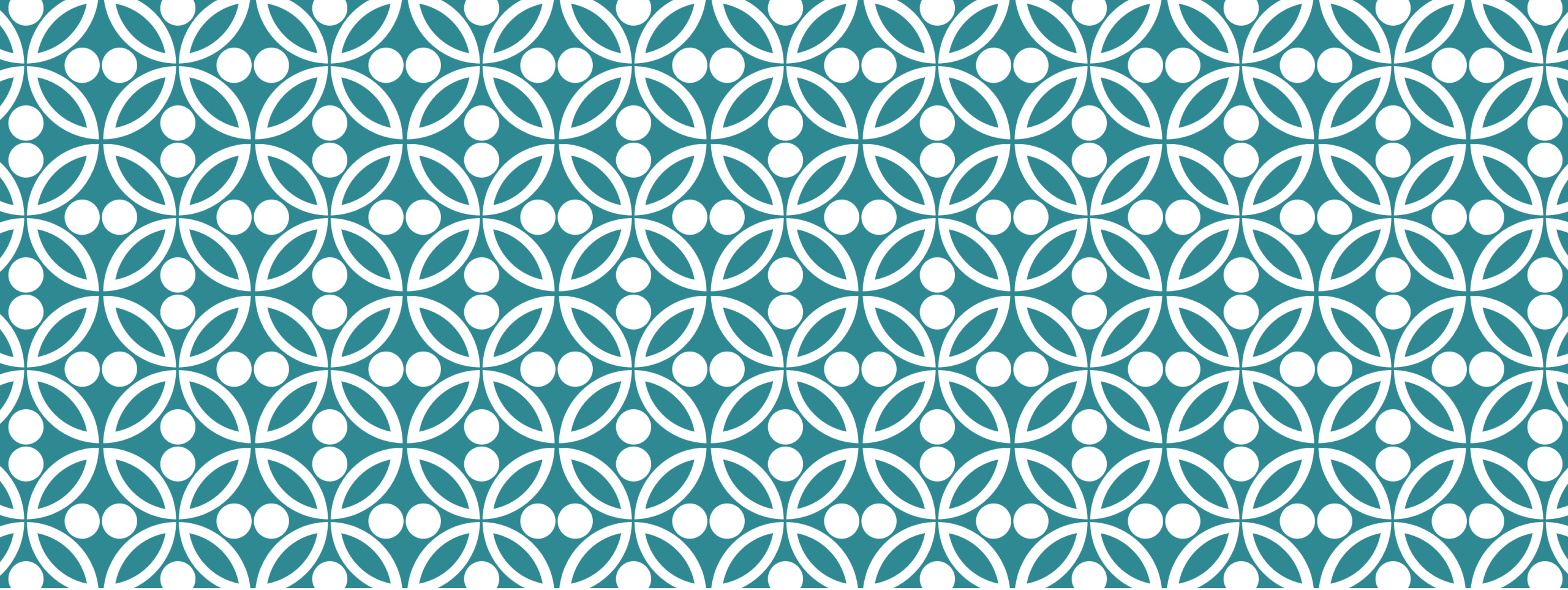


NODE.JS

Part I

JAVASCRIPT

The first incarnations of JavaScript lived in browsers

JavaScript is a “complete” language: you can use it in many contexts and achieve everything with it you can achieve with any other “complete” language

Node.js allows you to run JavaScript code in the backend, outside a browser.

```
console.log("Hello World");
```

```
node helloworld.js
```

MODULAR PROGRAMMING WITH NODE.JS

With Node.js, we not only implement our application, we also implement the whole HTTP server

In fact, our web application and its web server are basically the same

This might sound like a lot of work, but we will see in a moment that it is not so

It allows you to have a clean main file, which you execute with Node.js, and

Clean modules that can be used by the main file and among each other

It's more or less a standard to name your main file *index.js*.

It makes sense to put our server module into a file named *server.js*.

WRITING HTTP SERVER

The first line *require*s the *http* module that ships with Node.js and makes it accessible through the variable *http*

- `var http = require('http');`

We then call one of the functions the http module offers: *createServer*

This function returns an object

This object has a method named *listen*, and takes a numeric value which indicates the port number our HTTP server is going to listen on.

- `var server = http.createServer(<function as argument>);`
- `server.listen(8888);`

Because in JavaScript, functions can be passed around like any other value.

FUNCTIONAL PROGRAMMING IN JAVASCRIPT

```
function say(word) {
  console.log(word);
}

function execute(someFunction, value) {
  someFunction(value);
}

execute(say, "Hello");
```

```
function execute(someFunction, value) {
  someFunction(value);
}

execute(function(word){ console.log(word) }, "Hello");
```

- We define the function we want to pass to *execute* right there at the place where *execute* expects its first parameter.
- This way, we don't even need to give the function a name, which is why this is called an *anonymous function*.

CALLBACKS

```
var result = database.query("SELECT * FROM hugetable");
   console.log("Hello World");
```

The JavaScript interpreter of Node.js first has to read the complete result set from the database

Then it can execute the *console.log()* function

According to the execution model of Node.js - there is only one single process

If there is a slow database query somewhere in this process, this affects the whole process - eve ecution.

```
1 database.query("SELECT * FROM hugetable", function(rows) {
2     var result = rows;
3 });
4 console.log("Hello World");
```

CALLBACKS

```
1  database.query("SELECT * FROM hugetable", function(rows) {
2      var result = rows;
3  });
4  console.log("Hello World");
```

Node.js can handle the database request asynchronously.

Provided that *database.query()* is part of an asynchronous library, this is what Node.js does: just as before, it takes the query

Then sends it to the database.

Here, instead of expecting *database.query()* to directly return a result to us, we pass it a second parameter, an anonymous function.

But instead of waiting for it to be finished, it makes a mental note that says

- "When at some point in the future the database server is done and sends the result of the query, then I have to execute the anonymous function that was passed to *database.query()*."

After printing to the console log, it goes to an event loop

Node.js continuously cycles through this loop again and again whenever there is nothing else to do, waiting for events.

CALLBACKS

```
function onRequest(request, response) {
    console.log("Request received.");
    response.writeHead(200, {"Content-Type": "text/plain"});
    response.write("Hello World");
    response.end();
 }

 http.createServer(onRequest).listen(8888);

 console.log("Server has started.");
```

EVENT LOOP IN HTTP SERVER

This also explains why our HTTP server needs a function it can call upon incoming requests

if Node.js would start the server and then just pause, waiting for the next request, continuing only when it arrives, that would be highly inefficient

Multi client support

- It's important to note that this asynchronous, single-threaded, event-driven execution model isn't an infinitely scalable performance option

Node.js is just one single process, and it can run on only one single CPU core.

Node.js supports cluster module that enables creation of child processes to be executed on separate cores of a multi-core machine

SCALING FOR MULTI-CORE CPUS

For scaling throughput on a webservice, you should run multiple Node.js servers on one box, one per core and split request traffic between them.

This provides excellent CPU-affinity and will scale throughput nearly linearly with core count.

```
if (cluster.isMaster) {
// Fork workers.
     for (var i = 0; i < numCPUs; i++) {
             cluster.fork();
        } }
else {
         http.Server(function(req, res) { ... }).listen(8000); }
```

https://stackoverflow.com/questions/2387724/node-js-on-multi-core-machines

CREATING MODULES WITH NODE.JS

In C++ or C#, when we're talking about objects, we're referring to instances of classes or structs. Objects have different properties and methods, depending on which templates (that is, classes) they are instantiated from. That's not the case with JavaScript objects.
In JavaScript, objects are just collections of name/value pairs - think of a JavaScript object as a dictionary with string keys.

- Somewhere within Node.js lives a module called "http", and we can make use of it in our own code
- By requiring it and assigning the result of the require to a local variable
- This makes our local variable an object that carries all the public methods the *http* module provides.
- It's common practice to choose the name of the module for the name of the local variable

```
var http = require("http");
```

CREATING MODULES WITH NODE.JS

- We can put the different parts of our application into different files and wire them together by making them modules

- The functionality our HTTP server needs to export is simple: scripts requiring our server module simply need to start the server.

```
1  var server = require("./server");
2
3  server.start();
```

```
1  var http = require("http");
2
3  function start() {
4    function onRequest(request, response) {
5      console.log("Request received.");
6      response.writeHead(200, {"Content-Type": "text/plain"});
7      response.write("Hello World");
8      response.end();
9    }
10
11   http.createServer(onRequest).listen(8888);
12   console.log("Server has started.");
13 }
14
15 exports.start = start;
```

ROUTER

- Depending on which URL the browser requested from our server, we need to react differently
- For a very simple application, you could do this directly within the callback function *onRequest()*
- Making different HTTP requests point at different parts of our code is called “routing” – so, let’s create a module called *router*.
- We need to be able to feed the requested URL and possible additional GET and POST parameters into our router, and based on these the router then needs to be able to decide which code to execute
- To interpret the request object, we need two additional Node.js modules, namely *url* and *querystring*.
- *Querystring* can be used to parse the query string or the body of a POST request for parameters

PARSING A URL

Let's now add to our *onRequest()* function the logic needed to find out which URL path the browser requested

```
1  var http = require("http");
2  var url = require("url");
3
4  function start() {
5    function onRequest(request, response) {
6          var pathname = url.parse(request.url).pathname;
7          console.log("Request for " + pathname + " received.");
8          response.writeHead(200, {"Content-Type": "text/plain"});
9          response.write("Hello World");
10         response.end();
11   }
12
13   http.createServer(onRequest).listen(8888);
14   console.log("Server has started.");
15 }
16
17 exports.start = start;
```

ROUTER

```
1  function route(pathname) {
2    console.log("About to route a request for " + pathname);
3  }
4
5  exports.route = route;
```

Dependency Injection

```
var server = require("./server");
var router = require("./router");

server.start(router.route);
```

For this case, the routing “ends” in the router

REQUEST HANDLING

In C++ or C#, when we're talking about objects, we're referring to instances of classes or structs. Objects have different properties and methods, depending on which templates (that is, classes) they are instantiated from. That's not the case with JavaScript objects.
In JavaScript, objects are just collections of name/value pairs - think of a JavaScript object as a dictionary with string keys.

- Value can be data or functions!
- A list of request handlers will be added based on different URL portions
- In index.js, the mapping of the handle to appropriate handlers have been done

```
var handle = {};
      handle["/"] = requestHandlers.start;
      handle["/start"] = requestHandlers.start;
      handle["/upload"] = requestHandlers.upload;
```

- Thus, a handle is a collection of request handlers

SERVER FUNCTIONS

- Passing the list of handlers to the router
- Passing the requested resource extracted from the URL to the router

```
route(handle, pathname);
```

ROUTER FUNCTIONS

```
1  function route(handle, pathname) {
2    console.log("About to route a request for " + pathname);
3    if (typeof handle[pathname] === 'function') {
4      handle[pathname]();
5    } else {
6      console.log("No request handler found for " + pathname);
7    }
8  }
9
10 exports.route = route;
```

Server→router→requestHandler

Server→router→requestHandler

HANDLING REQUESTS

Server→router→requestHandler→router→server

```
function start() {
 console.log("Request handler 'start' was called.");
 return "Hello Start";
 }
function upload() {
 console.log("Request handler 'upload' was called.");
 return "Hello Upload";
 }
 exports.start = start;
 exports.upload = upload;
```

NONBLOCKING REQUEST HANDLING

Instead of expecting a return value from the *route()* function, we pass it a third parameter, our *response* object

Furthermore, we removed any *response* method calls from the *onRequest()* handler, because we now expect *route* to take care of that

```
1  function route(handle, pathname, response) {
2    console.log("About to route a request for " + pathname);
3    if (typeof handle[pathname] === 'function') {
4      handle[pathname](response);
5    } else {
6      console.log("No request handler found for " + pathname);
7      response.writeHead(404, {"Content-Type": "text/plain"});
8      response.write("404 Not found");
9      response.end();
10   }
11 }
12
13 exports.route = route;
```

WRITING A SEPARATE RESPONSE

```
function upload(response) {
        console.log("Request handler 'upload' was called.");
        response.writeHead(200, {"Content-Type": "text/html"});
        fs.readFile('./ChristmasPredicates.html', function
(error, data) {
         if (error) {
             response.writeHead(404);
             respone.write('file not found');
         } else {
             response.write(data);
         }
         response.end();
    });
       }
```

INVERSION OF CONTROL

- Inversion of Control (or IoC) covers a broad range of techniques that allow an object to become a passive participant in the system
- IoC is a software engineering principle that transfers control over objects or parts of a system to a container.
- It is most commonly used in the context of object-oriented programming.
- The IoC allows the framework to take control of the program execution flow and sends calls to the written code.
- The benefits of using IoC would be:
  - easier transition between different implementations,
  - greater modularity of the program,
  - easier testing of the program by isolating its components.

Dependency Injection

Aspect Oriented Programming

```
public interface PriceMatrix {
    public BigDecimal lookupPrice(Item item);
}

public class CashRegisterImpl implements CashRegister {
    private PriceMatrix priceMatrix = new PriceMatrixImpl();

    public BigDecimal calculateTotalPrice(ShoppingCart cart) {
        BigDecimal total = new BigDecimal("0.0");
        for (Item item : cart.getItems()) {
            total.add(priceMatrix.lookupPrice(item));
        }
        return total;
    }
}
```

PROBLEMS

```
public class CashRegisterImpl implements CashRegister {
    private PriceMatrix priceMatrix = new PriceMatrixImpl();

    public BigDecimal calculateTotalPrice(ShoppingCart cart) {
        BigDecimal total = new BigDecimal("0.0");
        for (Item item : cart.getItems()) {
            total.add(priceMatrix.lookupPrice(item));
        }
        return total;
    }
}
```

Every instance of CashRegisterImpl has a separate instance of PriceMatrixImpl

- With heavy services (those that are remote or those that require connections to external resources such as databases) it is preferable to share a single instance across multiple clients

The CashRegisterImpl now has concrete knowledge of the implementation of PriceMatrix

- CashRegisterImpl has tightly coupled itself to the concrete implementation class

One of the most important tenets of writing unit tests is to divorce them from any environment requirements

The unit test itself should run without connecting to outside resources

DON'T ASK FOR THE RESOURCE; I'LL GIVE IT TO YOU

```
public class CashRegisterImpl implements CashRegister {
    private PriceMatrix priceMatrix = new PriceMatrixImpl();

    public BigDecimal calculateTotalPrice(ShoppingCart cart) {
        BigDecimal total = new BigDecimal("0.0");
        for (Item item : cart.getItems()) {
            total.add(priceMatrix.lookupPrice(item));
        }
        return total;
    }
}
```

```
public class CashRegisterImpl implements CashRegister {
    private PriceMatrix priceMatrix;

    public setPriceMatrix(PriceMatrix priceMatrix) {
       this.priceMatrix = priceMatrix;
    }

    public BigDecimal calculateTotalPrice(ShoppingCart cart) {
        BigDecimal total = new BigDecimal("0.0");
        for (Item item : cart.getItems()) {
            total.add(priceMatrix.lookupPrice(item));
        }
        return total;
    }
}
```

DEPENDENCY INJECTION

Dependency Injection is a technique to wire an application together without any participation by the code that requires the dependency.

The client usually exposes setter methods so that the framework may inject any needed dependencies.

By moving the dependency out of the client object, it is no longer solely owned by CashRegisterImpl, and can now easily be shared among all classes.

The client also becomes much more testable.

The client has no environment-specific code to tie it to a particular framework.

DEPENDENCY INJECTION

Index→Server→router→requestHandler

- it's time to actually write our router
- We could hard-wire this dependency into the server
- A better way is to to loosely couple server and router by injecting this dependency
- In our index file, we could have passed the *router* object into the server, and the server could have called this object's *route* function.

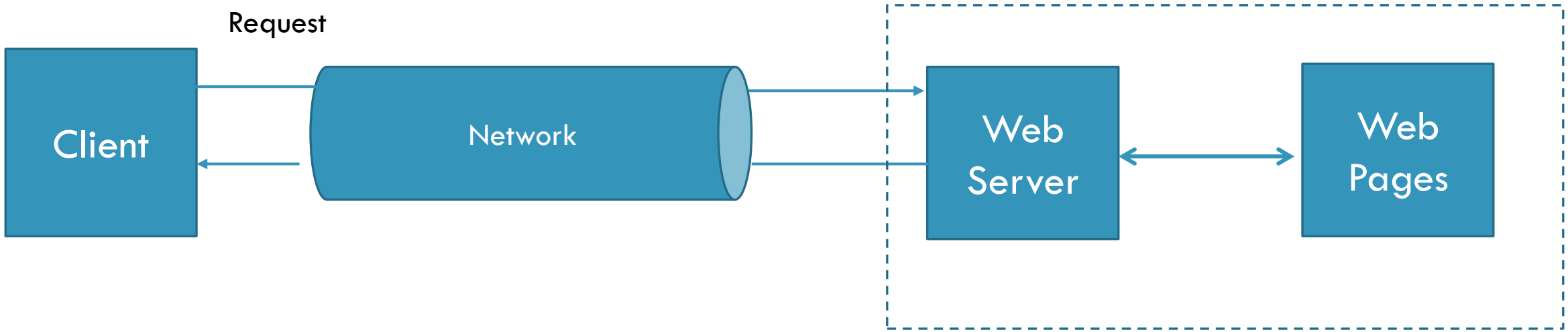
```
var server = require("./server");
var router = require("./router");

server.start(router.route);
```

Index→Server→router→requestHandler

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

```
app.get('/', (req, res) => {
  res.sendFile(path.join(__dirname, 'views/show1.html'));
});
```



PATH TO GET REQUEST

- User goes to `/` (ie. performs a **GET request** to `localhost:8000/`) => respond with **show.html**
- User goes to `/edit` (ie. performs a **GET request** to `localhost:8000/edit`) => respond with **edit.html**

```
const express = require('express');
const http = require('http');
const path = require('path');
const app = express();
const server = http.Server(app);

// Configuration

server.listen(process.env.PORT || 8000, () => {
  console.log(`[ server.js ] Listening on port ${server.address().port}`);
});

// Routes

app.get('/', (req, res) => {
  res.sendFile(path.join(__dirname, 'views/show.html'));
});

app.get('/edit', (req, res) => {
  res.sendFile(path.join(__dirname, 'views/edit.html'));
});
```