwieruch.de/reasons-why-i-moved-from-angular-to-react/>

## Requirements

Before you start to read the book, you should be familiar with HTML, CSS and JavaScript (ES5). The book will teach JavaScript ES6 and beyond. If you are coming from a different SPA framework or library, you should already be familiar with the basics. If you have just started in web development, you should feel comfortable with HTML, CSS and JavaScript ES5 to learn React.

Every developer needs tools to build applications. You will need an editor (IDE) and terminal (command line) tool. You can read my developer setup to organize your tools: [Developer Setup](#)<sup>21</sup>. It is adjusted for Mac users, but you can substitute most of the tools for other operating system.

The editor is used to organize and write your code. The terminal is used to execute commands. A command can be to start your application, to run tests or to install other libraries for your project.

Last but not least you will need an installation of [node and npm](#)<sup>22</sup>. Both are used to manage libraries you will need along the way to learn React. You will install external node packages via npm (node package manager). These node packages can be libraries or whole frameworks.

You can verify your versions of node and npm on the command line. If you don't get any output in the terminal, you need to install node and npm first. These are my versions:

### Command Line

---

```
node --version
*v7.4.0
npm --version
*v4.0.5
```

---

---

<sup>21</sup><https://www.robinwieruch.de/developer-setup/>

<sup>22</sup><https://nodejs.org/en/>

## node and npm

This chapter gives you a little crash course in node and npm. It is not exhaustive, but you will get all the necessary tools. If you are familiar with both of them, you can skip the chapter.

The **node package manager** (npm) allows you to install external **node packages** from the command line. These packages can be a set of utility functions, libraries or whole frameworks. They are the dependencies of your application. You can either install these packages to your global node package folder or to your local project folder.

Global node packages are accessible from everywhere in the terminal and you have to install them only once. You can install a global package by typing in your terminal:

### Command Line

---

```
npm install -g <package>
```

---

The `-g` flag tells npm to install the package globally. Local packages are used in your application. For instance, React as a library will be a local package which can be required in your application for usage. You can install it via the terminal by typing:

### Command Line

---

```
npm install <package>
```

---

In the case of React it would be:

### Command Line

---

```
npm install react
```

---

The installed package will automatically appear in a folder called *node\_modules/*. But be careful. Whenever you install a local package you shouldn't forget the neat `--save` flag:

### Command Line

---

```
npm install --save <package>
```

---

The `--save` flag tells npm to store the package requirement in a file called *package.json*. The file can be found in your project folder.

Not every project folder comes with a *package.json* file though. There is a npm command to initialize a npm project and thus a *package.json* file. Only when you have that file, you can install new local packages via npm.

### Command Line

---

```
npm init -y
```

---

The `-y` flag is a shortcut to initialize all the defaults in your `package.json`. If you don't use it, you have to decide how to configure the file.

One more word about the `package.json`. The file enables you to share your project with other developers without sharing all the node packages. The file has all the references of node packages used in your project. These packages are called dependencies. Everyone can copy your project without the dependencies. The dependencies are references in the `package.json`. Someone who copies your project can install all packages by using `npm install` on the command line.

I want to cover one more npm command to prevent confusion:

### Command Line

---

```
npm install --save-dev <package>
```

---

The `--save-dev` flag indicates that the node package is only used in the development environment. It will not be used in production when you deploy your application on a server. What kind of node package could that be? Imagine you want to test your application with the help of a node package. You need to install that package via npm, but want to exclude it from your production environment. There you don't want to test your application anymore. It should be tested already and work out of the box for users. That's only one use case where you would want to use the `--save-dev` flag.

You will encounter more npm commands on your way. But these will be sufficient for now.

## Exercises:

- setup a throw away npm project
  - create a new folder with `mkdir <folder_name>`
  - navigate into the folder with `cd <folder_name>`
  - execute `npm init -y`
  - install a local package like React with `npm install --save react`
  - have a look into the `package.json` file and the `node_modules/` folder
  - find out how to uninstall the `react` node package
- read more about [npm](https://docs.npmjs.com/)<sup>23</sup>

---

<sup>23</sup><https://docs.npmjs.com/>

## Installation

There are multiple approaches to get started with a React application.

The first one is to use a CDN. That may sound more complicated than it is. A CDN is a [content delivery network](#)<sup>24</sup>. Several companies have CDNs that host files publicly for users. These files can be libraries like React. After all a library can be only one JavaScript file. It can be hosted somewhere and you can require it in your application.

How to use a CDN to get started in React? You can inline the `<script>` tag in your HTML that points to a CDN url. To get started in React you need two files (libraries): *react* and *react-dom*.

### Code Playground

---

```
<script src="https://unpkg.com/react@15/dist/react.js"></script>
<script src="https://unpkg.com/react-dom@15/dist/react-dom.js"></script>
```

---

But why should you use a CDN when you have npm to install node packages (libraries)?

When your application has a *package.json* file, you can install *react* and *react-dom* from the command line. The requirement is that the folder is initialized as npm project with a *package.json* file. You can install multiple node packages in one line with npm.

### Command Line

---

```
npm install --save react react-dom
```

---

That approach is often used to add React to an existing application.

Unfortunately that's not everything. You would have to deal with [Babel](#)<sup>25</sup> to make your application aware of JSX - the React syntax - and JavaScript ES6. Babel transpiles your code that browsers can interpret ES6 and JSX. Not all browsers are capable of interpreting the syntax. The setup includes a lot of configuration and tooling. It can be overwhelming for React beginners to bother with all the configuration.

Because of this reason, Facebook introduced *create-react-app* as a zero-configuration React solution. The next chapter will show you how to setup your application.

## Exercises:

- read more about [React installations](#)<sup>26</sup>

---

<sup>24</sup>[https://en.wikipedia.org/wiki/Content\\_delivery\\_network](https://en.wikipedia.org/wiki/Content_delivery_network)

<sup>25</sup><http://babeljs.io/>

<sup>26</sup><https://facebook.github.io/react/docs/installation.html>

## Zero-Configuration Setup

In the Road to learn React you will use [create-react-app](https://github.com/facebookincubator/create-react-app)<sup>27</sup> to bootstrap your application. It's an opinionated yet zero-configuration starter kit for React introduced by Facebook in 2016. People would [recommend it to beginners by 96%](https://twitter.com/dan_abramov/status/806985854099062785)<sup>28</sup>. In *create-react-app* the tooling and configuration evolve in the background while the focus is on the application implementation.

To get started, you will have to install the package to your global node packages. After that you always have it available on the command line to bootstrap new React applications.

### Command Line

---

```
npm install -g create-react-app
```

---

You can check the version of *create-react-app* to verify a successful installation on your command line:

### Command Line

---

```
create-react-app --version
```

---

It should give you an output about the version.

Now you can bootstrap your first React application. We call it *hackernews*, but you can choose a different name. Afterward simply navigate into the folder:

### Command Line

---

```
create-react-app hackernews  
cd hackernews
```

---

Now you can open the application in your editor. The following folder structure should be presented to you:

---

<sup>27</sup><https://github.com/facebookincubator/create-react-app>

<sup>28</sup>[https://twitter.com/dan\\_abramov/status/806985854099062785](https://twitter.com/dan_abramov/status/806985854099062785)

## Folder Structure

---

```
hackernews/  
  README.md  
  node_modules/  
  package.json  
  .gitignore  
  public/  
    favicon.ico  
    index.html  
  src/  
    App.css  
    App.js  
    App.test.js  
    index.css  
    index.js  
    logo.svg
```

---

In the beginning everything you need is located in the *src/* folder.

The main focus lies on the *src/App.js* file to implement React components. It will be used to implement your application, but later you might want to split up your components into multiple files.

Additionally you will find a *src/App.test.js* file for tests and a *src/index.js* as entry point to the React world. You will get to know both files in a later chapter. In addition, there is a *src/index.css* and a *src/App.css* file to style your application and components. They all come with default style when you open them.

Next to the *src/* folder you will find the *package.json* file and *node\_modules/* folder to manage your node packages. The *create-react-app* application is a npm project. You can use npm to install and uninstall node packages to your project.

The *create-react-app* project comes with the following npm scripts for your command line:

### Command Line

---

```
// Runs the application in http://localhost:3000  
npm start  
  
// Runs the tests  
npm test  
  
// Builds the application for production  
npm run build
```

---

The scripts are defined in your *package.json* too. Your boilerplate React application is bootstrapped now.

## Exercises:

- `npm start` your application and visit the page in your browser
- run the interactive `npm test` script
- make yourself familiar with the folder structure
- make yourself familiar with the content of the files
- read more about [the scripts and create-react-app](https://github.com/facebookincubator/create-react-app)<sup>29</sup>

---

<sup>29</sup><https://github.com/facebookincubator/create-react-app>

## Introduction to JSX

Now you will get to know JSX. It is the syntax in React. As I mentioned before, *create-react-app* has already bootstrapped a boilerplate application. All files come with default implementations. Let's dive into the source code.

The only file you will touch in the beginning will be the *src/App.js* file.

*src/App.js*

---

```
import React, { Component } from 'react';
import logo from './logo.svg';
import './App.css';

class App extends Component {
  render() {
    return (
      <div className="App">
        <div className="App-header">
          <img src={logo} className="App-logo" alt="logo" />
          <h2>Welcome to React</h2>
        </div>
        <p className="App-intro">
          To get started, edit <code>src/App.js</code> and save to reload.
        </p>
      </div>
    );
  }
}

export default App;
```

---

Don't let yourself get confused by the import/export statements and class declaration. These features are already JavaScript ES6. We will revisit those in a later chapter.

In the file you have an **ES6 class component** with the name *App*. It is a component declaration. Basically after you have declared a component, you can use it as element everywhere in your application. It will produce an **instance** of your **component** or in other words: the component gets instantiated.

The **element** it returns is specified in the *render()* method. Elements are what components are made of. It is useful to understand the differences between component, instance and element.

Pretty soon you will see where the *App* component is used. Otherwise you wouldn't see the rendered output in the browser, would you? The *App* component is only the declaration, but not the usage. You would instantiate the component somewhere in your JSX with *<App />*.

The content in the render block looks pretty similar to HTML, but it's JSX. JSX allows you to mix HTML and JavaScript. It's powerful yet confusing when you are used to plain HTML. That's why a good starting point is to use basic HTML in your JSX. Next you can start to embed JavaScript expressions in between by using curly braces.

First let's remove all the clutter in the file.

src/App.js

---

```
import React, { Component } from 'react';
import './App.css';

class App extends Component {
  render() {
    return (
      <div className="App">
        <h2>Welcome to React</h2>
      </div>
    );
  }
}

export default App;
```

---

Now you only return HTML without JavaScript. Let's make the "Welcome to React" a variable. A variable can be used in your JSX.

src/App.js

---

```
import React, { Component } from 'react';
import './App.css';

class App extends Component {
  render() {
    var helloWorld = 'Welcome to React';
    return (
      <div className="App">
        <h2>{helloWorld}</h2>
      </div>
    );
  }
}

export default App;
```

---

It should work when you start your application on the command line.

Additionally you might have noticed the `className` attribute. It reflects the standard `class` attribute in HTML. Because of technical reasons, JSX had to replace a handful of internal HTML attributes. You can find all of the [supported HTML attributes in the React documentation](#)<sup>30</sup>. On your way to learn React you will come across some more JSX attributes.

## Exercises:

- define more variables and render them in your JSX
  - use a complex object to represent an user with a first name and last name
- read more about [JSX](#)<sup>31</sup>
- read more about [React components, elements and instances](#)<sup>32</sup>

---

<sup>30</sup><https://facebook.github.io/react/docs/dom-elements.html>

<sup>31</sup><https://facebook.github.io/react/docs/introducing-jsx.html>

<sup>32</sup><https://facebook.github.io/react/blog/2015/12/18/react-components-elements-and-instances.html>

## ES6 const and let

I guess you noticed that we declared the variable `helloWorld` with `var`. JavaScript ES6 comes with two more options to declare your variables: `const` and `let`. In JavaScript ES6 you will rarely find `var` anymore. Let's get some explanation for `const` and `let`:

A variable declared with `const` cannot be re-assigned or re-declared. It cannot get mutated (changed, modified). You embrace immutable data structures by using it. Once the data structure is defined, you cannot change it.

### Code Playground

---

```
// not allowed
const helloWorld = 'Welcome to React';
helloWorld = 'Bye Bye React';
```

---

A variable declared with `let` can get mutated.

### Code Playground

---

```
// allowed
let helloWorld = 'Welcome to React';
helloWorld = 'Bye Bye React';
```

---

You would use it when you would need to re-assign a variable.

However, you have to be careful with `const`. A variable declared with `const` cannot get modified. But when the variable is an array or object, the value it holds can get altered. The value it holds is not immutable.

### Code Playground

---

```
// allowed
const helloWorld = {
  text: 'Welcome to React'
};
helloWorld.text = 'Bye Bye React';
```

---

But when to use each declaration? There are different opinions about the usage. I suggest to use `const` whenever you can. It indicates that you want to keep your data structure immutable even though values in objects and arrays can get modified. If you want to modify your variable, you can use `let`.

Immutability is embraced in React and its ecosystem. That's why `const` should be your default choice when you define a variable. Still, in complex objects the values within can get modified. Be careful about this behavior.

In your application you should use `const` over `var`.

**src/App.js**

---

```
import React, { Component } from 'react';
import './App.css';

class App extends Component {
  render() {
    const helloWorld = 'Welcome to React';
    return (
      <div className="App">
        <h2>{helloWorld}</h2>
      </div>
    );
  }
}

export default App;
```

---

**Exercises:**

- read more about ES6 [const](https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Statements/const)<sup>33</sup>
- read more about ES6 [let](https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Statements/let)<sup>34</sup>
- research more about immutable data structures
  - why do they make sense in programming in general
  - why are they used in React and its ecosystem

---

<sup>33</sup><https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Statements/const>

<sup>34</sup><https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Statements/let>

## ReactDOM

Before you continue with the App component, you might want to see where it is used. It is located in your entry point to the React world: the `src/index.js` file.

`src/index.js`

---

```
import React from 'react';
import ReactDOM from 'react-dom';
import App from './App';
import './index.css';
```

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

---

Basically `ReactDOM.render()` uses a DOM node in your HTML to replace it with your JSX. That's how you can easily integrate React in every foreign application. It is not forbidden to use `ReactDOM.render()` multiple times across your application. You can use it at multiple places to bootstrap simple JSX syntax, a React component, multiple React components or a whole application.

`ReactDOM.render()` expects two arguments.

The first argument is JSX that gets rendered. The second argument specifies the place where the React application hooks into your HTML. It expects an element with an `id='root'`. You can open your `public/index.html` file to find the id attribute.

In the implementation `ReactDOM.render()` already takes your App component. However, it would be fine to pass simpler JSX as long as it is JSX. It doesn't have to be an instantiation of a component.

### Code Playground

---

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

---

## Exercises:

- open the `public/index.html` to see where the React applications hooks into your HTML
- read more about [rendering elements in React](https://facebook.github.io/react/docs/rendering-elements.html)<sup>35</sup>

---

<sup>35</sup><https://facebook.github.io/react/docs/rendering-elements.html>

## Hot Module Reloading

There is one thing that you can do in the `src/index.js` file to improve your experience as a developer.

In `create-react-app` it is already an advantage that the browser automatically refreshes the page when you change your source code. Try it by changing the `helloWorld` variable in your `src/App.js` file. The browser should refresh the page. But you can do better.

Hot Module Reloading (HMR) is a tool to reload your application in the browser. The browser doesn't perform a page refresh. You can easily activate it in `create-react-app`. In your `src/index.js` - your entry point to React - you have to add one little configuration.

`src/index.js`

---

```
import React from 'react';
import ReactDOM from 'react-dom';
import App from './App';
import './index.css';
```

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

```
if (module.hot) {
  module.hot.accept()
}
```

---

That's it. Try again to change the `helloWorld` variable in your `src/App.js` file. The browser shouldn't perform a page refresh, but the application reloads and shows the correct output.

HMR comes with multiple advantages.

Imagine you are debugging your code with `console.log()` statements. These statements will stay in your developer console, even though you change your code, because the browser doesn't refresh the page anymore. That can be convenient for debugging purposes.

In a growing application a page refresh delays your productivity. You have to wait until the page loads. A page reload can take several seconds in a large application. HMR takes away this disadvantage.

The biggest benefit is that you can keep the application state with HMR. Imagine you have a dialog in your application with multiple steps and you are at step 3. Basically it is a wizard. Without HMR you would change the source code and your browser refreshes the page. You would have to open the dialog again and would have to navigate from step 1 to step 3. With HMR your dialog stays open at step 3. It keeps the application state even though the source code changes. The application itself reloads, but not the page.

## Exercises:

- change your *src/App.js* source code a few times to see HMR in action
- watch the first 10 minutes of [Live React: Hot Reloading with Time Travel](https://www.youtube.com/watch?v=xsSnOQynTHs)<sup>36</sup> by Dan Abramov

---

<sup>36</sup><https://www.youtube.com/watch?v=xsSnOQynTHs>

## Complex JavaScript in JSX

Let's get back to your App component. So far you rendered some primitive variables in your JSX. Now you will start to render a list of items. The list will be artificial data in the beginning, but later you will fetch the data from an external API. That will be far more exciting.

First you have to define the list of items.

src/App.js

---

```
import React, { Component } from 'react';
import './App.css';

const list = [
  {
    title: 'React',
    url: 'https://facebook.github.io/react/',
    author: 'Jordan Walke',
    num_comments: 3,
    points: 4,
    objectID: 0,
  },
  {
    title: 'Redux',
    url: 'https://github.com/reactjs/redux',
    author: 'Dan Abramov, Andrew Clark',
    num_comments: 2,
    points: 5,
    objectID: 1,
  },
];

class App extends Component {
  ...
}
```

---

The artificial data will reflect the data we will fetch later on from the API. An item in the list has a title, an url and a author. Additionally it comes with an identifier, points (which indicate how popular an article is) and a count of comments.

Now you can use the built-in JavaScript `map` functionality in your JSX. It enables you to iterate over your list of items to display them. As mentioned, you will use curly braces to encapsulate the JavaScript expression in your JSX.

**src/App.js**

---

```
class App extends Component {

  render() {
    return (
      <div className="App">
        { list.map(function(item) {
          return <div>{item.title}</div>;
        })}
      </div>
    );
  }
}

export default App;
```

---

That's pretty powerful in JSX. Usually you might have used `map` to convert one list of items to another list of items. This time you use `map` to convert a list of items to HTML elements.

So far, only the `title` will be displayed for each item. But let's display some more of the item properties.

**src/App.js**

---

```
class App extends Component {

  render() {
    return (
      <div className="App">
        { list.map(function(item) {
          return (
            <div>
              <span>
                <a href={item.url}>{item.title}</a>
              </span>
              <span>{item.author}</span>
              <span>{item.num_comments}</span>
              <span>{item.points}</span>
            </div>
          );
        })}
      </div>
    );
  }
}

export default App;
```

---

```
    );  
  }  
}  
  
export default App;
```

---

You can see how the map function is simply inlined in your JSX. Each item property is displayed in a `<span>` tag. Moreover the url property of the item is used in the `href` attribute of the anchor tag.

React will do all the work for you and display each item. But you should add one helper for React to embrace its full potential and improve its performance. You have to assign a key attribute to each list element. Only that way React is able to identify added, changed and removed items when the list changes. The artificial list items come with an identifier already.

src/App.js

---

```
{ list.map(function(item) {  
  return (  
    <div key={item.objectID}>  
      <span>  
        <a href={item.url}>{item.title}</a>  
      </span>  
      <span>{item.author}</span>  
      <span>{item.num_comments}</span>  
      <span>{item.points}</span>  
    </div>  
  );  
}})
```

---

You should make sure that the key attribute is a stable identifier. Don't make the mistake of using the item index in the array. The array index isn't stable at all. For instance, when the list changes its order, React will have a hard time identifying the items properly.

src/App.js

---

```
// don't do this  
{ list.map(function(item, key) {  
  return (  
    <div key={key}>  
      ...  
    </div>  
  );  
}})
```

---

You are displaying both list items now. You can start your app, open your browser and see both items of the list displayed.

## Exercises:

- read more about [React lists and keys](https://facebook.github.io/react/docs/lists-and-keys.html)<sup>37</sup>
- recap the [standard built-in Array functionalities in JavaScript](https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects/Array/map)<sup>38</sup>
- use more JavaScript expressions on your own in JSX

---

<sup>37</sup><https://facebook.github.io/react/docs/lists-and-keys.html>

<sup>38</sup>[https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global\\_Objects/Array/map](https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects/Array/map)

## ES6 Arrow Functions

JavaScript ES6 introduced arrow functions. An arrow function expression is shorter than a function expression.

### Code Playground

---

```
// function expression
function () { ... }

// arrow function expression
() => { ... }
```

---

But you have to be aware of its functionalities. One of them is a different behavior with the `this` object. A function expression always defines its own `this` object. Arrow function expressions still have the `this` object of the enclosing context. Don't get confused when using `this` in an arrow function.

There is another valuable fact about arrow functions regarding the parenthesis. You can remove the parenthesis when the function gets only one argument, but have to keep them when it gets multiple arguments.

### Code Playground

---

```
// allowed
item => { ... }

// allowed
(item) => { ... }

// not allowed
item, key => { ... }

// allowed
(item, key) => { ... }
```

---

However, let's have a look at the `map` function. You can write it more concisely with an ES6 arrow function.

src/App.js

---

```
{ list.map(item => {  
  return (  
    <div key={item.objectID}>  
      <span>  
        <a href={item.url}>{item.title}</a>  
      </span>  
      <span>{item.author}</span>  
      <span>{item.num_comments}</span>  
      <span>{item.points}</span>  
    </div>  
  );  
}}}
```

---

Additionally you can remove the *block body* of the ES6 arrow function. In a *concise body* an implicit return is attached thus you can remove the return statement. That will happen more often in the book, so be sure to understand the difference between a block body and a concise body.

src/App.js

---

```
{ list.map(item =>  
  <div key={item.objectID}>  
    <span>  
      <a href={item.url}>{item.title}</a>  
    </span>  
    <span>{item.author}</span>  
    <span>{item.num_comments}</span>  
    <span>{item.points}</span>  
  </div>  
)}
```

---

Your JSX looks more concise and readable now. It omits the function statement, the curly braces and the return statement.

## Exercises:

- read more about [ES6 arrow functions](https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Functions/Arrow_functions)<sup>39</sup>

---

<sup>39</sup>[https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Functions/Arrow\\_functions](https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Functions/Arrow_functions)

## ES6 Classes

JavaScript ES6 introduced classes. A class is commonly used in object-oriented programming languages. JavaScript was and is very flexible in its programming paradigms. You can do functional programming and object-oriented programming side by side for their particular use cases.

Even though React embraces functional programming, for instance with immutable data structures, classes are used to declare components. They are called ES6 class components. React mixes the good parts of both programming paradigms.

Let's consider the following Developer class to examine a JavaScript ES6 class without thinking about a component.

### Code Playground

---

```
class Developer {
  constructor(firstname, lastname) {
    this.firstname = firstname;
    this.lastname = lastname;
  }

  getName() {
    return this.firstname + ' ' + this.lastname;
  }
}
```

---

A class has a constructor to make it instantiable. The constructor can take arguments to assign it to the class instance. Additionally a class can define functions. Because the function is associated with a class, it is called a method. Sometimes it is referenced as class method.

The Developer class is only the class declaration. You can create multiple instances of the class by invoking it. It is similar to the ES6 class component, that has a declaration, but you have to use it somewhere else to instantiate it.

Let's see how you can instantiate the class and how you can use its methods.

### Code Playground

---

```
const robin = new Developer('Robin', 'Wieruch');
console.log(robin.getName());
// output: Robin Wieruch
```

---

React uses JavaScript ES6 classes for ES6 class components. You already used one ES6 class component.

src/App.js

---

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

...

class App extends Component {
  render() {
    ...
  }
}
```

---

The App class extends from Component. Basically you declare the App component, but it extends from another component. What does extend mean? In object-oriented programming you have the principle of inheritance. It is used to pass over functionalities from one class to another class.

The App class extends functionality from the Component class. To be more specific, it inherits functionalities from the Component class. The Component is used to extend a basic ES6 class to a ES6 component class. It has all the functionalities a component needs to have. One of these functionalities, a method, you have already used: the `render()` method. But you will learn about more functionalities.

The Component class encapsulates all the React functionalities that a developer doesn't need to see. It enables developers to use classes as components in React.

The methods a React Component exposes is the public interface. One of these methods has to be overwritten, the others don't need to be overwritten. You will learn about the latter ones when the book arrives at lifecycle methods in a later chapter. The `render()` method has to be overwritten, because it defines the output of a React Component.

Now you know the basics around JavaScript ES6 classes and how they are used in React to extend them to components. As I said, you will learn more about the Component methods when the book describes React lifecycle methods.

## Exercises:

- read more about [ES6 classes](https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Classes)<sup>40</sup>

---

<sup>40</sup><https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Classes>

You have learned to bootstrap your own React application! Let's recap the last chapters:

- React
  - create-react-app bootstraps a React application
  - JSX mixes up HTML and JavaScript to define React components
  - components, instances and elements are different things
  - ReactDOM.render() is an entry point for a React application
  - built-in JavaScript functionalities can be used in JSX
    - \* map can be used to render a list of items as HTML elements
- ES6
  - variable declarations with const and let for particular use cases
  - arrow functions can be used to shorten your function declarations
  - classes are used to define components in React

It makes sense to take a break at this point. Internalize the learnings and apply them on your own. You can experiment with the source code you have written so far.

You can find the source code in the [official repository](https://github.com/rwieruch/hackernews-client)<sup>41</sup>.

---

<sup>41</sup><https://github.com/rwieruch/hackernews-client/tree/0c5a701170dcc72fe68bdd594df3a6522f58fbb3>

# Basics in React

The chapter will guide you through the basics of React. It covers state and interactions in components, because static components are a bit dull, aren't they? Additionally you will learn about the different ways to declare a component and how to keep components composable and reusable. Be prepared to breathe life into your components.

## Internal Component State

Internal component state allows you to store, modify and delete properties of your component. The ES6 class component can use a constructor to initialize internal component state. The constructor is called only once when the component initializes.

Let's introduce a class constructor where you can set the initial internal component state.

src/App.js

---

```
class App extends Component {  
  
  constructor(props) {  
    super(props);  
  
    this.state = {  
      list: list,  
    };  
  
  }  
  
  ...  
  
}
```

---

In your case the initial state is the artificial list of items. Note that you have to call `super(props)`; to call the constructor of the extended `Component` class. It's mandatory, because it sets `this.props` in your constructor. You should follow the best practice, otherwise you might run into bugs in the future.

The state is bound to the class with the `this` object. You can access the state in your component. For instance, it can be used in the `render()` method. Before you have mapped a static list of items. Now you are about to use the list from your internal component state.

src/App.js

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    return (  
      <div className="App">  
        { this.state.list.map(item =>
```

---

```
    <div key={item.objectID}>
      <span>
        <a href={item.url}>{item.title}</a>
      </span>
      <span>{item.author}</span>
      <span>{item.num_comments}</span>
      <span>{item.points}</span>
    </div>
  )}
</div>
);
}
```

---

The list is part of the component now. It resides in the internal component state. You could add items, change items or remove items in and from your list. Every time you change your component state, the `render()` method of your component will run again. That's how you can simply change your internal component state and be sure that the component re-renders.

But be careful. Don't mutate the state directly. You have to use a method called `setState()` to modify your state. You will get to know it in a following chapter.

## Exercises:

- experiment with the internal state
  - define more initial state in the constructor
  - use the state in your `render()` method
- read more about [the ES6 class constructor](https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Classes#Constructor)<sup>42</sup>

---

<sup>42</sup><https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Classes#Constructor>

## ES6 Object\_INITIALIZER

In JavaScript ES6 you can use a shorthand property syntax to initialize your objects more concise. Imagine the following object initialization:

### Code Playground

---

```
const name = 'Robin';

const user = {
  name: name,
};
```

---

When the property name in your object can be the same as your variable name, you can do the following:

### Code Playground

---

```
const name = 'Robin';

const user = {
  name,
};
```

---

In your application you can do the same. The list variable name and the state property name share the same name.

### Code Playground

---

```
// ES5
this.state = {
  list: list,
};

// ES6
this.state = {
  list,
};
```

---

Another neat helper are shorthand method names. In ES6 you can initialize methods in an object more concise.

### Code Playground

---

```
// ES5
var userService = {
  getUserName: function (user) {
    return user.firstname + ' ' + user.lastname;
  },
};

// ES6
const userService = {
  getUserName(user) {
    return user.firstname + ' ' + user.lastname;
  },
};
```

---

Last but not least, you are allowed to use computed property names in ES6.

### Code Playground

---

```
// ES5
var user = {
  name: 'Robin',
};

// ES6
const key = 'name';
const user = {
  [key]: 'Robin',
};
```

---

Computed property names might make no sense yet. Why should you need it? In a future chapter in the book you will come to a point where you can use it.

## Exercises:

- experiment with ES6 object initializer
- read more about [ES6 object initializer](https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Operators/Object_initializer)<sup>43</sup>

---

<sup>43</sup>[https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Operators/Object\\_initializer](https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Operators/Object_initializer)

## Unidirectional Data Flow

Now you have some internal state in your App component. However, you have not manipulated the internal state yet. The state is static and thus is the component. A good way to experience state manipulation is to have some component interaction.

Let's add a button for each item in the displayed list. The button says "Dismiss" and will remove the item from the list. It could be useful eventually when you only want to keep a list of unread items.

src/App.js

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    return (  
      <div className="App">  
        { this.state.list.map(item =>  
          <div key={item.objectID}>  
            <span>  
              <a href={item.url}>{item.title}</a>  
            </span>  
            <span>{item.author}</span>  
            <span>{item.num_comments}</span>  
            <span>{item.points}</span>  
            <span>  
              <button  
                onClick={() => this.onDismiss(item.objectID)}  
                type="button"  
              >  
                Dismiss  
              </button>  
            </span>  
          </div>  
        )}  
      </div>  
    );  
  }  
}
```

---

As you can see the `onDismiss()` method in the `onClick` function gets enclosed by another function. Only that way you can sneak in the `objectID` property. Otherwise you would have to define the function outside. However, by using an ES6 arrow function you can inline it.

Note that elements with multiple attributes get messy as one line at some point. That's why the button element is already used with multilines and indentation to keep it readable. But it is not mandatory. It is only a code style recommendation.

Now you have to implement the `onDismiss()` functionality. It takes an item id to identify the item to dismiss. The function is bound to the class and thus becomes a class method. You have to bind class methods in the constructor. Additionally you have to define its functionality in your class.

`src/App.js`

---

```
class App extends Component {  
  
  constructor(props) {  
    super(props);  
  
    this.state = {  
      list,  
    };  
  
    this.onDismiss = this.onDismiss.bind(this);  
  }  
  
  onDismiss(id) {  
    ...  
  }  
  
  render() {  
    ...  
  }  
}
```

---

Now you can define what happens inside of the class method. Since you want to remove the clicked item from your list, you can do that with the built-in array filter functionality. The filter function takes a function to evaluate each item in the list. If the evaluation for an item is true, the item stays in the list. Otherwise it will get removed. Additionally the function returns a new list and doesn't mutate the old list. It keeps the immutable data structure.

src/App.js

---

```
onDismiss(id) {  
  
  function isNotId(item) {  
    return item.objectID !== id;  
  }  
  
  const updatedList = this.state.list.filter(isNotId);  
}
```

---

You can do it more concise by using an ES6 arrow function again.

src/App.js

---

```
onDismiss(id) {  
  const isNotId = item => item.objectID !== id;  
  const updatedList = this.state.list.filter(isNotId);  
}
```

---

You could even inline it - like we did in the `onClick()` handler of the button - but it might get less readable.

src/App.js

---

```
onDismiss(id) {  
  const updatedList = this.state.list.filter(item => item.objectID !== id);  
}
```

---

The list removes the clicked item now. However the state isn't updated yet. Therefore you can finally use the `setState()` class method to update the list in the internal component state.

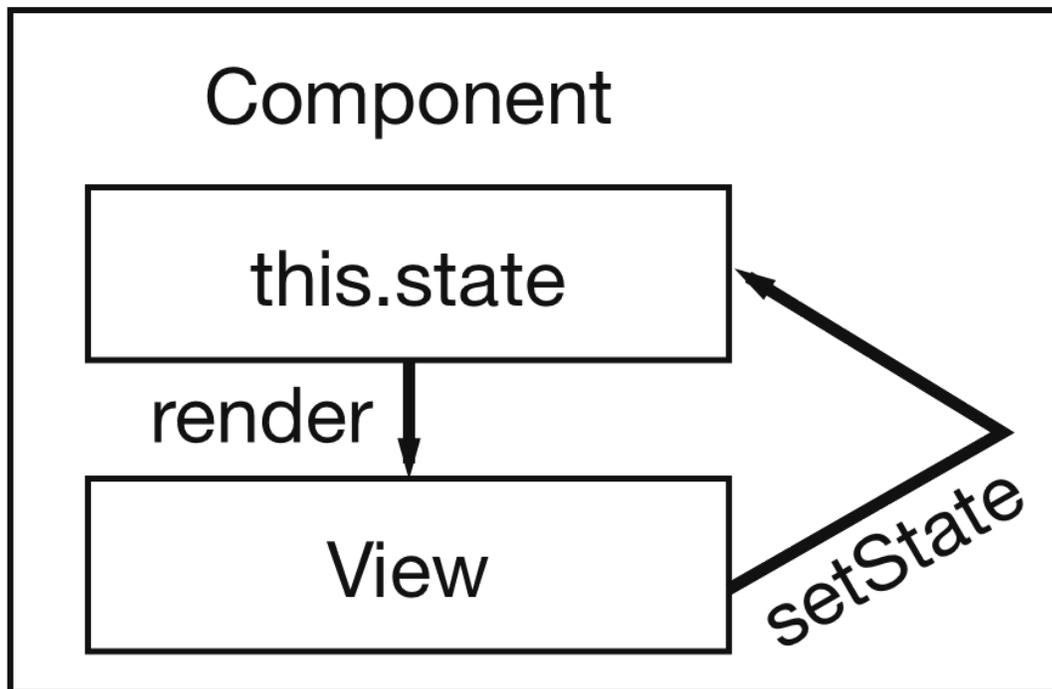
src/App.js

---

```
onDismiss(id) {  
  const isNotId = item => item.objectID !== id;  
  const updatedList = this.state.list.filter(isNotId);  
  this.setState({ list: updatedList });  
}
```

---

Now run again your application and try the “Dismiss” button. It should work. What you experience now is the **unidirectional data flow** in React. You trigger an action in your view - with `onClick()` - a function or class method modifies the internal component state and the `render()` method of the component runs again to update the view.



Internal state update with unidirectional data flow

## Exercises:

- read more about [the state and lifecycle in React](https://facebook.github.io/react/docs/state-and-lifecycle.html)<sup>44</sup>

---

<sup>44</sup><https://facebook.github.io/react/docs/state-and-lifecycle.html>

## Interactions with Forms and Events

Let's add another interaction to experience forms and events in React. The interaction is a search functionality. The input of the search field should be used to filter your list based on the title property of an item.

First you define your input field in your JSX.

src/App.js

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    return (  
      <div className="App">  
        <form>  
          <input type="text" />  
        </form>  
        { this.state.list.map(item =>  
          ...  
        )}  
      </div>  
    );  
  }  
}
```

---

In the following scenario you will type into the field and filter the list temporary by the search term. To be able to filter the list, you need the value of the input field to update the state. But how do you access the value? You can use **synthetic events** in React to access the event payload.

Let's define an onChange() callback function for the input field.

src/App.js

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    return (  
      <div className="App">  
        <form>
```

```
        <input
          type="text"
          onChange={this.onSearchChange}
        />
      </form>
      ...
    </div>
  );
}
```

---

The function is bound to the component and thus a class method again. You have to bind and define the method.

src/App.js

---

```
class App extends Component {

  constructor(props) {
    super(props);

    this.state = {
      list,
    };

    this.onSearchChange = this.onSearchChange.bind(this);
    this.onDismiss = this.onDismiss.bind(this);
  }

  onSearchChange() {
    ...
  }

  ...
}
```

---

The method argument gives you access to the synthetic React event. The event has the value of the input field in its target object. Now you can manipulate the state for the search term:

src/App.js

---

```
class App extends Component {  
  
  ...  
  
  onSearchChange(event) {  
    this.setState({ searchTerm: event.target.value });  
  }  
  
  ...  
}
```

---

Additionally you have to define the initial state for the `searchTerm` in the constructor.

src/App.js

---

```
class App extends Component {  
  
  constructor(props) {  
    super(props);  
  
    this.state = {  
      list,  
      searchTerm: '',  
    };  
  
    this.onSearchChange = this.onSearchChange.bind(this);  
    this.onDismiss = this.onDismiss.bind(this);  
  }  
  
  ...  
}
```

---

Now you store the input value to your internal component state every time the value in the input field changes. However, the list doesn't update yet. You have to filter the list temporary based on the `searchTerm`. That's fairly simple. Before you map the list you can apply a filter on it. You have already used the built-in JavaScript filter functionality.

**src/App.js**

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    return (  
      <div className="App">  
        <form>  
          <input  
            type="text"  
            onChange={this.onSearchChange}  
          />  
        </form>  
        { this.state.list.filter(...).map(item =>  
          ...  
        )}  
      </div>  
    );  
  }  
}
```

---

Let's approach the filter function in a different way this time. We want to define the filter argument - the function - outside of our ES6 class component. There we don't have access to the state of the component - thus we have no access to the `searchTerm` property to evaluate the filter condition. We have to pass the `searchTerm` to the filter function and have to return a new function to evaluate the condition. That's called a higher order function.

Normally I wouldn't mention higher order functions, but in a React book it makes totally sense. It makes sense to know about higher order functions, because React deals with a concept called higher order components. You will get to know the concept later in the book. Now again, let's focus on the filter functionality.

First you have to define the higher order function outside of your class.

src/App.js

---

```
function isSearched(searchTerm) {  
  return function(item) {  
    // some condition which returns true or false  
  }  
}
```

```
class App extends Component {  
  
  ...  
  
}
```

---

The function takes the `searchTerm` and returns another function which takes an item. The returned function will be used to filter the list based on the condition defined in the function.

Let's define the condition.

src/App.js

---

```
function isSearched(searchTerm) {  
  return function(item) {  
    return !searchTerm ||  
           item.title.toLowerCase().includes(searchTerm.toLowerCase());  
  }  
}
```

```
class App extends Component {  
  
  ...  
  
}
```

---

The condition says multiple things. You filter the list only when a `searchTerm` is set. When a `searchTerm` is set, you match the incoming `searchTerm` pattern with the title of the item. You can do that with the built-in `includes` JavaScript functionality. Only when the pattern matches, you return true and the item stays in the list. But be careful with pattern matching: You shouldn't forget to lower case both strings. Otherwise there will be mismatches between a search term 'redux' and an item title 'Redux'.

One thing is left to mention: We cheated a bit by using the built-in `includes` JavaScript functionality. It is already an ES6 feature. How would that look like in JavaScript ES5? You would use the `indexOf()` function to get the index of the item in the list. When the item is in the list, `indexOf()` will return a positive index.

### Code Playground

---

```
// ES5
string.indexOf(pattern) !== -1
```

```
// ES6
string.includes(pattern)
```

---

Another neat refactoring can be done with an ES6 arrow function again. It makes the function more concise:

### Code Playground

---

```
// ES5
function isSearched(searchTerm) {
  return function(item) {
    return !searchTerm || item.title.toLowerCase().includes(searchTerm.toLowerCase());
  }
}
```

```
// ES6
const isSearched = (searchTerm) => (item) =>
  !searchTerm || item.title.toLowerCase().includes(searchTerm.toLowerCase());
```

---

One could argue which function is more readable. Personally I prefer the second one. The React ecosystem uses a lot of functional programming concepts. It happens often that you will use a function which returns a function (higher order functions). In ES6 you can express these more concise with arrow functions.

Last but not least, you have to use the defined `isSearched()` function to filter your list.

### src/App.js

---

```
class App extends Component {
  ...

  render() {
    return (
      <div className="App">
        <form>
          <input
```

```
        type="text"
        onChange={this.onSearchChange}
      />
    </form>
    { this.state.list.filter(isSearched(this.state.searchTerm)).map(item =>
      ...
    )}
  </div>
);
}
```

---

The search functionality should work now. Try it.

## Exercises:

- read more about [React events](https://facebook.github.io/react/docs/handling-events.html)<sup>45</sup>
- read more about [higher order functions](https://en.wikipedia.org/wiki/Higher-order_function)<sup>46</sup>

---

<sup>45</sup><https://facebook.github.io/react/docs/handling-events.html>

<sup>46</sup>[https://en.wikipedia.org/wiki/Higher-order\\_function](https://en.wikipedia.org/wiki/Higher-order_function)

## ES6 Destructuring

There is a way in ES6 to access properties in objects and arrays easier. It's called destructuring. Compare the following snippet in JavaScript ES5 and ES6.

### Code Playground

---

```
const user = {
  firstname: 'Robin',
  lastname: 'Wieruch',
};

// ES5
var firstname = user.firstname;
var lastname = user.lastname;

// ES6
const { firstname, lastname } = user;

console.log(firstname + ' ' + lastname);
// output: Robin Wieruch
```

---

While you have to add an extra line each time you want to access an object property in ES5, you can do it in one line in ES6. Additionally you don't have to have duplicated property names. A best practice for readability is to use multilines when you destructure an object into multiple properties.

### Code Playground

---

```
const {
  firstname,
  lastname
} = user;
```

---

The same goes for arrays. You can destructure them too, but keep it more readable with multilines.

### Code Playground

---

```
const users = ['Robin', 'Andrew', 'Dan'];
const [
  userOne,
  userTwo,
  userThree
] = users;

console.log(userOne, userTwo, userThree);
// output: Robin Andrew Dan
```

---

Perhaps you have noticed that the state in the App component can get destructured the same way. You can shorten the filter and map line of code.

### src/App.js

---

```
render() {
  const { searchTerm, list } = this.state;
  return (
    <div className="App">
      ...
      { list.filter(isSearched(searchTerm)).map(item =>
        ...
      )}
    </div>
  );
}
```

---

You can do it the ES5 or ES6 way:

### Code Playground

---

```
// ES5
var searchTerm = this.state.searchTerm;
var list = this.state.list;

// ES6
const { searchTerm, list } = this.state;
```

---

But since the book uses JavaScript ES6 most of the time, you should stick to ES6.

## Exercises:

- read more about [ES6 destructuring](https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Operators/Destructuring_assignment)<sup>47</sup>

---

<sup>47</sup>[https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Operators/Destructuring\\_assignment](https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Operators/Destructuring_assignment)

## Controlled Components

You already learned about the unidirectional data flow in React. The same law applies for the input field, which updates the state that in turn filters the list. The state was changed, the `render()` method runs again and uses the recent `searchTerm` state to apply the filter condition.

But didn't we forget something in the input element? A HTML input tag comes with a `value` attribute. The value attribute usually has the value that is shown in the input field - in our case the `searchTerm` property. However, it seems like we don't need that in React.

That's wrong. Form elements such as `<input>`, `<textarea>` and `<select>` hold their own state. They modify the value internally once someone changes it from the outside. In React that's called an **uncontrolled component**, because it handles its own state. In React you should make sure to make those elements **controlled components**.

How should you do that? You only have to set the value attribute of the input field. The value is already saved in the `searchTerm` state property.

`src/App.js`

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    const { searchTerm, list } = this.state;  
    return (  
      <div className="App">  
        <form>  
          <input  
            type="text"  
            value={searchTerm}  
            onChange={this.onSearchChange}  
          />  
        </form>  
        ...  
      </div>  
    );  
  }  
}
```

---

That's it. The unidirectional data flow cycle for the input field is self-contained now. The internal component state is the single source of truth for the input field.

The whole internal state management and unidirectional data flow might be new to you. But once you are used to it, it will be your natural flow to implement things in React. In general, React brought a novel pattern with the unidirectional data flow to the world of single page applications. It is adopted by several frameworks and libraries.

## Exercises:

- read more about [React forms](https://facebook.github.io/react/docs/forms.html)<sup>48</sup>

---

<sup>48</sup><https://facebook.github.io/react/docs/forms.html>

## Split Up Components

You have one large App component now. It keeps growing and can be confusing eventually. You can start to split it up into chunks - smaller components.

Let's start to use a component for the search input and a component for the list of items.

src/App.js

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    const { searchTerm, list } = this.state;  
    return (  
      <div className="App">  
        <Search />  
        <Table />  
      </div>  
    );  
  }  
}
```

---

You can pass those components properties which they can use themselves.

src/App.js

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    const { searchTerm, list } = this.state;  
    return (  
      <div className="App">  
        <Search  
          value={searchTerm}  
          onChange={this.onSearchChange}  
        />  
        <Table  
          list={list}  
          pattern={searchTerm}  
          onDismiss={this.onDismiss}  
        />  
      </div>  
    );  
  }  
}
```

```
        />
      </div>
    );
  }
}
```

---

Now you can define the components next to your App component. Those components will be ES6 class components as well. They render the same elements like before.

The first one is the Search component.

src/App.js

---

```
class App extends Component {
  ...
}

class Search extends Component {
  render() {
    const { value, onChange } = this.props;
    return (
      <form>
        <input
          type="text"
          value={value}
          onChange={onChange}
        />
      </form>
    );
  }
}
```

---

The second one is the Table component.

src/App.js

---

```
...  
  
class Table extends Component {  
  render() {  
    const { list, pattern, onDismiss } = this.props;  
    return (  
      <div>  
        { list.filter(isSearched(pattern)).map(item =>  
          <div key={item.objectID}>  
            <span>  
              <a href={item.url}>{item.title}</a>  
            </span>  
            <span>{item.author}</span>  
            <span>{item.num_comments}</span>  
            <span>{item.points}</span>  
            <span>  
              <button  
                onClick={() => onDismiss(item.objectID)}  
                type="button"  
              >  
                Dismiss  
              </button>  
            </span>  
          </div>  
        )}  
      </div>  
    );  
  }  
}
```

---

Now you have three ES6 class components. Perhaps you have noticed the `this.props` object. The `props` - short form for properties - have all the values you have passed to the components when you used them in your `App` component. You could reuse these components somewhere else but pass them different values. They are reusable.

## Exercises:

- figure out which components you could split up
  - but don't do it now, otherwise you will run into conflicts in the next chapters

## Composable Components

There is one more little property which is accessible in the props object: the `children` prop. You can use it to pass elements to your components from above - which are unknown to the component itself - but make it possible to compose components into each other. Let's see how this looks like when you only pass a text (string) as a child to the Search component.

src/App.js

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    const { searchTerm, list } = this.state;  
    return (  
      <div className="App">  
        <Search  
          value={searchTerm}  
          onChange={this.onSearchChange}  
        >  
          Search  
        </Search>  
        <Table  
          list={list}  
          pattern={searchTerm}  
          onDismiss={this.onDismiss}  
        />  
      </div>  
    );  
  }  
}
```

---

Now the Search component can destructure the children property from props. Then it can specify where the children should be displayed.

**src/App.js**

---

```
class Search extends Component {
  render() {
    const { value, onChange, children } = this.props;
    return (
      <form>
        {children} <input
          type="text"
          value={value}
          onChange={onChange}
        />
      </form>
    );
  }
}
```

---

The “Search” text should be visible next to your input field now. When you use the Search component somewhere else, you can choose a different text if you like. After all it is not only text that you can pass as children. You can pass an element and element trees (which can be encapsulated by components again) as children. The children property makes it possible to weave components into each other.

**Exercises:**

- read more about [the composition model of React](https://facebook.github.io/react/docs/composition-vs-inheritance.html)<sup>49</sup>

---

<sup>49</sup><https://facebook.github.io/react/docs/composition-vs-inheritance.html>

## Reusable Components

Reusable and composable components empower you to come up with capable component hierarchies. They are the foundation of your view layer. The last chapters mentioned often the term reusability. You can reuse the Table and Search components already. Not to forget the App component.

Let's define one more reusable component - a Button component - which gets reused more often eventually.

src/App.js

---

```
class Button extends Component {
  render() {
    const {
      onClick,
      className,
      children,
    } = this.props;

    return (
      <button
        onClick={onClick}
        className={className}
        type="button"
      >
        {children}
      </button>
    );
  }
}
```

---

It might seem redundant to declare such a component. You will use a Button instead of a button. It only spares the `type="button"`. Except for the type attribute you have to define everything else when you want to use the Button component. But you have to think about the long term investment here. Imagine you have several buttons in your application, but want to change an attribute, style or behavior for the button. Without the component you would have to refactor every button. Instead the Button component ensures to have only one single source of truth. One Button to refactor all buttons at once.

Since you already have a button element, you can use the Button component instead. It omits the type attribute.

**src/App.js**

---

```
class Table extends Component {
  render() {
    const { list, pattern, onDismiss } = this.props;
    return (
      <div>
        { list.filter(isSearched(pattern)).map(item =>
          <div key={item.objectID}>
            <span>
              <a href={item.url}>{item.title}</a>
            </span>
            <span>{item.author}</span>
            <span>{item.num_comments}</span>
            <span>{item.points}</span>
            <span>
              <Button onClick={() => onDismiss(item.objectID)}>
                Dismiss
              </Button>
            </span>
          </div>
        )}
      </div>
    );
  }
}
```

---

The Button component expects a `className` property in the props. But we didn't pass any `className` when the Button was used. It should be more explicit in the Button component that the `className` is optional.

You can use a JavaScript ES6 feature: the default parameter.

**src/App.js**

---

```
class Button extends Component {
  render() {
    const {
      onClick,
      className = '',
      children,
    } = this.props;
```

```
    ...  
  }  
}
```

---

Now, whenever there is no `className` property, the value will be an empty string.

## Exercises:

- read more about [ES6 default parameters](https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Functions/Default_parameters)<sup>50</sup>

---

<sup>50</sup>[https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Functions/Default\\_parameters](https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Functions/Default_parameters)

## Component Declarations

By now you have four ES6 class components. But you can do better. Let me introduce functional stateless components as alternative for ES6 class components. Before you will refactor your components, let's introduce the different types of components.

- **Functional Stateless Components:** These components are functions which get an input and return an output. The input is the props object. The output is a component instance. So far it is quite similar to an ES6 class component. However, functional stateless components are functions (functional) and they have no internal state (stateless). You cannot access the state with `this.state` because there is no `this` object. Additionally they have no lifecycle methods. You didn't learn about lifecycle methods yet, but you already used two: `constructor()` and `render()`. Keep this fact about functional stateless components in mind, when you arrive at the lifecycle methods chapter later on.
- **ES6 Class Components:** You already used this type of component declaration. In the class definition they extend from the React component. The `extend` hooks all the lifecycle methods - available in the React component API - to the component. As I mentioned, you already used two of them. Additionally you can store and manipulate state in ES6 class components.
- **React.createClass:** The component declaration was used in older versions of React and still in JavaScript ES5 React applications. But [Facebook declared it as deprecated<sup>51</sup>](#) in favor of ES6. You will not use it in the book.

But when to use functional stateless components over ES6 class components? A rule of thumb is to use functional stateless components when you don't need internal component state or component lifecycle methods. Usually you start to implement your components as functional stateless components. Once you need access to the state or lifecycle methods, you have to refactor it to an ES6 class component.

Let's get back to your application. The App component uses internal state. That's why it has to stay as an ES6 class component. But the other three of your ES6 class components are stateless without lifecycle methods. Let's refactor together the Search component to a stateless functional component. The Table and Button component refactoring will remain as your exercise.

---

<sup>51</sup><https://facebook.github.io/react/blog/2015/03/10/react-v0.13.html>

src/App.js

---

```
function Search(props) {
  const { value, onChange, children } = props;
  return (
    <form>
      {children} <input
        type="text"
        value={value}
        onChange={onChange}
      />
    </form>
  );
}
```

---

That's basically it. But you can do more code wise in a functional stateless component. You already know the ES6 destructuring. The best practice is to use it in the function signature to destructure the props.

src/App.js

---

```
function Search({ value, onChange, children }) {
  return (
    <form>
      {children} <input
        type="text"
        value={value}
        onChange={onChange}
      />
    </form>
  );
}
```

---

But it can get better. You know already that ES6 arrow functions allow you to keep your functions concise. You can remove the block body of the function. In a concise body an implicit return is attached thus you can remove the return statement. Since your functional stateless component is a function, you can keep it concise as well.

src/App.js

---

```
const Search = ({ value, onChange, children }) =>
  <form>
    {children} <input
      type="text"
      value={value}
      onChange={onChange}
    />
  </form>
```

---

The last step was especially useful to enforce only to have props as input and an element as output. Nothing in between. Still, you could *do something* in between by using a block body in your ES6 arrow function.

Code Playground

---

```
const Search = ({ value, onChange, children }) => {

  // do something

  return (
    <form>
      {children} <input
        type="text"
        value={value}
        onChange={onChange}
      />
    </form>
  );
}
```

---

But you don't need it for now. That's why you can keep the previous version without the block body. Now you have one lightweight functional stateless component. Once you would need access to its internal component state or lifecycle methods, you would refactor it to an ES6 class component. In addition you saw how JavaScript ES6 can be used in React components to make them more elegant.

## Exercises:

- refactor the Table and Button component to stateless functional components
- read more about [ES6 class components and functional stateless components](https://facebook.github.io/react/docs/components-and-props.html)<sup>52</sup>

---

<sup>52</sup><https://facebook.github.io/react/docs/components-and-props.html>

## Styling Components

Let's add some basic styling to your application and components. You can reuse the `src/App.css` and `src/index.css` files. I prepared some CSS to copy and paste, but feel free to use your own style.

`src/index.css`

---

```
body {
  color: #222;
  background: #f4f4f4;
  font: 400 14px CoreSans, Arial, sans-serif;
}

a {
  color: #222;
}

a:hover {
  text-decoration: underline;
}

ul, li {
  list-style: none;
  padding: 0;
  margin: 0;
}

input {
  padding: 10px;
  border-radius: 5px;
  outline: none;
  margin-right: 10px;
  border: 1px solid #dddddd;
}

button {
  padding: 10px;
  border-radius: 5px;
  border: 1px solid #dddddd;
  background: transparent;
  color: #808080;
  cursor: pointer;
}
```

```
button:hover {
  color: #222;
}

*:focus {
  outline: none;
}
```

---

#### src/App.css

---

```
.page {
  margin: 20px;
}

.interactions {
  text-align: center;
}

.table {
  margin: 20px 0;
}

.table-header {
  display: flex;
  line-height: 24px;
  font-size: 16px;
  padding: 0 10px;
  justify-content: space-between;
}

.table-empty {
  margin: 200px;
  text-align: center;
  font-size: 16px;
}

.table-row {
  display: flex;
  line-height: 24px;
  white-space: nowrap;
  margin: 10px 0;
}
```

```
padding: 10px;
background: #ffffff;
border: 1px solid #e3e3e3;
}

.table-header > span {
  overflow: hidden;
  text-overflow: ellipsis;
  padding: 0 5px;
}

.table-row > span {
  overflow: hidden;
  text-overflow: ellipsis;
  padding: 0 5px;
}

.button-inline {
  border-width: 0;
  background: transparent;
  color: inherit;
  text-align: inherit;
  -webkit-font-smoothing: inherit;
  padding: 0;
  font-size: inherit;
  cursor: pointer;
}

.button-active {
  border-radius: 0;
  border-bottom: 1px solid #38BB6C;
}
```

---

Now you can use the style in some of your components. Don't forget to use React `className` instead of `class` as HTML attribute.

First, apply it in your App ES6 class component.

**src/App.js**

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    const { searchTerm, list } = this.state;  
    return (  
      <div className="page">  
        <div className="interactions">  
          <Search  
            value={searchTerm}  
            onChange={this.onSearchChange}  
          >  
            Search  
          </Search>  
        </div>  
        <Table  
          list={list}  
          pattern={searchTerm}  
          onDismiss={this.onDismiss}  
        />  
      </div>  
    );  
  }  
}
```

---

Second, apply it in your Table functional stateless component.

**src/App.js**

---

```
const Table = ({ list, pattern, onDismiss }) =>  
  <div className="table">  
    { list.filter(isSearched(pattern)).map(item =>  
      <div key={item.objectID} className="table-row">  
        <span>  
          <a href={item.url}>{item.title}</a>  
        </span>  
        <span>{item.author}</span>  
        <span>{item.num_comments}</span>  
        <span>{item.points}</span>  
        <span>  

```

```

    <Button
      onClick={() => onDismiss(item.objectID)}
      className="button-inline"
    >
      Dismiss
    </Button>
  </span>
</div>
)}
</div>

```

---

Now you have styled your application and components with basic CSS. It should look decent. As you know, JSX mixes up HTML and JavaScript. One could argue to add CSS in the mix as well. That's called inline style. You can define JavaScript objects and pass them to the style attribute of an element.

Let's keep the Table column width flexible by using inline style.

src/App.js

```

const Table = ({ list, pattern, onDismiss }) =>
  <div className="table">
    { list.filter(isSearched(pattern)).map(item =>
      <div key={item.objectID} className="table-row">
        <span style={{ width: '40%' }}>
          <a href={item.url}>{item.title}</a>
        </span>
        <span style={{ width: '30%' }}>
          {item.author}
        </span>
        <span style={{ width: '10%' }}>
          {item.num_comments}
        </span>
        <span style={{ width: '10%' }}>
          {item.points}
        </span>
        <span style={{ width: '10%' }}>
          <Button
            onClick={() => onDismiss(item.objectID)}
            className="button-inline"
          >
            Dismiss
          </Button>
        </span>
      </div>
    )}
  </div>

```

```
      </span>
    </div>
  )}
</div>
```

---

It is really inlined now. You could define the style objects outside of your elements to make it cleaner.

### Code Playground

---

```
const largeColumn = {
  width: '40%',
};

const midColumn = {
  width: '30%',
};

const smallColumn = {
  width: '10%',
};
```

---

After that you could use it in your columns: `<span style={smallColumn}>`.

In general, you will find different opinions and solutions for style in React. You used pure CSS and inline style now. It is sufficient to get started.

I don't want to be opinionated here, but I want to leave you some more options. You can read about them and apply them on your own. But if you are new to React, I would recommend to stick to pure CSS and inline style for now.

- [radium](https://github.com/FormidableLabs/radium)<sup>53</sup>
- [aphrodite](https://github.com/khan/aphrodite)<sup>54</sup>
- [styled-components](https://github.com/styled-components/styled-components)<sup>55</sup>
- [CSS Modules](https://github.com/css-modules/css-modules)<sup>56</sup>

---

<sup>53</sup><https://github.com/FormidableLabs/radium>

<sup>54</sup><https://github.com/khan/aphrodite>

<sup>55</sup><https://github.com/styled-components/styled-components>

<sup>56</sup><https://github.com/css-modules/css-modules>

You have learned the basics to write your own React application! Let's recap the last chapters:

- React
  - use `this.state` and `setState` to manage your internal component state
  - use forms and events in React to add interactions
  - unidirectional data flow is an important concept in React
  - compose components with children and reusable components
  - usage and implementation of ES6 class components and functional stateless components
  - approaches to style your components
- ES6
  - arrow functions with block and concise bodies to shorten your function declarations
  - functions that are bound to a class are class methods
  - destructuring of objects and arrays
  - default parameters
- General
  - higher order functions

Again it makes sense to take a break. Internalize the learnings and apply them on your own. You can experiment with the source code you have written so far. Additionally you can read more in the official [documentation](#)<sup>57</sup>.

You can find the source code in the [official repository](#)<sup>58</sup>.

---

<sup>57</sup><https://facebook.github.io/react/docs/installation.html>

<sup>58</sup><https://github.com/rwieruch/hackernews-client/tree/2705dcd1a2027c4a6ecb8132428b399785afdfa5>

# Getting Real with an API

Now it's time to get real with an API, because it can get boring to deal with artificial data. Do you know [Hacker News](https://news.ycombinator.com/)<sup>59</sup>? It's a great news aggregator. You will use the Hacker News API to fetch trending stories from the platform. There is a [basic](https://github.com/HackerNews/API)<sup>60</sup> and [search](https://hn.algolia.com/api)<sup>61</sup> API to get data from the platform. The latter one makes sense in your case to search stories on Hacker News. You can visit the API specification to get a glimpse of the data structure.

---

<sup>59</sup><https://news.ycombinator.com/>

<sup>60</sup><https://github.com/HackerNews/API>

<sup>61</sup><https://hn.algolia.com/api>

## Lifecycle Methods

You will need the knowledge about React lifecycle methods before you can start to fetch data. These methods are a hook into the lifecycle of a React component. They can be used in ES6 class components, but not in functional stateless components.

Do you remember when a previous chapter taught you about JavaScript ES6 classes and how they are used in React? Apart from the `render()` method, I mentioned several methods that can be overwritten in a React ES6 class component. All of these are the lifecycle methods. Let's dive into them:

You already know two lifecycle methods in a ES6 class component: `constructor()` and `render()`.

The constructor is only called when an instance of the component is created and inserted in the DOM. The component gets instantiated. That process is called mounting of the component.

The `render()` method is called during the mount process too, but also when the component updates. Each time when the state or the props of a component change, the `render()` method is called.

Now you know more about the two lifecycle methods and when they are called. You already used them as well. But there are more of them.

The mounting of a component has two more lifecycle methods: `componentWillMount()` and `componentDidMount()`. The constructor is called first, `componentWillMount()` gets called before the `render()` method and `componentDidMount()` is called after the `render()` method.

Overall the mounting process has 4 lifecycle methods. They are invoked in the following order:

- `constructor()`
- `componentWillMount()`
- `render()`
- `componentDidMount()`

But what about the update lifecycle of a component that happens when the state or the props change? Overall it has 5 lifecycle methods in the following order:

- `componentWillReceiveProps()`
- `shouldComponentUpdate()`
- `componentWillUpdate()`
- `render()`
- `componentDidUpdate()`

Last but not least there is the unmounting lifecycle. It has only one lifecycle method: `componentWillUnmount()`.

After all, you don't need to know all of these lifecycle methods from the beginning. It can be intimidating yet you will not use all of them - even in a mature React application. Still, it is good to know that each lifecycle method can be used for specific use cases:

- **constructor(props)** - It is called when the component gets initialized. You can set an initial component state and bind useful class methods during that lifecycle method.
- **componentWillMount()** - It is called before the `render()` lifecycle method. That's why it could be used to set internal component state, because it will not trigger a second rendering of the component. Generally it is recommend to use the `constructor()` to set the initial state.
- **render()** - The lifecycle method is mandatory and returns the elements as an output of the component. The method should be pure and therefore shouldn't modify the component state. It gets an input as props and state and returns an element.
- **componentDidMount()** - It is called only once when the component mounted. That's the perfect time to do an asynchronous request to fetch data from an API. The fetched data would get stored in the internal component state to display it in the `render()` lifecycle method.
- **componentWillReceiveProps(nextProps)** - The lifecycle method is called during an update lifecycle. As input you get the next props. You can diff the next props with the previous props (`this.props`) to apply a different behavior based on the diff. Additionally you can set state based on the next props.
- **shouldComponentUpdate(nextProps, nextState)** - It is always called when the component updates due to state or props changes. You will use it in mature React applications for performance optimizations. Depending on a boolean that you return from this lifecycle method, the component and all its children will render or will not render on an update lifecycle. You can prevent the render lifecycle method of a component.
- **componentWillUpdate(nextProps, nextState)** - The lifecycle method is immediately invoked before the `render()` method. You already have the next props and next state at your disposal. You can use the method as last opportunity to perform preparations before the render method gets executed. Note that you cannot trigger `setState()` anymore. If you want to compute state based on the next props, you have to use `componentWillReceiveProps()`.
- **componentDidUpdate(prevProps, prevState)** - The lifecycle method is immediately invoked after the `render()` method. You can use it as opportunity to perform DOM operations or to perform further asynchronous requests.
- **componentWillUnmount()** - It is called before you destroy your component. You can use the lifecycle method to perform any clean up tasks.

The `constructor()` and `render()` lifecycle methods are already used by you. These are the commonly used lifecycle methods for ES6 class components. Actually the `render()` method is required, otherwise you wouldn't return a component instance.

## Exercises:

- read more about [lifecycle methods in React](#)<sup>62</sup>
- read more about [the state related to lifecycle methods in React](#)<sup>63</sup>

---

<sup>62</sup><https://facebook.github.io/react/docs/react-component.html>

<sup>63</sup><https://facebook.github.io/react/docs/state-and-lifecycle.html>

## Fetching Data

Now you are prepared to fetch data from the Hacker News API. I mentioned one lifecycle method that can be used to fetch data: `componentDidMount()`. You will use the native `fetch` API to perform the request.

Before we can use it, let's set up the url constants and default parameters to breakup the API request into chunks.

`src/App.js`

---

```
import React, { Component } from 'react';
import './App.css';

const DEFAULT_QUERY = 'redux';

const PATH_BASE = 'https://hn.algolia.com/api/v1';
const PATH_SEARCH = '/search';
const PARAM_SEARCH = 'query=';

...
```

---

In ES6 JavaScript you can use [template strings](#)<sup>64</sup> to concatenate strings. You will use it to concatenate your url for the API endpoint.

**Code Playground**

---

```
// ES6
const url = `${PATH_BASE}${PATH_SEARCH}?${PARAM_SEARCH}${DEFAULT_QUERY}`;

// ES5
var url = PATH_BASE + PATH_SEARCH + '?' + PARAM_SEARCH + DEFAULT_QUERY;

console.log(url);
// output: https://hn.algolia.com/api/v1/search?query=redux
```

---

That will keep your url composition flexible in the future.

But let's get to the API request where you will use the url. The whole data fetch process will be presented at once, but each step will get explained afterward.

---

<sup>64</sup>[https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Template\\_literals](https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Template_literals)

**src/App.js**

---

```
...

class App extends Component {

  constructor(props) {
    super(props);

    this.state = {
      result: null,
      searchTerm: DEFAULT_QUERY,
    };

    this.setSearchTopstories = this.setSearchTopstories.bind(this);
    this.fetchSearchTopstories = this.fetchSearchTopstories.bind(this);
    this.onSearchChange = this.onSearchChange.bind(this);
    this.onDismiss = this.onDismiss.bind(this);
  }

  setSearchTopstories(result) {
    this.setState({ result });
  }

  fetchSearchTopstories(searchTerm) {
    fetch(`${PATH_BASE}${PATH_SEARCH}?${PARAM_SEARCH}${searchTerm}`)
      .then(response => response.json())
      .then(result => this.setSearchTopstories(result));
  }

  componentDidMount() {
    const { searchTerm } = this.state;
    this.fetchSearchTopstories(searchTerm);
  }

  ...
}
```

---

A lot of things happen in the code. I thought about it to break it into smaller pieces. Then again it would be difficult to grasp the relations of each piece to each other. Let me explain each step in detail.

First, you can remove the artificial list of items, because you return a result from the Hacker News API. The initial state of your component has an empty result and default search term. The same default search term is used in the search field and in your first request.

Second, you use the `componentDidMount()` lifecycle method to fetch the data after the component did mount. In the very first fetch the default search term from the component state is used. It will fetch “redux” related stories, because that is the default parameter.

Third, the native fetch is used. The JavaScript ES6 template strings allow it to compose the url with the `searchTerm`. The url is the argument for the native fetch API function. The response needs to get transformed to json, that’s a mandatory step in a native fetch, and can finally be set in the internal component state.

Last but not least, don’t forget to bind your new component methods.

Now you can use the fetched data instead of the artificial list of items. However, you have to be careful again. The result is not only a list of data. [It’s a complex object with meta information and a list of hits \(stories\).](#)<sup>65</sup> You can output the internal state with `console.log(this.state);` in your `render()` method to visualize it.

Let’s use the result to render it. But we will prevent to render anything - return null - when there is no result. Once the request to the API succeeded, the result is saved to the state and the App component will re-render with the updated state.

#### src/App.js

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    const { searchTerm, result } = this.state;  
  
    if (!result) { return null; }  
  
    return (  
      <div className="page">  
        ...  
        <Table  
          list={result.hits}  
          pattern={searchTerm}  
          onDismiss={this.onDismiss}  
        />  
      </div>  
    );  
  }  
}
```

---

<sup>65</sup><https://hn.algolia.com/api>

```
}  
}
```

---

Let's recap what happens during the component lifecycle. Your component gets initialized by the constructor. After that it renders for the first time. But you prevent to display it, because the result is empty. Then the `componentDidMount()` lifecycle method runs. In that method you fetch the data from the Hacker News API asynchronously. Once the data arrives, it changes your internal component state. After that the update lifecycle comes into play. The component runs the `render()` method again, but this time with populated data in your internal component state. The component and thus the Table component with its content gets re-rendered.

You used the native fetch API that is supported by most browsers to perform an asynchronous request to an API. The *create-react-app* configuration makes sure that it is supported in every browser. There are third party node packages that you can use to substitute the native fetch API: [superagent](#)<sup>66</sup> and [axios](#)<sup>67</sup>.

Back to your application: The list of hits should be visible now. But the “Dismiss” button is broken. We will fix that in the next chapter.

## Exercises:

- read more about [ES6 template strings](#)<sup>68</sup>
- read more about [the native fetch API](#)<sup>69</sup>
- experiment with the [Hacker News API](#)<sup>70</sup>

---

<sup>66</sup><https://github.com/visionmedia/superagent>

<sup>67</sup><https://github.com/mzabriskie/axios>

<sup>68</sup>[https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Template\\_literals](https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Template_literals)

<sup>69</sup>[https://developer.mozilla.org/en/docs/Web/API/Fetch\\_API](https://developer.mozilla.org/en/docs/Web/API/Fetch_API)

<sup>70</sup><https://hn.algolia.com/api>

## ES6 Spread Operators

The “Dismiss” button doesn’t work because the `onDismiss()` method is not aware of the complex result object. Let’s change that:

`src/App.js`

---

```
onDismiss(id) {  
  const isNotId = item => item.objectID !== id;  
  const updatedHits = this.state.result.hits.filter(isNotId);  
  this.setState({  
    ...  
  });  
}
```

---

But what happens in `setState()` now? Unfortunately the result is a complex object. The list of hits is only one of multiple properties in the object. However, only the list gets updated, when an item gets removed in the result object, while the other properties stay the same.

One approach could be to mutate the hits in the result object. I will demonstrate it, but we won’t do it that way.

Code Playground

---

```
this.state.result.hits = updatedHits;
```

---

React embraces functional programming. Thus you shouldn’t mutate an object (or mutate the state directly). A better approach is to generate a new object based on information you have. Thereby none of the objects get altered. You will keep the immutable data structures. You will always return a new object and never alter an object.

Let’s do it in JavaScript ES5. `Object.assign()` takes as first argument a target object. All following arguments are source objects. These objects are merged into the target object. The target object can be an empty object. It embraces immutability, because no source object gets mutated. It would look similar to the following:

Code Playground

---

```
const updatedHits = { hits: updatedHits };  
const updatedResult = Object.assign({}, this.state.result, updatedHits);
```

---

Now let’s do it in the `onDismiss()` method:

### src/App.js

---

```
onDismiss(id) {
  const isNotId = item => item.objectID !== id;
  const updatedHits = this.state.result.hits.filter(isNotId);
  this.setState({
    result: Object.assign({}, this.state.result, { hits: updatedHits })
  });
}
```

---

That's it in JavaScript ES5. There is a simpler solution in ES6 and future JavaScript releases. May I introduce the spread operator to you? It only consists of three dots: `...` When it is used, every value from an array or object gets copied to another array or object.

Let's examine the ES6 array spread operator even though you don't need it yet.

### Code Playground

---

```
const userList = ['Robin', 'Andrew', 'Dan'];
const additionalUser = 'Jordan';
const allUsers = [ ...userList, additionalUser ];

console.log(allUsers);
// output: ['Robin', 'Andrew', 'Dan', 'Jordan']
```

---

The `allUsers` variable is a completely new array. The other variables `userList` and `additionalUser` stay the same. You can even merge two arrays that way into a new array.

### Code Playground

---

```
const oldUsers = ['Robin', 'Andrew'];
const newUsers = ['Dan', 'Jordan'];
const allUsers = [ ...oldUsers, ...newUsers ];

console.log(allUsers);
// output: ['Robin', 'Andrew', 'Dan', 'Jordan']
```

---

Now let's have a look at the object spread operator. It is not ES6! It is a [proposal for a future ES version](#)<sup>71</sup> yet already used by the React community. That's why *create-react-app* incorporated the feature in the configuration.

Basically it is the same as the JavaScript ES6 array spread operator but with objects. It copies each key value pair into a new object.

---

<sup>71</sup><https://github.com/sebmarkbage/ecmascript-rest-spread>

### Code Playground

---

```
const usernames = { firstname: 'Robin', lastname: 'Wieruch' };
const age = 28;
const user = { ...usernames, age };

console.log(user);
// output: { firstname: 'Robin', lastname: 'Wieruch', age: 28 }
```

---

Multiple objects can be spread like in the array spread example.

### Code Playground

---

```
const usernames = { firstname: 'Robin', lastname: 'Wieruch' };
const userAge = { age: 28 };
const user = { ...usernames, ...userAge };

console.log(user);
// output: { firstname: 'Robin', lastname: 'Wieruch', age: 28 }
```

---

After all it can be used to replace ES5 `Object.assign()`.

### src/App.js

---

```
onDismiss(id) {
  const isNotId = item => item.objectID !== id;
  const updatedHits = this.state.result.hits.filter(isNotId);
  this.setState({
    result: { ...this.state.result, hits: updatedHits }
  });
}
```

---

The “Dismiss” button should work again.

## Exercises:

- read more about [Object.assign\(\)](#)<sup>72</sup>
- read more about the [ES6 array spread operator](#)<sup>73</sup>
  - the object spread operator is briefly mentioned

---

<sup>72</sup>[https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Global\\_Objects/Object/assign](https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Global_Objects/Object/assign)

<sup>73</sup>[https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Operators/Spread\\_operator](https://developer.mozilla.org/en/docs/Web/JavaScript/Reference/Operators/Spread_operator)

## Conditional Rendering

The conditional rendering is introduced pretty early in React applications. It happens when you want to make a decision to render either one or another element. Sometimes it means to render an element or nothing. After all, a conditional rendering simplest usage can be expressed by an if-else statement in JSX.

The `result` object in the internal component state is null in the beginning. So far, the `App` component returned no elements when the `result` hasn't arrived from the API. That's already a conditional rendering, because you return earlier from the `render()` lifecycle method for a certain condition. The `App` component either renders nothing or its elements.

But let's go one step further. It makes more sense to wrap the `Table` component, which is the only component that depends on the `result`, in an independent conditional rendering. Everything else should be displayed, even though there is no `result` yet. You can simply use a ternary expression in your JSX.

`src/App.js`

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    const { searchTerm, result } = this.state;  
    return (  
      <div className="page">  
        <div className="interactions">  
          <Search  
            value={searchTerm}  
            onChange={this.onSearchChange}  
          >  
            Search  
          </Search>  
        </div>  
        { result  
          ? <Table  
            list={result.hits}  
            pattern={searchTerm}  
            onDismiss={this.onDismiss}  
          />  
          : null  
        }  
      </div>  
    );  
  }  
}
```

```
    );  
  }  
}
```

---

That's your second option to express a conditional rendering. A third option is the logical `&&` operator. In JavaScript a `true && 'Hello World'` always evaluates to `'Hello World'`. A `false && 'Hello World'` always evaluates to `false`.

### Code Playground

---

```
const result = true && 'Hello World';  
console.log(result);  
// output: Hello World
```

```
const result = false && 'Hello World';  
console.log(result);  
// output: false
```

---

In React you can make use of that behavior. If the condition is true, the expression after the logical `&&` operator will be the output. If the condition is false, React ignores and skips the expression. It is applicable in the Table conditional rendering case, because it should return a Table or nothing.

### src/App.js

---

```
{ result &&  
  <Table  
    list={result.hits}  
    pattern={searchTerm}  
    onDismiss={this.onDismiss}  
  />  
}
```

---

These were a few approaches to use conditional rendering in React. You can read about [more alternatives on my website](#)<sup>74</sup> where I keep an exhaustive list of conditional renderings. Moreover you will get to know their different use cases and when to apply them.

After all, you should be able to see the fetched data in your application. Everything except the Table is displayed when the data fetching is pending. Once the request resolves the result, the Table is displayed.

---

<sup>74</sup><https://www.robinwieruch.de/conditional-rendering-react/>

## Exercises:

- read more about [React conditional rendering](https://facebook.github.io/react/docs/conditional-rendering.html)<sup>75</sup>
- read more about [different ways for conditional renderings](https://www.robinwieruch.de/conditional-rendering-react/)<sup>76</sup>

---

<sup>75</sup><https://facebook.github.io/react/docs/conditional-rendering.html>

<sup>76</sup><https://www.robinwieruch.de/conditional-rendering-react/>

## Client- or Server-side Search

When you use the search input field now, you will filter the list. That's happening on the client-side though. Now you are going to use the Hacker News API to search on the server-side. Otherwise you would deal only with the first API response which you got on `componentDidMount()` with the default search term parameter.

You can define an `onSubmit()` method in your ES6 class component, which fetches results from the Hacker News API. It will be the same `fetch` like in your `componentDidMount()` lifecycle method. But it fetches it with the modified search term from the search field input.

`src/App.js`

---

```
class App extends Component {  
  
  constructor(props) {  
    super(props);  
  
    this.state = {  
      result: null,  
      searchTerm: DEFAULT_QUERY,  
    };  
  
    this.setSearchTopstories = this.setSearchTopstories.bind(this);  
    this.fetchSearchTopstories = this.fetchSearchTopstories.bind(this);  
    this.onSearchChange = this.onSearchChange.bind(this);  
    this.onSearchSubmit = this.onSearchSubmit.bind(this);  
    this.onDismiss = this.onDismiss.bind(this);  
  }  
  
  ...  
  
  onSearchSubmit() {  
    const { searchTerm } = this.state;  
    this.fetchSearchTopstories(searchTerm);  
  }  
  
  ...  
}
```

---

The Search component gets an additional button. The button has to explicitly trigger the search. Otherwise you would fetch data every time from the Hacker News API when your input changes.

As alternative you could debounce (delay) the `onChange()` function and spare the button, but it would add more complexity at this time. Let's keep it simple without a debounce.

First, pass the `onSearchSubmit()` method to your Search component.

**src/App.js**

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    const { searchTerm, result } = this.state;  
    return (  
      <div className="page">  
        <div className="interactions">  
          <Search  
            value={searchTerm}  
            onChange={this.onSearchChange}  
            onSubmit={this.onSearchSubmit}  
          >  
            Search  
          </Search>  
        </div>  
        { result &&  
          <Table  
            list={result.hits}  
            pattern={searchTerm}  
            onDismiss={this.onDismiss}  
          />  
        }  
      </div>  
    );  
  }  
}
```

---

Second, introduce a button in your Search component. The button has the `type="submit"` and the form uses its `onSubmit()` attribute to pass the `onSubmit()` method. You can reuse the children property, but this time it will be used as the content of the button.

src/App.js

---

```
const Search = ({
  value,
  onChange,
  onSubmit,
  children
}) =>
  <form onSubmit={onSubmit}>
    <input
      type="text"
      value={value}
      onChange={onChange}
    />
    <button type="submit">
      {children}
    </button>
  </form>
```

---

In the Table you can remove the filter functionality, because there will be no client-side filter (search) anymore. The result comes directly from the Hacker News API after you have clicked the “Search” button.

src/App.js

---

```
class App extends Component {
  ...

  render() {
    const { searchTerm, result } = this.state;
    return (
      <div className="page">
        ...
        { result &&
          <Table
            list={result.hits}
            onDismiss={this.onDismiss}
          />
        }
      </div>
    );
  }
}
```

```
}  
  
...  
  
const Table = ({ list, onDismiss }) =>  
  <div className="table">  
    { list.map(item =>  
      ...  
    )}  
  </div>
```

---

When you try to search now, you will notice that the browser reloads. That's a native browser behavior for a submit callback in a form. In React you will often come across the `preventDefault()` event method to suppress the native browser behavior.

src/App.js

---

```
onSearchSubmit(event) {  
  const { searchTerm } = this.state;  
  this.fetchSearchTopstories(searchTerm);  
  event.preventDefault();  
}
```

---

Now you should be able to search different Hacker News stories. You interact with a real world API. There should be no client-sided search anymore.

## Exercises:

- read more about [synthetic events in React](https://facebook.github.io/react/docs/events.html)<sup>77</sup>

---

<sup>77</sup><https://facebook.github.io/react/docs/events.html>

## Paginated Fetch

Did you have a closer look at the returned data structure yet? The [Hacker News API](#)<sup>78</sup> returns more than a list of hits. The `page` property, which is 0 in the first response, can be used to fetch more paginated data. You only need to pass the next page with the same search term to the API.

Let's extend the composable API constants that it can deal with paginated data.

src/App.js

---

```
const DEFAULT_QUERY = 'redux';
const DEFAULT_PAGE = 0;

const PATH_BASE = 'https://hn.algolia.com/api/v1';
const PATH_SEARCH = '/search';
const PARAM_SEARCH = 'query=';
const PARAM_PAGE = 'page=';
```

---

Now you can use these constants to add the page parameter to your API request.

### Code Playground

---

```
const url = `${PATH_BASE}${PATH_SEARCH}?${PARAM_SEARCH}${searchTerm}&${PARAM_PAGE}${PAGE}`;

console.log(url);
// output: https://hn.algolia.com/api/v1/search?query=redux&page=
```

---

The `fetchSearchTopstories()` method will take the page as second argument. The `componentDidMount()` and `onSearchSubmit()` methods take the `DEFAULT_PAGE` for the initial API calls. They should fetch the first page on the first request. Every additional fetch should fetch the next page.

src/App.js

---

```
class App extends Component {
  ...

  componentDidMount() {
    const { searchTerm } = this.state;
    this.fetchSearchTopstories(searchTerm, DEFAULT_PAGE);
  }
}
```

---

<sup>78</sup><https://hn.algolia.com/api>

```
    fetchSearchTopstories(searchTerm, page) {
      fetch(`${PATH_BASE}${PATH_SEARCH}?${PARAM_SEARCH}${searchTerm}&${PARAM_PAGE}\
${page}`)
        .then(response => response.json())
        .then(result => this.setSearchTopstories(result));
    }

    onSearchSubmit(event) {
      const { searchTerm } = this.state;
      this.fetchSearchTopstories(searchTerm, DEFAULT_PAGE);
      event.preventDefault();
    }

    ...
  }
}
```

---

Now you can use the current page from the API response in `fetchSearchTopstories()`. You can use this method in a button to fetch more stories on a button click. Let's use the Button to fetch more paginated data from the Hacker News API. You only need to define the `onClick()` function which takes the current search term and the next page (current page + 1).

#### src/App.js

---

```
class App extends Component {
  ...

  render() {
    const { searchTerm, result } = this.state;
    const page = (result && result.page) || 0;
    return (
      <div className="page">
        <div className="interactions">
          ...
          { result &&
            <Table
              list={result.hits}
              onDismiss={this.onDismiss}
            />
          }
        <div className="interactions">
```

```
        <Button onClick={() => this.fetchSearchTopstories(searchTerm, page + 1\
    )}>
            More
        </Button>
    </div>
</div>
);
}
```

---

You should make sure to default to page 0 when there is no result.

There is one step missing. You fetch the next page of data, but it will overwrite your previous page of data. You want to concatenate the old and new data. Let's adjust the functionality to add the new data rather than to overwrite it.

src/App.js

---

```
setSearchTopstories(result) {
    const { hits, page } = result;

    const oldHits = page !== 0
        ? this.state.result.hits
        : [];

    const updatedHits = [
        ...oldHits,
        ...hits
    ];

    this.setState({
        result: { hits: updatedHits, page }
    });
}
```

---

First, you get the hits and page from the result.

Second, you have to check if there are already old hits. When the page is 0, it is a new search request from `componentDidMount()` or `onSearchSubmit()`. The hits are empty. But when you click the "More" button to fetch paginated data the page isn't 0. It is the next page. The old hits are already stored in your state and thus can be used.

Third, you don't want to overwrite the old hits. You can merge old and new hits from the recent API request. The merge of both lists can be done with the JavaScript ES6 array spread operator.

Fourth, you set the merged hits and page in the internal component state.

You can make one last adjustment. When you try the “More” button it only fetches a few list items. The API url can be extended to fetch more list items with each request. Again you can add more composeable path constants.

src/App.js

---

```
const DEFAULT_QUERY = 'redux';
const DEFAULT_PAGE = 0;
const DEFAULT_HPP = '100';

const PATH_BASE = 'https://hn.algolia.com/api/v1';
const PATH_SEARCH = '/search';
const PARAM_SEARCH = 'query=';
const PARAM_PAGE = 'page=';
const PARAM_HPP = 'hitsPerPage=';
```

---

Now you can use the constants to extend the API url.

src/App.js

---

```
fetchSearchTopstories(searchTerm, page) {
  fetch(`${PATH_BASE}${PATH_SEARCH}?${PARAM_SEARCH}${searchTerm}&${PARAM_PAGE}${\
page}&${PARAM_HPP}${DEFAULT_HPP}`)
    .then(response => response.json())
    .then(result => this.setSearchTopstories(result));
}
```

---

Afterward the request to the Hacker News API fetches more list items in one request than before.

## Exercises:

- experiment with the [Hacker News API parameters](https://hn.algolia.com/api)<sup>79</sup>

---

<sup>79</sup><https://hn.algolia.com/api>

## Client Cache

Each search submit makes a request to the Hacker News API. You might search for “redux”, followed by “react” and eventually “redux” again. In total it makes 3 requests. But you searched for “redux” twice and both times it took a whole asynchronous roundtrip to fetch the data. In a client-sided cache you would store each result. When a request to the API is made, it checks if a result is already there. If it is there, the cache is used. Otherwise an API request is made to fetch the data.

In order to have a client cache for each result, you have to store multiple `results` rather than one result in your internal component state. The results object will be a map with the search term as key and the result as value. Each result from the API will be saved by search term (key).

At the moment your result in the component state looks similar to the following:

### Code Playground

---

```
result: {  
  hits: [ ... ],  
  page: 2,  
}
```

---

Imagine you have made two API requests. One for the search term “redux” and another one for “react”. The results map should look like the following:

### Code Playground

---

```
results: {  
  redux: {  
    hits: [ ... ],  
    page: 2,  
  },  
  react: {  
    hits: [ ... ],  
    page: 1,  
  },  
  ...  
}
```

---

Let’s implement a client-side cache with React `setState()`. First, rename the `result` object to `results` in the initial component state. Second, define a temporary `searchKey` which is used to store each `result`.

**src/App.js**

---

```
class App extends Component {  
  
  constructor(props) {  
    super(props);  
  
    this.state = {  
      results: null,  
      searchKey: '',  
      searchTerm: DEFAULT_QUERY,  
    };  
  
    ...  
  
  }  
  
  ...  
  
}
```

---

The `searchKey` has to be set before each request is made. It reflects the `searchTerm`. You might wonder: Why don't we use the `searchTerm` in the first place? The `searchTerm` is a fluctuant variable, because it gets changed every time you type into the Search input field. However, in the end you will need a non fluctuant variable. It determines the recent submitted search term to the API and can be used to retrieve the correct result from the map of results. It is a pointer to your current result in the cache.

**src/App.js**

---

```
componentDidMount() {  
  const { searchTerm } = this.state;  
  this.setState({ searchKey: searchTerm });  
  this.fetchSearchTopstories(searchTerm, DEFAULT_PAGE);  
}  
  
onSearchSubmit(event) {  
  const { searchTerm } = this.state;  
  this.setState({ searchKey: searchTerm });  
  this.fetchSearchTopstories(searchTerm, DEFAULT_PAGE);  
  event.preventDefault();  
}
```

---

Now you have to adjust the functionality where the result is stored to the internal component state. It should store each result by searchKey.

src/App.js

---

```
class App extends Component {  
  
  ...  
  
  setSearchTopstories(result) {  
    const { hits, page } = result;  
    const { searchKey, results } = this.state;  
  
    const oldHits = results && results[searchKey]  
      ? results[searchKey].hits  
      : [];  
  
    const updatedHits = [  
      ...oldHits,  
      ...hits  
    ];  
  
    this.setState({  
      results: {  
        ...results,  
        [searchKey]: { hits: updatedHits, page }  
      }  
    });  
  }  
  
  ...  
  
}
```

---

The searchKey will be used as key to save the updated hits and page in a results map.

First, you have to retrieve the searchKey from the component state. Remember that the searchKey gets set on componentDidMount() and onSearchSubmit().

Second, the old hits have to get merged with the new hits as before. But this time the old hits get retrieved from the results map with the searchKey as key.

Third, a new result can be set in the results map in the state. Let's examine the results object in setState().

**src/App.js**

---

```
results: {  
  ...results,  
  [searchKey]: { hits: updatedHits, page }  
}
```

---

The bottom part makes sure to store the updated result by `searchKey` in the results map. The value is an object with a `hits` and `page` property. The `searchKey` is the search term. You already learned the `[searchKey]` syntax. It is an ES6 computed property name. It helps you to allocate values dynamically in an object.

The upper part needs to object spread all other results by `searchKey` in the state. Otherwise you would lose all results you stored before.

Now you store all results by search term. That's the first step to enable your cache. In the next step you can retrieve the result depending on the search term from your map of results.

**src/App.js**

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    const {  
      searchTerm,  
      results,  
      searchKey  
    } = this.state;  
  
    const page = (  
      results &&  
      results[searchKey] &&  
      results[searchKey].page  
    ) || 0;  
  
    const list = (  
      results &&  
      results[searchKey] &&  
      results[searchKey].hits  
    ) || [];  
  
    return (  

```

```

<div className="page">
  <div className="interactions">
    <Search
      value={searchTerm}
      onChange={this.onSearchChange}
      onSubmit={this.onSearchSubmit}
    >
      Search
    </Search>
  </div>
  <Table
    list={list}
    onDismiss={this.onDismiss}
  />
  <div className="interactions">
    <Button onClick={() => this.fetchSearchTopstories(searchKey, page + 1)}\
  >
    More
  </Button>
  </div>
</div>
);
}
}

```

---

Since you default to an empty list when there is no result by `searchKey`, you can spare the conditional rendering for the `Table` component now. Additionally you will need to pass the `searchKey` rather than the `searchTerm` to the “More” button. Otherwise your paginated fetch depends on the `searchTerm` value which is fluctuant. Moreover make sure to keep the fluctuant `searchTerm` property for the input field in the “Search” component.

The search functionality should work again. It stores all results from the Hacker News API.

Additionally the `onDismiss()` method needs to get improved. It still deals with the `result` object. Now it has to deal with multiple `results`.

## src/App.js

---

```
onDismiss(id) {
  const { searchKey, results } = this.state;
  const { hits, page } = results[searchKey];

  const isNotId = item => item.objectID !== id;
  const updatedHits = hits.filter(isNotId);

  this.setState({
    results: {
      ...results,
      [searchKey]: { hits: updatedHits, page }
    }
  });
}
```

---

The “Dismiss” button should work again.

However, nothing stops the application from sending an API request on each search submit. Even though there might be already a result, there is no check that prevents the request. The cache functionality is not complete yet. The last step would be to prevent the request when a result is available in the cache.

## src/App.js

---

```
class App extends Component {

  constructor(props) {

    ...

    this.needToSearchTopstories = this.needToSearchTopstories.bind(this);
    this.setSearchTopstories = this.setSearchTopstories.bind(this);
    this.fetchSearchTopstories = this.fetchSearchTopstories.bind(this);
    this.onSearchChange = this.onSearchChange.bind(this);
    this.onSearchSubmit = this.onSearchSubmit.bind(this);
    this.onDismiss = this.onDismiss.bind(this);
  }

  needToSearchTopstories(searchTerm) {
    return !this.state.results[searchTerm];
  }
}
```

```
...

onSearchSubmit(event) {
  const { searchTerm } = this.state;
  this.setState({ searchKey: searchTerm });

  if (this.needsToSearchTopstories(searchTerm)) {
    this.fetchSearchTopstories(searchTerm, DEFAULT_PAGE);
  }

  event.preventDefault();
}

...
}
```

---

Now your client makes a request to the API only once although you search for a search term twice. Even paginated data with several pages gets cached that way, because you always save the last page for each result in the `results` map.

You have learned to interact with an API in React! Let's recap the last chapters:

- React
  - ES6 class component lifecycle methods for different use cases
  - `componentDidMount()` for API interactions
  - conditional renderings
  - synthetic events on forms
- ES6
  - template strings to compose strings
  - spread operator for immutable data structures
  - computed property names
- General
  - Hacker News API interaction
  - native `fetch` browser API
  - client- and server-side search
  - pagination of data
  - client-side caching

Again it makes sense to take a break. Internalize the learnings and apply them on your own. You can experiment with the source code you have written so far.

You can find the source code in the [official repository](https://github.com/rwieruch/hackernews-client)<sup>80</sup>.

---

<sup>80</sup><https://github.com/rwieruch/hackernews-client/tree/e60436a9d6c449e76a362aef44dd5667357b7994>

# Code Organization and Testing

The chapter will focus on important topics to keep your code maintainable in a scaling application. You will learn about code organization to embrace best practices when structuring your folders and files. Another aspect you will learn is testing, which is important to keep your code robust.

## ES6 Modules: Import and Export

In JavaScript ES6 you can import and export functionalities from modules. These functionalities can be functions, classes, components, constants etc. Basically everything that you can assign to a variable. The modules can be single files or whole folders with one index file as entry point.

In the beginning of the book, after you have bootstrapped your application with *create-react-app*, you already had several `import` and `export` statements across your initial files. Now it is the appropriate time to explain these.

The `import` and `export` statements help you to share code across multiple files. Before there were already several solutions for this in the JavaScript environment. It was a mess, because you would want to follow one standardized way rather than having several approaches for the same thing. Now it is a native behavior in JavaScript ES6.

Additionally these statements embrace code splitting. You distribute your code across multiple files to keep it reusable and maintainable. The former is true because you can import the piece of code in multiple files. The latter is true because you have one single source where you maintain the piece of code.

Last but not least, it helps you to think about code encapsulation. Not every functionality needs to get exported from a file. Some of these functionalities should only be used in the file where they have been defined. The exports of a file are basically the public API to the file. Only the exported functionalities are available to be reused somewhere else. It follows the best practice of encapsulation.

But let's get practical. How do these `import` and `export` statements work? The following examples showcase the statements by sharing one or multiple variables across two files. In the end, the approach can scale to multiple files and could share more than simple variables.

You can export one or multiple variables. It is called a named export.

Code Playground: file1.js

---

```
const firstname = 'robin';
const lastname = 'wieruch';

export { firstname, lastname };
```

---

And import them in another file with a relative path to the first file.

**Code Playground: file2.js**

---

```
import { firstname, lastname } from './file1.js';

console.log(firstname);
// output: robin
```

---

You can also import all exported variables from another file as one object.

**Code Playground: file2.js**

---

```
import * as person from './file1.js';

console.log(person.firstname);
// output: robin
```

---

Imports can have an alias. It can happen that you import functionalities from multiple files that have the same named export. That's why you can use an alias.

**Code Playground: file2.js**

---

```
import { firstname as foo } from './file1.js';

console.log(foo);
// output: robin
```

---

Last but not least there exists the `default` statement. It can be used for a few use cases:

- to export and import a single functionality
- to highlight the main functionality of the exported API of a module
- to have a fallback import functionality

**Code Playground: file1.js**

---

```
const robin = {
  firstname: 'robin',
  lastname: 'wieruch',
};

export default robin;
```

---

**Code Playground: file2.js**

---

```
import developer from './file1.js';

console.log(developer);
// output: { firstname: 'robin', lastname: 'wieruch' }
```

---

The import name can differ from the exported default name. You can also use it in conjunction with the named export and import statements.

**Code Playground: file1.js**

---

```
const firstname = 'robin';
const lastname = 'wieruch';

const person = {
  firstname,
  lastname,
};

export {
  firstname,
  lastname,
};

export default person;
```

---

**Code Playground: file2.js**

---

```
import developer, { firstname, lastname } from './file1.js';

console.log(developer);
// output: { firstname: 'robin', lastname: 'wieruch' }
console.log(firstname, lastname);
// output: robin wieruch
```

---

In named exports you can spare additional lines and export the variables directly.

**Code Playground: file1.js**

---

```
export const firstname = 'robin';
export const lastname = 'wieruch';
```

---

These are the main functionalities for ES6 modules. They help you to organize your code, to maintain your code and to design reusable module APIs. You can also export and import functionalities to test them. You will do that in one of the following chapters.

**Exercises:**

- read more about [ES6 import](#)<sup>81</sup>
- read more about [ES6 export](#)<sup>82</sup>

---

<sup>81</sup><https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Statements/import>

<sup>82</sup><https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Statements/export>

## Code Organization with ES6 Modules

You might wonder: Why didn't we follow the best practices of code splitting for the `src/App.js` file? In the file we already have multiple components which could be defined in their own files/folders (modules). For the sake of learning React, it is practical to keep these things at one place. But once your React application grows, you should consider to split up these components into multiple modules. Only that way your application scales.

In the following I will propose several module structures you *could* apply. I would recommend to apply them as an exercise at the end of the book. To keep the book itself simple, I will not perform the code splitting and will continue the following chapters with the `src/App.js` file.

One possible module structure could be:

### Folder Structure

---

```
src/  
  index.js  
  index.css  
  App.js  
  App.test.js  
  App.css  
  Button.js  
  Button.test.js  
  Button.css  
  Table.js  
  Table.test.js  
  Table.css  
  Search.js  
  Search.test.js  
  Search.css
```

---

It doesn't look too promising. You can see a lot of naming duplications and only the file extension differs. Another module structure could be:

### Folder Structure

---

```
src/  
  index.js  
  index.css  
  App/  
    index.js  
    test.js  
    index.css  
  Button/  
    index.js  
    test.js  
    index.css  
  Table/  
    index.js  
    test.js  
    index.css  
  Search/  
    index.js  
    test.js  
    index.css
```

---

It looks cleaner than before. A component is defined by its component declaration in the JavaScript file, but also by its style and tests.

Another step could be extracting the constant variables from the App component. These constants were used to compose the Hacker News API url.

### Folder Structure

---

```
src/  
  index.js  
  index.css  
  constants/  
    index.js  
  components/  
  App/  
    index.js  
    test.js  
    index..css  
  Button/  
    index.js  
    test.js
```

```
index.css
```

```
...
```

---

Naturally the modules would split up into *src/constants/* and *src/components/*.

Now the *src/constants/index.js* file could look like the following:

Code Playground: *src/constants/index.js*

---

```
export const DEFAULT_QUERY = 'redux';
export const DEFAULT_PAGE = 0;
export const DEFAULT_HPP = '100';

export const PATH_BASE = 'https://hn.algolia.com/api/v1';
export const PATH_SEARCH = '/search';
export const PARAM_SEARCH = 'query=';
export const PARAM_PAGE = 'page=';
export const PARAM_HPP = 'hitsPerPage=';
```

---

The *App/index.js* file could import these variables in order to use them.

Code Playground: *src/components/App/index.js*

---

```
import {
  DEFAULT_QUERY,
  DEFAULT_PAGE,
  DEFAULT_HPP,

  PATH_BASE,
  PATH_SEARCH,
  PARAM_SEARCH,
  PARAM_PAGE,
  PARAM_HPP,
} from '../constants/index.js';
```

```
...
```

---

When you use the *index.js* naming convention, you can omit the filename from the relative path.

**Code Playground: src/components/App/index.js**

---

```
import {
  DEFAULT_QUERY,
  DEFAULT_PAGE,
  DEFAULT_HPP,

  PATH_BASE,
  PATH_SEARCH,
  PARAM_SEARCH,
  PARAM_PAGE,
  PARAM_HPP,
} from '../constants';

...
```

---

But what's behind the *index.js* file naming? The convention was introduced in the node.js world. The index file is the entry point to a module. It describes the public API to the module. External modules are only allowed to use the *index.js* file to import shared code from the module. Consider the following made up module structure to demonstrate it:

**Folder Structure**

---

```
src/
  index.js
  App/
    index.js
  Buttons/
    index.js
    SubmitButton.js
    SaveButton.js
    CancelButton.js
```

---

The *Buttons/* folder has multiple button components defined in its distinct files. Each file can export default the specific component making it available to *Buttons/index.js*. The *Buttons/index.js* file imports all different button representations and exports them as public module API.

**Code Playground: src/Buttons/index.js**

---

```
import SubmitButton from './SubmitButton';
import SaveButton from './SaveButton';
import CancelButton from './CancelButton';

export {
  SubmitButton,
  SaveButton,
  CancelButton,
};
```

---

Now the *src/App/index.js* can import the buttons from the public module API located in the *index.js* file.

**Code Playground: src/App/index.js**

---

```
import {
  SubmitButton,
  SaveButton,
  CancelButton
} from '../Buttons';
```

---

By going with this constraint, it would be a bad practice to reach into other files than the *index.js* in the module. It would break the rules of encapsulation.

**Code Playground: src/App/index.js**

---

```
// bad practice, don't do it
import SubmitButton from '../Buttons/SubmitButton';
```

---

Now you know how you could refactor your source code in modules with the constraints of encapsulation. As I said, for the sake of keeping the tutorial simple I will not apply these changes. But you should do the refactoring at the end of the book.

**Exercises:**

- refactor your *src/App.js* file into multiple component modules when you finished the book

## Component Interface with PropTypes

You may know [TypeScript](https://www.typescriptlang.org/)<sup>83</sup> or [Flow](https://flowtype.org/)<sup>84</sup> to introduce a type interface to JavaScript. A typed language is less error prone, because the code gets validated based on its program text. Editors and other utilities can catch these errors before the program runs. It makes your program more robust.

React comes with a built-in type checker to prevent bugs. You can use PropTypes to describe your component interface. All the props that get passed from a parent component to a child component get validated based on the PropTypes interface assigned to the child component.

The chapter will show you how you can make all your components type safe with PropTypes. I will omit the changes for the following chapters, because they add unnecessary code refactorings. But you should keep and update them along the way to keep your components interface type safe.

Initially you can import PropTypes explicitly:

src/App.js

---

```
import React, { Component, PropTypes } from 'react';
```

---

Let's start to assign a props interface to the components:

src/App.js

---

```
const Button = ({ onClick, className = '', children }) =>  
  <button  
    onClick={onClick}  
    className={className}  
    type="button"  
  >  
    {children}  
  </button>
```

```
Button.propTypes = {  
  onClick: PropTypes.func,  
  className: PropTypes.string,  
  children: PropTypes.node,  
};
```

---

That's it. You take every argument from the function signature and assign a PropTypes to it. The basic PropTypes for primitives and complex objects are:

---

<sup>83</sup><https://www.typescriptlang.org/>

<sup>84</sup><https://flowtype.org/>

### Code Playground

---

```
* PropTypes.array
* PropTypes.bool
* PropTypes.func
* PropTypes.number
* PropTypes.object
* PropTypes.string
```

---

Additionally you have two more PropTypes to define a renderable fragment (node), e.g. a string, and a React element.

### Code Playground

---

```
* PropTypes.node
* PropTypes.element
```

---

You already used the node PropType for the Button component. Overall there are more PropType definitions that you can read up in the official React documentation.

At the moment all of the defined PropTypes for the Button are optional. The parameters can be null or undefined. But for several props you want to enforce that they are defined. You can make it a requirement that these props are passed to the component.

src/App.js

---

```
Button.propTypes = {
  onClick: PropTypes.func.isRequired,
  className: PropTypes.string,
  children: PropTypes.node.isRequired,
};
```

---

The className is not required, because it can default to an empty string. Next you will define a PropType interface for the Table component:

src/App.js

---

```
Table.propTypes = {
  list: PropTypes.array.isRequired,
  onDismiss: PropTypes.func.isRequired,
};
```

---

You can define the content of an array PropType more explicit:

**src/App.js**

---

```
Table.propTypes = {
  list: PropTypes.arrayOf(
    PropTypes.shape({
      objectID: PropTypes.string.isRequired,
      author: PropTypes.string,
      url: PropTypes.string,
      num_comments: PropTypes.number,
      points: PropTypes.number,
    })
  ).isRequired,
  onDismiss: PropTypes.func.isRequired,
};
```

---

Only the `objectID` is required, because you know that some of your code depends on it. The other properties are only displayed, thus they are not necessarily required. Moreover you cannot be sure that the Hacker News API has always a defined property for each object in the array.

That's it for `PropTypes`. But there is one more aspect. You can define default props in your component. Let's take again the `Button` component. The `className` property has an ES6 default parameter in the component signature.

**src/App.js**

---

```
const Button = ({ onClick, className = '', children }) =>
  ...
```

---

You could replace it with the internal React default prop:

**src/App.js**

---

```
const Button = ({ onClick, className, children }) =>
  <button
    onClick={onClick}
    className={className}
    type="button"
  >
    {children}
  </button>

Button.defaultProps = {
  className: '',
};
```

---

Same as the ES6 default parameter, the default prop ensures that the property is set to a default value when the parent component didn't specify it. The PropTypes type check happens after the default prop is evaluated.

## Exercises:

- answer yourself the following question
  - does the App component have a PropTypes interface?
- define the PropTypes interface for the Search component
- add and update the PropTypes interfaces when you add and update components in the next chapters
- read more about [React PropTypes](https://facebook.github.io/react/docs/typechecking-with-proptypes.html)<sup>85</sup>

---

<sup>85</sup><https://facebook.github.io/react/docs/typechecking-with-proptypes.html>

## Snapshot Tests with Jest

Jest<sup>86</sup> is a JavaScript testing framework. At Facebook it is used to validate the JavaScript code. In the React community it is used for React components test coverage. Fortunately *create-react-app* already comes with Jest.

Let's start to test your first components. Before you can do that, you have to export the components from your *src/App.js* file to test them in a different file.

*src/App.js*

---

```
...  
  
class App extends Component {  
  ...  
}  
  
...  
  
export default App;  
  
export {  
  Button,  
  Search,  
  Table,  
};
```

---

In your *App.test.js* file you will find a first test. It verifies that the App component renders without any errors.

*src/App.test.js*

---

```
import React from 'react';  
import ReactDOM from 'react-dom';  
import App from './App';  
  
it('renders without crashing', () => {  
  const div = document.createElement('div');  
  ReactDOM.render(<App />, div);  
});
```

---

You can run it by using the interactive *create-react-app* scripts on the command line.

---

<sup>86</sup><https://facebook.github.io/jest/>

### Command Line

---

```
npm run test
```

---

Now Jest enables you to write Snapshot tests. These tests make a snapshot of your rendered component and run this snapshot against future snapshots. When a future snapshot changes you will get notified during the test. You can either accept the snapshot change, because you changed the component implementation on purpose, or deny the change and investigate for an error.

Jest stores the snapshots in a folder. Only that way it can show the diff to future snapshots. Additionally the snapshots can be shared across teams.

You have to install an utility library before you can write your first Snapshot test.

### Command Line

---

```
npm install --save-dev react-test-renderer
```

---

Now you can extend the App component test with your first Snapshot test.

### src/App.test.js

---

```
import React from 'react';
import ReactDOM from 'react-dom';
import renderer from 'react-test-renderer';
import App from './App';

describe('App', () => {

  it('renders', () => {
    const div = document.createElement('div');
    ReactDOM.render(<App />, div);
  });

  test('snapshots', () => {
    const component = renderer.create(
      <App />
    );
    let tree = component.toJSON();
    expect(tree).toMatchSnapshot();
  });
});
```

---

Run your tests again and see how the tests either succeed or fail. They should succeed. Once you change the output of the render block in your App component, the Snapshot test should fail. Then you can decide to update the snapshot or investigate in your App component.

Let's add more tests for our independent components. First, the Search component:

src/App.test.js

---

```
import React from 'react';
import ReactDOM from 'react-dom';
import renderer from 'react-test-renderer';
import App, { Search } from './App';

...

describe('Search', () => {

  it('renders', () => {
    const div = document.createElement('div');
    ReactDOM.render(<Search>Search</Search>, div);
  });

  test('snapshots', () => {
    const component = renderer.create(
      <Search>Search</Search>
    );
    let tree = component.toJSON();
    expect(tree).toMatchSnapshot();
  });
});
```

---

Second, the Button component:

src/App.test.js

---

```
...
import App, { Search, Button } from './App';

...

describe('Button', () => {

  it('renders', () => {
```

```
    const div = document.createElement('div');
    ReactDOM.render(<Button>Give Me More</Button>, div);
  });

  test('snapshots', () => {
    const component = renderer.create(
      <Button>Give Me More</Button>
    );
    let tree = component.toJSON();
    expect(tree).toMatchSnapshot();
  });
});
```

---

Last but not least, the Table component:

src/App.test.js

---

```
...
import App, { Search, Button, Table } from './App';

...

describe('Table', () => {

  const props = {
    list: [
      { title: '1', author: '1', num_comments: 1, points: 2, objectID: 'y' },
      { title: '2', author: '2', num_comments: 1, points: 2, objectID: 'z' },
    ],
  };

  it('renders', () => {
    const div = document.createElement('div');
    ReactDOM.render(<Table { ...props } />, div);
  });

  test('snapshots', () => {
    const component = renderer.create(
      <Table { ...props } />
    );
    let tree = component.toJSON();
    expect(tree).toMatchSnapshot();
  });
});
```

```
});
```

```
});
```

---

Snapshot tests usually stay pretty basic. You only want to cover that the component doesn't change its output. Once its changes the output, you have to decide if you accept the changes. Otherwise you have to fix the component when the output is not the desired output.

## Exercises:

- see how the Snapshot tests fail once you change your component implementation
  - either accept or deny the snapshot change
- keep your snapshots tests up to date when the implementation changes in next chapters
- read more about [Jest in React](https://facebook.github.io/jest/docs/tutorial-react.html)<sup>87</sup>

---

<sup>87</sup><https://facebook.github.io/jest/docs/tutorial-react.html>

## Unit Tests with Enzyme

[Enzyme<sup>88</sup>](#) is a testing utility by Airbnb to assert, manipulate and traverse your React components. You can use it to conduct unit tests to complement your snapshot tests.

Let's see how you can use enzyme. First you have to install it since it doesn't come with *create-react-app*.

### Command Line

---

```
npm install --save-dev enzyme react-addons-test-utils
```

---

Now you can write your first unit test in the Table describe block. You will use `shallow()` to render your component and assert that the Table has two items.

### src/App.test.js

---

```
import React from 'react';
import ReactDOM from 'react-dom';
import renderer from 'react-test-renderer';
import { shallow } from 'enzyme';
import App, { Search, Button, Table } from './App';

describe('Table', () => {

  const props = {
    list: [
      { title: '1', author: '1', num_comments: 1, points: 2, objectID: 'y' },
      { title: '2', author: '2', num_comments: 1, points: 2, objectID: 'z' },
    ],
  };

  ...

  it('shows two items in list', () => {
    const element = shallow(
      <Table { ...props } />
    );

    expect(element.find('.table-row').length).toBe(2);
  });
});
```

---

<sup>88</sup><https://github.com/airbnb/enzyme>

Shallow renders the component without child components. You can make the test very dedicated to one component.

Enzyme has overall three rendering mechanisms in its API. You already know `shallow()`, but there also exist `mount()` and `render()`. Both instantiate instances of the parent component and all child components. Additionally `mount()` gives you more access to the component lifecycle methods. But when to use which render mechanism? Here some rules of thumb:

- Always begin with a shallow test
- If `componentDidMount()` or `componentDidUpdate()` should be tested, use `mount()`
- If you want to test component lifecycle and children behavior, use `mount()`
- If you want to test children rendering with less overhead than `mount()` and you are not interested in lifecycle methods, use `render()`

You could continue to unit test your components. But make sure to keep the tests simple and maintainable. Otherwise you will have to refactor them once you change your components. That's why Facebook introduced Snapshot tests with Jest in the first place.

## Exercises:

- keep your unit tests up to date during the following chapters
- read more about [enzyme and its rendering API](https://github.com/airbnb/enzyme)<sup>89</sup>

---

<sup>89</sup><https://github.com/airbnb/enzyme>

You have learned how to organize your code and how to test it! Let's recap the last chapters:

- React
  - PropTypes let you define type checks for components
  - Jest allows you to write snapshot tests for your components
  - Enzyme allows you to write unit tests for your components
- ES6
  - import and export statements help you to organize your code
- General
  - code organization allows you to scale your application with best practices

You can find the source code in the [official repository](https://github.com/rwieruch/hackernews-client/tree/393ce5a350aa34b1c7ae056333f7bb7b0807caef)<sup>90</sup>.

---

<sup>90</sup><https://github.com/rwieruch/hackernews-client/tree/393ce5a350aa34b1c7ae056333f7bb7b0807caef>

# Advanced React Components

The chapter will focus on the implementation of advanced React components. You will learn about higher order components and how to implement them. In addition you will dive into more advanced topics in React and implement complex interactions.

## Ref a DOM Element

Sometimes you need to interact with your DOM nodes in React. The `ref` attribute gives you access to a node in your elements. Usually that is an anti pattern in React, because you should use its declarative way of doing things and its unidirectional data flow. But there are certain cases where you need access to the DOM node. The official documentation mentions three use cases:

- to use the DOM API (focus, media playback etc.)
- to invoke imperative DOM node animations
- to integrate with third-party library that needs the DOM node (e.g. [D3.js](https://d3js.org/)<sup>91</sup>)

Let's do it by example with the Search component. When the application renders the first time, the input field should be focused. That's one use case where you would need access to the DOM API. This chapter will show you how it works, but since it is not very useful for the application itself, we will omit the changes after the chapter. You can keep it for your own application if you want.

In general, you can use the `ref` attribute in both functional stateless components and ES6 class components. In the example of the focus use case, you will need a lifecycle method. That's why I will first show you the approach of using the `ref` attribute with an ES6 class component.

The initial step is to refactor the functional stateless component to an ES6 class component.

src/App.js

---

```
class Search extends Component {  
  
  render() {  
    const {  
      value,  
      onChange,  
      onSubmit,  
      children  
    } = this.props;  
  
    return (  
      <form onSubmit={onSubmit}>  
        <input  
          type="text"  
          value={value}  
          onChange={onChange}  
        />  
        <button type="submit">
```

---

<sup>91</sup><https://d3js.org/>

```
        {children}
      </button>
    </form>
  );
}
}
```

---

The `this` object of an ES6 class component helps us to reference the DOM node with the `ref` attribute.

**src/App.js**

---

```
class Search extends Component {

  render() {
    const {
      value,
      onChange,
      onSubmit,
      children
    } = this.props;

    return (
      <form onSubmit={onSubmit}>
        <input
          type="text"
          value={value}
          onChange={onChange}
          ref={(node) => { this.input = node; }}
        />
        <button type="submit">
          {children}
        </button>
      </form>
    );
  }
}
```

---

Now you can focus the input field when the component mounted by using the `this` object and the appropriate lifecycle method.

src/App.js

---

```
class Search extends Component {  
  
  componentDidMount() {  
    this.input.focus();  
  }  
  
  render() {  
    const {  
      value,  
      onChange,  
      onSubmit,  
      children  
    } = this.props;  
  
    return (  
      <form onSubmit={onSubmit}>  
        <input  
          type="text"  
          value={value}  
          onChange={onChange}  
          ref={(node) => { this.input = node; }}  
        />  
        <button type="submit">  
          {children}  
        </button>  
      </form>  
    );  
  }  
}
```

---

The input field should be focused when the application is rendered. That's it basically.

But how would you get access to the ref in a functional stateless component without the this object? The following functional stateless component demonstrates it.

**src/App.js**

---

```
const Search = ({
  value,
  onChange,
  onSubmit,
  children
}) => {
  let input;
  return (
    <form onSubmit={onSubmit}>
      <input
        type="text"
        value={value}
        onChange={onChange}
        ref={(node) => input = node}
      />
      <button type="submit">
        {children}
      </button>
    </form>
  );
}
```

---

In the example of the focus use case it wouldn't help you, because you have no lifecycle method to trigger the focus by using the DOM API. But in the future you might come across other use cases where it can make sense to use a functional stateless component with the `ref` attribute.

## Exercises

- read more about [the ref attribute in React](https://facebook.github.io/react/docs/refs-and-the-dom.html)<sup>92</sup>

---

<sup>92</sup><https://facebook.github.io/react/docs/refs-and-the-dom.html>

## Loading ...

Now let's get back to the application. You might want to show a loading indicator when you submit a search request to the Hacker News API. The request is asynchronous and you should show your user some feedback that something is about to happen. Let's define a reusable Loading component in your `src/App.js` file.

`src/App.js`

---

```
const Loading = () =>
  <div>Loading ...</div>
```

---

Now you will need a property to store the loading state. Based on the loading state you can decide to show the Loading component later on.

`src/App.js`

---

```
class App extends Component {

  constructor(props) {
    super(props);

    this.state = {
      results: null,
      searchKey: '',
      searchTerm: DEFAULT_QUERY,
      isLoading: false,
    };

    ...
  }

  ...
}
```

---

The initial value of that property is false. You don't load anything before the App component is mounted.

When you make the request, you set a loading state to true. Eventually the request will succeed and you can set the loading state to false.

**src/App.js**

---

```
class App extends Component {  
  
  ...  
  
  setSearchTopstories(result) {  
    const { hits, page } = result;  
    const { searchKey, results } = this.state;  
  
    const oldHits = results && results[searchKey]  
      ? results[searchKey].hits  
      : [];  
  
    const updatedHits = [  
      ...oldHits,  
      ...hits  
    ];  
  
    this.setState({  
      results: {  
        ...results,  
        [searchKey]: { hits: updatedHits, page }  
      },  
      isLoading: false  
    });  
  }  
  
  fetchSearchTopstories(searchTerm, page) {  
    this.setState({ isLoading: true });  
  
    fetch(`${PATH_BASE}${PATH_SEARCH}?${PARAM_SEARCH}${searchTerm}&${PARAM_PAGE}\`  
    ${page}&${PARAM_HPP}${DEFAULT_HPP}`)  
      .then(response => response.json())  
      .then(result => this.setSearchTopstories(result));  
  }  
  
  ...  
  
}
```

---

In the last step you will use the Loading component in your App. A conditional rendering based on

the loading state will decide whether you show a Loading component or Button component. The latter one is your button to fetch more data.

src/App.js

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    const {  
      searchTerm,  
      results,  
      searchKey,  
      isLoading  
    } = this.state;  
  
    const page = (  
      results &&  
      results[searchKey] &&  
      results[searchKey].page  
    ) || 0;  
  
    const list = (  
      results &&  
      results[searchKey] &&  
      results[searchKey].hits  
    ) || [];  
  
    return (  
      <div className="page">  
        ...  
        <div className="interactions">  
          { isLoading  
            ? <Loading />  
            : <Button  
              onClick={() => this.fetchSearchTopstories(searchKey, page + 1)}>  
              More  
            </Button>  
          }  
        </div>  
      </div>  
    );  
  }  
}
```

```
}  
}
```

---

Initially the Loading component will show up when you start your application, because you make a request on `componentDidMount()`. There is no Table component, because the list is empty. When the response returns from the Hacker News API, the result is shown, the loading state is set to false and the Loading component disappears. The “More” button to fetch more data appears. Once you fetch more data, the button will disappear. Instead the Loading component will show up.

## Exercises:

- use a library like [Font Awesome](http://fontawesome.io/)<sup>93</sup> to show a loading icon instead of the “Loading ...” text

---

<sup>93</sup><http://fontawesome.io/>

## Higher Order Components

Higher order components (HOC) are an advanced concept in React. HOCs are an equivalent to higher order functions. They take any input - most of the time a component, but also optional arguments - and return a component as output. The returned component is an enhanced version of the input component and can be used in your JSX.

HOCs are used for different use cases. They can prepare properties, manage state or alter the representation of a component. One use case could be to use a HOC as a helper for a conditional rendering. Imagine you have a List component that renders a list of items or nothing, because the list is empty or null. The HOC could shield away that the list would render nothing when there is no list. On the other hand the plain List component doesn't need to bother anymore about a non-existent list. It only cares about rendering the list.

Let's do a simple HOC which takes a component as input and returns a component. You can place it in your *src/App.js* file.

*src/App.js*

---

```
function withFoo(Component) {  
  return function(props) {  
    return <Component { ...props } />;  
  }  
}
```

---

One neat convention is to prefix the naming of a HOC with *with*. Since you are using JavaScript ES6, you can express the HOC more concise with an ES6 arrow function.

*src/App.js*

---

```
const withFoo = (Component) => (props) =>  
  <Component { ...props } />
```

---

In the example the input component would stay the same as the output component. Nothing happens. It renders the same component instance and passes all of the props to the output component. But that's useless. Let's enhance the output component. The output component should show the Loading component, when the loading state is true, otherwise it should show the input component. A conditional rendering is a great use case for a HOC.

src/App.js

---

```
const withLoading = (Component) => (props) =>
  props.isLoading ? <Loading /> : <Component { ...props } />
```

---

Based on the loading property you can apply a conditional rendering. The function will return the Loading component or the input component.

In general it can be very efficient to spread an object, like the props object, as input for a component. See the difference in the following code snippet.

Code Playground

---

```
// before you would have to destructure the props before passing them
const { foo, bar } = props;
<SomeComponent foo={foo} bar={bar} />

// but you can use the object spread operator to pass all object properties
<SomeComponent { ...props } />
```

---

There is one little thing that you should avoid. You pass all the props including the `isLoading` property, by spreading the object, into the input component. However, the input component doesn't care about the `isLoading` property. You can use the ES6 rest destructuring to avoid it.

src/App.js

---

```
const withLoading = (Component) => ({ isLoading, ...rest }) =>
  isLoading ? <Loading /> : <Component { ...rest } />
```

---

It takes one property out of the object, but keeps the remaining object. It works with multiple properties as well. You might have already read about it in the [destructuring assignment](#)<sup>94</sup>.

Now you can use the HOC in your JSX. A use case in the application could be to show either the “More” button or the Loading component. The Loading component is already encapsulated in the HOC, but an input component is missing. In the use case of showing a Button component or a Loading component, the Button is the input component of the HOC. The enhanced output component is a ButtonWithLoading component.

---

<sup>94</sup>[https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Operators/Destructuring\\_assignment](https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Operators/Destructuring_assignment)

**src/App.js**

---

```
const Button = ({ onClick, className = '', children }) =>
  <button
    onClick={onClick}
    className={className}
    type="button"
  >
    {children}
  </button>

const Loading = () =>
  <div>Loading ...</div>

const withLoading = (Component) => ({ isLoading, ...rest }) =>
  isLoading ? <Loading /> : <Component { ...rest } />

const ButtonWithLoading = withLoading(Button);
```

---

Everything is defined now. As a last step, you have to use the `ButtonWithLoading` component, which receives the loading state as an additional property. While the HOC consumes the loading property, all other props get passed to the `Button` component.

**src/App.js**

---

```
class App extends Component {
  ...

  render() {
    ...
    return (
      <div className="page">
        ...
        <div className="interactions">
          <ButtonWithLoading
            isLoading={isLoading}
            onClick={() => this.fetchSearchTopstories(searchKey, page + 1)}>
            More
          </ButtonWithLoading>
        </div>
      </div>
    );
  }
}
```

```
}  
}
```

---

When you run your tests again, you will notice that your snapshot test for the App component fails. It should show the following diff on the command line.

#### Command Line

---

```
-   <button  
-     className=""  
-     onClick={ [Function] }  
-     type="button">  
-     More  
-   </button>  
+   <div>  
+     Loading ...  
+   </div>
```

---

You can either fix the component now, when you think there is something wrong about it, or can accept the new snapshot. Because you introduced the Loading component in this chapter, you can accept the failing snapshot test with `u` on the command line in the interactive test.

Higher order components are an advanced technique in React. They have multiple purposes like improved reusability of components, greater abstraction, composeability of components and manipulations of props, state and view. Don't worry if you don't understand them immediately. It takes time to get used to them.

### Exercises:

- experiment with the HOC you have created
- think about a use case where another HOC would make sense
  - implement the HOC, if there is a use case

## Advanced Sorting

You have already implemented a client- and server-side search interaction. Since you have a Table component, it would make sense to enhance the Table with advanced interactions. What about enabling sorting by the Table columns?

It would be possible to write your own sort function, but personally I prefer to use a utility library for such cases. [Lodash](https://lodash.com/)<sup>95</sup> is one of these utility libraries. Let's install and use it for the sort functionality.

### Command Line

---

```
npm install --save lodash
```

---

Now you can import the sort functionality of lodash in your *src/App.js* file.

### src/App.js

---

```
import React, { Component } from 'react';  
import { sortBy } from 'lodash';  
import './App.css';
```

---

You have several columns in your Table. There are title, author, comments and points columns. You can define sort functions where each function takes a list and returns a list of items sorted by property. Additionally you will need one default sort function which doesn't sort but only returns the unsorted list.

### src/App.js

---

```
...  
  
const SORTS = {  
  NONE: list => list,  
  TITLE: list => sortBy(list, 'title'),  
  AUTHOR: list => sortBy(list, 'author'),  
  COMMENTS: list => sortBy(list, 'num_comments').reverse(),  
  POINTS: list => sortBy(list, 'points').reverse(),  
};  
  
class App extends Component {  
  ...  
}  
  
...
```

---

<sup>95</sup><https://lodash.com/>

You can see that two of the sort functions return a reversed list. That's because you want to see the items with the highest comments and points rather than to see the items with the lowest.

The SORTS object allows you to reference any sort function now.

Again your App component is responsible for storing the state of the sort. The initial state will be the initial default sort function, which doesn't sort at all and returns the input list as output.

src/App.js

---

```
this.state = {
  results: null,
  searchKey: '',
  searchTerm: DEFAULT_QUERY,
  isLoading: false,
  sortKey: 'NONE',
};
```

---

Once you choose a different sortKey, let's say the AUTHOR key, you will sort the list with the appropriate sort function.

Now you can define a new sort method in your App component that simply sets a sortKey to your internal component state.

src/App.js

---

```
class App extends Component {

  constructor(props) {

    ...

    this.needToSearchTopstories = this.needToSearchTopstories.bind(this);
    this.setSearchTopstories = this.setSearchTopstories.bind(this);
    this.fetchSearchTopstories = this.fetchSearchTopstories.bind(this);
    this.onSearchSubmit = this.onSearchSubmit.bind(this);
    this.onSearchChange = this.onSearchChange.bind(this);
    this.onDismiss = this.onDismiss.bind(this);
    this.onSort = this.onSort.bind(this);
  }

  onSort(sortKey) {
    this.setState({ sortKey });
  }
}
```

```
...  
}
```

---

The next step is to pass the method and `sortKey` to your Table component.

`src/App.js`

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    const {  
      searchTerm,  
      results,  
      searchKey,  
      isLoading,  
      sortKey  
    } = this.state;  
  
    const page = (  
      results &&  
      results[searchKey] &&  
      results[searchKey].page  
    ) || 0;  
  
    const list = (  
      results &&  
      results[searchKey] &&  
      results[searchKey].hits  
    ) || [];  
  
    return (  
      <div className="page">  
        <div className="interactions">  
          <Search  
            value={searchTerm}  
            onChange={this.onSearchChange}  
            onSubmit={this.onSearchSubmit}  
          >  
            Search  
        </Search>  
      </div>  
    );  
  }  
}
```

```

    </div>
    <Table
      list={list}
      sortKey={sortKey}
      onSort={this.onSort}
      onDismiss={this.onDismiss}
    />
    <div className="interactions">
      <ButtonWithLoading
        isLoading={isLoading}
        onClick={() => this.fetchSearchTopstories(searchKey, page + 1)}>
        More
      </ButtonWithLoading>
    </div>
  </div>
);
}
}

```

---

The Table component is responsible for sorting the list. It takes one of the SORT functions by `sortKey` and passes the list as input. Afterward it keeps mapping over the sorted list.

src/App.js

---

```

const Table = ({
  list,
  sortKey,
  onSort,
  onDismiss
}) =>
  <div className="table">
    { SORTS[sortKey](list).map(item =>
      <div key={item.objectID} className="table-row">
        <span style={{ width: '40%' }}>
          <a href={item.url}>{item.title}</a>
        </span>
        <span style={{ width: '30%' }}>
          {item.author}
        </span>
        <span style={{ width: '10%' }}>
          {item.num_comments}
        </span>
        <span style={{ width: '10%' }}>

```

```

      {item.points}
    </span>
    <span style={{ width: '10%' }}>
      <Button
        onClick={() => onDismiss(item.objectID)}
        className="button-inline"
      >
        Dismiss
      </Button>
    </span>
  </div>
)}
</div>

```

---

In theory the list would get sorted by one of the functions. But the default sort is set to `NONE`. So far no one executes the `onSort()` method to change the `sortKey`. Let's extend the `Table` with a row of headers that use `Sort` components in columns to sort each column.

#### src/App.js

---

```

const Table = ({
  list,
  sortKey,
  onSort,
  onDismiss
}) =>
  <div className="table">
    <div className="table-header">
      <span style={{ width: '40%' }}>
        <Sort
          sortKey={'TITLE'}
          onSort={onSort}
        >
          Title
        </Sort>
      </span>
      <span style={{ width: '30%' }}>
        <Sort
          sortKey={'AUTHOR'}
          onSort={onSort}
        >
          Author
        </Sort>
      </span>
    </div>

```

```

    </span>
    <span style={{ width: '10%' }}>
      <Sort
        sortKey={'COMMENTS'}
        onSort={onSort}
      >
        Comments
      </Sort>
    </span>
    <span style={{ width: '10%' }}>
      <Sort
        sortKey={'POINTS'}
        onSort={onSort}
      >
        Points
      </Sort>
    </span>
    <span style={{ width: '10%' }}>
      Archive
    </span>
  </div>
  { SORTS[sortKey](list).map(item =>
    ...
  )}
</div>

```

---

Each Sort component gets a specific `sortKey` and the general `onSort()` function. Internally it calls the method with the `sortKey` to set the specific key.

`src/App.js`

```

const Sort = ({ sortKey, onSort, children }) =>
  <Button onClick={() => onSort(sortKey)}>
    {children}
  </Button>

```

---

As you can see, the Sort component reuses your common Button component. On a button click each individual passed `sortKey` will get set by the `onSort()` method. Now you should be able to sort the list when you click on the column headers.

But a button in a column header looks a bit silly. Let's give the Sort a proper `className`.

**src/App.js**

---

```
const Sort = ({ sortKey, onSort, children }) =>
  <Button
    onClick={() => onSort(sortKey)}
    className="button-inline"
  >
    {children}
  </Button>
```

---

It should look nice now. The next goal would be to implement reverse sort as well. The list should get reverse sorted once you click a Sort component twice. First you need to define the reverse state.

**src/App.js**

---

```
this.state = {
  results: null,
  searchKey: '',
  searchTerm: DEFAULT_QUERY,
  isLoading: false,
  sortKey: 'NONE',
  isSortReverse: false,
};
```

---

Now in your sort method you can evaluate if the list is reverse sorted. It is when sortKey in the state is the same as the incoming sortKey and the reverse state is not already set to true.

**src/App.js**

---

```
onSort(sortKey) {
  const isSortReverse = this.state.sortKey === sortKey && !this.state.isSortReverse;
  this.setState({ sortKey, isSortReverse });
}
```

---

Again you can pass the reverse prop to your Table component.

**src/App.js**

---

```
class App extends Component {  
  
  ...  
  
  render() {  
    const {  
      searchTerm,  
      results,  
      searchKey,  
      isLoading,  
      sortKey,  
      isSortReverse  
    } = this.state;  
  
    const page = (  
      results &&  
      results[searchKey] &&  
      results[searchKey].page  
    ) || 0;  
  
    const list = (  
      results &&  
      results[searchKey] &&  
      results[searchKey].hits  
    ) || [];  
  
    return (  
      <div className="page">  
        ...  
        <Table  
          list={list}  
          sortKey={sortKey}  
          isSortReverse={isSortReverse}  
          onDismiss={this.onDismiss}  
          onSort={this.onSort}  
        />  
        ...  
      </div>  
    );  
  }  
}
```

---

The Table has to have an arrow function block body to compute the data now.

src/App.js

---

```
const Table = ({
  list,
  sortKey,
  isSortReverse,
  onSort,
  onDismiss
}) => {
  const sortedList = SORTS[sortKey](list);
  const reverseSortedList = isSortReverse
    ? sortedList.reverse()
    : sortedList;

  return(
    <div className="table">
      <div className="table-header">
        ...
      </div>
      { reverseSortedList.map(item =>
        ...
      )}
    </div>
  );
}
```

---

The reverse sort should work now.

Last but not least you have to deal with one open question for the sake of an improved user experience. Can a user distinguish which column is actively sorted? So far, it is not possible. Let's give the user a visual feedback.

Each Sort component gets its specific `sortKey` already. It could be used to identify the activated sort. You can pass the `sortKey` from the internal component state as active sort key to your Sort component.

**src/App.js**

---

```
const Table = ({
  list,
  sortKey,
  isSortReverse,
  onSort,
  onDismiss
}) => {
  const sortedList = SORTS[sortKey](list);
  const reverseSortedList = isSortReverse
    ? sortedList.reverse()
    : sortedList;

  return(
    <div className="table">
      <div className="table-header">
        <span style={{ width: '40%' }}>
          <Sort
            sortKey={'TITLE'}
            onSort={onSort}
            activeSortKey={sortKey}
          >
            Title
          </Sort>
        </span>
        <span style={{ width: '30%' }}>
          <Sort
            sortKey={'AUTHOR'}
            onSort={onSort}
            activeSortKey={sortKey}
          >
            Author
          </Sort>
        </span>
        <span style={{ width: '10%' }}>
          <Sort
            sortKey={'COMMENTS'}
            onSort={onSort}
            activeSortKey={sortKey}
          >
            Comments
          </Sort>
        </span>
      </div>
    </div>
  );
}
```

```

    </span>
    <span style={{ width: '10%' }}>
      <Sort
        sortKey={'POINTS'}
        onSort={onSort}
        activeSortKey={sortKey}
      >
        Points
      </Sort>
    </span>
  </div>
  { reverseSortedList.map(item =>
    ...
  )}
</div>
);
}

```

---

Now in your Sort component you know based on the `sortKey` and `activeSortKey` if the sort is active. Give your Sort component an extra `class` attribute, when it is sorted, to give the user a visual feedback.

`src/App.js`

---

```

const Sort = ({
  sortKey,
  activeSortKey,
  onSort,
  children
}) => {
  const sortClass = ['button-inline'];

  if (sortKey === activeSortKey) {
    sortClass.push('button-active');
  }

  return (
    <Button
      onClick={() => onSort(sortKey)}
      className={sortClass.join(' ')}
    >

```

```
    >
      {children}
    </Button>
  );
}
```

---

The way to define the class is a bit clumsy, isn't it? There is a neat little library to get rid of this. First you have to install it.

#### Command Line

---

```
npm install --save classnames
```

---

And second you have to import it on top of your *src/App.js* file.

#### src/App.js

---

```
import React, { Component } from 'react';
import { sortBy } from 'lodash';
import classNames from 'classnames';
import './App.css';
```

---

Now you can use it to define your component `className` with conditional classes.

#### src/App.js

---

```
const Sort = ({
  sortKey,
  activeSortKey,
  onSort,
  children
}) => {
  const sortClass = classNames(
    'button-inline',
    { 'button-active': sortKey === activeSortKey }
  );

  return (
    <Button
      onClick={() => onSort(sortKey)}
      className={sortClass}
    >
      {children}
    </Button>
  );
}
```

```
    </Button>
  );
}
```

---

Again, when you run your tests, you should see failing snapshot tests but also failing unit tests for the Table component. Since you changed again your component representations, you can accept the snapshot tests. But you have to fix the unit test. In your *src/App.test.js* file you need to provide a `sortKey` and the `isSortReverse` boolean for the Table component.

**src/App.test.js**

---

```
...

describe('Table', () => {

  const props = {
    list: [
      { title: '1', author: '1', num_comments: 1, points: 2, objectID: 'y' },
      { title: '2', author: '2', num_comments: 1, points: 2, objectID: 'z' },
    ],
    sortKey: 'TITLE',
    isSortReverse: false,
  };

  ...

});
```

---

Once again you might need to accept the failing snapshot tests for your Table component, because you provided props for the Table and the full component renders now.

Your advanced sort interaction is complete now.

## Exercises:

- use a library like [Font Awesome](http://fontawesome.io/)<sup>96</sup> to indicate the (reverse) sort
  - it could be an arrow up or down icon next to each Sort header
- read more about the [classnames library](https://github.com/JedWatson/classnames)<sup>97</sup>

---

<sup>96</sup><http://fontawesome.io/>

<sup>97</sup><https://github.com/JedWatson/classnames>

You have learned advanced component techniques in React! Let's recap the last chapters:

- React
  - the ref attribute to reference DOM nodes
  - higher order components are a common way to build advanced components
  - implementation of advanced interactions in React
  - conditional classNames with a neat helper library
- ES6
  - rest destructuring to split up objects and arrays

You can find the source code in the [official repository](#)<sup>98</sup>.

---

<sup>98</sup><https://github.com/rwieruch/hackernews-client/tree/9456117fb67bbe98d7e3f41bbc85b4a035020e7e>

# State Management in React and beyond

You have learned the basics of state management in React already in the previous chapters. This chapter digs a bit deeper into the topic. You will learn best practices, how to apply them and why you could consider an third party state management library.

## Lifting State

Only the App component is a stateful ES6 component in your application. It handles a lot of application state and logic (methods). Maybe you have noticed that you pass a lot of properties to your Table component. Most of the props are only used in the component. It makes no sense that the App component knows about them.

The sort functionality is only handled in the Table component. You could move it closer to the Table component. The App component doesn't need to know about it at all. The process of refactoring substate from one component to another is known as *lifting state*. In your case you want to move state that isn't used in the App component closer to the Table component. The state moves down from parent to child component.

In order to deal with state and methods in the Table component, it has to become an ES6 class component. The refactoring from functional stateless component to ES6 class component is straight forward.

Your Table component as functional stateless component:

src/App.js

---

```
const Table = ({
  list,
  sortKey,
  isSortReverse,
  onSort,
  onDismiss
}) => {
  const sortedList = SORTS[sortKey](list);
  const reverseSortedList = isSortReverse
    ? sortedList.reverse()
    : sortedList;

  return(
    ...
  );
}
```

---

Can get refactored to an ES6 class component:

src/App.js

---

```
class Table extends Component {

  render() {
    const {
      list,
      sortKey,
      isSortReverse,
      onSort,
      onDismiss
    } = this.props;

    const sortedList = SORTS[sortKey](list);
    const reverseSortedList = isSortReverse
      ? sortedList.reverse()
      : sortedList;

    return(
      ...
    );
  }
}
```

---

Since you want to deal with state and methods in your component, you have to add a constructor and initial state.

src/App.js

---

```
class Table extends Component {

  constructor(props) {
    super(props);

    this.state = {};
  }

  render() {
    ...
  }
}
```

---

Now you can move state and methods from your App component down to your Table component.

**src/App.js**

---

```
class Table extends Component {

  constructor(props) {
    super(props);

    this.state = {
      sortKey: 'NONE',
      isSortReverse: false,
    };

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

  onSort(sortKey) {
    const isSortReverse = this.state.sortKey === sortKey && !this.state.isSortReverse;
    this.setState({ sortKey, isSortReverse });
  }

  render() {
    ...
  }
}
```

---

Don't forget to remove the moved state and `onSort()` method from your App component.

**src/App.js**

---

```
class App extends Component {

  constructor(props) {
    super(props);

    this.state = {
      results: null,
      searchKey: '',
      searchTerm: DEFAULT_QUERY,
      isLoading: false,
    };

    this.setSearchTopstories = this.setSearchTopstories.bind(this);
  }
}
```

```
    this.fetchSearchTopstories = this.fetchSearchTopstories.bind(this);
    this.onDismiss = this.onDismiss.bind(this);
    this.onSearchSubmit = this.onSearchSubmit.bind(this);
    this.onSearchChange = this.onSearchChange.bind(this);
    this.needsToSearchTopstories = this.needsToSearchTopstories.bind(this);
  }

  ...

}
```

---

Additionally you can make the Table component API more lightweight. Remove the props which are handled internally in the Table component.

src/App.js

---

```
class App extends Component {

  ...

  render() {
    const {
      searchTerm,
      results,
      searchKey,
      isLoading
    } = this.state;

    const page = (
      results &&
      results[searchKey] &&
      results[searchKey].page
    ) || 0;

    const list = (
      results &&
      results[searchKey] &&
      results[searchKey].hits
    ) || [];

    return (
      <div className="page">
        ...
      </div>
    );
  }
}
```

```
        <Table
          list={list}
          onDismiss={this.onDismiss}
        />
        ...
      </div>
    );
  }
}
```

---

Now in your Table component you can use the internal `onSort()` method and the internal Table state.

**src/App.js**

---

```
class Table extends Component {
  ...

  render() {
    const {
      list,
      onDismiss
    } = this.props;

    const {
      sortKey,
      isSortReverse,
    } = this.state;

    const sortedList = SORTS[sortKey](list);
    const reverseSortedList = isSortReverse
      ? sortedList.reverse()
      : sortedList;

    return(
      <div className="table">
        <div className="table-header">
          <span style={{ width: '40%' }}>
            <Sort
              sortKey={'TITLE'}
              onSort={this.onSort}
              activeSortKey={sortKey}
            />
          </span>
        </div>
      </div>
    );
  }
}
```

```
    >
      Title
    </Sort>
  </span>
  <span style={{ width: '30%' }}>
    <Sort
      sortKey={'AUTHOR'}
      onSort={this.onSort}
      activeSortKey={sortKey}
    >
      Author
    </Sort>
  </span>
  <span style={{ width: '10%' }}>
    <Sort
      sortKey={'COMMENTS'}
      onSort={this.onSort}
      activeSortKey={sortKey}
    >
      Comments
    </Sort>
  </span>
  <span style={{ width: '10%' }}>
    <Sort
      sortKey={'POINTS'}
      onSort={this.onSort}
      activeSortKey={sortKey}
    >
      Points
    </Sort>
  </span>
  <span style={{ width: '10%' }}>
    Archive
  </span>
</div>
{ reverseSortedList.map((item) =>
  ...
)}
</div>
);
}
}
```

---

Your application should still work. But you made a crucial refactoring. You moved functionality and state closer to a component. Other components got more lightweight again. Additionally the component API of the Table got more lightweight because it deals internally with the sort functionality.

The process of lifting state can go the other way as well: from child to parent component - lifting state up. Imagine you were dealing with internal state in a child component. Now you want to fulfill a requirement to show the state in your parent component as well. You would have to lift up the state to your parent component. But it goes even further. Imagine you want to show the state in a sibling component of your child component. Again you would have to lift the state up to your parent component. The parent component deals with the internal state, but exposes it to both child components.

## Exercises:

- read more about [lifting state in React](https://facebook.github.io/react/docs/lifting-state-up.html)<sup>99</sup>

---

<sup>99</sup><https://facebook.github.io/react/docs/lifting-state-up.html>

## Revisited: setState()

So far, you have used React `setState()` to manage your internal component state. You can pass an object to the function where you can update partially the internal state.

### Code Playground

---

```
this.setState({ foo: bar });
```

---

But `setState()` doesn't take only an object. In its second version, you can pass a function to update the state.

### Code Playground

---

```
this.setState((prevState, props) => {  
  ...  
});
```

---

Why should you want to do that? There is one crucial use case where it makes sense to use a function over an object. It is when you update the state depending on the previous state or props. If you don't use a function, the internal state management can cause bugs.

But why does it cause bugs to use an object over a function when the update depends on the previous state or props? The React `setState()` method is asynchronous. React batches `setState()` calls and executes them eventually. It can happen that the previous state or props changed in between when you would rely on it.

### Code Playground

---

```
const { fooCount } = this.state;  
const { barCount } = this.props;  
this.setState({ count: fooCount + barCount });
```

---

Imagine that `fooCount` and `barCount`, thus the state or the props, can change somewhere else in your components. In a growing application you have more often 'setState()' calls across your application. Since `setState()` executes asynchronously, you would rely in the example on likely stale values.

With the function approach, the function in `setState()` is a callback that operates on the state and props at the time of executing the callback function. Even though `setState()` is asynchronous, with a function it takes the state and props at the time when it is executed.

### Code Playground

---

```
this.setState((prevState, props) => {
  const { fooCount } = prevState;
  const { barCount } = props;
  return { count: fooCount + barCount };
});
```

---

Now, let's get back to your code to fix this behavior. Together we will fix it for one place where `setState()` is used and relies on the state or props. Afterward you are able to fix it at places where the state update relies on the previous state or props.

The `setSearchTopstories()` method relies on the previous state and thus is a perfect example to use a function over an object in `setState()`. Right now it looks like the following code snippet. You extract values from the state, but update the state depending on the previous state asynchronously.

#### src/App.js

---

```
setSearchTopstories(result) {
  const { hits, page } = result;
  const { searchKey, results } = this.state;

  const oldHits = results && results[searchKey]
    ? results[searchKey].hits
    : [];

  const updatedHits = [
    ...oldHits,
    ...hits
  ];

  this.setState({
    results: {
      ...results,
      [searchKey]: { hits: updatedHits, page }
    },
    isLoading: false
  });
}
```

---

Now you can use the function to prevent bugs because of a stale state.

src/App.js

---

```
setSearchTopstories(result) {
  const { hits, page } = result;

  this.setState(prevState => {
    ...
  });
}
```

---

You can move the whole block that you already implemented into the function. You only have to exchange that you operate on the `prevState` rather than `this.state`.

src/App.js

---

```
setSearchTopstories(result) {
  const { hits, page } = result;

  this.setState(prevState => {
    const { searchKey, results } = prevState;

    const oldHits = results && results[searchKey]
      ? results[searchKey].hits
      : [];

    const updatedHits = [
      ...oldHits,
      ...hits
    ];

    return {
      results: {
        ...results,
        [searchKey]: { hits: updatedHits, page }
      },
      isLoading: false
    };
  });
}
```

---

That will fix the issue with a stale state. Since it is a function, you can extract the function for an improved readability. That's one more advantage to use a function over an object. The function can live outside of the component. But you have to use a higher order function to pass the result. After all you want to update the state based on the fetched result from the API.

src/App.js

---

```
setSearchTopstories(result) {  
  const { hits, page } = result;  
  this.setState(updateSearchTopstoriesState(hits, page));  
}
```

---

The `updateSearchTopstoriesState()` function has to return a function. It is a higher order function. You can define this higher order function outside of your App component. Note how the function signature changes slightly now.

src/App.js

---

```
const updateSearchTopstoriesState = (hits, page) => (prevState) => {  
  const { searchKey, results } = prevState;  
  
  const oldHits = results && results[searchKey]  
    ? results[searchKey].hits  
    : [];  
  
  const updatedHits = [  
    ...oldHits,  
    ...hits  
  ];  
  
  return {  
    results: {  
      ...results,  
      [searchKey]: { hits: updatedHits, page }  
    },  
    isLoading: false  
  };  
};  
  
class App extends Component {  
  ...  
}
```

---

That's it. The function over an object approach in `setState()` fixes potential bugs yet increases readability and maintainability of your code.

## Exercise:

- read more about [React using state correctly](https://facebook.github.io/react/docs/state-and-lifecycle.html#using-state-correctly)<sup>100</sup>
- refactor all setState methods to use a function
  - but only when it makes sense, because it relies on props or state

---

<sup>100</sup><https://facebook.github.io/react/docs/state-and-lifecycle.html#using-state-correctly>

## Taming the State

The previous chapters have shown you that state management can be a crucial topic in your application. In general, not only React but a lot of SPA frameworks struggle with it. Applications got more complex in the recent years. One big challenge in web applications nowadays is to tame and control the state.

Compared to other solutions React already made a big step forward. The unidirectional data flow and a simple API to manage state in a component are indispensable. These concepts make it easier to reason about your state and your state changes. It makes it easier to reason about it on a component level and to a certain degree on a application level.

In a growing application it gets harder to reason about state changes. You can introduce bugs by operating on stale state when using an object over a function in `setState()`. You have to lift state around to share necessary or hide unnecessary state across components. It can happen that a component needs to lift up state, because its sibling component depends on it. Perhaps the component is far away in the component tree and you have to share the state across the whole component tree. It happens that components get involved to a greater extent in state management. But after all the main responsibility of components should be representing the UI, shouldn't it?

Because of all these reasons, there exist standalone solutions to take care of the state management. These solutions are not only used in React. However, that's what makes the React ecosystem such a powerful place. You can use different solutions to solve your problems. To address the problem of scaling state management, you might have heard of the libraries [Redux](#)<sup>101</sup> or [MobX](#)<sup>102</sup>. You can use either of these solutions in a React application. They come with extensions, [react-redux](#)<sup>103</sup> and [mobx-react](#)<sup>104</sup>, to integrate with React.

Redux and MobX are outside of the scope of this book. When you finished the book, you will get guidance how you can continue to learn React and its ecosystem. One learning path could be to learn Redux. Before you dive into the topic of external state management, I can recommend to read this [article](#)<sup>105</sup>. It aims to give you a better understanding of how to learn external state management.

### Exercises:

- read more about [external state management and how to learn it](#)<sup>106</sup>

---

<sup>101</sup><http://redux.js.org/docs/introduction/>

<sup>102</sup><https://mobx.js.org/>

<sup>103</sup><https://github.com/reactjs/react-redux>

<sup>104</sup><https://github.com/mobxjs/mobx-react>

<sup>105</sup><https://www.robinwieruch.de/redux-mobx-confusion/>

<sup>106</sup><https://www.robinwieruch.de/redux-mobx-confusion/>

You have learned advanced state management in React! Let's recap the last chapters:

- React
  - lift state management up and down to suitable components
  - setState can use a function to prevent stale state bugs
  - existing external solutions that help you to tame the state

You can find the source code in the [official repository](https://github.com/rwieruch/hackernews-client/tree/72a0828790f365af9d68a9f529c8ebe5db2e9c7f)<sup>107</sup>.

---

<sup>107</sup><https://github.com/rwieruch/hackernews-client/tree/72a0828790f365af9d68a9f529c8ebe5db2e9c7f>

# Final Steps to Production

The last chapters will show you to deploy your application to production. You will use the free hosting service Heroku. On the way to deploy your application you will learn more about *create-react-app*.

## Eject

The following step and knowledge is **not necessary** to deploy your application to production. Still, I want to explain it to you. *create-react-app* comes with one feature to prevent vendor lock-in. A vendor lock-in usually happens when you buy into a technology but there is no escape hatch. In a vendor lock-in it is hard to change the technology. In *create-react-app* you have the escape hatch with “eject”.

In your *package.json* you will find the scripts to *start*, *test* and *build* your application. The last script is *eject*. You could try it, but there is no way back. **It is a one-way operation. Once you eject, you canâ€™t go back!** If you just started to learn React, it makes no sense to leave the convenient environment of *create-react-app*.

If you would run `npm run eject`, the command would copy all the configuration and dependencies to your *package.json* and a new *config/* folder. You would convert the whole project into a custom setup with tooling that includes Babel, Webpack and ESLint. After all, you would have full control over all these tools.

The official documentation says that *create-react-app* is suitable for small to mid size projects. You shouldn’t feel obligated to use the “eject” command.

### Exercises:

- read more about [eject](#)<sup>108</sup>

---

<sup>108</sup><https://github.com/facebookincubator/create-react-app#converting-to-a-custom-setup>

## Deploy your App

In the end no application should stay on localhost. You want to go live. Heroku is a platform as a service where you can host your application. They offer a seamless integration with React. To be more specific: It's possible to deploy a create-react-app in minutes. It is a zero-configuration deployment which follows the philosophy of create-react-app.

You need to fulfill two requirements before you can deploy your application to Heroku:

- install the [Heroku CLI](#)<sup>109</sup>
- create a [free Heroku account](#)<sup>110</sup>

If you have installed Homebrew, you can install the Heroku CLI from command line:

### Command Line

---

```
brew update  
brew install heroku-toolbelt
```

---

Now you can use git and Heroku CLI to deploy your application.

### Command Line

---

```
git init  
heroku create -b https://github.com/mars/create-react-app-buildpack.git  
git add .  
git commit -m "react-create-app on Heroku"  
git push heroku master  
heroku open
```

---

That's it. I hope your application is up and running now. If you run into problems you can check the following resources:

- [Deploying React with Zero Configuration](#)<sup>111</sup>
- [Heroku Buildpack for create-react-app](#)<sup>112</sup>

---

<sup>109</sup><https://devcenter.heroku.com/articles/heroku-command-line>

<sup>110</sup><https://www.heroku.com/>

<sup>111</sup><https://blog.heroku.com/deploying-react-with-zero-configuration>

<sup>112</sup><https://github.com/mars/create-react-app-buildpack>

# Final Words

That was the last chapter of the book. I hope you liked it so far. Share it with your friends, it would mean a lot to me. You can already pre-order the next book: [The Road to learn Redux](#)<sup>113</sup>.

**But where can you go from here?** You can either extend the application on your own or dive into your own React project. Before you dive into another book or tutorial, you should create your own hands-on React project. Do it for one week, release it somewhere and reach out to me on [Twitter](#)<sup>114</sup>. I am curious what you will build after you have read the book. You can also find me on [GitHub](#)<sup>115</sup> to share your repository.

If you are looking for further extensions for your application, I can recommend several learning paths:

- **Code Organization:** On your way reading the book you came across one chapter about Code Organization. You could apply these changes now, if you haven't done it yet. It will organize your components in structured files and folders (modules). In addition it helps to understand and learn the principles of code splitting, reusability, maintainability and module API design.
- **Asynchronous Requests:** You can substitute the native fetch API with third party alternatives to perform asynchronous requests: [superagent](#)<sup>116</sup> or [axios](#)<sup>117</sup>. There is no perfect solution to make asynchronous requests. But by exchanging the building blocks around React, you make the experience how powerful it can be to have this flexibility. In frameworks you stick to one solution, in a flexible ecosystem like React you can exchange the solutions.
- **Type Checking:** In one chapter you have used React PropTypes to define component interfaces. It is a good practice to prevent bugs. But the PropTypes are only checked on runtime. You can go one step further to introduce static type checking in your editor. [TypeScript](#)<sup>118</sup> is one popular approach. But in the React ecosystem people prefer to use [Flow](#)<sup>119</sup>. I can recommend to give Flow a shot.
- **Tooling with Webpack and Babel:** You have setup your application with *create-react-app*. At some point, when you learned React, you want to learn the tooling around it to setup your own project without *create-react-app*. I can recommend to follow a minimal setup with [Webpack and Babel](#)<sup>120</sup>. Afterward you could [setup ESLint](#)<sup>121</sup> to follow a unified code style in your application.

---

<sup>113</sup><https://gumroad.com/products/uwiyI>

<sup>114</sup><https://twitter.com/rwieruch>

<sup>115</sup><https://github.com/rwieruch>

<sup>116</sup><https://github.com/visionmedia/superagent>

<sup>117</sup><https://github.com/mzabriskie/axios>

<sup>118</sup><https://www.typescriptlang.org/>

<sup>119</sup><https://flowtype.org/>

<sup>120</sup><https://www.robinwieruch.de/minimal-react-webpack-babel-setup/>

<sup>121</sup><https://www.robinwieruch.de/react-eslint-webpack-babel/>

- **State Management:** You have used React `setState` to manage internal component state. That's a perfect start. However, in a scaling application you will experience the limits of internal component state. Therefore you have third party state management libraries like Redux or MobX.
- **Routing:** You can implement routing for your application with [react-router](#)<sup>122</sup>. So far you only have one page in your application. React Router helps you to have multiple pages across different URLs.

### More Readings:

- [The Minimal React Webpack Babel Setup](#)<sup>123</sup>
- [Reasons why I moved from Angular to React](#)<sup>124</sup>
- [Tips to learn React + Redux](#)<sup>125</sup>
- [All the Conditional Renderings in React](#)<sup>126</sup>
- [Redux or MobX: An attempt to dissolve the Confusion](#)<sup>127</sup>
- [SoundCloud Client in React + Redux](#)<sup>128</sup> with Extensions like ESLint, Flow, Normalizr, MobX and Observables<sup>129</sup>

### More Resources:

- A real SoundCloud Client in React + Redux: [Live](#)<sup>130</sup> & [Source](#)<sup>131</sup>
- A real SoundCloud Client in React + MobX: [Source](#)<sup>132</sup>

In general I invite you to visit my website [www.robinwieruch.de](http://www.robinwieruch.de)<sup>133</sup> to find more interesting topics. You can [subscribe](#)<sup>134</sup> to my Newsletter to get content updates.

If you liked the book, I hope you will share it with your friends. I would really appreciate it. Stay tuned for [The Road to learn Redux](#)<sup>135</sup> that you can already pre-order to support me. Thanks for reading - Robin.

---

<sup>122</sup><https://github.com/ReactTraining/react-router>

<sup>123</sup><https://www.robinwieruch.de/minimal-react-webpack-babel-setup/>

<sup>124</sup><https://www.robinwieruch.de/reasons-why-i-moved-from-angular-to-react/>

<sup>125</sup><https://www.robinwieruch.de/tips-to-learn-react-redux/>

<sup>126</sup><https://www.robinwieruch.de/conditional-rendering-react/>

<sup>127</sup><https://www.robinwieruch.de/redux-mobx-confusion/>

<sup>128</sup><https://www.robinwieruch.de/the-soundcloud-client-in-react-redux>

<sup>129</sup><https://github.com/rwieruch/react-redux-soundcloud>

<sup>130</sup><http://www.favesound.de/>

<sup>131</sup><https://github.com/rwieruch/favesound-redux>

<sup>132</sup><https://github.com/rwieruch/favesound-mobx>

<sup>133</sup><https://www.robinwieruch.de/>

<sup>134</sup><https://www.getrevue.co/profile/rwieruch>

<sup>135</sup><https://gumroad.com/products/uwiyI>