# Introduction to Node.js

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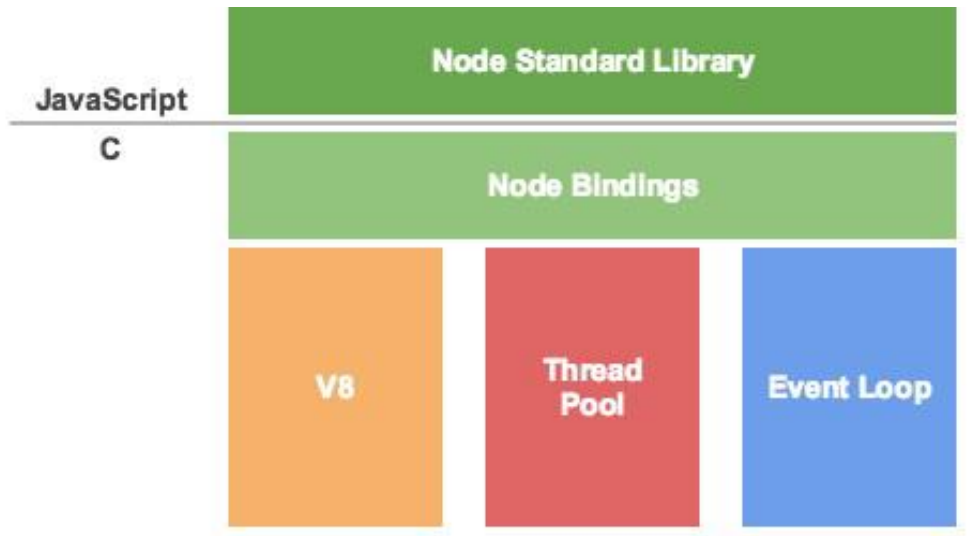
## Agenda

- What is node.js
- The Dev Env for the Labs
- Event-based processes
- Callbacks in node
- Introduction to Express

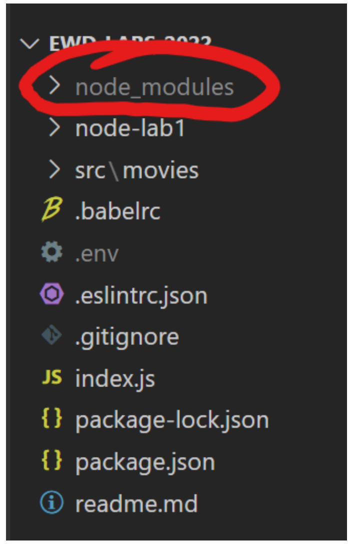
## What's Node: Basics

- A Javascript runtime. “Server side JS”
- The “.js” doesn’t mean that it’s written completely in JavaScript.
  - approx. 40% JS and 60% C++
- Ecosystem of packages (**NPM**)
- Official site: “Node's goal is to provide an easy way to build scalable network programs”.
- Single Threaded, Event based
  - Supports concurrency using events and callbacks…



# NPM – the Package Manager

- Node has a small core API
- Most applications depend on third party modules
- Curated in online registry called the Node Package Manager system (NPM)
- NPM downloads and installs modules, placing them into a **node_modules** folder in your current folder.



```
EWD-LABS-2022
  > node_modules
  > node-lab1
  > src\movies
    .babelrc
    .env
    .eslintrc.json
    .gitignore
    index.js
    package-lock.json
    package.json
    readme.md
```

## NPM init

- You can use NPM to manage your node projects
- Run the following in the root folder of your app/project:

  **npm init**
- This will ask you a bunch of questions, and then create a **package.json** for you.
- It attempts to make reasonable guesses about what you want things to be set to, and then writes a package.json file with the options you've selected.

## NPM Common Commands

- **npm init**
  *initialize a package.json file*
- **npm install <package name> -g**
  *install a package, if –g option is given package will be installed globally,*
- ***--save*** *and* ***--save-dev***

  *add package to your dependencies*
- **npm install**
  *install packages listed in package.json*
- **npm ls –g**
  *list local packages (without –g) or global packages (with –g)*
- **npm update <package name>** *update a package*

## NPX - the package runner

- Makes it easy to run a Node.js based executable that you would normally install via npm.
- Can use it at command line to execute packages, even if they are not previously installed.
- Very good for one-off commands/tests (like in-class demos!)
- Comes with the latest versions of NPM
- The following example will execute the babel-node package to transpile and run index.js.

```
npx babel-node index.js
```

## Node Development Environment

## Development Environment Setup for Labs

**Node.js:**

We just talked about it

**Babel:**

Allow us to use up-to-date Javascript features, according to ECMAScript Standardisation

**Nodemon:**

monitor for any changes in your source and automatically restart your node app.

**ESLint:**

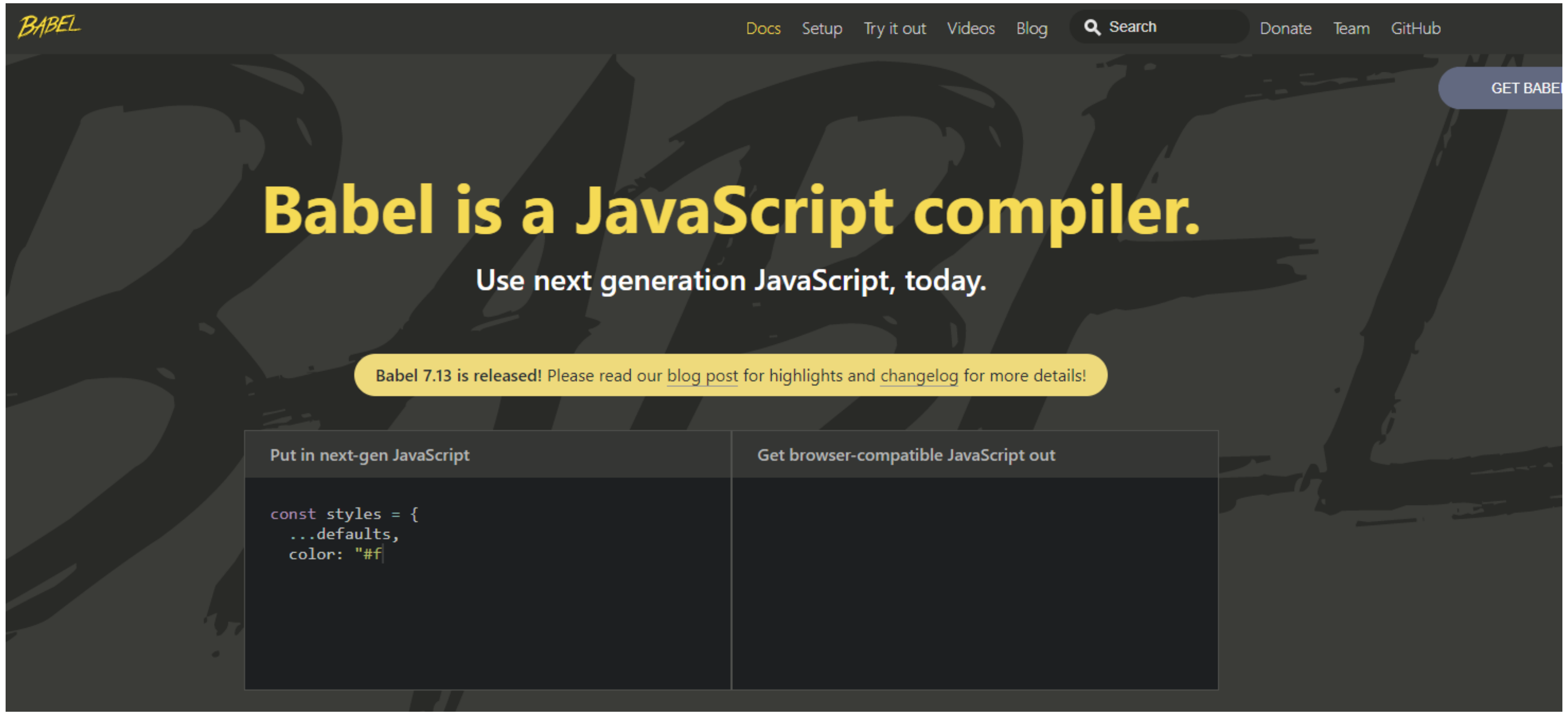
Find, report and fix problems in your javascript

**Testing:**

Manual: Postman

Automated: Mocha, Should, Sinon (maybe…)

# Babel



Babel is a JavaScript compiler.

Use next generation JavaScript, today.

**Babel 7.13 is released!** Please read our blog post for highlights and changelog for more details!

Put in next-gen JavaScript

```
const styles = {
  ...defaults,
  color: "#f
```

Get browser-compatible JavaScript out

# Node.js and Babel

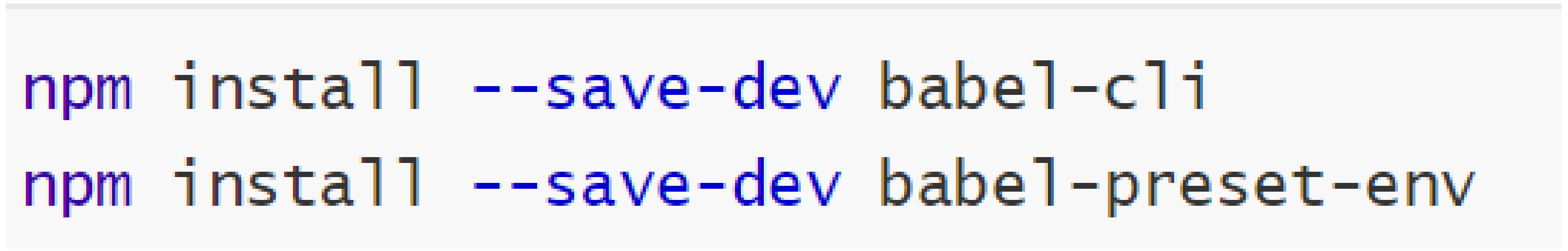
We’re using ES6+ syntax for front end development

E.g. imports, spread operator, arrow functions, export default

**Node.js, as yet,  does not support all of the latest and greatest ES6+ features**

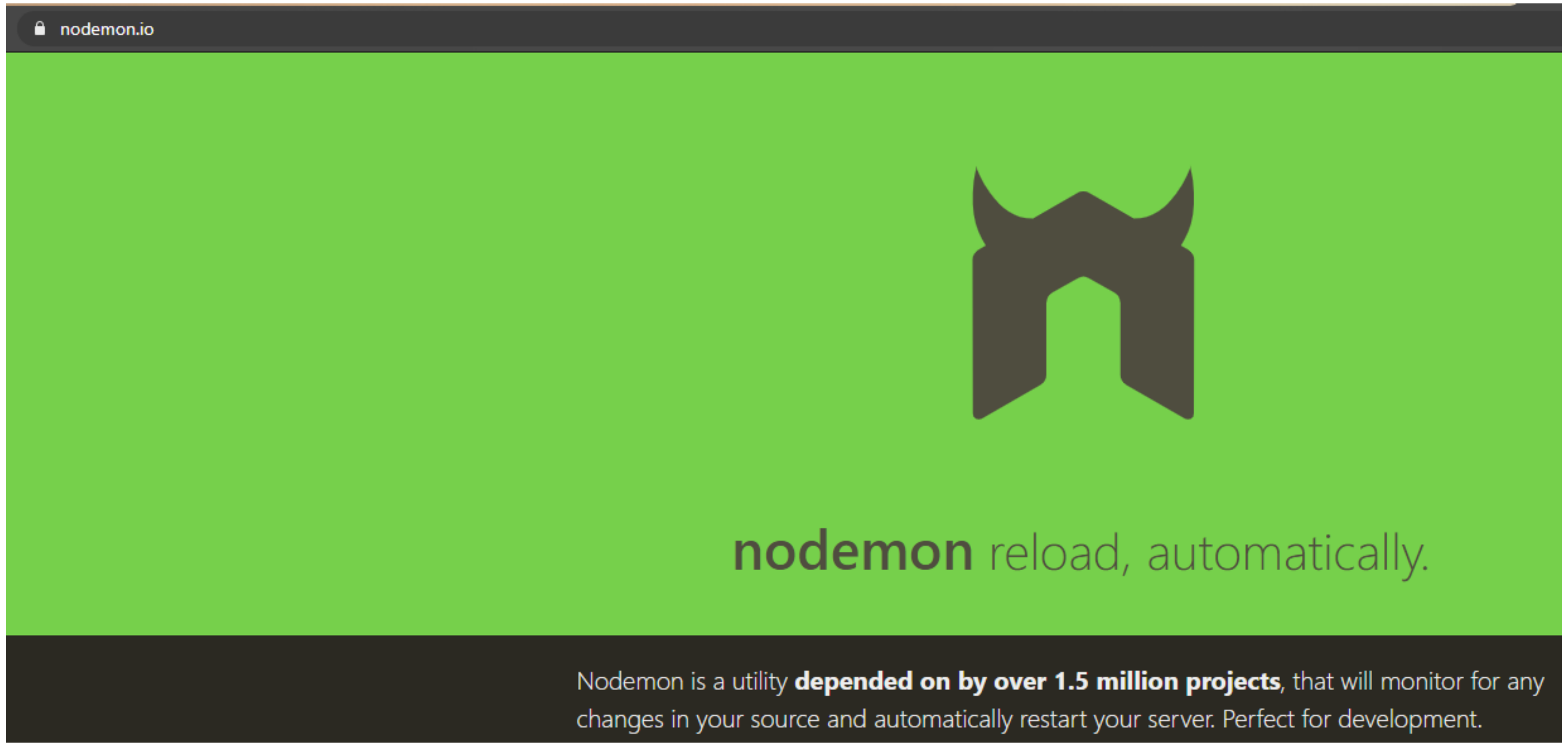
We can use Babel to *“Transpile”* code from ES6+ to ES5 before we run it

We will install as **Development Dependency** for our project



```
npm install --save-dev babel-cli
npm install --save-dev babel-preset-env
```

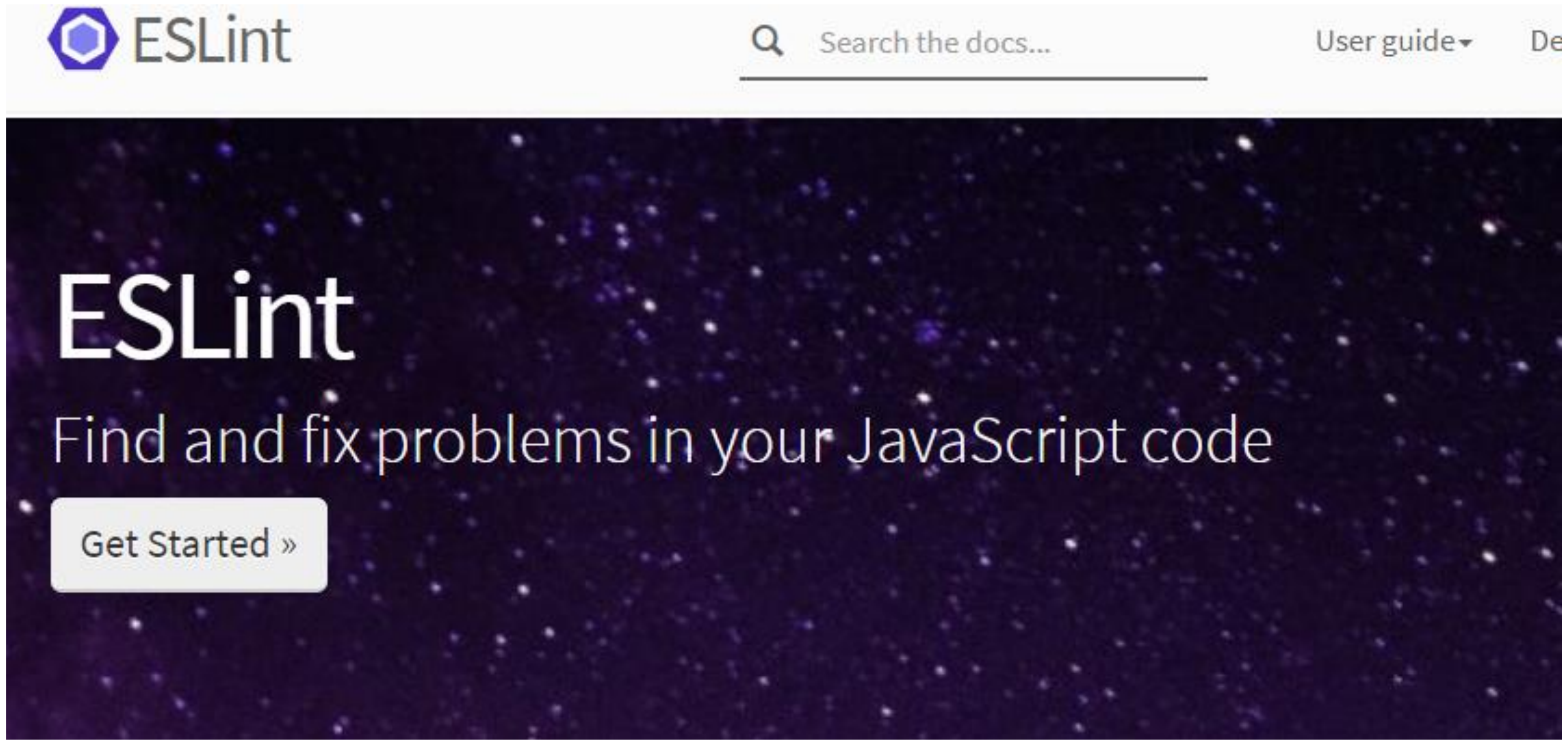
## Nodemon


nodemon.io

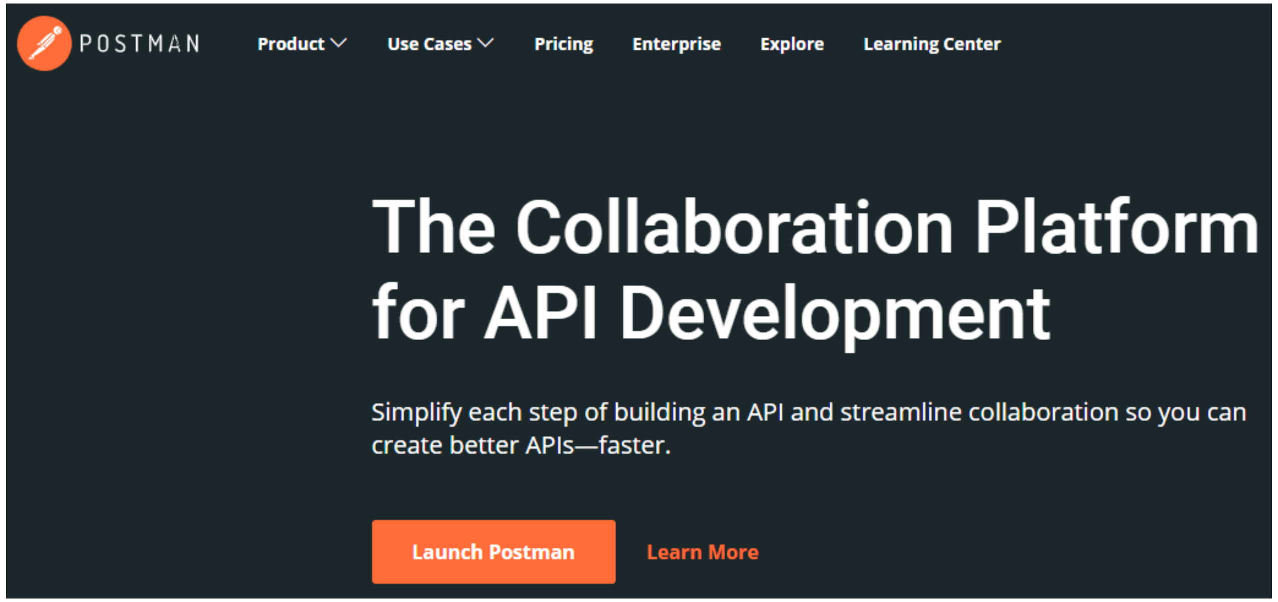
**nodemon** reload, automatically.

Nodemon is a utility **depended on by over 1.5 million projects**, that will monitor for any changes in your source and automatically restart your server. Perfect for development.

# ESLint

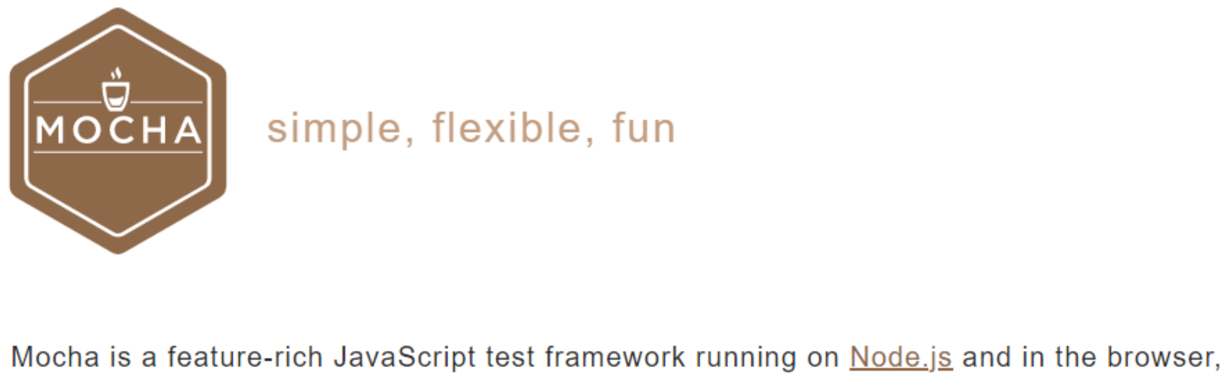

ESLint
Search the docs...
User guide
De
ESLint
Find and fix problems in your JavaScript code
Get Started »

# Testing(Maybe…)



The Collaboration Platform for API Development

Simplify each step of building an API and streamline collaboration so you can create better APIs—faster.



simple, flexible, fun

Mocha is a feature-rich JavaScript test framework running on Node.js and in the browser,

# Input/Output

- Input/Output (io) is slow.
  - Reading/writing to data store, network access.
  - Read 4K randomly from SSD* 150,000 ns ~1GB/sec SSD
  - Round trip over network within same datacenter 500,000 ns
  - Send packet US->Netherlands->US 150,000,000 ns
- CPU operations are fast.
  - L1 cache reference 0.5 ns
  - L2 cache reference 7 ns

- I/O operations detrimental to highly concurrent apps (e.g. web applications)
- Solutions to deal with this are:
  - **Blocking code** combined with multiple threads of execution (e.g. Apache, IIS)
  - **Non-blocking**, **event-based code** in single thread (e.g. NGINX, Node.js)

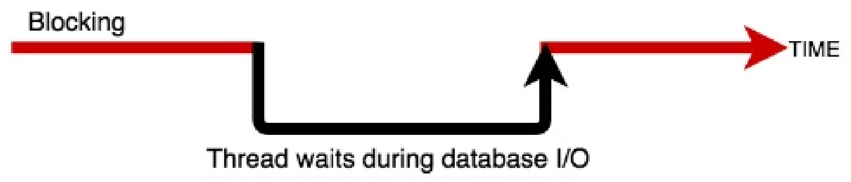
Source: https://gist.github.com/jboner/2841832

1ns = $10^{-9}$ s (0.000000001s)

# Blocking/Non-blocking Example

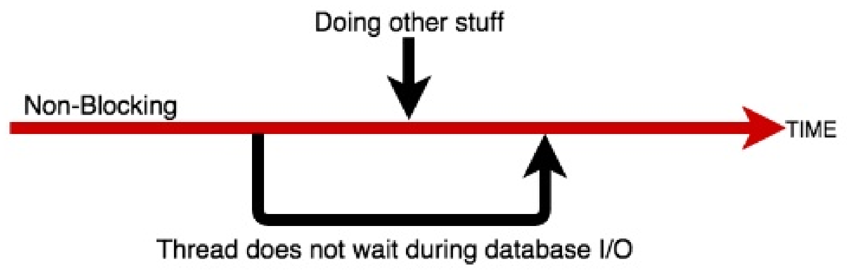
## Blocking

1. Read from db and set equal to contents
2. Print Contents
3. Do other stuff...



## Non-blocking

1) Read from db
   Whenever read is complete, print contents
2) Do other stuff...



# Blocking/Non-blocking example: Javascript

## Blocking

```
import fs from 'fs';

const contents = fs.readFileSync('./text.txt', 'utf8');
console.log(contents);
console.log('Doing something else');
```

Console output

```
Hello World……
Doing something else
```

## Non-blocking

```
import fs from 'fs';
fs.readFile('./text.txt','uft8', (err, contents) => {
    console.log(contents);
});
console.log('Doing something else');
```

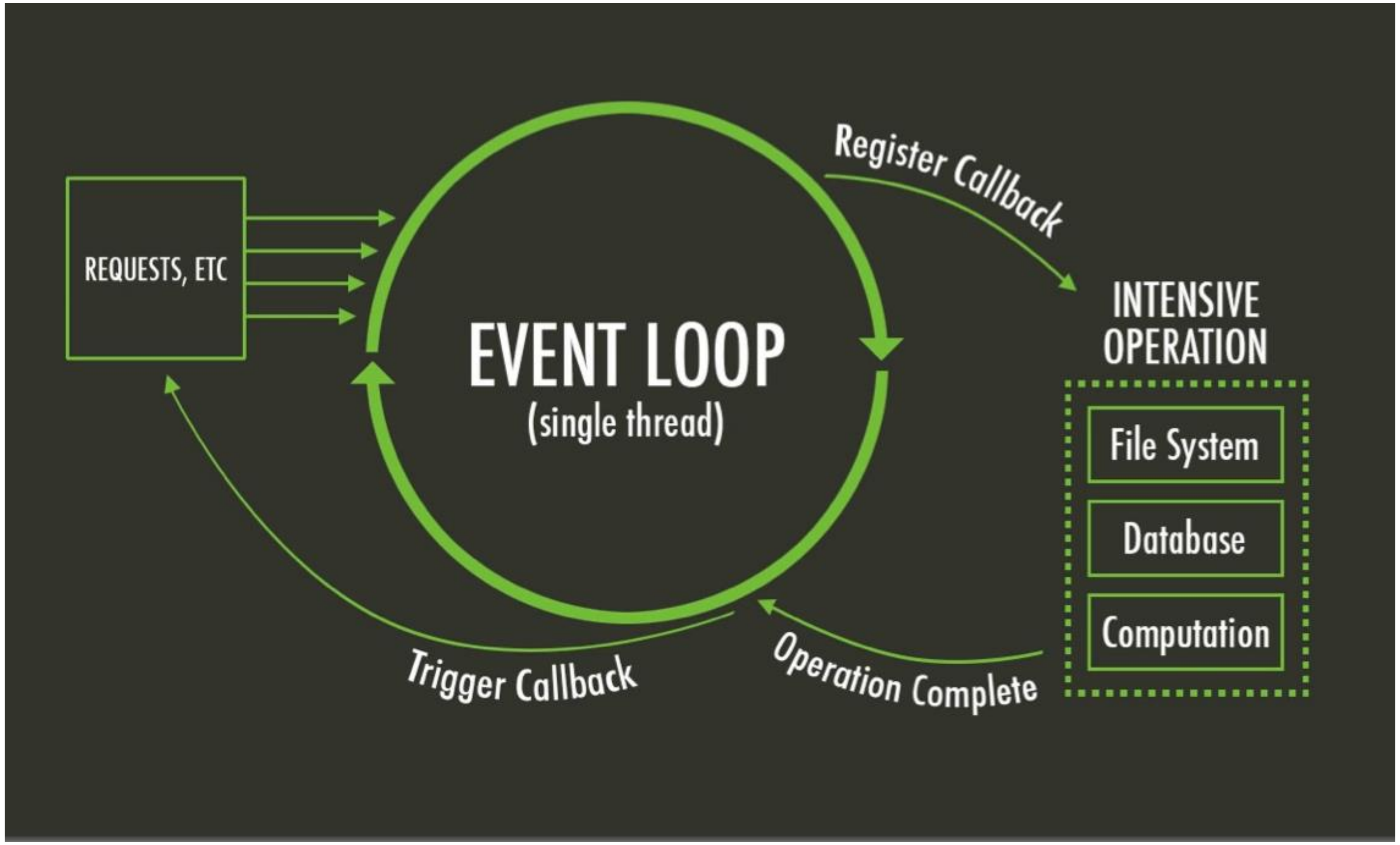
callback

Console output

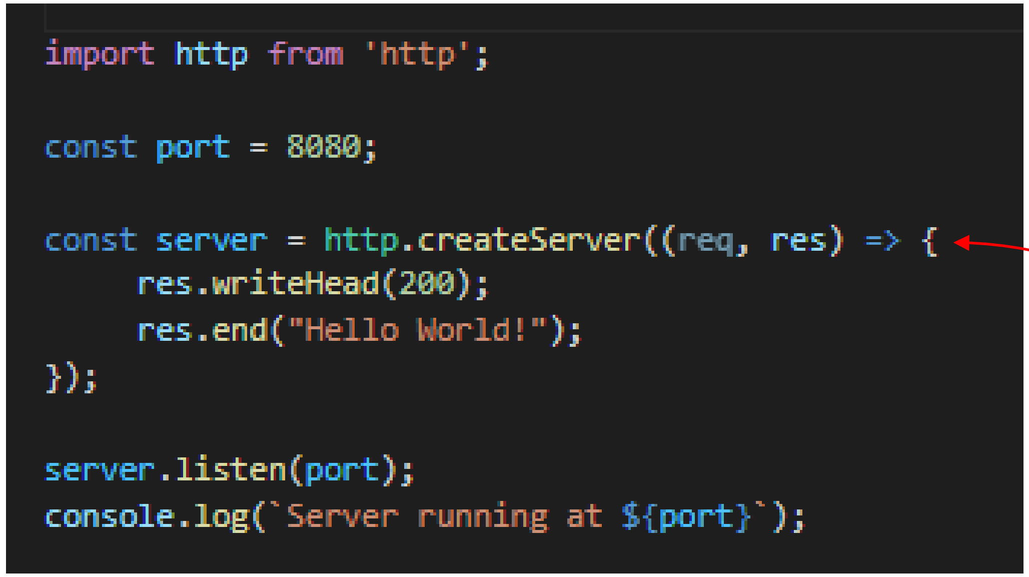
```
Doing something else
Hello World ……
```

## The Node Event Loop and Callbacks

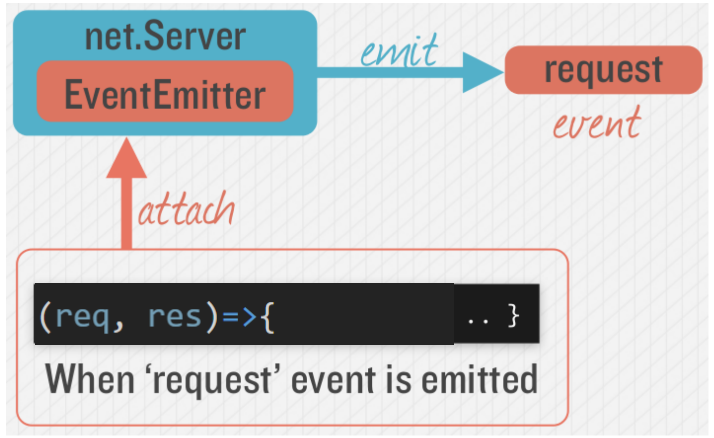
- A **Callback** is a function called at the completion of a given task. This prevents any blocking, and allows other code to be run in the meantime
- The Event Loop checks for known events, registers Callbacks and triggers callback on completion of operation
- More info here: [https://developer.ibm.com/tutorials/learn-nodejs-the-event-loop/](https://developer.ibm.com/tutorials/learn-nodejs-the-event-loop/)

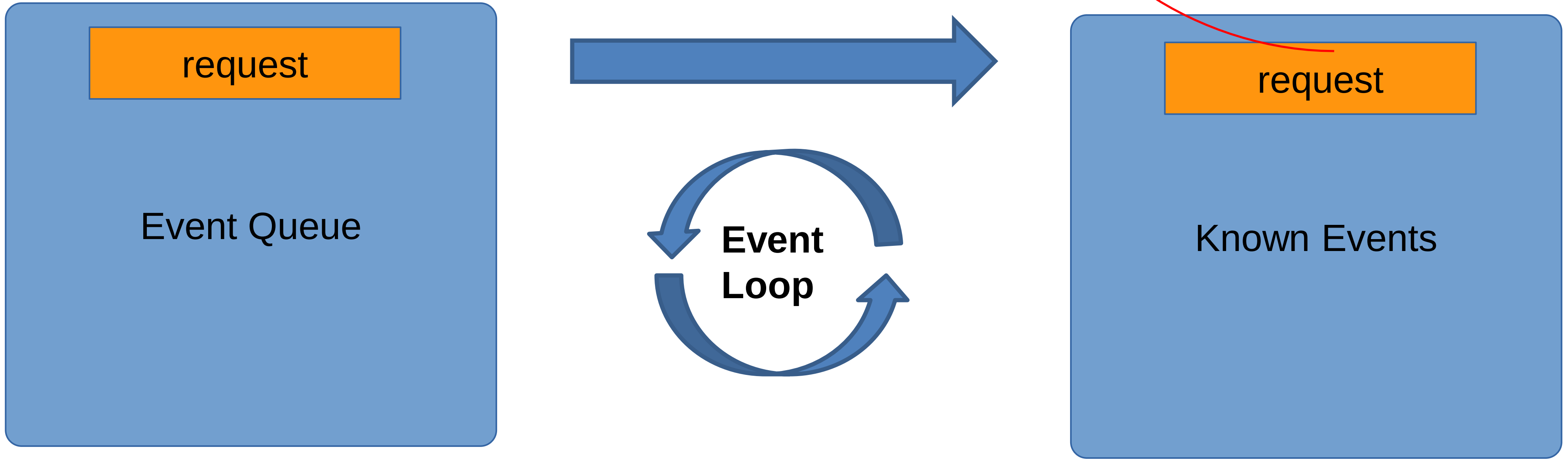


# Node.js - Simple HTTP Server



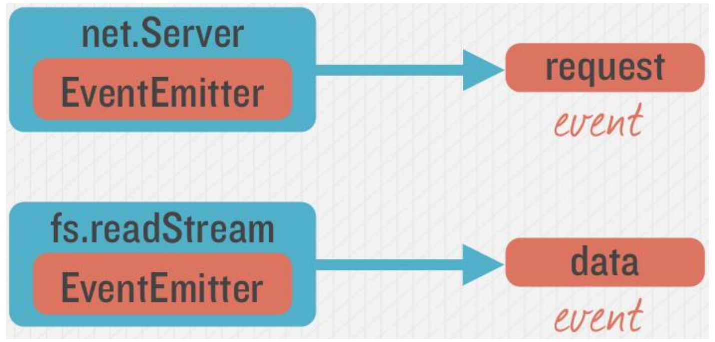
```
import http from 'http';

const port = 8080;

const server = http.createServer((req, res) => {
      res.writeHead(200);
      res.end("Hello World!");
});

server.listen(port);
console.log(`Server running at ${port}`);
```



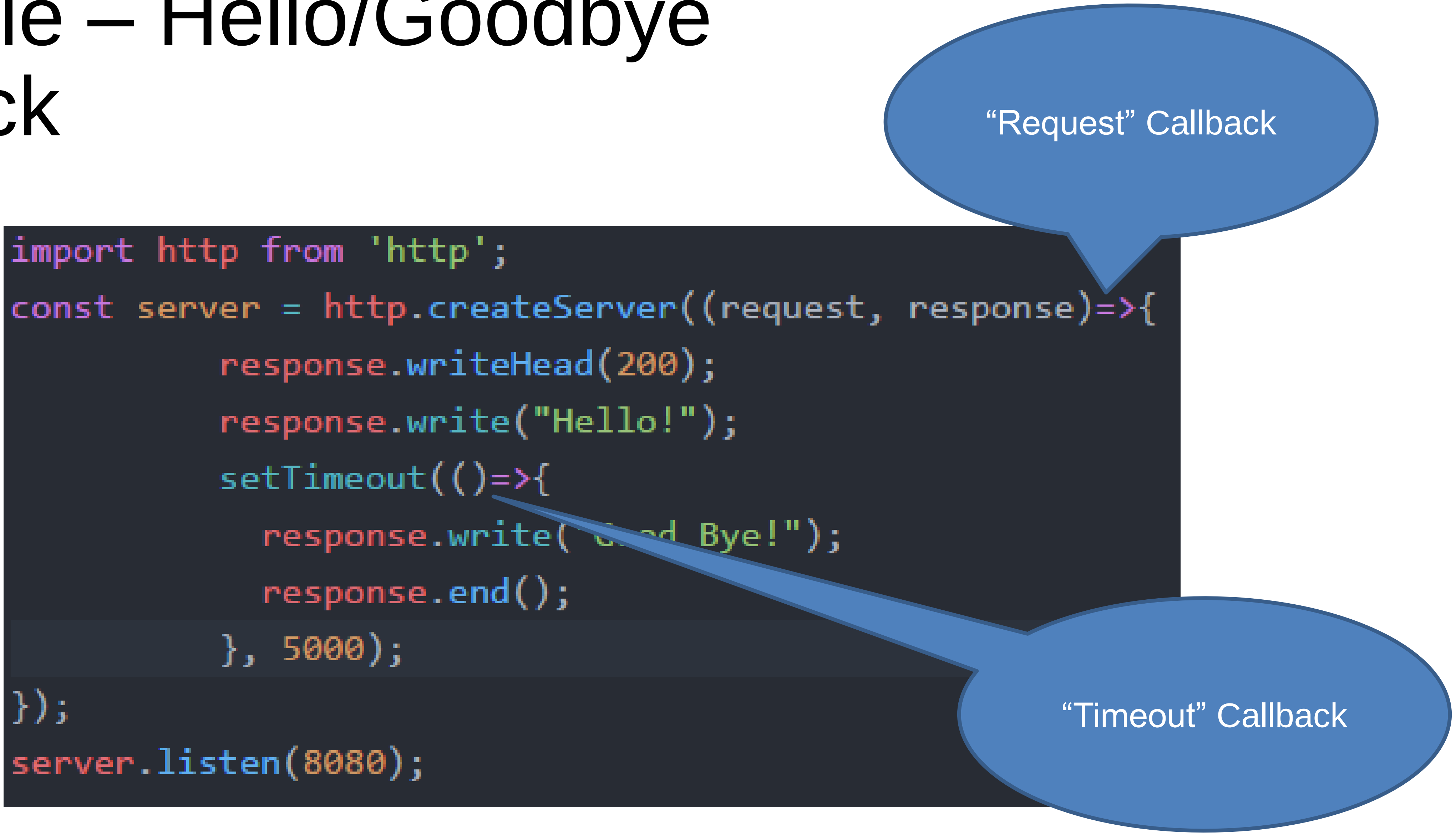


## Emitting Event in Node

Many objects can emit events in node.

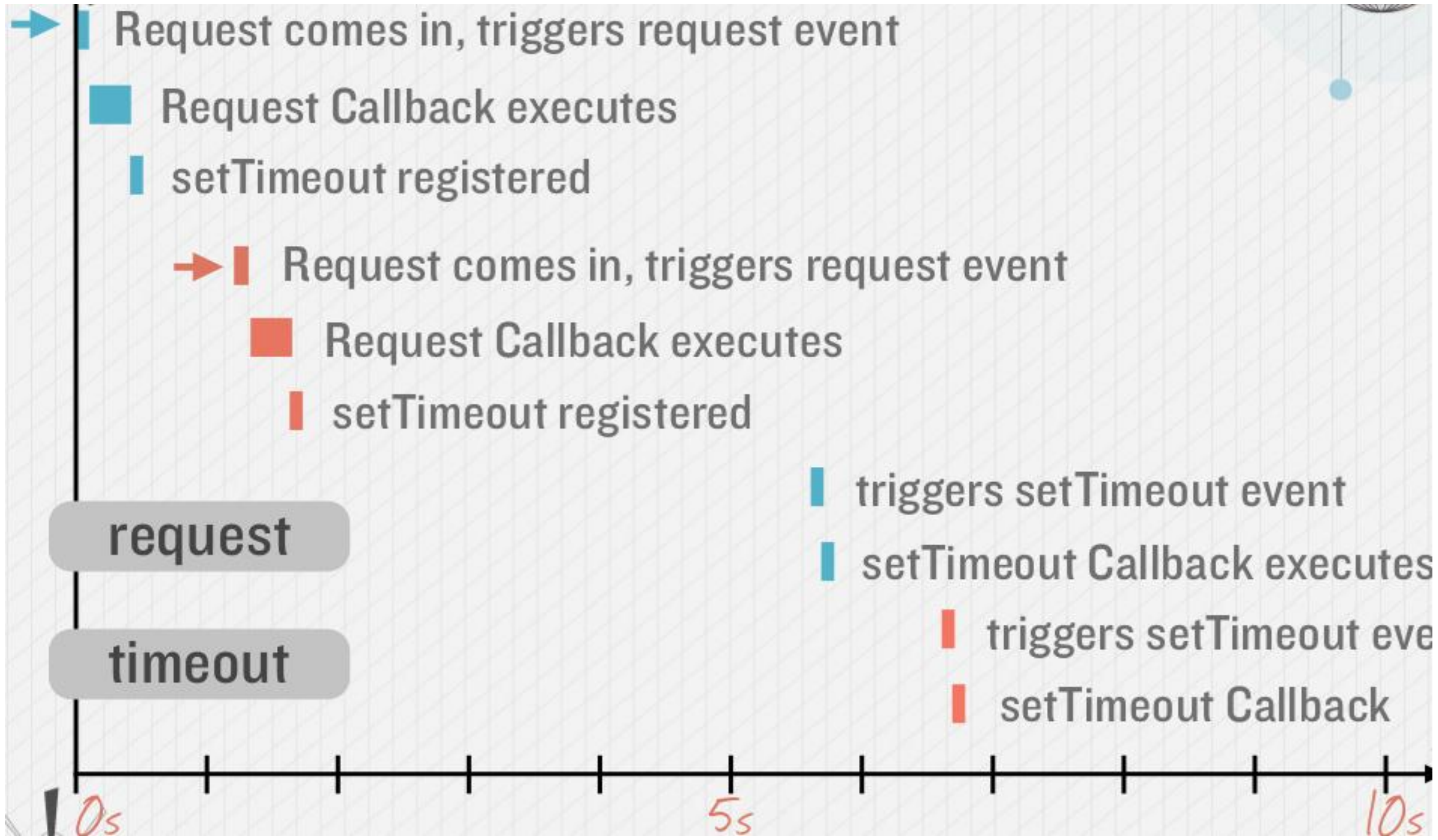


# Example – Hello/Goodbye Callback


```
import http from 'http';
const server = http.createServer((request, response)=>{
          response.writeHead(200);
          response.write("Hello!");
          setTimeout(()=>{
            response.write("Good Bye!");
            response.end();
          }, 5000);
});
server.listen(8080);
```

# Callback Timeline, Non Blocking

Timing example: 2 requests to web application (indicated by red and blue in diagram)


Request comes in, triggers request event
Request Callback executes
setTimeout registered
Request comes in, triggers request event
Request Callback executes
setTimeout registered
triggers setTimeout event
setTimeout Callback executes
triggers setTimeout eve
setTimeout Callback
request
timeout
0s
5s
10s

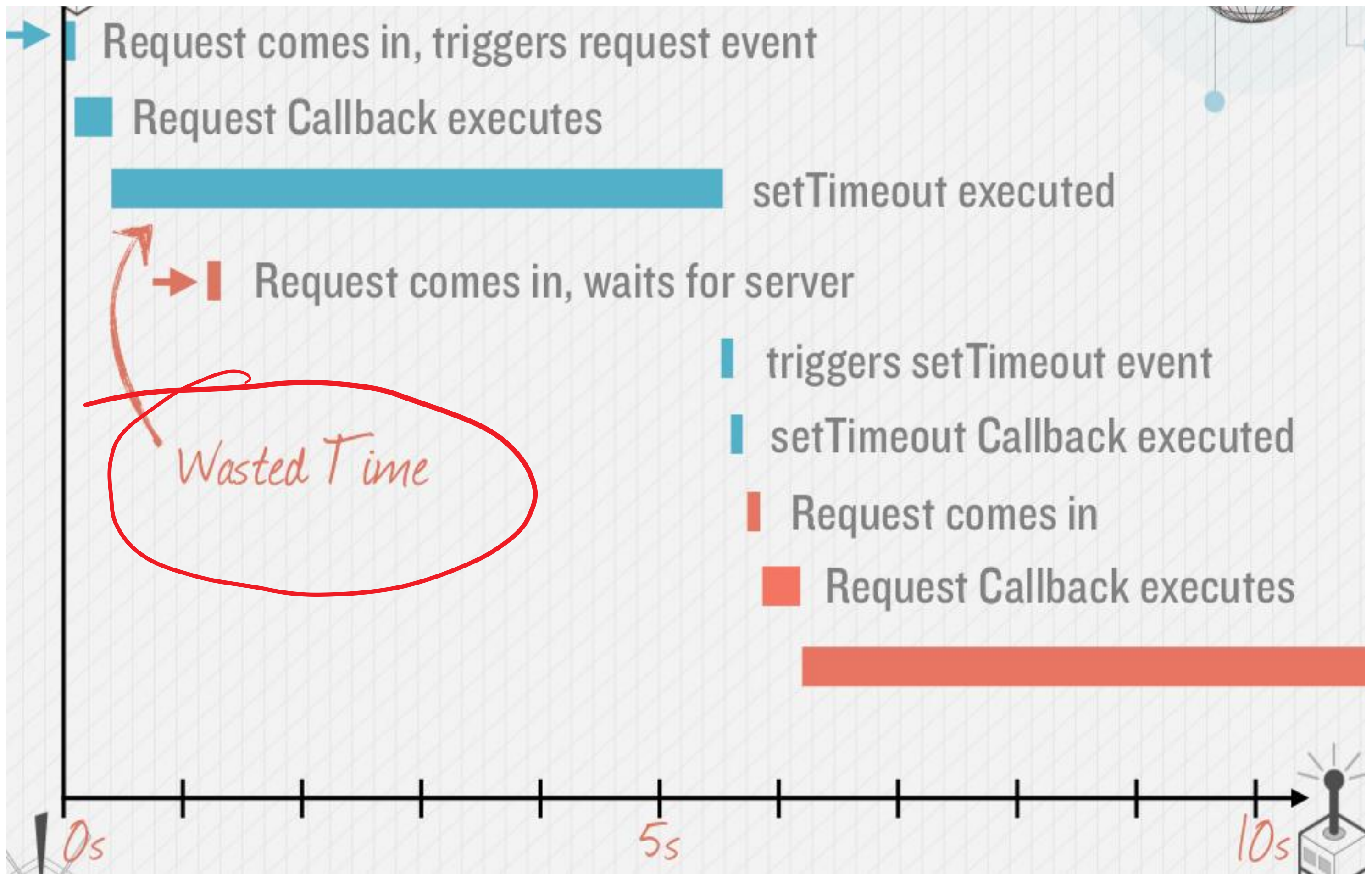
# Avoid Blocking Calls in Node.js apps

- setTimeout in previous slide is an example of an asynchronous, non-blocking call.
- Avoid potential blocking/ synchronous calls
- **Activity likely to be blocking should be called asynchronously.**

Examples:

- Calls to 3rd party Web Services
- Database queries
- Computationally expensive operations (image file processing)

**What if setTimeout() blocked…**


Request comes in, triggers request event
Request Callback executes
setTimeout executed
Request comes in, waits for server
triggers setTimeout event
setTimeout Callback executed
Request comes in
Request Callback executes
Wasted Time
0s
5s
10s

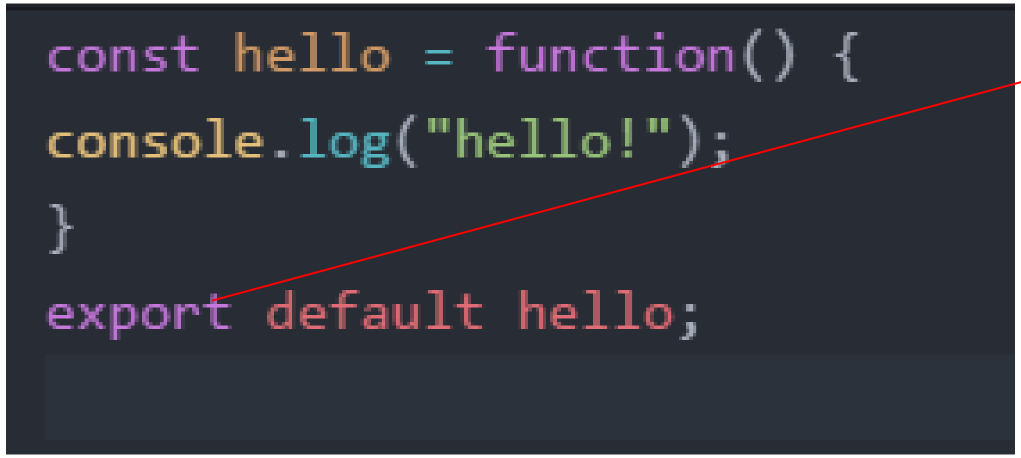
# Node Modules

## Node Modules

- To install NPM modules, navigate to the  application folder and run “npm install”. For example :
- **npm install express --save**
- This installs into a “**node_module**” folder in the current folder.
- The **--save** bit updates your **package.json** with the dependency
- To use the module in your code, use:
- **import express from 'express';**
- This loads express from local **node_modules** folder.

## Creating your own Node Modules

- We want to create the following module called **custom_hello.js:**



```
const hello = function() {
console.log("hello!");
}
export default hello;
```

Export defines what import returns

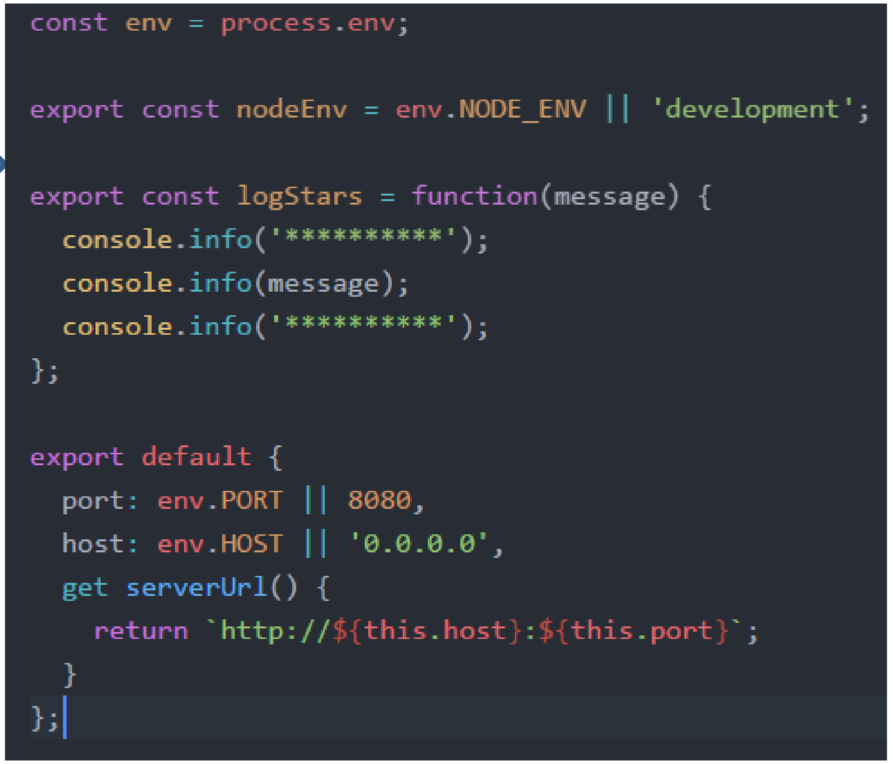
- To access in our application, **index.js:**

```
import hello from './custom_hello';
hello();
```

# Creating your own Node Modules

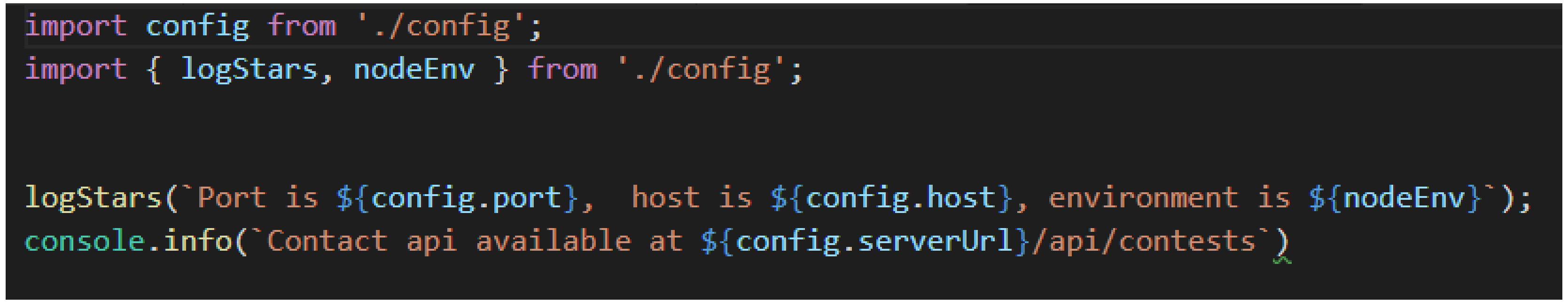
- Exporting Multiple Properties

Config.js

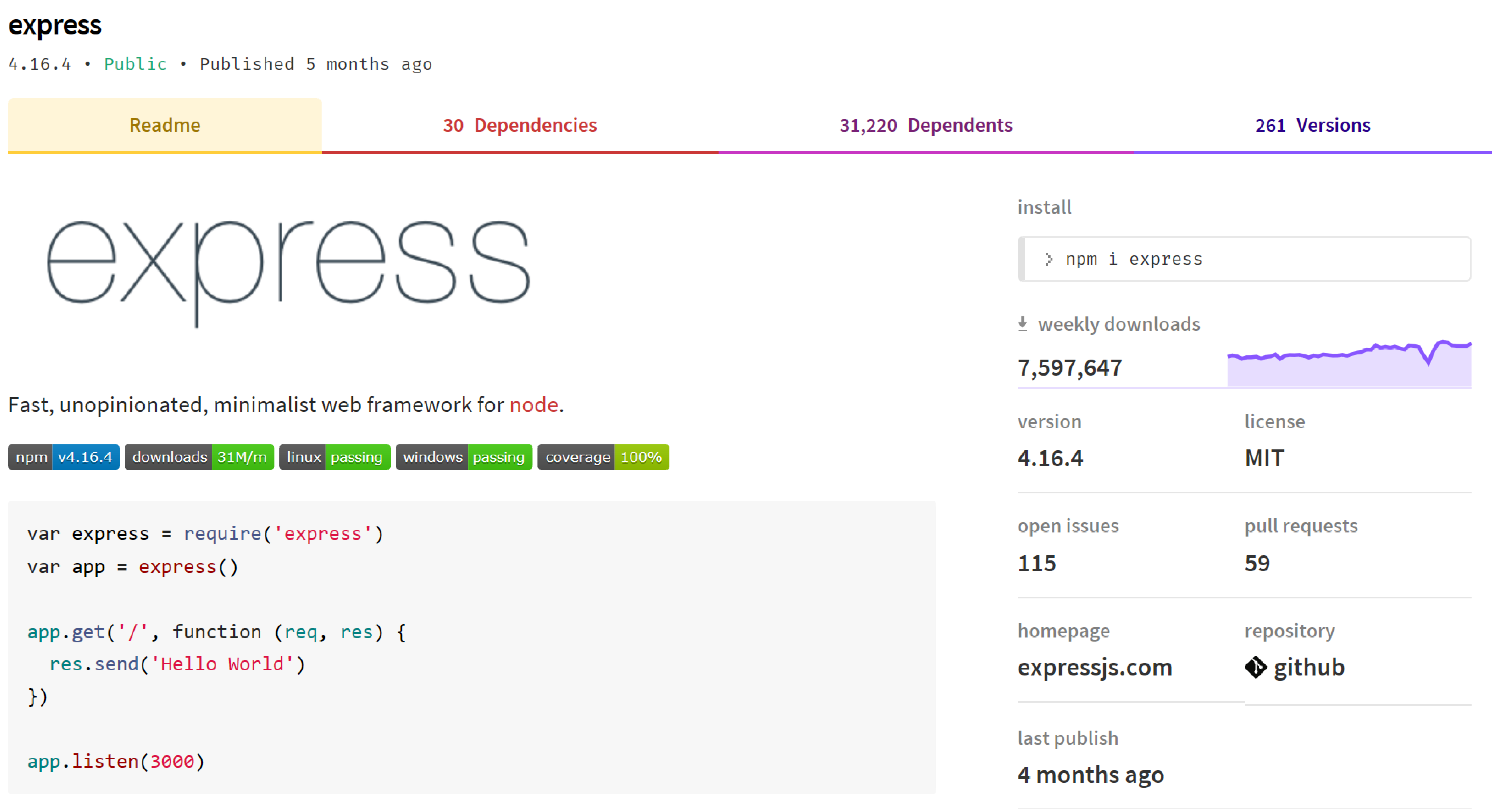


```
const env = process.env;

export const nodeEnv = env.NODE_ENV || 'development';

export const logStars = function(message) {
  console.info('**********');
  console.info(message);
  console.info('**********');
};

export default {
  port: env.PORT || 8080,
  host: env.HOST || '0.0.0.0',
  get serverUrl() {
    return `http://${this.host}:${this.port}`;
  }
};
```

- Accessing in other scripts



```
import config from './config';
import { logStars, nodeEnv } from './config';


logStars(`Port is ${config.port},  host is ${config.host}, environment is ${nodeEnv}`);
console.info(`Contact api available at ${config.serverUrl}/api/contests`)
```



express

4.16.4 • Public • Published 5 months ago

Readme | 30 Dependencies | 31,220 Dependents | 261 Versions

express

Fast, unopinionated, minimalist web framework for node.

npm v4.16.4 | downloads 31M/m | linux passing | windows passing | coverage 100%

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

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

app.listen(3000)
```

install

```
> npm i express
```

weekly downloads

7,597,647

| version | license |
|---|---|
| 4.16.4 | MIT |

| open issues | pull requests |
|---|---|
| 115 | 59 |

| homepage | repository |
|---|---|
| expressjs.com | github |

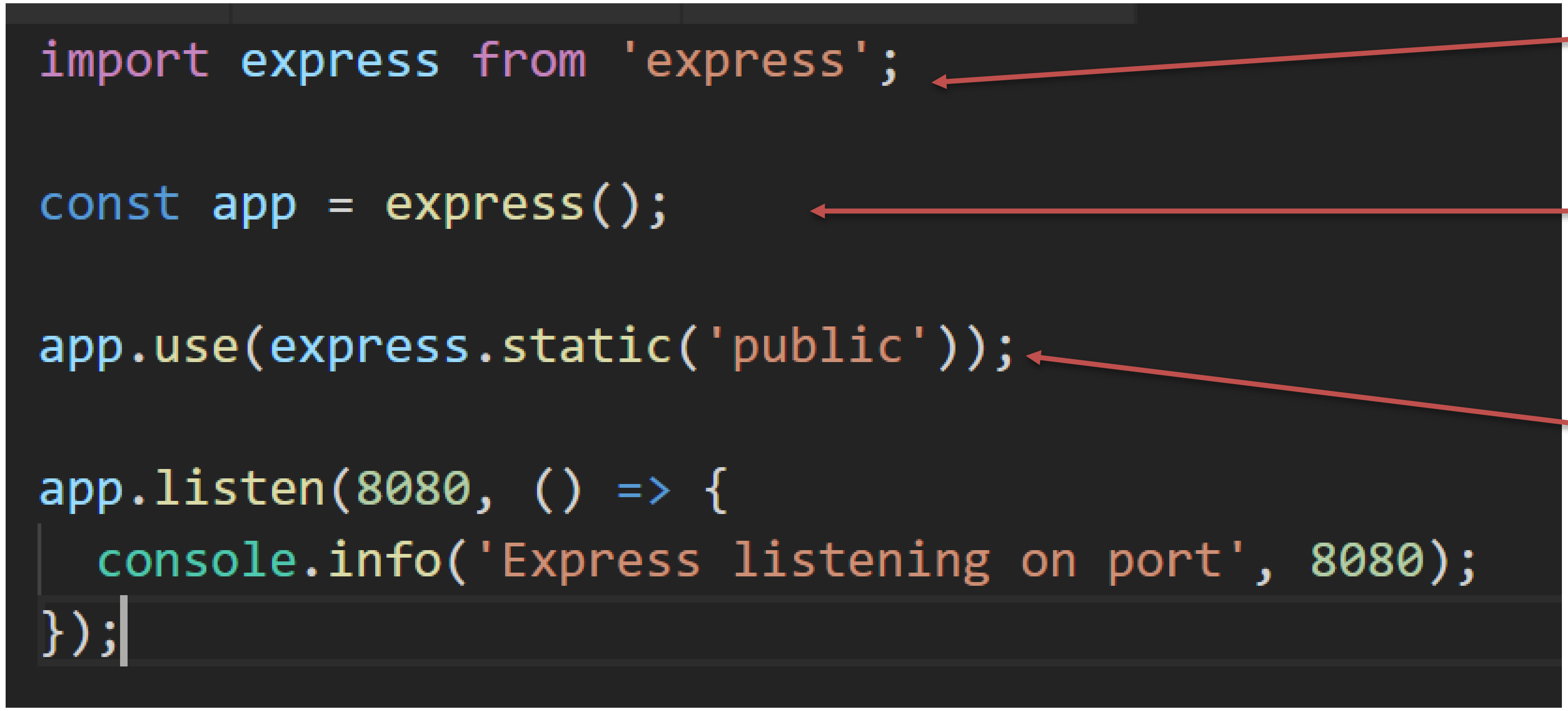
last publish

4 months ago

## What Express Gives Us...

- Parses arguments and headers
- Easy Routing
    - Route a URL to a callback function
- Sessions
- File Uploads
- Middleware…

## Simple Express App (index.js)



```
import express from 'express';

const app = express();

app.use(express.static('public'));

app.listen(8080, () => {
  console.info('Express listening on port', 8080);
});
```

Loads Express module

Instantiates Express server

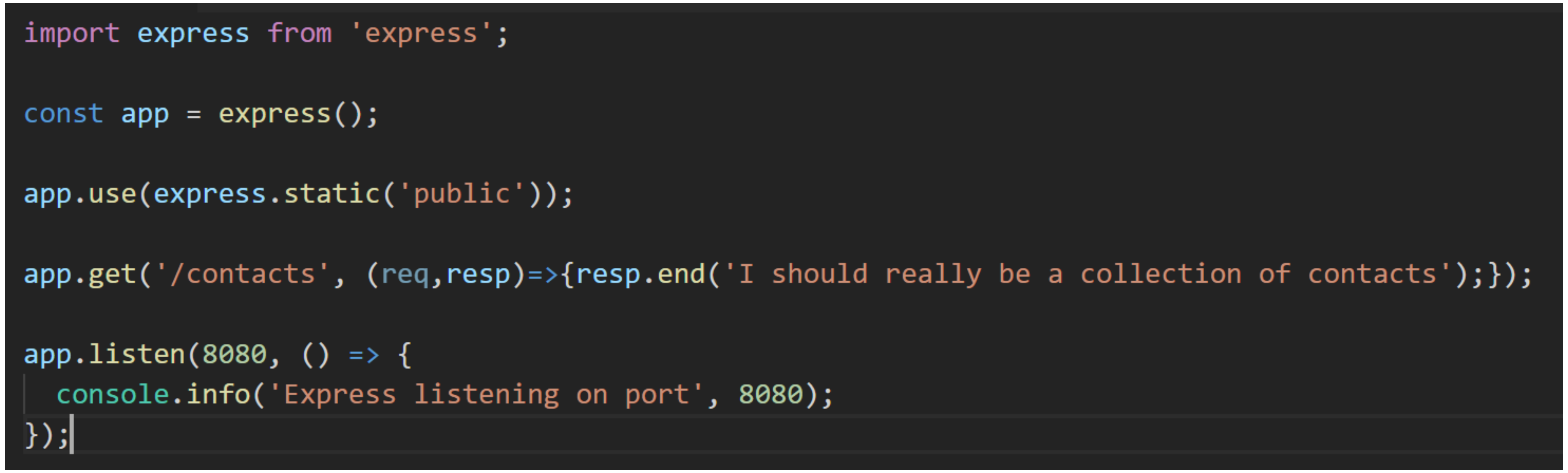
Define static content for HTTP GET

(/*)?

# Routing Examples

Syntax follows the pattern:

**App.[verb](path, (req,res)=>{});**



```
import express from 'express';

const app = express();

app.use(express.static('public'));

app.get('/contacts', (req,resp)=>{resp.end('I should really be a collection of contacts');});

app.listen(8080, () => {
  console.info('Express listening on port', 8080);
});
```

```
// Other Route examples
app.post('/contacts', createContact);
app.get('/contacts/:id', contactsRouter);

//Catch-all
app.all('/private(/*)?', requiresLogin);
```

HTTP POST request

Parametised URL. Accepts :app route argument

Catch-all – works for all HTTP verbs