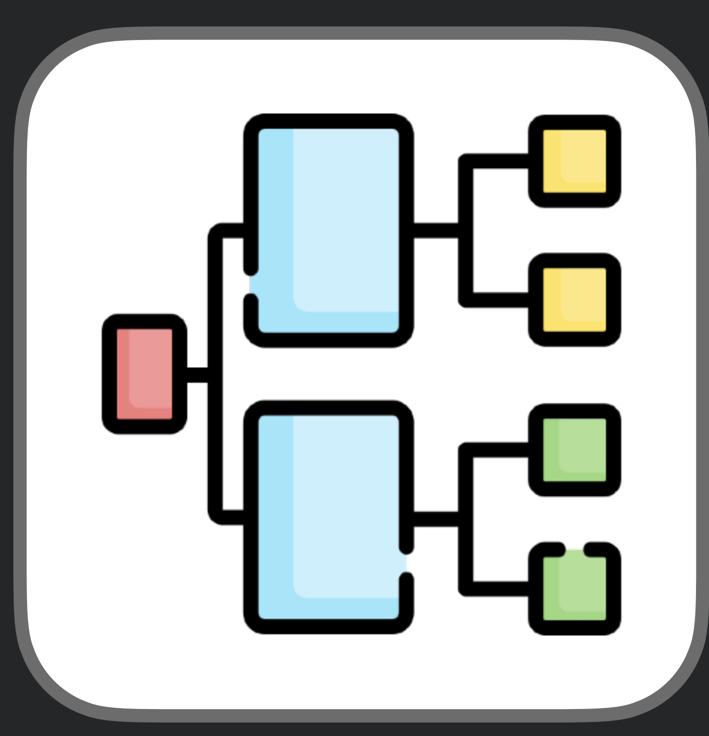
SWE 432 -Web Application Development

Fall 2022

George Mason University

Dr. Kevin Moran

Week 2: Javascript Tools and Testing



Review: Closures

- Closures are expressions that work with variables in a specific context
- Closures contain a function, and its needed state
  - Closure is a stack frame that is allocated when a function starts executing and not freed after the function returns
- That state just refers to that state by name (sees updates)

```
var x = 1;
function f() {
    var y = 2;
    return function() {
        console.log(x + y);
        y++;
    };
}
var g = f();
g();            // 1+2 is 3
g();            // 1+3 is 4
```

This function attaches itself to x and y so that it can continue to access them.

It "**closes up**" those references

Closures

```
var x = 1;
function f() {
    var y = 2;
    return function() {
        console.log(x + y);
        y++;
    };
}
var g = f();
g();               // 1+2 is 3
g();               // 1+3 is 4
```

Global

var x 1

f()

var y 2

function

Closure

Closures

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Closure

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Global

var x 1

f()

var y 4

function

Closure

JavaScript Tooling & Testing

- Web Development Tools
- What's behavior driven development and why do we want it?
- Some tools for testing web apps - focus on Jest

An (older) Way to Export Modules

- Prior to ES6, was no language support for exposing modules.
- Instead did it with libraries (e.g., node) that handled exports
- Works similarly: declare what functions / classes are publicly visible, import classes
- Syntax:
  In the file exporting a function or class sum:
  ```
  module.exports = sum;
  ```
  In the file importing a function or class sum:
  ```
  const sum = require('./sum');
  ```
  Where sum.js is the name of a file which defines sum.

Options for Executing JavaScript

- Browser
  - Pastebin—useful for debugging & experimentation
- Outside of the browser (focus for now)
  - node.js—runtime for JavaScript

Demo: Pastebin

```
var course = { name: 'SWE 432' };

console.log('Hello'  + course.name + '!');
```

https://replit.com/@kmoran/SWE-Replit-Demo#script.js

Demo: Pastebin

replit.com

SWE-Replit-Demo - Replit

kmoran / SWE-Replit-Demo

Invite

Files

index.html
script.js
style.css

script.js ×

```
1  var course = { name: 'SWE 432' };
2  console.log('Hello'  + course.name +
   '!');
```

https://SWE-Replit-Demo.kmoran.repl.co

Console Shell

Node.js

- Node.js is a *runtime* that lets you run JS outside of a browser
- We're going to write backends with Node.js
- Download and install it: https://nodejs.org/en/
  - We recommend LTS (LTS -> Long Term Support, designed to be super stable)
  - David will go over this in the "Hands-on Session" this week!

Demo: Node.js

```
var course = { name: 'SWE 432' };
console.log('Hello'  + course.name + '!');
```

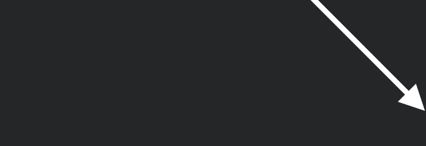
Demo: Node.js

```
Example — -bash — 46x15
Legacy:Example KevinMoran$
```

Node Package Manager

Working with Libraries

“The old way”

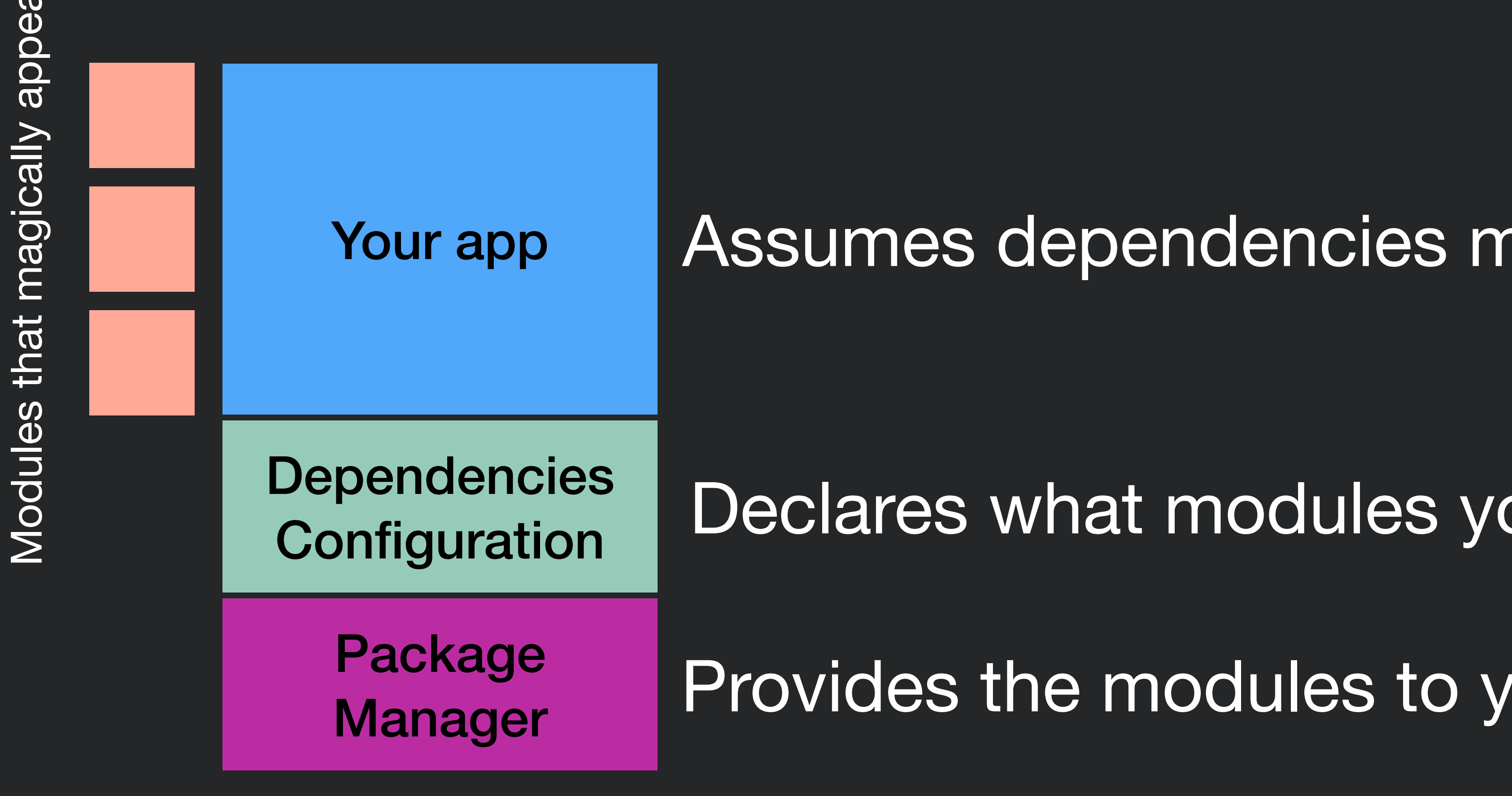


```
<script src="https://fb.me/react-15.0.0.js"></script>
<script src=“https://fb.me/react-dom-15.0.0.js"></script>
<script src="https://cdnjs.cloudflare.com/ajax/libs/babel-core/5.8.34/
browser.min.js"></script>
```

- What’s wrong with this?
    - No standard format to say:
        - What’s the name of the module?
        - What’s the version of the module?
        - Where do I find it?
    - Ideally: Just say “Give me React 15 and everything I need to make it work!”

A Better Way for Modules

- Describe what your modules are
- Create a central repository of those modules
- Make a utility that can automatically find and include those modules



NPM: Not an acronym, but the Node Package Manager

- Bring order to our modules and dependencies
- Declarative approach:
  - “My app is called helloworld”
  - “It is version 1”
  - You can run it by saying “node index.js”
  - “I need express, the most recent version is fine”
- Config is stored in json - specifically package.json

Generated by `npm` **commands:**

```
{
  "name": "helloworld",
  "version": "1.0.0",
  "description": "",
  "main": "index.js",
  "scripts": {
    "test": "echo \"Error: no test specified\" && exit 1"
  },
  "author": "",
  "license": "ISC",
  "dependencies": {
    "express": "^4.14.0"
  }
}
```

Installing packages with NPM

- `npm install <package> --save` will download a package and add it to your package.json
- `npm install` will go through all of the packages in package.json and make sure they are installed/up to date
- Packages get installed to the `node_modules` directory in your project

Using NPM

- Your “project” is a directory which contains a special file, package.json
- Everything that is going to be in your project goes in this directory
- Step 1: Create NPM project
```
npm init
```
- Step 2: Declare dependencies
```
npm install <packagename> --save
```
- Step 3: Use modules in your app
```
var myPkg = require(“packagename”)
```
- Do NOT include node_modules in your git repo! Instead, just do
```
npm install
```
  - This will download and install the modules on your machine given the existing config!

https://docs.npmjs.com/index

NPM Scripts

- Scripts that run at specific times.
- For starters, we'll just worry about *test* scripts

https://docs.npmjs.com/misc/scripts

```
{
    "name": "starter-node-react",
    "version": "1.1.0",
    "description": "a starter project structure for react-app",
    "main": "src/server/index.js",
    "scripts": {
        "start": "babel-node src/server/index.js",
        "build": "webpack --config config/webpack.config.js",
        "dev": "webpack-dev-server --config config/webpack.config.js --
devtool eval --progress --colors --hot --content-base dist/"
    },
    "repository": {
        "type": "git",
        "url": "git+https://github.com/wwsun/starter-node-react.git"
    },
    "author": "Weiwei SUN",
    "license": "MIT",
    "bugs": {
        "url": "https://github.com/wwsun/starter-node-react/issues"
    },
    "homepage": "https://github.com/wwsun/starter-node-react#readme",
    "dependencies": {
        "babel-cli": "^6.4.5",
        "babel-preset-es2015-node5": "^1.1.2",
        "co-views": "^2.1.0",
        "history": "^2.0.0-rc2",
        "koa": "^1.0.0",
        "koa-logger": "^1.3.0",
        "koa-route": "^2.4.2",
        "koa-static": "^2.0.0",
        "react": "^0.14.0",
        "react-dom": "^0.14.0",
        "react-router": "^2.0.0-rc5",
        "swig": "^1.4.2"
    },
    "devDependencies": {
        "babel-core": "^6.1.2",
        "babel-loader": "^6.0.1",
        "babel-preset-es2015": "^6.3.13",
        "babel-preset-react": "^6.1.2",
        "webpack": "^1.12.2",
        "webpack-dev-server": "^1.14.1"
```

Demo: NPM

Example-Node — -bash — 84×22

```
Legacy:Example-Node KevinMoran$
```

Unit Testing

- Unit testing is testing some program unit in isolation from the rest of the system (which may not exist yet)
- Usually the programmer is responsible for testing a unit during its implementation
- Easier to debug when a test finds a bug (compared to full-system testing)

Integration Testing

- ***Motivation:*** Units that worked in isolation may not work in combination
- Performed after all units to be integrated have passed all unit tests
- Reuse unit test cases that cross unit boundaries (that previously required stub(s) and/or driver standing in for another unit)

Unit vs Integration Tests

Unit test vs. Integration test

Writing Good Tests

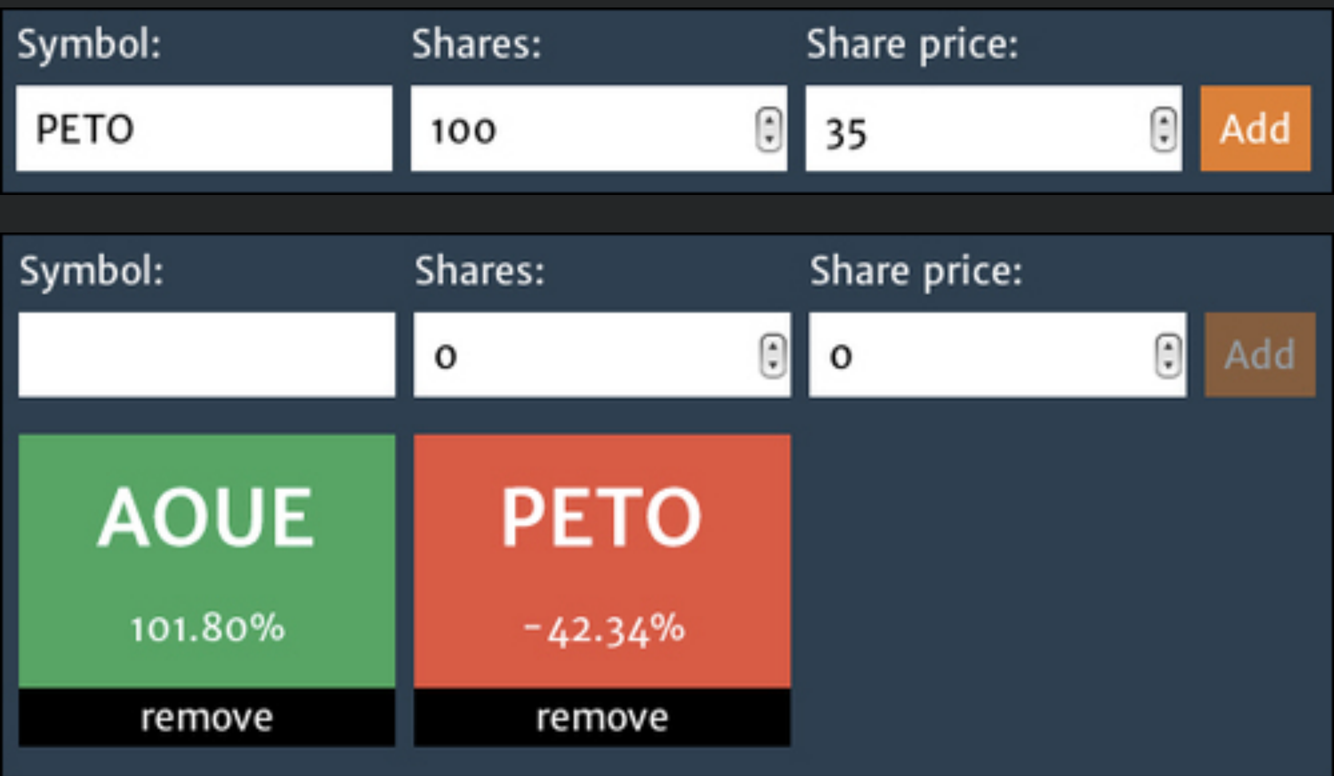
- How do we know when we have tested “enough”?
  - Did we test all of the features we created?
  - Did we test all possible values for those features?

Behavior Driven Development

- Establish *specifications* that say what an app should do
- We write our spec *before* writing the code!
- Only write code if it's to make a spec work
- Provide a mapping between those specifications, and some observable application functionality
- This way, we can have a clear map from specifications to tests

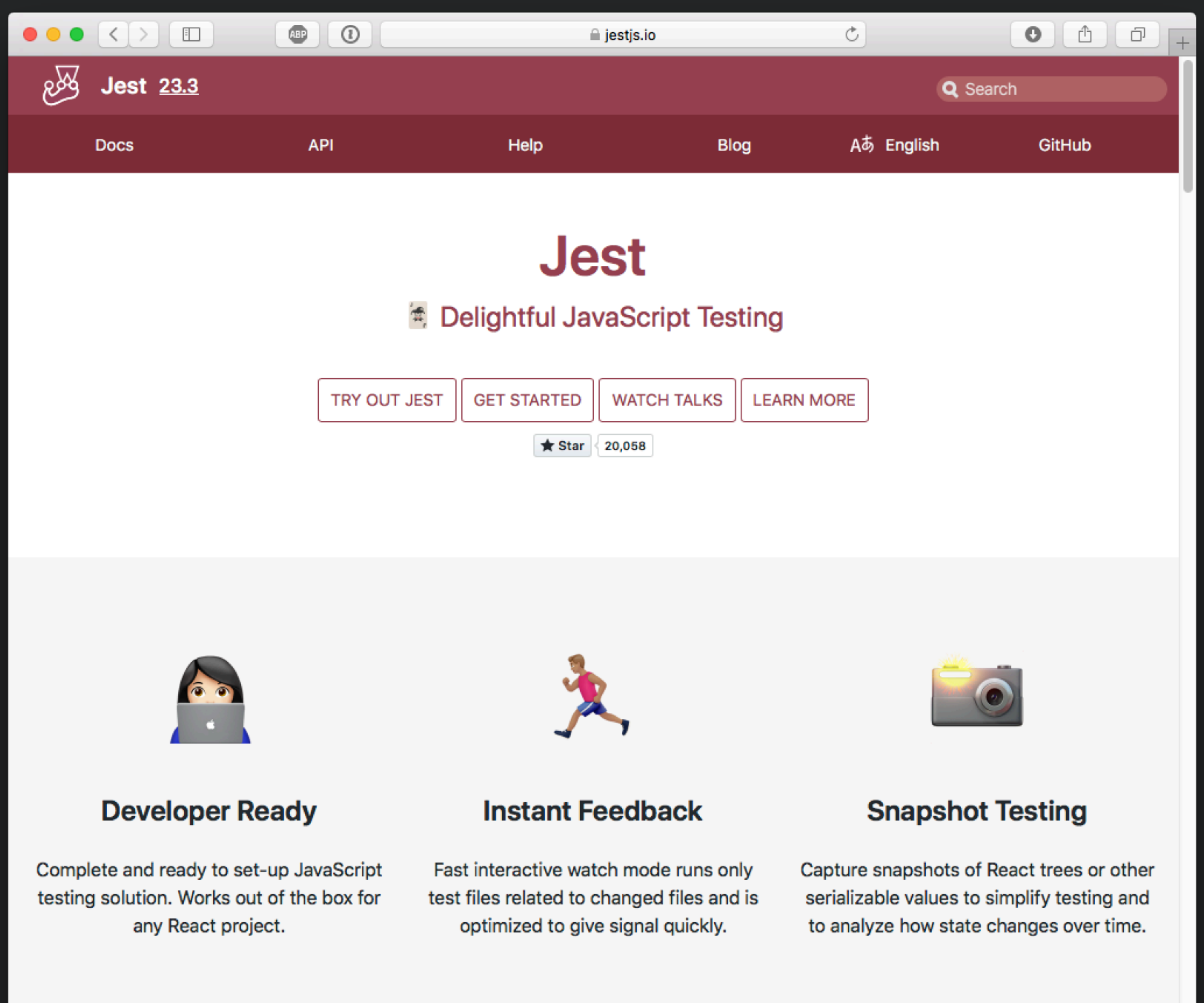
Investment Tracker

- Users make investments by entering a ticker symbol, number of shares, and the price that the user paid per share
- Once the investment has been input, the user can see the current status of their investments
- How do we test this?



Investment Tracker

- What's an investment for our app?
  - Given an investment, it:
    - Should be of a stock
    - Should have the invested shares quantity
    - Should have the share paid price
    - Should have a current price
    - When its current price is higher than the paid price:
      - It should have a positive return of investment
      - It should be a good investment


jestjs.io
Jest 23.3
Search
Docs
API
Help
Blog
English
GitHub
Jest
Delightful JavaScript Testing
TRY OUT JEST
GET STARTED
WATCH TALKS
LEARN MORE
Star
20,058
Developer Ready
Complete and ready to set-up JavaScript testing solution. Works out of the box for any React project.
Instant Feedback
Fast interactive watch mode runs only test files related to changed files and is optimized to give signal quickly.
Snapshot Testing
Capture snapshots of React trees or other serializable values to simplify testing and to analyze how state changes over time.

Jest Lets You Specify Behavior in *Specs*

- Specs are written in JS
- Key functions:
    - `describe`, `test`, `expect`
- `Describe` a high level scenario by providing a name for the scenario and function(s) that contains some `test`s by saying what you `expect` it to be
- Example:

```
describe("Alyssa P Hacker tests", () => {
    test("Calling fullName directly should always work", () => {
        expect(profHacker.fullName()).toEqual("Alyssa P Hacker");
    });
}
```

Writing Specs

- Can specify some code to run before or after checking a spec

```
var profHacker;
beforeEach(() => {
    profHacker = {
        firstName: "Alyssa",
        lastName: "P Hacker",
        teaches: "SWE 432",
        office: "ENGR 6409",
        fullName: function () {
            return this.firstName + " " + this.lastName;
        }
    };
});
```

Making it work

- Add `jest` library to your project (npm install --save-dev jest)
- Configure NPM to use jest for test in package.json

```
"scripts": {
  "test": "jest"
},
```

- For file `x.js`, create `x.test.js`
- Run `npm test`

Multiple Specs

- Can have as many tests as you would like

```
test("Calling fullName directly should always work", () => {
     expect(profHacker.fullName()).toEqual("Alyssa P Hacker");
 });

 test("Calling fullName without binding but with a function ref is undefined", () => {
     var func = profHacker.fullName;
     expect(func()).toEqual("undefined undefined");
 });
 test("Calling fullName WITH binding with a function ref works", () => {
     var func = profHacker.fullName;
     func = func.bind(profHacker);
     expect(func()).toEqual("Alyssa P Hacker");
 });
 test("Changing name changes full name", ()=>{
     profHacker.firstName = "Dr. Alyssa";
     expect(profHacker.fullName()).toEqual("Dr. Alyssa P Hacker");
 })
```

Nesting Specs

- “When its current price is higher than the paid price:
  - It should have a positive return of investment
  - It should be a good investment”
- How do we describe that?

```
describe("when its current price is higher than the paid price", function() {
    beforeEach(function() {
      stock.sharePrice = 40;
    });
    test("should have a positive return of investment", function() {
      expect(investment.roi()).toBeGreaterThan(0);
    });
    test("should be a good investment", function() {
      expect(investment.isGood()).toBeTruthy();
    });
  });
});
```

Matchers

- How does Jest determine that something is what we expect?

```
expect(investment.roi()).toBeGreaterThan(0);
expect(investment).isGood().toBeTruthy();
expect(investment.shares).toEqual(100);
expect(investment.stock).toBe(stock);
```

- These are “matchers” for Jest - that compare a given value to some criteria
- Basic matchers are built in:
  - toBe, toEqual, toContain, toBeNaN, toBeNull, toBeUndefined, >, <, >=, <=, !=, regular expressions
- Can also define your own matcher

```
test('null', () => {
  const n = null;
  expect(n).toBeNull();
  expect(n).toBeDefined();
  expect(n).not.toBeUndefined();
});

const shoppingList = [
  'diapers',
  'kleenex',
  'trash bags',
  'paper towels',
  'beer',
];

test('the shopping list has beer on it', () => {
  expect(shoppingList).toContain('beer');
  expect(new Set(shoppingList)).toContain('beer');
});
```

Demo: Jest

Example-Node — -bash — 69×17

```
Legacy:Example-Node KevinMoran$
```

In Class Exercise: JEST

- Modify our `FacultyAPI` closure with the capability of adding a new faculty member, and then use `getFaculty` to view their formatted name.
- Write a JEST test case that ensure that this function works correctly.

`https://replit.com/@kmoran/SWE-432-Week-2-Jest-Example?v=1`

Exercise: Closures

```
var facultyAPI = (function(){
  var faculty = [{name:"Prof Moran", section: 2}, {name:"Prof
Johnson”, section:1}];

   return {
    getFaculty : function(i)
    {
     return faculty[i].name + " ("+faculty[i].section +")";
    }

 };       C
})();

console.log(facultyAPI.getFaculty(0));
```

Here’s our simple closure. Add a new function to create a new faculty, then call `getFaculty` to view their formatted name. Then write Jest test(s) in order to ensure that this is functioning correctly.

Acknowledgements

Slides adapted from Dr. Thomas LaToza's SWE 632 course