Getting Started with TDD in React

Introduction

You've spent some time with React, maybe even written a few tests. But you're not really sure how best to test your components. Where do you start? And what exactly do you test, anyway?

Some React components seem so simple that it's not even clear whether they need tests at all.

If you've come to React from Angular, you may have a bit of a love/hate relationship with tests.

On one hand, Angular comes with a lot of tools to help with testing, but at the same time, writing the tests can painful. There is a lot of boilerplate code, and forgetting a call to `$digest` can cause your tests to fail when you think they should pass, greatly increasing debugging time.

React tests have much less ceremony and are a bit easier to wrap your head around. And TDD with React captures the quick, fast iterations that make testing fun.

This tutorial will focus on React only — no Redux for now. The ecosystem can be totally overwhelming in the beginning, so we'll start small.

Prerequisites

- Node.js (available here or via nvm)
- npm (comes bundled with node)

Environment

First things first, we need an environment to test with. Testing React Components with Enzyme and Mocha is a great starting point and explains the process nicely. If you've gone through that article already, or have the time to read it now, start there.

On the other hand, if you want to take a shortcut for now, follow these steps:

Install quik. This package gets you up and running quickly without having to manually set up a build. We'll use `-g` to install it globally, which will install a new `quik` command.

```
$ npm install -g quik
```

We need a library for making assertions in our tests. Chai is a popular one. We'll install a library for setting up spies too — Sinon. We also want to install Enzyme, a library for testing React components created by Airbnb, and jsdom, a library for simulating a browser DOM in JavaScript.

```
$ npm install chai sinon enzyme jsdom
```

Enzyme requires React as a peer dependency, and also needs `react-dom` and `react-addon-test-utils` so we'll install those as well:

```
$ npm install react react-dom react-addons-test-utils
```

We need a *test runner*. There are a few options out there — Mocha, Tape, Jasmine, and more. Mocha is a popular one in the React community, so we'll use that. Install it globally so that we get a `mocha` command.

```
$ npm install -g mocha
```

Since we'll be using ES6 and JSX in our test files, the tests need to be *transpiled* with Babel before Mocha can run them. To make that work, we'll install Babel and a few presets (`es2015` for ES6 aka ES2015, and `react` for JSX).

```
$ npm install babel-core babel-preset-es2015 babel-preset-react
```

Finally, Babel needs to be told to use those 2 presets. This configuration goes in a file named `.babelrc`. Create that file and paste this in:

```
{
  "presets": ["es2015", "react"]
}
```

Don't forget the braces.

One more thing: we need a `setup.js` file to initialize our fake DOM. Create the `setup.js` file and paste this in:

```
require('babel-register')();

var jsdom = require('jsdom').jsdom;

var exposedProperties = ['window', 'navigator', 'document'];

global.document = jsdom('');
global.window = document.defaultView;
Object.keys(document.defaultView).forEach((property) => {
```

```
  if (typeof global[property] === 'undefined') {
    exposedProperties.push(property);
    global[property] = document.defaultView[property];
  }
});

global.navigator = {
  userAgent: 'node.js'
};
```

Make Sure Everything Works

Before we go any further, this is a great time to check that your environment is set up and working.

Test that Mocha is working

Create a file called `components.spec.js`. Paste this in:

```
import { expect } from 'chai';

describe('the environment', () => {
  it('works, hopefully', () => {
    expect(true).to.be.true;
  });
});
```

Then run Mocha, like so:

```
$ mocha --require setup.js *.spec.js
```

You should see a passing test. If you see an error, go back through the steps above and make sure you didn't miss anything.

Test That Quik is Working

Let's also test that Quik is working correctly. Create a file named `index.js` and paste this in:

```
import React from 'react';
import ReactDOM from 'react-dom';

let Hello = () => <span>Hi</span>

ReactDOM.render(<Hello/>, document.querySelector('#root'));
```

Then, run Quik like so:

```
$ quik
```

You should see a browser window appear with the text "Hi." If that doesn't appear, try refreshing the browser, or restarting `quik`.

In case you're curious, here's how Quik works: when you installed Quik, it came bundled with its own hot-reloading Webpack build, which it applies to every project you invoke it in.

When you run the `quik` command, it looks for a file named `index.js` and treats it as the root of your application — that `index.js` file should at the very least call `ReactDOM.render()`. You can put as little or as much as you like in this file, and `import` other files as necessary.

The Tools

Let's go over the "tools of the trade," the libraries and apps we'll be using to test our React code.

Mocha is the test runner (or test "framework"). It's the top-level tool in this hierarchy. Mocha is responsible for finding and loading test files, transpiling them, and running the test code itself: the `describe` and `it` blocks that compose the tests.

Chai is the assertion library. It supplies the `expect` and `assert` calls we'll use in the tests to verify everything is working correctly.

Sinon is a library for creating and inspecting spies. Spies let you mock and stub pieces of functionality in order to keep the tests laser-focused on the component under test.

Enzyme is a library for rendering and making assertions on React components. It's the only one of these 4 that is specific to React.

Here's how these all work together:

1. You run `mocha` at the command line (with some arguments).
2. It finds your test files, and transpiles them.
3. It executes the tests, which are written in JavaScript (ES6 in our case).
4. Each test will `import` *enzyme* and *chai*, then use them to render components and make assertions.

The roles of these tools will become clearer as we start to write some tests.

The Strategy

Way back at the beginning of this article, we talked about some of the motivations: why are we testing our React components, and more importantly, what exactly do we need to test about them?

And React components can be very simple — are they worth testing even if they're very straightforward? Even with more complex components, it's not too hard to look at them and figure out what's going on…

Why Test?

Every component is worth testing to some degree, even if the test is simple. This gives you confidence that the component works as expected (even if that seems obvious at a single glance), and it gives you confidence to refactor later on.

The ability to refactor is key. When you have tests for even the simple components that render a user's name and email address (for example), you can later split that component up into pieces and be confident that it still works correctly.

How to Test?

The technique we will be taking advantage of heavily is *shallow rendering*.

This means that when we render a component, it only renders one level deep. You can think of it as "running" the component, but not "running" any of its children.

Here's an example. Let's say we have a `person` object with a `name` and `age`. Here's a component for displaying that person:

```
let Person = ({person}) => (
  <span>
    <Name person={person}/>
    <Age person={person}/>
  </span>
)
```

By running this through a shallow render process, we'll end up with this element (and notice how the `Name` and `Age` are intact — their internals are not evaluated)

```
<span>
  <Name person={person}/>
  <Age person={person}/>
</span>
```

Whereas, if we had run a full (deep) render, React would evaluate the `Name` and `Age` resulting in an element like this:

```
<span>
  <span className="name">Dave</span>
  <span className="age">32</span>
</span>
```

So why is shallow rendering valuable?

Rendering this way means that we don't need to concern ourselves with how the child components are implemented. It's a little like "mocking," but we get it for free. It also means that we do not need a DOM.

In this case, it keeps our test focused on how `Person` works, instead of tightly coupling the implementation of `Person` to the way `Name` and `Age` work.

What would happen if we were testing with deep-rendered components, and the implementation of `Name` changed from first-name-only to "lastName, firstName"? Well, our test for `Person` would have to be updated, even though the implementation of `Person` didn't change. Extra work for us!

So that's why we'll be making heavy use of shallow rendering in testing our components.

In some of the last few tests that deal with input handling, we'll need to fully render the component — this is why we needed to install `jsdom`, and also why we need the `setup.js` file.

What to Test?

It must render: At the very least, make sure the component renders without error. This verifies there are no JSX syntax errors, that all variables are defined, etc. This could be as simple as verifying that the rendered output is not null.

Test the output: One step above "it renders" is "it renders the correct thing." Given a set of props, what output is expected? Does `Person` render its name and age, or does it render a name and "TODO: age coming in v2.1"?

Test the states: Every conditional should be accounted for. If the classNames are conditional (enabled/disabled, success/warning/error, etc), make sure to test that the className-deciding logic is working well. Likewise for conditionally-rendered children: if the `Logout` button is only visible when the user is logged in, for instance, make sure to test for that.

Test the events: If the component can be interacted with (an `input` or `button` with an `onClick` or `onChange` or `onAnything`), test that the events work as expected and call the specified functions with the correct arguments (including binding `this`, if it matters).

Test the edge cases: Anything that operates on an array could have boundary cases — an empty array, an array with 1 element, a paginated list that should truncate at 25 items, and so on. Try out every edge case you can think of, and make sure they all work correctly.

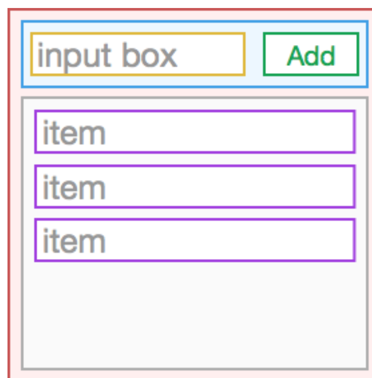
What We're Testing

We're going to build a very simple "list" application. And I do mean very simple: it will allow adding items, and viewing a list of those items.

Even for such a simple set of functionality, there are a few ways to approach the implementation: bottom-up or top-down.

When building your own application, you'll also want to decide between "UI-first" or "data-first" — do you create the UI you want to see (with fake data initially), or do you start with a data structure and build a UI around it? Here we're doing UI-first.

Here is a mockup of the UI:



Let's give the components some names, and then get started with the tests:

- **BeerListContainer**: The top-level wrapper component
  - **InputArea**: A wrapper around the input + button
    - **input**: A plain old HTML5 input tag
    - **button**: A plain old HTML5 button
- **BeerList**: The list of items (its root will be a `ul`)
  - **li**: Each row is a plain `li`

Before we begin, you can clone the finished repository from Github and use it to check your work if something goes wrong.

Here We Go

Let's start with some basic code to render a fairly empty container.

Open up the `index.js` file and replace the entire file with these contents:

```
import React, { Component } from 'react';
import ReactDOM from 'react-dom';
import {BeerListContainer} from './components';

ReactDOM.render(
  <BeerListContainer/>,
  document.querySelector('#root'));
```

This `index.js` file is responsible for rendering the root component.

We'll write the components themselves in `components.js`. Create that file and type this in:

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

export class BeerListContainer extends Component {
  render() {
    return <span>Beer!</span>
  }
}
```

For the sake of simplicity, we'll be keeping everything in one file for this exercise. In your own code, you'd want to break these components up into separate files.

You may wonder why we split up the files at all — why not keep everything in `index.js`? The reason is because we need to `import` the components into our test, and if we import them from the `index.js` file, `ReactDOM.render()` will execute. This causes us to be dependent on the existence of a DOM, even though most of our tests won't need it (because they're using shallow rendering).

Before we begin, we'll start up both `quik` and `mocha` so we'll get live feedback about the tests and simultaneously see how the UI is coming together.

So back in your project directory, start Quik:

```
$ quik
```

And then open a separate terminal window, and start Mocha:

```
$ mocha --watch --require setup.js *.spec.js
```

Your browser should pop open and display "Beer!"

Now let's write the first test. Open up the `components.spec.js` file we created earlier. Replace the contents with this code:

```
import React from 'react';
import { expect } from 'chai';
import { shallow, mount } from 'enzyme';
import { BeerListContainer } from './components';

describe('BeerListContainer', () => {
  it('should render InputArea and BeerList', () => {
    const wrapper = shallow(<BeerListContainer/>);
    expect(wrapper.containsAllMatchingElements([
      <InputArea/>,
      <BeerList/>
    ])).to.equal(true);
  });
});
```

This will fail immediately because `InputArea` is not defined yet (neither is `BeerList`).

> ReferenceError: InputArea is not defined

Before we fix that, though, let's look at what this is doing.

First, we import all the necessary parts. React is necessary because we're using JSX (which will be compiled to a call to `React.createElement`). We also pull in `expect` and `shallow`, as well as our component. We're importing `mount` now, but won't use it until later.

We call `shallow`, passing in a JSX expression `<BeerListContainer/>`.

We want it to contain `InputArea` and `BeerList`, so we check for those children with `wrapper.containsAllMatchin`

But notice: even though we're shallow-rendering the container, the child component names must be defined so that we can check that they exist. They're not defined yet, so this test is erroring out. Let's fix that.

Back in `components.js`, add these 2 components to the end:

```
export class InputArea extends Component {
  render() {
    return <input/>
  }
}

export class BeerList extends Component {
  render() {
    return <ul/>
  }
}
```

They're extremely minimal, and we'll fix that later. But now that they exist, go back to `components.spec.js` and add this line to the imports up top:

```
import { InputArea, BeerList } from './components';
```

Now does the test pass? Nope! It no longer throws an error, which is progress, but we need to fix `BeerListContainer`. Back in `components.js`, modify the `BeerListContainer` component to read like this:

```
export class BeerListContainer extends Component {
  render() {
    return (
      <div>
        <InputArea/>
        <BeerList/>
      </div>
    );
```

```
  }
}
```

Now the test is passing!

Notice that the shallow rendering isn't just one level deep. It will actually render all of the builtin components (`div`, `span`, etc), and stop short of rendering any custom components.

To prove it to yourself, wrap another `div` around that `div`, and see that the test still passes.

Test 2: Container State

Architecturally, it would be ideal if the container was in charge of the list: maintaining the state, and adding items to it. Let's work on that functionality before we descend into the child components.

Initially, it should contain an empty array of items. Write the test in `components.spec.js`:

```
describe('BeerListContainer', () => {
  // ...

  it('should start with an empty list', () => {
    const wrapper = shallow(<BeerListContainer/>);
    expect(wrapper.state('beers')).to.equal([]);
  });
});
```

It fails:

> Cannot read property 'beers' of null

The component's `state` is null, because we never initialized it.

We need to add a constructor to `BeerListContainer` and initialize the state there. Back in `components.js`:

```
export class BeerListContainer extends Component {
  constructor(props) {
    super(props);
    this.state = {
      beers: []
```

```
    };
  }

  // ...
}
```

It's a good idea to call `super` with the given props, so we do that as well. Save that, and now the tests should pass.

Wait, it failed with another error:

> AssertionError: expected [] to equal []

This is because we used `.equal`, which tests for object equality with the `===` operator. Two empty arrays are not the exact same object, therefore they're not equal.

If we use `eql` instead, the test will pass. In `components.spec.js`, change that expectation to this:

```
expect(wrapper.state('beers')).to.eql([]);
```

And now it's passing.

Test 3: Adding an Item

Now that the container has an empty list, let's give it a way to add items to that list.

Remember, the container is responsible for maintaining the list state. It will have an `addItem` function, which we'll pass down to the `InputArea` later on.

In `components.spec.js`, add a test for the nonexistient `addItem` function:

```
describe('BeerListContainer', () => {
  // ...

  it('adds items to the list', () => {
    const wrapper = shallow(<BeerListContainer/>);
    wrapper.addItem('Sam Adams');
    expect(wrapper.state('beers')).to.eql(['Sam Adams']);
  });
});
```

And it fails because `addItem` doesn't exist:

> wrapper.addItem is not a function

Add that function in `components.js`:

```
export class BeerListContainer extends Component {
  // ...

  addItem(name) {
    // do nothing for now
  }

  // ...
}
```

Does it pass? Well, no. But we also get the same error, which seems strange…

> wrapper.addItem is not a function

What happened is that the object returned by `shallow(<BeerListContainer/>)` is not actually an instance of `BeerListContainer`. However, we can access the class instance with `wrapper.instance()`. Change that line from:

```
    wrapper.addItem('Sam Adams');
```

to

```
    wrapper.instance().addItem('Sam Adams');
```

And now the test fails differently:

> expected [] to deeply equal ['Sam Adams']

Progress! Now we can update `state` from inside `addItem`. Change `addItem` to look like this:

```
export class BeerListContainer extends Component {
  // ...

  addItem(name) {
```

```
    this.setState({
      beers: [].concat(this.state.beers).concat([name])
    });
  }

  // ...
}
```

Now the test is passing.

The way we updated the array might look unfamiliar: doing it this way ensures that we don't mutate the existing state. Avoiding mutations on `state` is a good habit to get into, especially if you use (or plan to use) Redux. It ensures that the rendered view is always in sync with the current state.

Using a library like Immutable.js makes it easier to write immutable code like this. We are not using Immutable.js in this tutorial in order to keep complexity down, but it is worth checking out once you have a handle on the basics.

Test 4: Pass the Function Down

Everything is working well in our container now, so let's pass the `addItem` function as a prop to `InputArea`, which will be responsible for calling `addItem` later on.

Whenever we add a new prop to a component, it's a really good idea to create a *PropTypes definition* for it. You can read more about why PropTypes are important but in a nutshell: you can define the expected props and their types, and React will give you a console warning if you forget to pass a required prop or pass the wrong type.

PropTypes make debugging a lot easier — not only when you're first writing a component, but also in the future when you go to reuse it.

So before we write the test, we'll add the PropType in `components.js`:

```
export class InputArea extends Component {
  // ...
}
InputArea.PropTypes = {
  onSubmit: React.PropTypes.func.isRequired
};
```

Now add the test to `components.spec.js`:

```
describe('BeerListContainer', () => {
  // ...

  it('passes addItem to InputArea', () => {
    const wrapper = shallow(<BeerListContainer/>);
    const inputArea = wrapper.find(InputArea);
    const addItem = wrapper.instance().addItem;
    expect(inputArea.prop('onSubmit')).to.eql(addItem);
  });
});
```

We grab a reference to the `InputArea`, and then verify that its `onSubmit` prop is passed the `addItem` function. It should fail:

> expected undefined to deeply equal [Function: addItem]

To make the test pass, modify the `render` method of `BeerListContainer` to pass the `onSubmit` prop to `InputArea`:

```
export class BeerListContainer extends Component {
  // ...

  render() {
    return (
      <div>
        <InputArea onSubmit={this.addItem}/>
        <BeerList/>
      </div>
    );
  }
}
```

At this point we've got 4 passing tests.

Test 5: Check the Binding

Let's just make sure that the function passed to `InputArea` is still working. This might seem a bit redundant, but add this test:

```
describe('BeerListContainer', () => {
  // ...

  it('passes a bound addItem function to InputArea', () => {
    const wrapper = shallow(<BeerListContainer/>);
    const inputArea = wrapper.find(InputArea);
    inputArea.prop('onSubmit')('Sam Adams');
    expect(wrapper.state('beers')).to.eql(['Sam Adams']);
  });
});
```

And… it fails?

> Cannot read property 'setState' of undefined

This is a tricky gotcha when using ES6 classes with React: the instance methods (like `addItem` here) are not automatically bound to the instance.

Quick aside: calling a function with dot notation is not the same as calling it directly:

```
// Calls addItem, setting 'this' === theInstance
theInstance.addItem()

// Save a reference to the addItem function
let addItemFn = theInstance.addItem;

// Calls addItem, setting 'this' === undefined
addItem()
```

There are 2 common ways to fix this in React:

1. bind the function once, in the constructor
2. bind the function every time it's passed as a prop

Option 1 is the better way to go, and what we'll use here. Modify the constructor of `BeerListComponent` (in `components.js`) to read like this:

```
export class BeerListContainer extends Component {
  constructor(props) {
    super(props);
    this.state = {
```

```
      beers: []
    };
    this.addItem = this.addItem.bind(this);
  }
  // ...
}
```

That new line at the end binds `addItem` once and for all, and now our test passes.

Test 6: InputArea Children

We're all done with `BeerListContainer`, so we'll move down the hierarchy into `InputArea`. The component already exists, but it doesn't do much.

Let's write a test that `InputArea` should contain an `input` and a `button`. In `components.spec.js`, create a new top-level `describe` block:

```
describe('InputArea', () => {
  it('should contain an input and a button', () => {
    const wrapper = shallow(<InputArea/>);
    expect(wrapper.containsAllMatchingElements([
      <input/>,
      <button>Add</button>
    ])).to.equal(true);
  });
});
```

This test also verifies the text of the button. And it fails.

> AssertionError: expected false to equal true

Back over in `components.js`, modify `InputArea` to render correctly:

```
export class InputArea extends Component {
  render() {
    return (
      <div>
        <input/>
        <button>Add</button>
      </div>
```

```
    );
  }
}
```

With that, all of the tests are passing again.

Test 7: Accepting Input

Now let's wire up the `input` box to accept changes. Write the test:

```
describe('InputArea', () => {
  // ...

  it('should accept input', () => {
    const wrapper = shallow(<InputArea/>);
    const input = wrapper.find('input');
    input.simulate('change', {target: { value: 'Resin' }});
    expect(wrapper.state('text')).to.equal('Resin');
    expect(input.prop('value')).to.equal('Resin');
  });
});
```

We use `input.simulate` here to fire the `onChange` event with the given object as an argument. This should set some internal state, which should feed back into the input's `value` prop.

It should fail:

> TypeError: Cannot read property 'text' of null

This might look familiar. It's the same error we got in Test 2 when `state` wasn't initialized.

Let's initialize the state, and we'll also add the `setText` method (complete with binding) which we'll need shortly:

```
export class InputArea extends Component {
  constructor(props) {
    super(props);
    this.state = {
      text: ''
    };
```

```
    this.setText = this.setText.bind(this);
  }

  setText(event) {
    this.setState({text: event.target.value});
  }

  // ...
}
```

You've seen a constructor like this before, and the `setText` method uses a common pattern to update the state with the new value of an input.

Now it fails with a different error:

> AssertionError: expected '' to equal 'Resin'

This is because the `input` isn't wired up. We need to pass our `setText` method as the `onChange` prop, and pass the text from `state` as the `value` prop.

```
export class InputArea extends Component {
  // ...

  render() {
    return (
      <div>
        <input value={this.state.text} onChange={this.setText}/>
        <button>Add</button>
      </div>
    );
  }
}
```

Even with this change, it's still not working. We get the same error.

But it's failing on a different line: the first `expect`, which checks the state, passes fine. The second `expect`, however, is failing because the input's `value` prop is not being updated.

Way back in the beginning I mentioned that we'll need full rendering (instead of shallow) for the input handling. Now is the time to make that change. Update the test to call `mount` instead of `shallow`:

```
describe('InputArea', () => {
  // ...

  it('should accept input', () => {
    const wrapper = mount(<InputArea/>);
    // ...
```

All tests should be passing once again.

Test 8: Enable the Add Button

We currently have an “Add” button that does nothing. Let’s fix that.

When the button is clicked, we want to call the `onSubmit` prop passed into `InputArea`. We already wrote tests to verify that the `addItem` function is being passed in correctly, so this should be the last piece of functionality to implement before we can add items to the list.

Before writing the test, we need to add a new import to the top of `components.spec.js`:

```
import { spy } from 'sinon';
```

Now we can use the `spy()` function in our test:

```
describe('InputArea', () => {
  // ...

  it('should call onSubmit when Add is clicked', () => {
    const addItemSpy = spy();
    const wrapper = shallow(<InputArea onSubmit={addItemSpy}/>);
    wrapper.setState({text: 'Octoberfest'});
    const addButton = wrapper.find('button');

    addButton.simulate('click');

    expect(addItemSpy.calledOnce).to.equal(true);
    expect(addItemSpy.calledWith('Octoberfest')).to.equal(true);
  });
});
```

We create a spy to track calls to the `onSubmit` prop. Then we set the state’s `text` as if the user had typed in a value, and click the button. Finally, we verify that the spy was called and that it was called with the right value.

And it should fail, of course.

> AssertionError: expected false to equal true

We need an intermediate handler function, `handleClick`, to respond to the click and call `onSubmit` with the current input text. This needs to be bound in the constructor, and passed in to the `onClick` prop on the button.

```
export class InputArea extends Component {
  constructor(props) {
    super(props);
    this.state = {
      text: ''
    };
    this.setText = this.setText.bind(this);
    this.handleClick = this.handleClick.bind(this);
  }

  // ...

  handleClick() {
    this.props.onSubmit(this.state.text);
  }

  render() {
    return (
      <div>
        <input value={this.state.text} onChange={this.setText}/>
        <button onClick={this.handleClick}>Add</button>
      </div>
    );
  }
}
```

Now the test is passing. We're getting close, but we're still not rendering a list. Let's fix that.

Tests 9-11: Render the List

Let's first test that the list handles the "empty" cases. These are the first tests for `BeerList` so create a new top-level describe block, and add these tests:

```
describe('BeerList', () => {
  it('should render zero items', () => {
    const wrapper = shallow(<BeerList items={[]}/>);
    expect(wrapper.find('li')).to.have.length(0);
  });

  it('should render undefined items', () => {
    const wrapper = shallow(<BeerList items={undefined}/>);
    expect(wrapper.find('li')).to.have.length(0);
  });

  it('should render some items', () => {
    const items = ['Sam Adams', 'Resin', 'Octoberfest'];
    const wrapper = shallow(<BeerList items={items}/>);
    expect(wrapper.find('li')).to.have.length(3);
  });
});
```

The tests for empty lists pass, but this isn't too surprising: the `BeerList` component is very barebones right now, just a single empty `<ul/>` tag. The 3rd test, rendering items, fails as expected.

> AssertionError: expected { Object (root, unrendered, …) } to have a length of 3 but got 0

Update `BeerList` to render the array it receives via its `items` prop:

```
export class BeerList extends Component {
  render() {
    return (
      <ul>
        {this.props.items.map((item, index) => (
          <li key={index}>{item}</li>
        ))}
      </ul>
    );
  }
}
```

Now the 'undefined items' test is failing, but the other two are passing:

> TypeError: Cannot read property 'map' of undefined

This makes sense, because `this.props.items` is undefined. There are 2 problems here:

1. The component errors out of `items` is undefined or null.
2. We're not checking for `items` in `propTypes`.

To fix these, modify the `BeerList` render function to check that `items` is truthy before rendering it, and also add `propTypes` to the end.

```
export class BeerList extends Component {
  render() {
    return this.props.items ?
      (<ul>
        {this.props.items.map((item, index) => (
          <li key={index}>{item}</li>
        ))}
      </ul>)
    : null;
  }
}
BeerList.propTypes = {
  items: React.PropTypes.array.isRequired
};
```

Now all tests are passing again.

Even better, the code should be working now! If you still have the Quik dev server running, switch over to your browser (you might need to refresh the tab) and try adding some items to the list.

Wait… it's not working? You're clicing Add, but the items aren't showing up?

First thing to do: check the console. There's a warning because we forgot to pass `items`:

> Warning: Failed propType: Required prop `items` was not specified in `BeerList`. Check the render method of `BeerListContainer`.

Now we know exactly where to look.

Test 12: Rendering the Items

Before we fix the problem, let's write a failing test for it. In `components.spec.js`, we want to assert that when doing a deep render of `BeerListContainer` with some items, the items should appear.

```
describe('BeerListContainer', () => {
  // ...

  it('renders the items', () => {
    const wrapper = mount(<BeerListContainer/>);
    wrapper.instance().addItem('Sam Adams');
    wrapper.instance().addItem('Resin');
    expect(wrapper.find('li').length).to.equal(2);
  });
}
```

The test fails, as expected:

> AssertionError: expected 0 to equal 2

Update `BeerListContainer` to pass down the beers:

```
export class BeerListContainer extends Component {
  // ...

  render() {
    return (
      <div>
        <InputArea onSubmit={this.addItem}/>
        <BeerList items={this.state.beers}/>
      </div>
    );
  }
}
```

With this last test passing, the application should be fully functional. Refresh the browser (if Quik's auto-refresh didn't trigger) and make sure it works.

Wrapping Up

At this point, you have a very simple but functional list. If you want to keep going, here are some ideas for enhancements:

- Clear the input box when the Add button is clicked.
- Allow the user to add items by simply pressing **Enter**.
- Add a rating next to each list item, and keep track of the state in the `BeerListContainer` component.

You're sure to run into situations we didn't cover here, and in addition to the ever-faithful Google, the official documentation can be a great help. Here are some links:

- Sinon docs
- Enzyme docs
- Chai docs

What Next?

By now you've got a good feel for TDD with React. The best thing you can do now is to try it out on your own. "Practice makes perfect" is as true about TDD as anything else.

Follow the ideas above to enhance this simple list component, and try building some more ambitious components with TDD too. As you work TDD into your routine, you'll get faster at it — and your code will get better too!

Hopefully this has been a helpful jumpstart into the world of TDD with React.