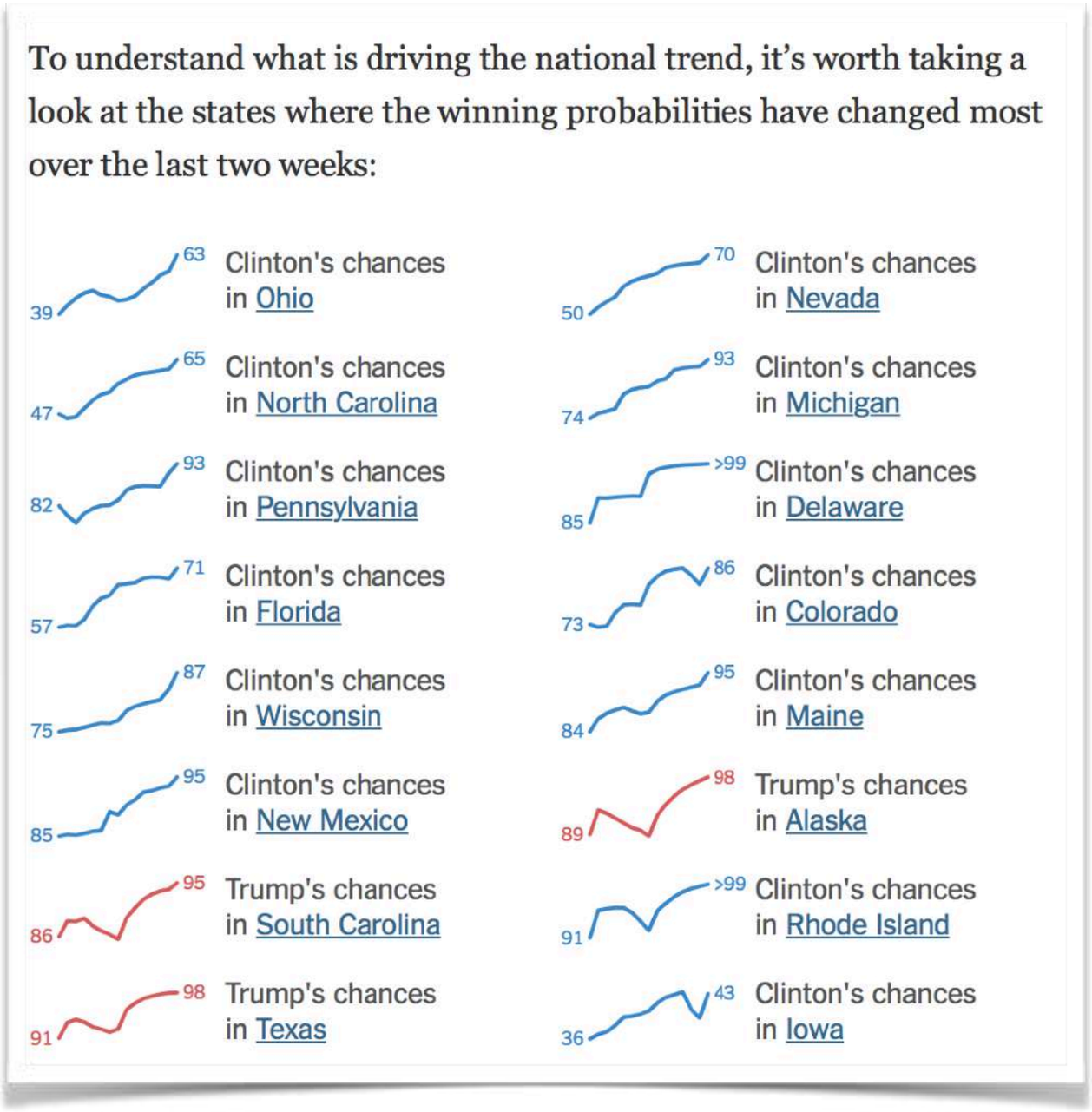
Backend Development

SWE 432, Fall 2016

Design and Implementation of Software for the Web

Show & Tell

Sparklines in NYT



To understand what is driving the national trend, it's worth taking a look at the states where the winning probabilities have changed most over the last two weeks:

63 39 Clinton's chances in Ohio

65 47 Clinton's chances in North Carolina

93 82 Clinton's chances in Pennsylvania

71 57 Clinton's chances in Florida

87 75 Clinton's chances in Wisconsin

95 85 Clinton's chances in New Mexico

95 86 Trump's chances in South Carolina

98 91 Trump's chances in Texas

70 50 Clinton's chances in Nevada

93 74 Clinton's chances in Michigan

>99 85 Clinton's chances in Delaware

86 73 Clinton's chances in Colorado

95 84 Clinton's chances in Maine

98 89 Trump's chances in Alaska

>99 91 Clinton's chances in Rhode Island

43 36 Clinton's chances in Iowa

http://www.nytimes.com/interactive/2016/upshot/presidential-polls-forecast.html

Today

- Why do we need backend programming?
- How can/should we structure those backends?
- Node.JS

For further reading:

https://nodejs.org (Docs + Examples)

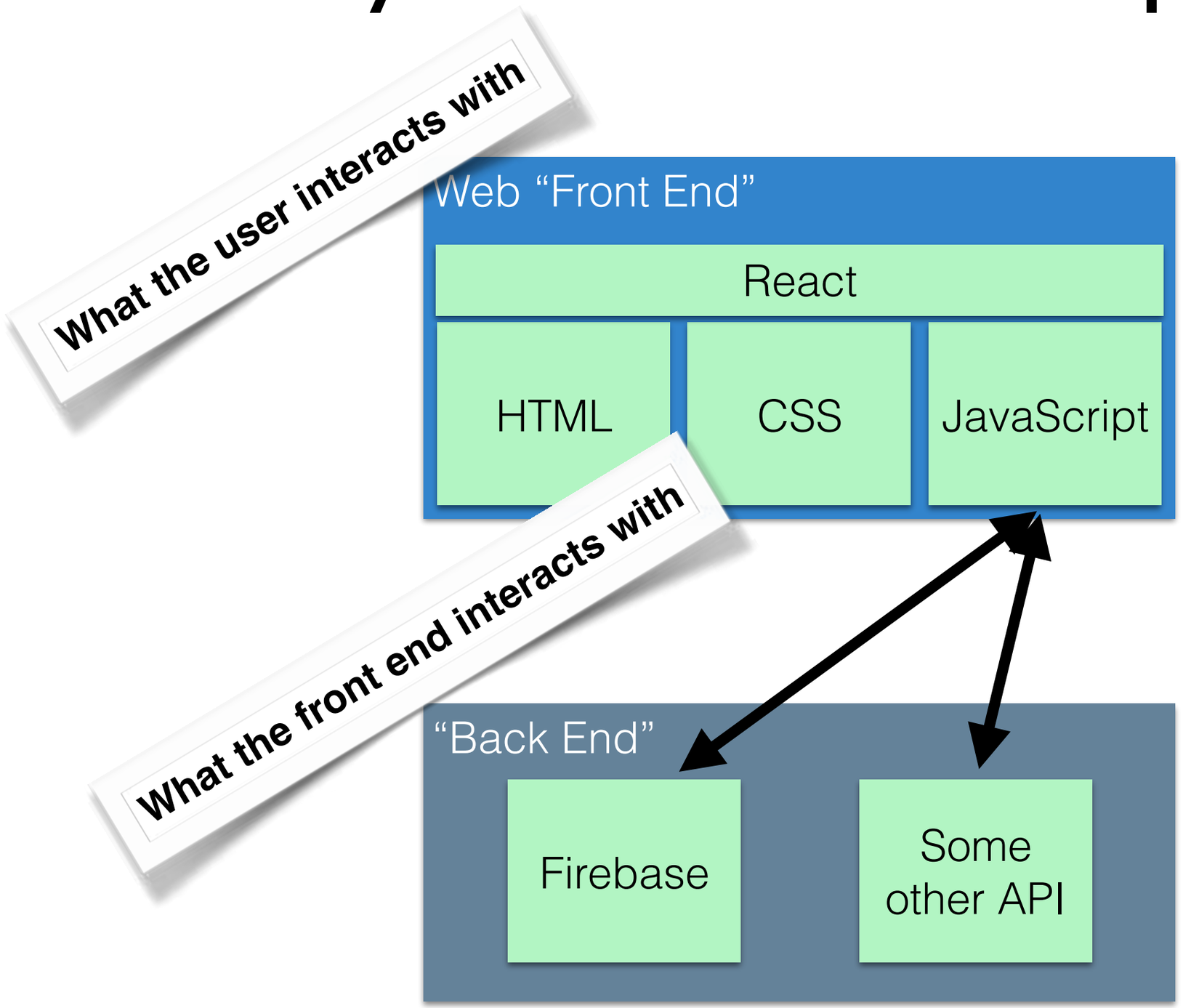
https://www.npmjs.com (Docs + Examples)

https://firebase.google.com/docs/server/setup

Why we need backends

- Security: *SOME* part of our code needs to be “trusted”
  - Validation, security, etc. that we don’t want to allow users to bypass
- Performance:
  - Avoid duplicating computation (do it once and cache)
  - Do heavy computation on more powerful machines
  - Do data-intensive computation “nearer” to the data
- Compatibility:
  - Can bring some dynamic behavior without requiring much JS support

Dynamic Web Apps



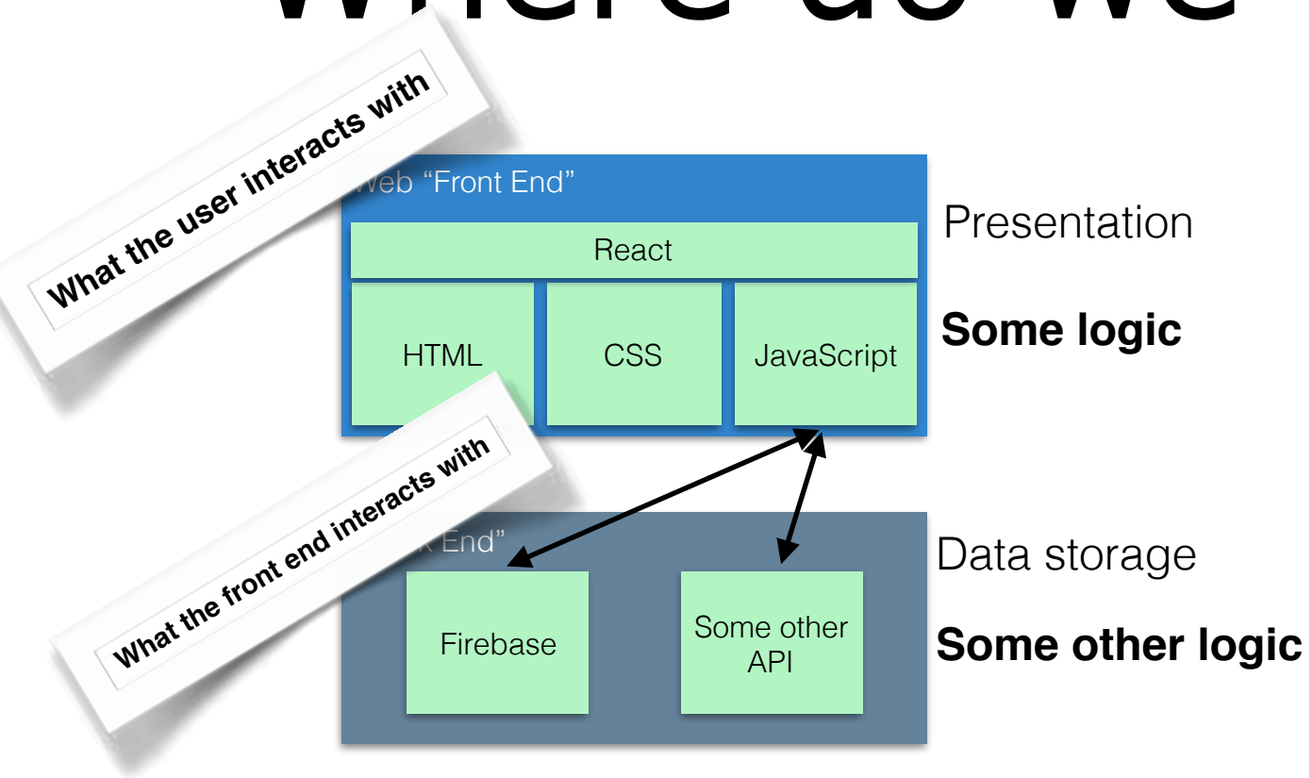
Presentation

Some logic

Data storage

Some other logic

Where do we put the logic?



Frontend

Pros

Very responsive (low latency)

Cons

Security

Performance

Unable to share between front-ends

Backend

Pros

Easy to refactor between multiple clients

Logic is hidden from users (good for security, compatibility, and intensive computation)

Cons

Interactions require a round-trip to server

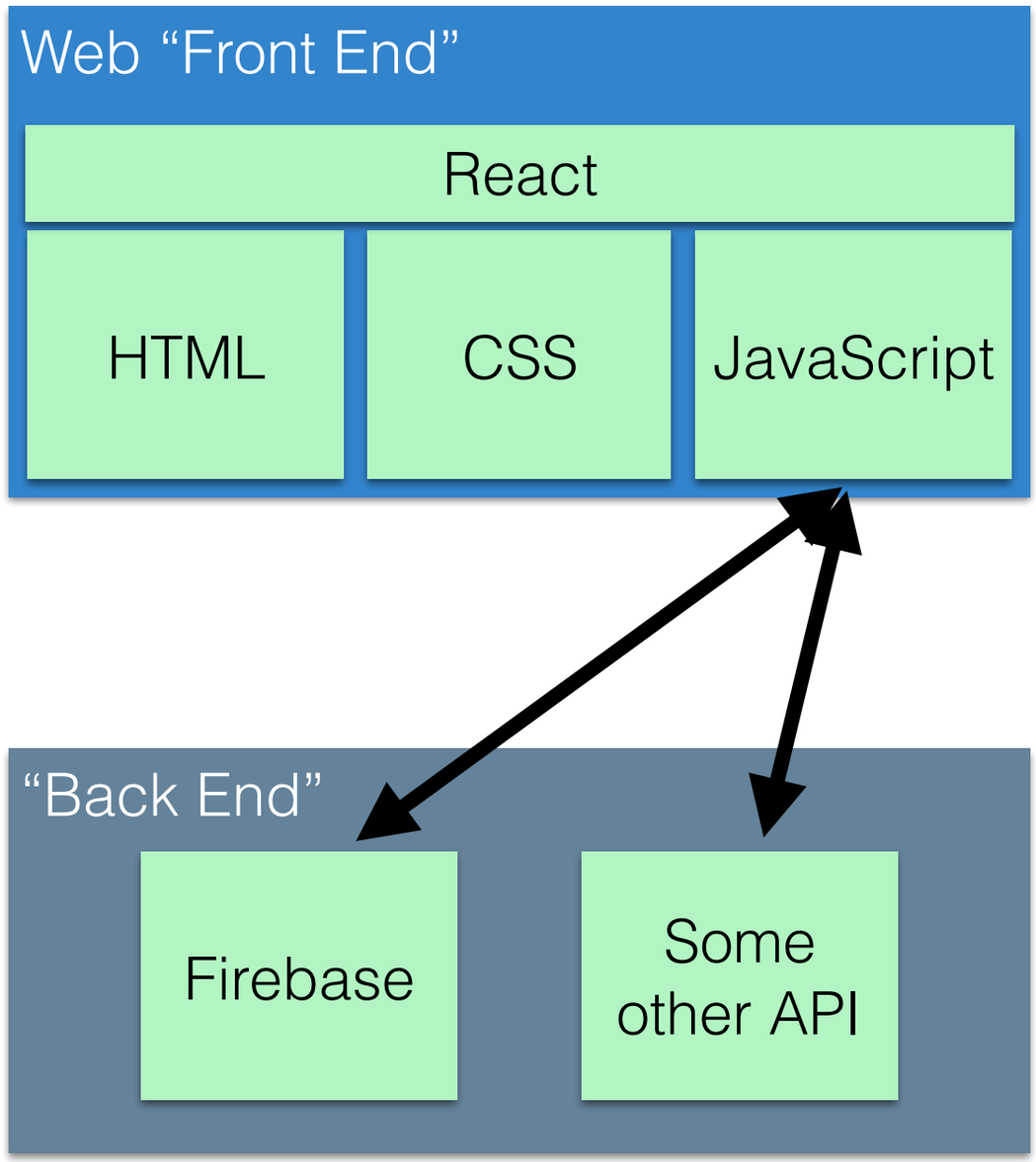
Why Trust Matters

- Example: Transaction app

```
function updateBalance(user, amountToAdd)
{
    user.balance = user.balance + amountToAdd;
    fireRef.child(user.username).child("balance").set(user.balance);
}
```

- What's wrong?
- How do you fix that?

Dynamic Web Apps



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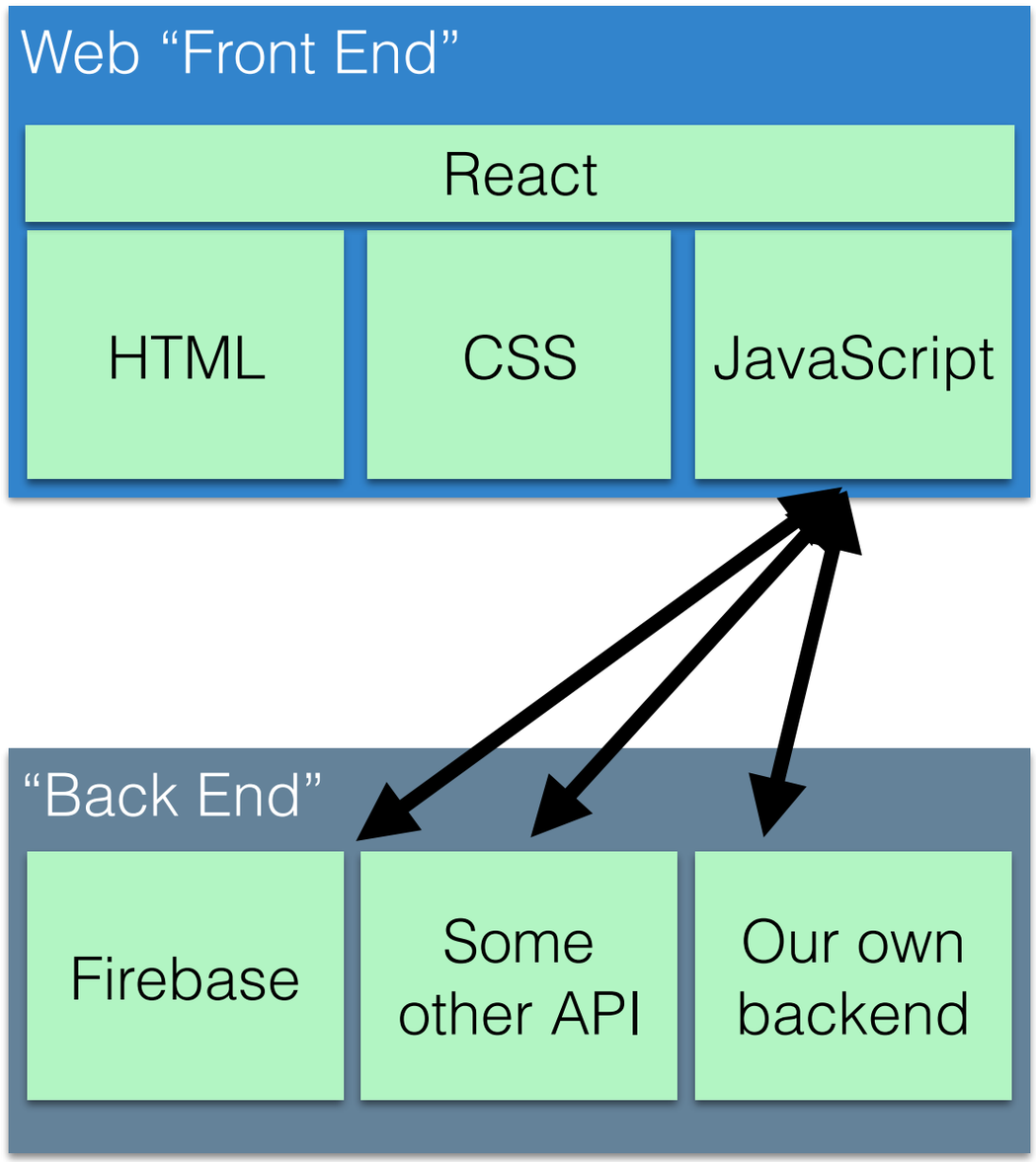
Dynamic Web Apps



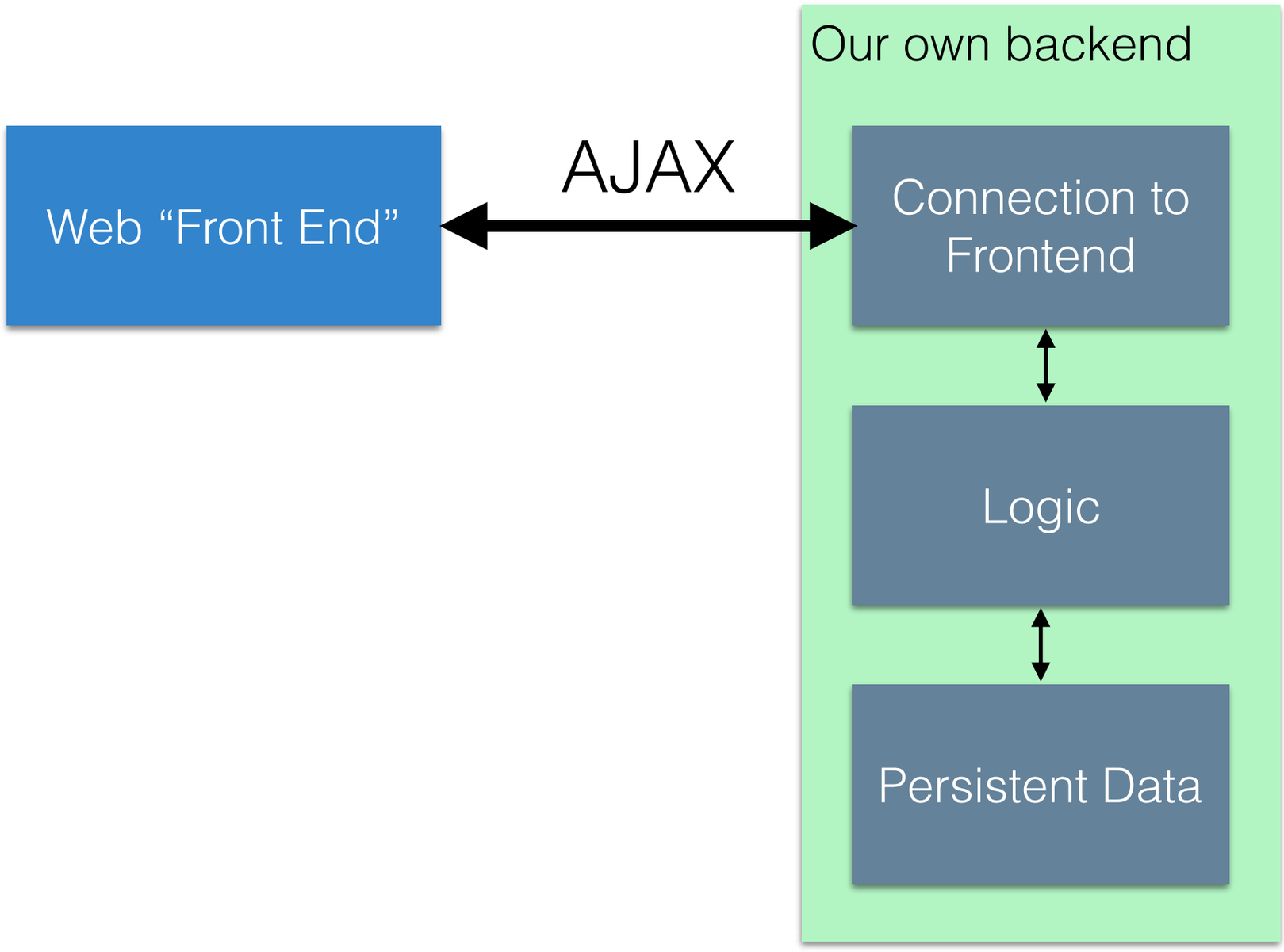
Presentation

Some logic

Data storage

Some other logic

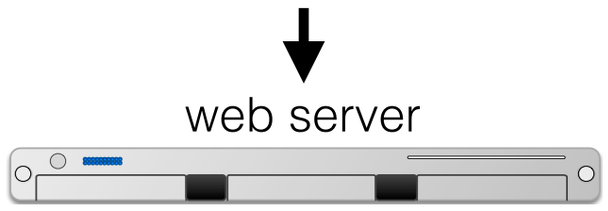
What does our backend look like?



The “good” old days of backends

HTTP Request

```
GET /myApplicationEndpoint HTTP/1.1
Host: cs.gmu.edu
Accept: text/html
```



Runs a program

Web Server Application

Give me **/myApplicationEndpoint**

Does whatever it wants

My Application Backend

Here’s some text to send back

HTTP Response

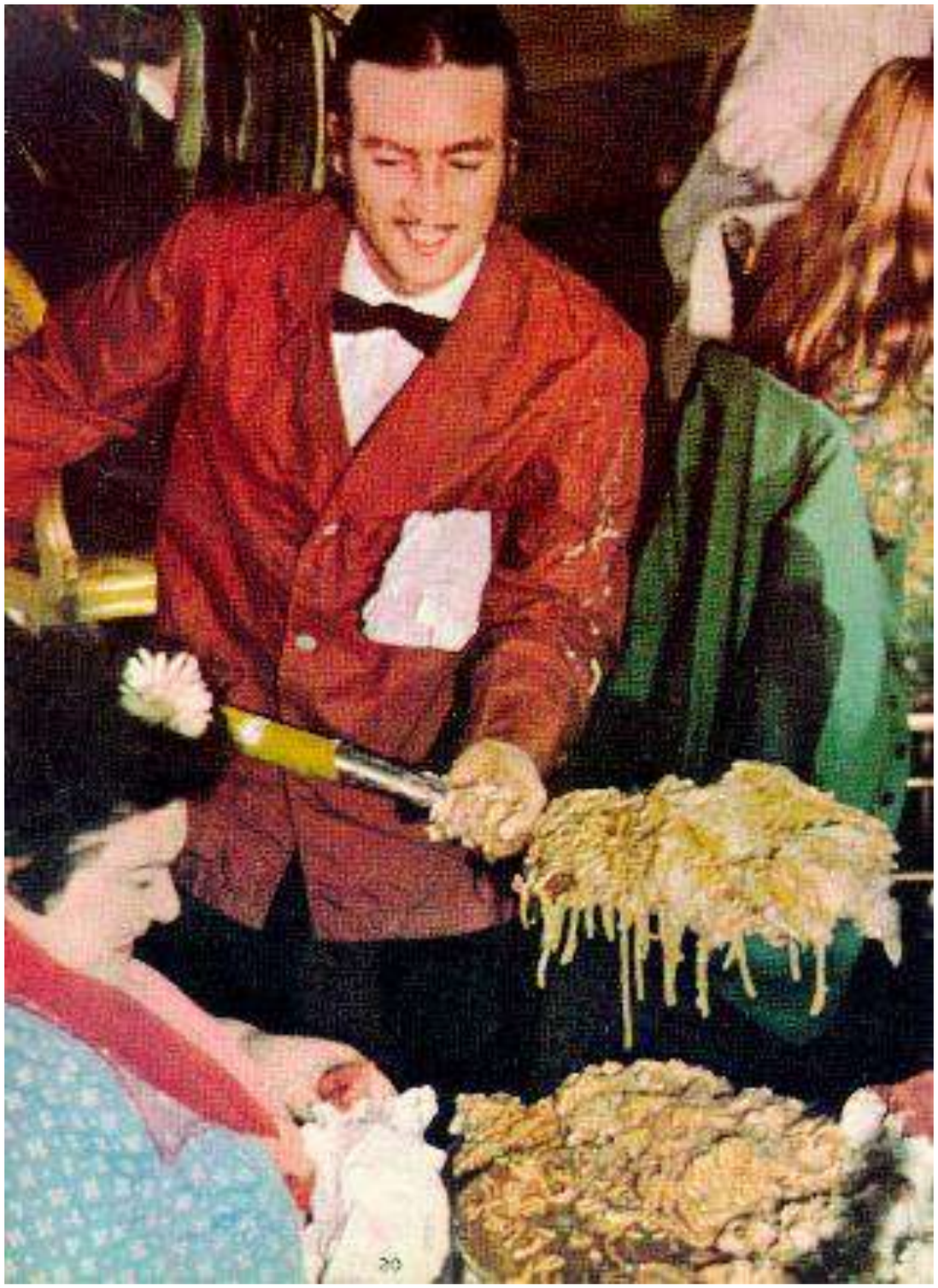
```
HTTP/1.1 200 OK
Content-Type: text/html; charset=UTF-8

<html><head>...
```

What’s wrong with this picture?

History of Backend Development

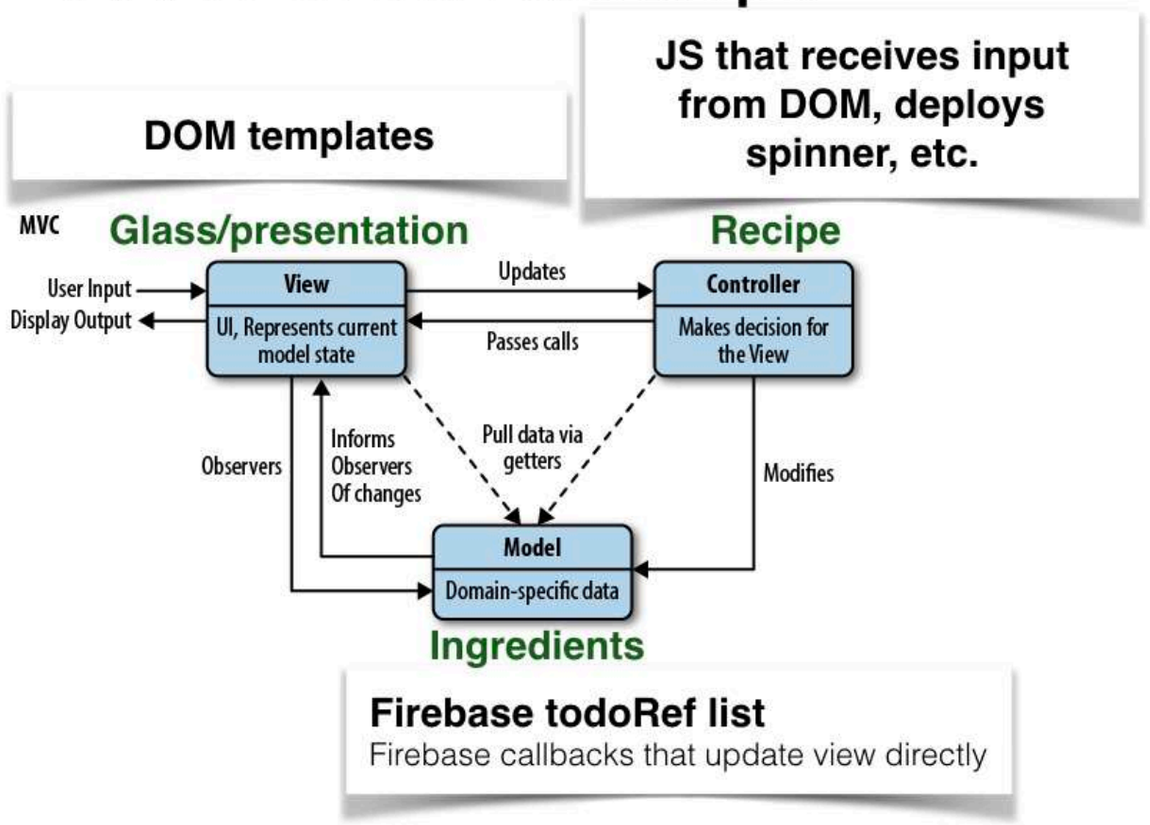
- In the beginning, you wrote whatever you wanted using whatever language you wanted and whatever framework you wanted
- Then… PHP and ASP
  - Languages “designed” for writing backends
  - Encouraged spaghetti code
  - A lot of the web was built on this
- A whole lot of other languages were also springing up in the 90’s…
  - Ruby, Python, JSP

Backend Spaghetti



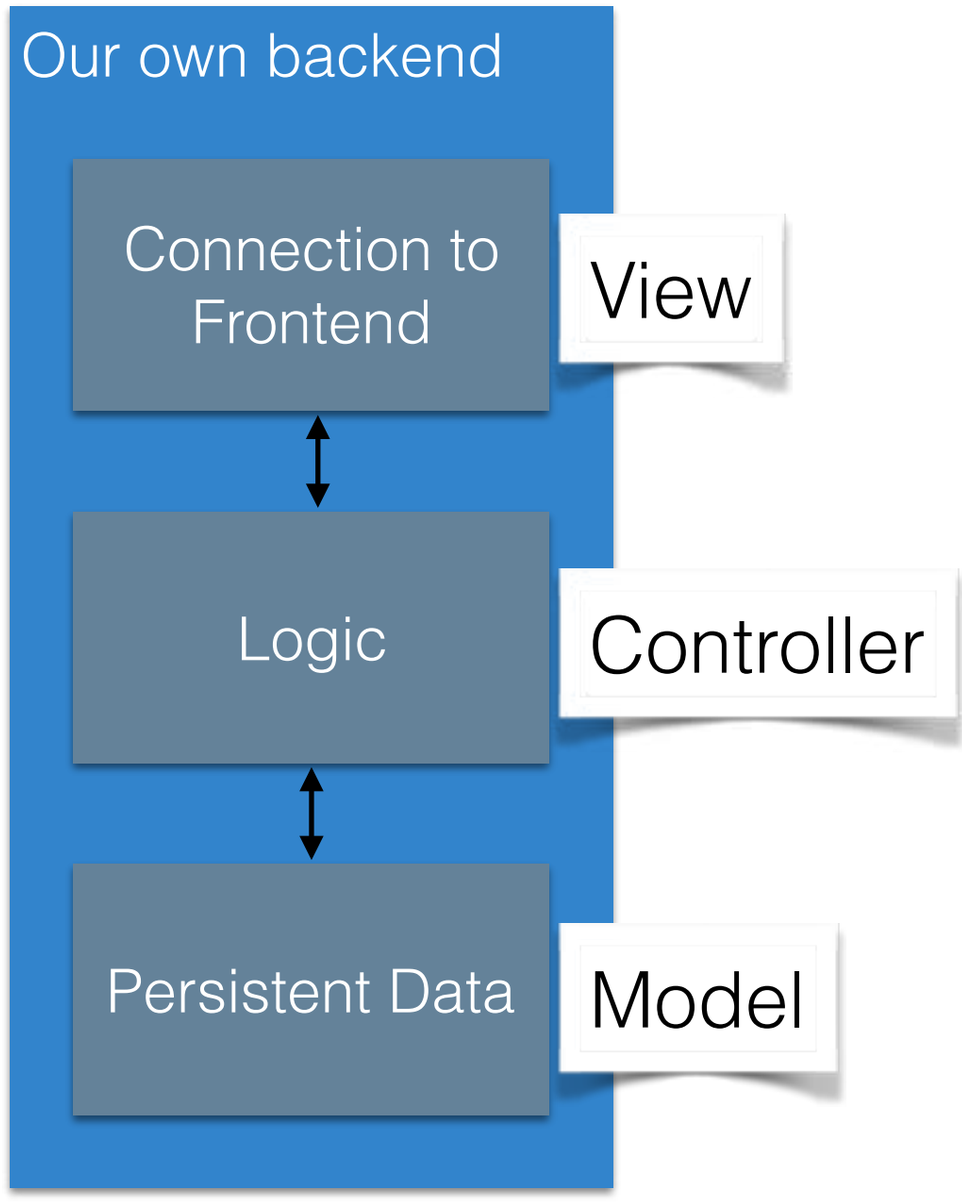
De-Spaghettification

MVC & JavaScript



***Note that in drink factory, the glass doesn't care about the ingredients**

Lecture 10



MVC & Backend Servers

- There are a ton of backend frameworks that support MVC
  - SailsJS, Ruby on Rails, PHP Symfony, Python Django, ASP.NET, EJB…
- Old days: View was server-generated HTML
- New days: View is an API
- Today we'll talk about Node.JS backend development
- We will **not** talk about making MVC backends and will **not** require you to do so

Node.JS

- We're going to write backends with Node.JS
- Why use Node?
  - Easy to get into after learning JS (it's JS)
  - Event based: really efficient for sending lots of quick updates to lots of clients
- Why not use Node?
  - Bad for CPU heavy stuff
  - It's relatively immature

Node.JS

- Node.JS is a *runtime* that lets you run JS outside of a browser
- Node.JS has a very large ecosystem of packages
  - Example: express (web server), nodemon (automatically restarts your server when it changes)
- Must be downloaded and installed
  https://nodejs.org/en/
  - We recommend v4.5.0 LTS (LTS -> Long Term Support, designed to be super stable)

More on Modules

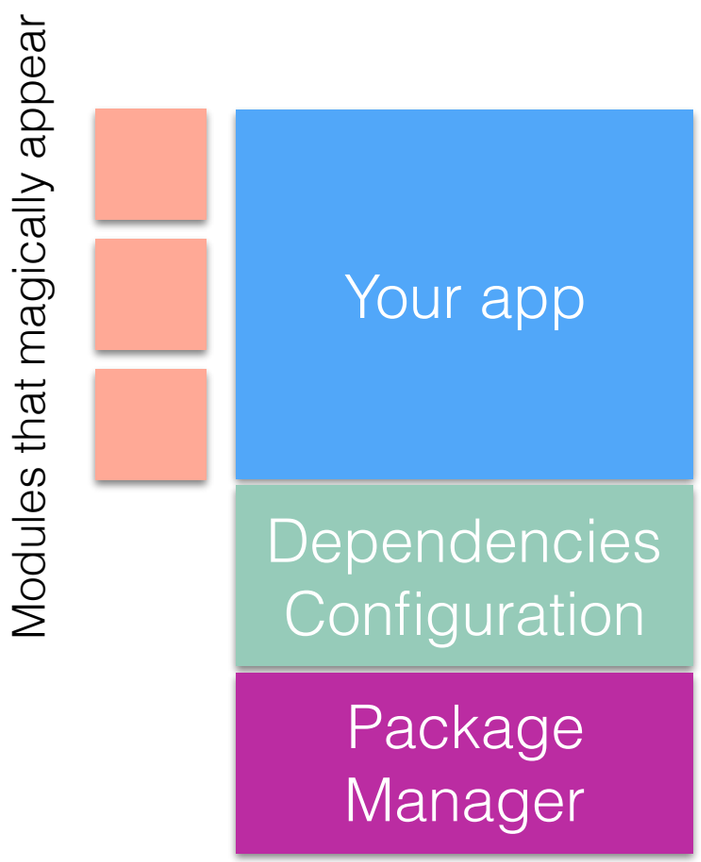
- How have we been using libraries so far?

```
<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!"
- This is slowly being fixed for ES6 and on… but Node has a great (non-standardized) approach we can use for backend development

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



Assumes dependencies magically exist

Declares what modules you need

Provides the modules to your app

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"
  }
}
```

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

```
node install
```

  - This will download and install the modules on your machine given the existing config!

Demo: Hello World Server

1: Make a directory, myapp

2: Enter that directory, type **`npm init`** (accept all defaults)

Creates a configuration file for your project

3: Type **`npm install express --save`**

Tells NPM that you want to use express, and to save that in your project config

4: Create text file app.js:

```
var express = require('express');
var app = express();
var port = process.env.port || 3000;
app.get('/', function (req, res) {
  res.send('Hello World!');
});

app.listen(port, function () {
  console.log('Example app listening on port' + port);
});
```

5: Type **`node app.js`**

6: Point your browser to http://localhost:3000

Runs your app

Demo: Hello World Server

```
var express = require('express');
```

Import the module express

```
var app = express();
```

Create a new instance of express

```
var port = process.env.port || 3000;
```

Decide what port we want express to listen on

```
app.get('/', function (req, res) {
  res.send('Hello World!');
});
```

Create a *callback* for express to call when we have a "`get`" request to "`/`". That callback has access to the request (`req`) and response (`res`).

```
app.listen(port, function () {
  console.log('Example app listening on port' + port);
});
```

Tell our new instance of express to listen on `port`, and print to the console once it starts successfully

Express

- Basic setup:
  - For get:

```
app.get("/somePath", function(req, res){
    //Read stuff from req, then call res.send(myResponse)
});
```

  - For post:

```
app.post("/somePath", function(req, res){
    //Read stuff from req, then call res.send(myResponse)
});
```

  - Serving static files:

```
app.use(express.static('myFileWithStaticFiles'));
```

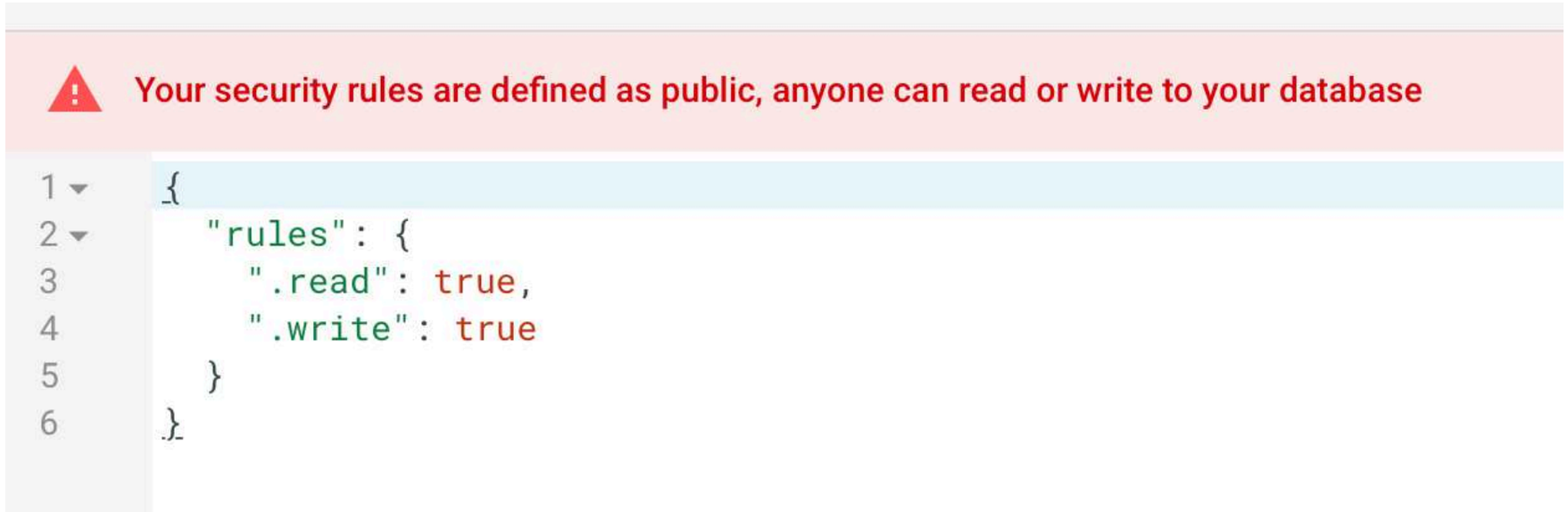
    - Make sure to declare this *last*
- Additional helpful module - bodyParser (for reading POST data)

Putting it together:

Firebase + Node

Moving Firebase into Node

- General rule:
  - If you set your database to be writeable by everyone… then make sure NOBODY has your private key



In our security lecture we'll talk about having some data writable through the web app directly and some only through node. For now, we'll talk about the simplest case: Only allow writes through our node backend.

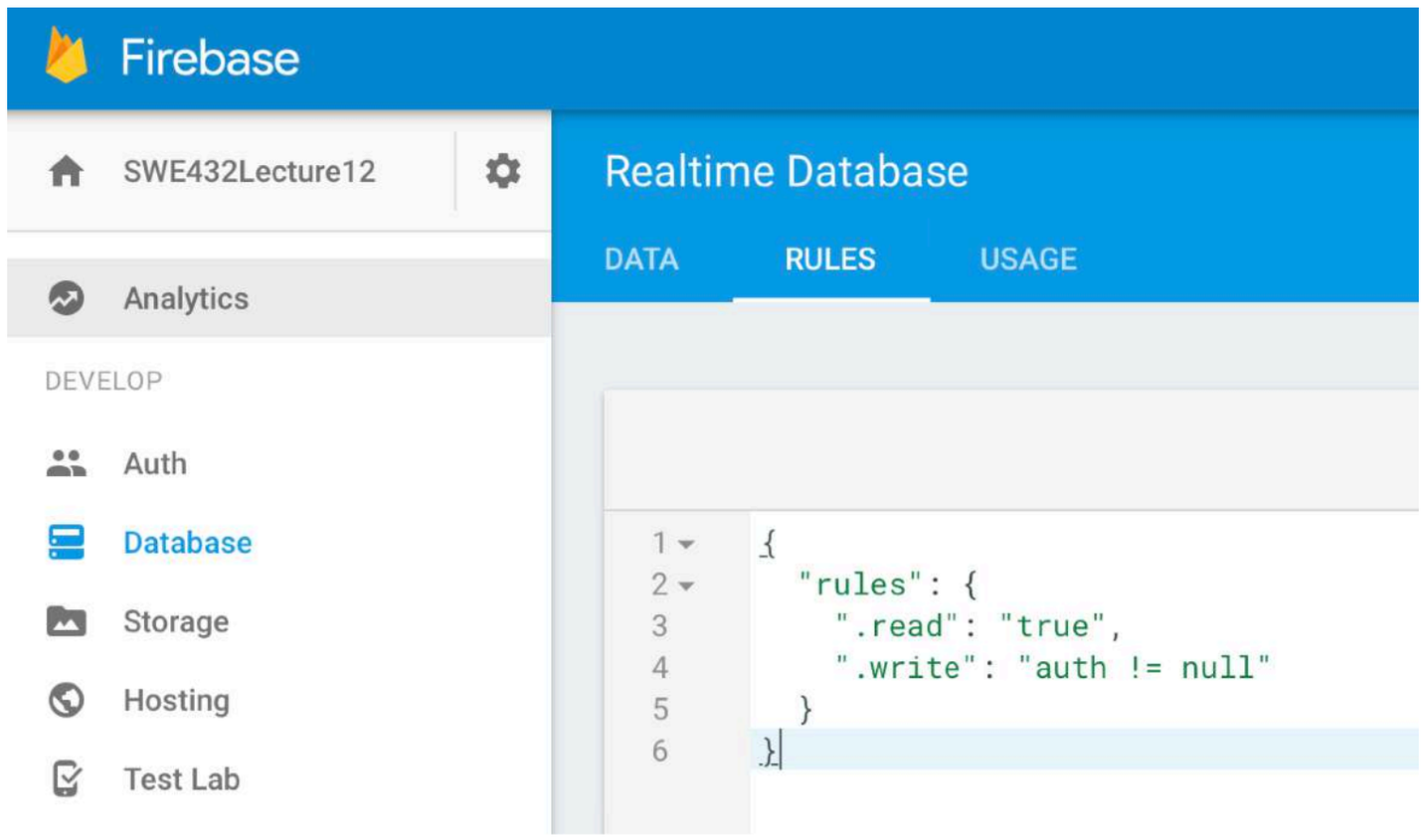
Firebase + Node

- Step 1: Create a special access key for our Node app to use to access our database
- This key will distinguish our node app from the web app
- Now you can keep publishing your API key, but have a **private** key that you never publish publicly
- https://firebase.google.com/docs/server/setup

1 Create a Firebase project in the Firebase console, if you don't already have one. If you already have an existing Google project associated with your app, click **Import Google Project**. Otherwise, click **Create New Project**.
2 Click settings and select **Permissions**.
3 Select **Service accounts** from the menu on the left.
4 Click **Create service account**.
   a Enter a name for your service account. You can optionally customize the ID from the one automatically generated from the name.
   b Choose **Project > Editor** from the **Role** dropdown.
   c Select **Furnish a new private key** and leave the **Key type** as **JSON**.
   d Leave **Enable Google Apps Domain-wide Delegation** unselected.
   e Click **Create**.

Firebase + Node

- Step 2: Configure our database to allow writes from ONLY clients that have authenticated with a private key
- Database -> Rules -> Set .write to be “auth != null”



Firebase + Node

- Step 3: Declare our dependency on firebase
  - In our project directory, run:
    `npm install firebase --save`
  - In our app, write:
    - `var firebase = require("firebase");`
- Step 4: Copy our downloaded private key (step 1) to our directory and configure Firebase to connect with it

Demo: Firebase + NodeJS

What's to come?

- How do we create structured APIs?
- How do we maintain some state between our backend and frontend?
- Privacy & Security
- Architecting many services together
- Deploying our backend services