JONAS.IO
SCHMEDTMANN

Subscribe here

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

SLIDES FOR THEORY LECTURES

(DON'T SKIP THEM, THEY ARE SUPER IMPORTANT 🤓)

Follow me here

@JONASSCHMEDTMAN

📖 TABLE OF CONTENTS: THEORY LECTURES (CLICK THE TITLES)

SECTION 2 — INTRODUCTION TO NODE.JS

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

INTRODUCTION TO NODE.JS

LECTURE

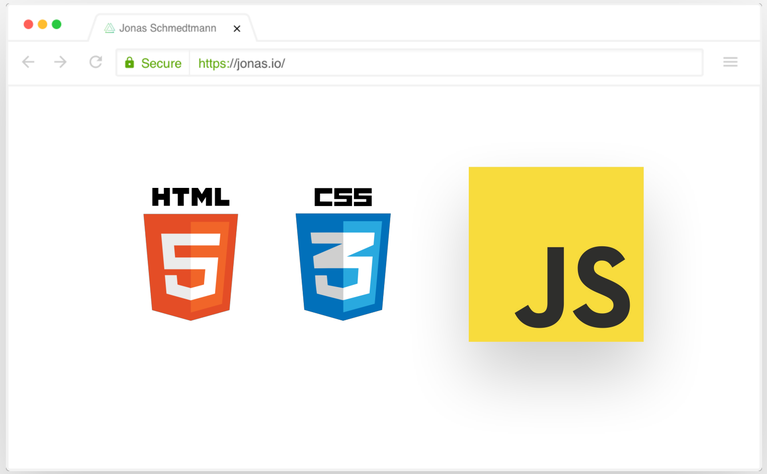
WHAT IS NODE.JS AND WHY USE IT?

WHAT IS NODE.JS?

NODE.JS

NODE.JS IS A JAVASCRIPT RUNTIME BUILT ON GOOGLE'S OPEN-SOURCE V8 JAVASCRIPT ENGINE. 🤔

NODE.JS: JAVASCRIPT OUTSIDE OF THE BROWSER



BROWSER

NODE.JS

JAVASCRIPT ON THE SERVER!

Perfect conditions for using Node.js as a web server

We can use JavaScript on the server-side of web development 😄

Build fast, highly scalable network applications (back-end)

WHY AND WHEN TO USE NODE.JS?

NODE.JS PROS

- Single-threaded, based on event driven, non-blocking I/O model 🤯😅
- Perfect for building **fast** and **scalable** data-intensive apps;
- Companies like NETFLIX UBER PayPal ebay have started using node in production;
- **JavaScript across the entire stack:** faster and more efficient development;
- **NPM:** huge library of open-source packages available for everyone for free;
- **Very active** developer community.

USE NODE.JS

- API with database behind it (preferably NoSQL);
- Data streaming (think YouTube);
- Real-time chat application;
- Server-side web application.

DON'T USE

- Applications with heavy server-side processing (CPU-intensive).

RAILS php

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

INTRODUCTION TO NODE.JS

LECTURE

BLOCKING AND NON-BLOCKING:
ASYNCHRONOUS NATURE OF NODE.JS

SYNCHRONOUS VS. ASYNCHRONOUS CODE (BLOCKING VS. NON-BLOCKING)

```
const fs = require('fs');

// Blocking code execution
const input = fs.readFileSync('input.txt', 'utf-8');
console.log(input);
```

SYNCHRONOUS

BLOCKING 👎

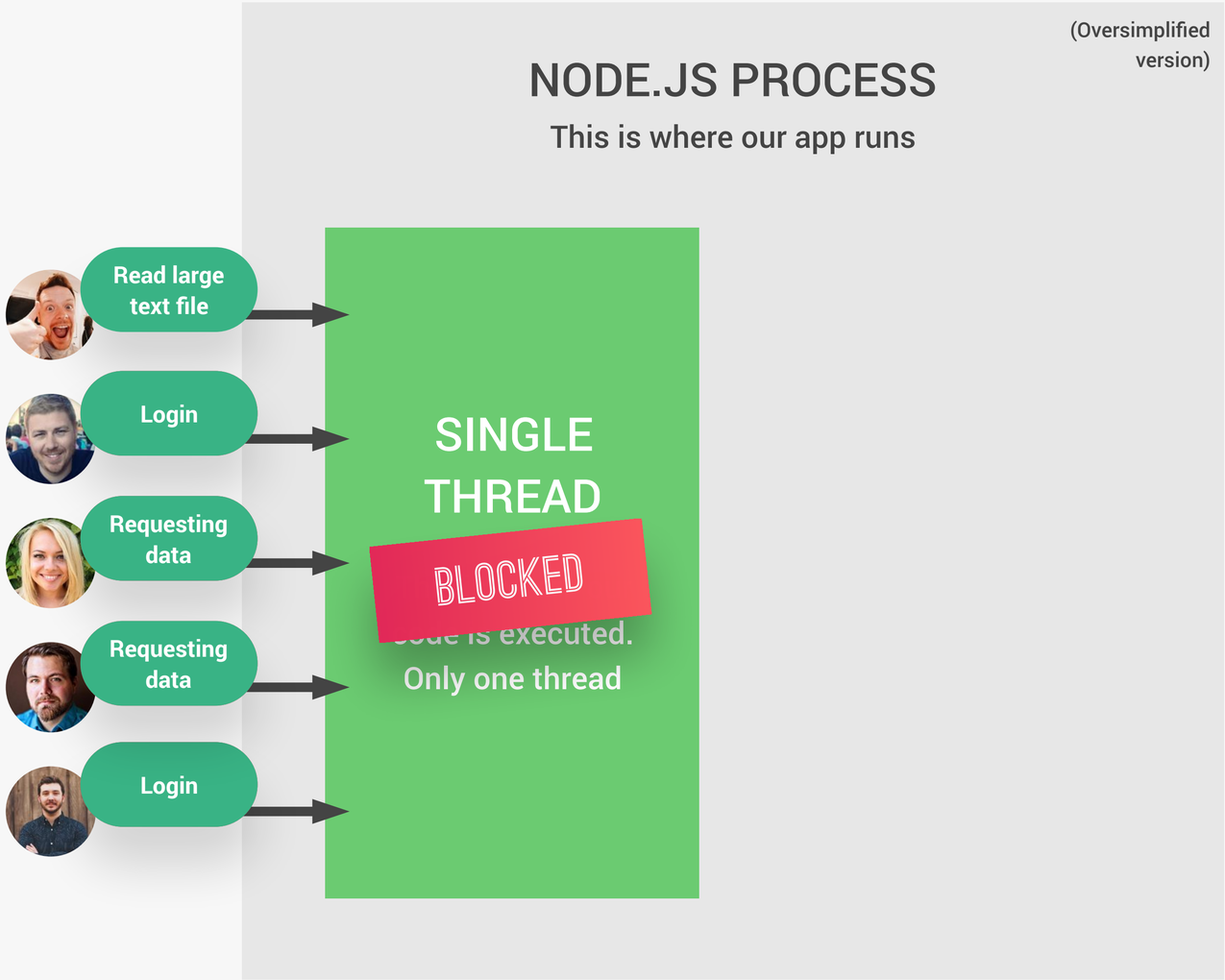
```
const fs = require('fs');

// Non-blocking code execution
fs.readFile('input.txt', 'utf-8', (err, data) => {
    console.log(data);
});
console.log('Reading file...');
```

ASYNCHRONOUS

NON-BLOCKING 👍

THE ASYNCHRONOUS NATURE OF NODE.JS: AN OVERVIEW



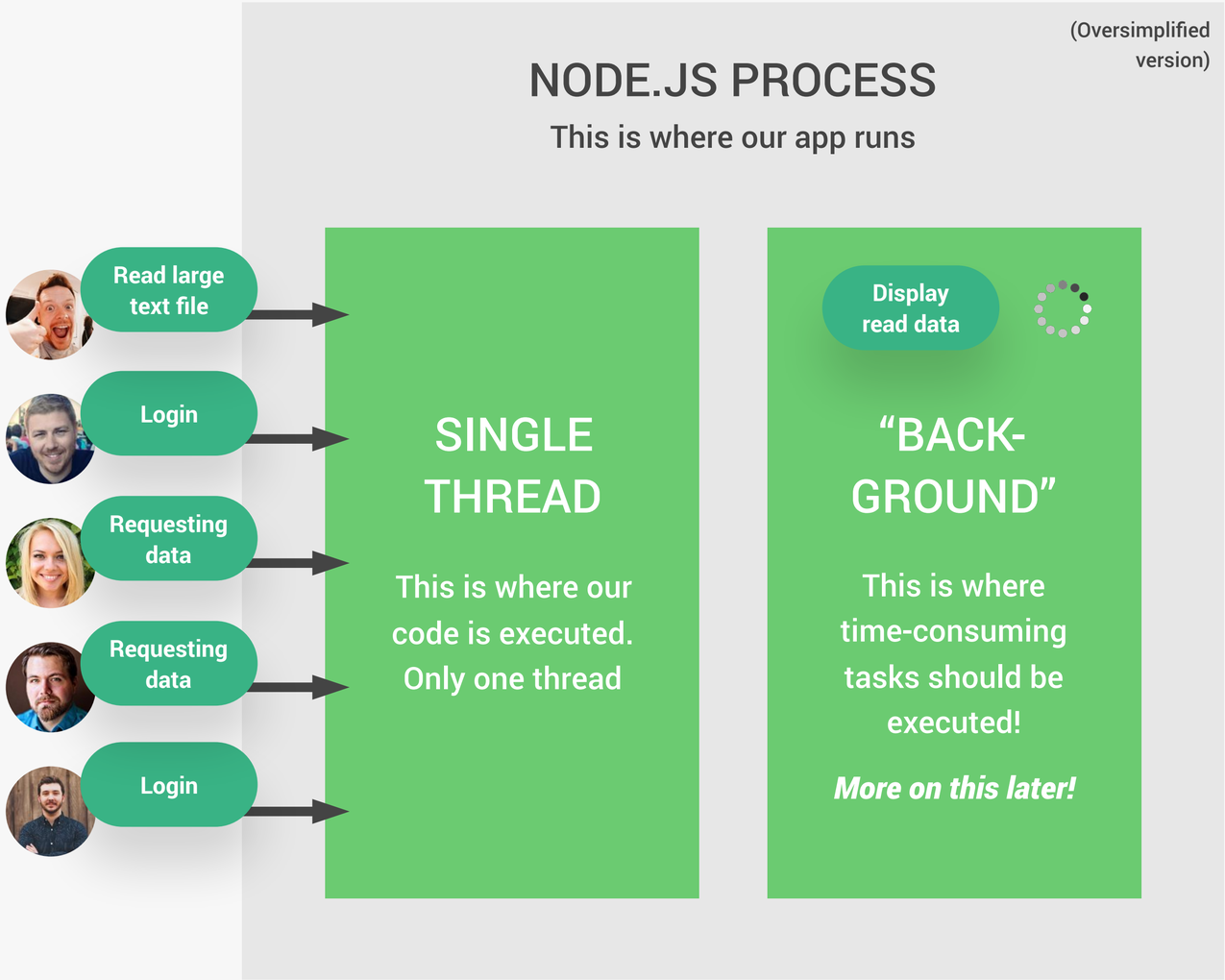
SYNCHRONOUS WAY

```
const fs = require('fs');

// Blocking code execution
const input = fs.readFileSync('input.txt', 'utf-8');
console.log(input);
```

👉 It's **YOUR** job as a developer to avoid this kind of situation!

THE ASYNCHRONOUS NATURE OF NODE.JS: AN OVERVIEW



ASYNCHRONOUS WAY

```
const fs = require('fs');

// Non-blocking code execution
fs.readFile('input.txt', 'utf-8', (err, data) => {
    console.log(data);
});
console.log('Reading file...');
```

👉 Non-blocking I/O model

👉 This is why we use so many callback functions in Node.js

👉 Callbacks ≠ Asynchronous

THE PROBLEM: CALLBACK HELL...

CALLBACK HELL

```
const fs = require('fs');

fs.readFile('start.txt', 'utf-8', (err, data1) => {
    fs.readFile(`${data1}.txt`, 'utf-8', (err, data2) => {
        fs.readFile('append.txt', 'utf-8', (err, data3) => {
            fs.writeFile('final.txt', `${data2} ${data3}`, 'utf-8', (err) => {
                if (err) throw err;
                console.log('Your file has been saved :D');
            });
        });
    });
});
```

👉 **SOLUTION:** Using Promises or Async/Await [Optional Section]

SECTION 3 — INTRODUCTION TO BACK-END WEB DEVELOPMENT

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

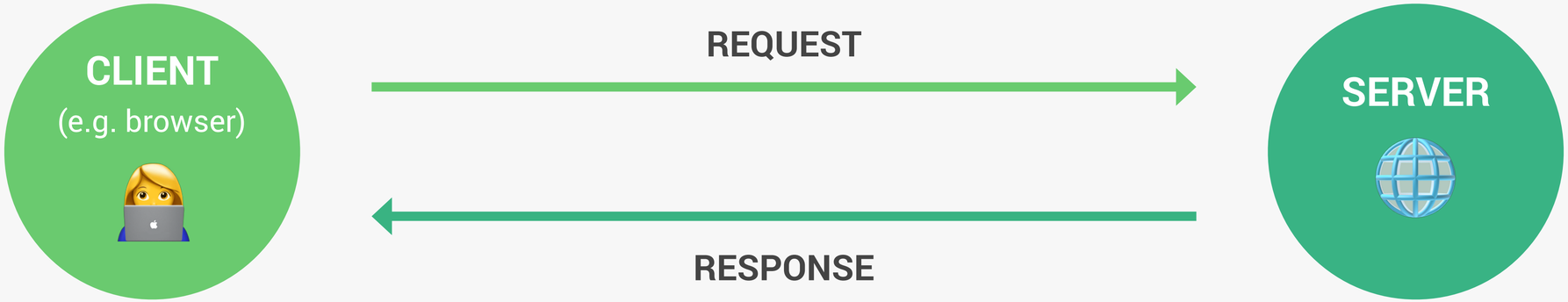
INTRODUCTION TO BACK-END WEB DEVELOPMENT

LECTURE

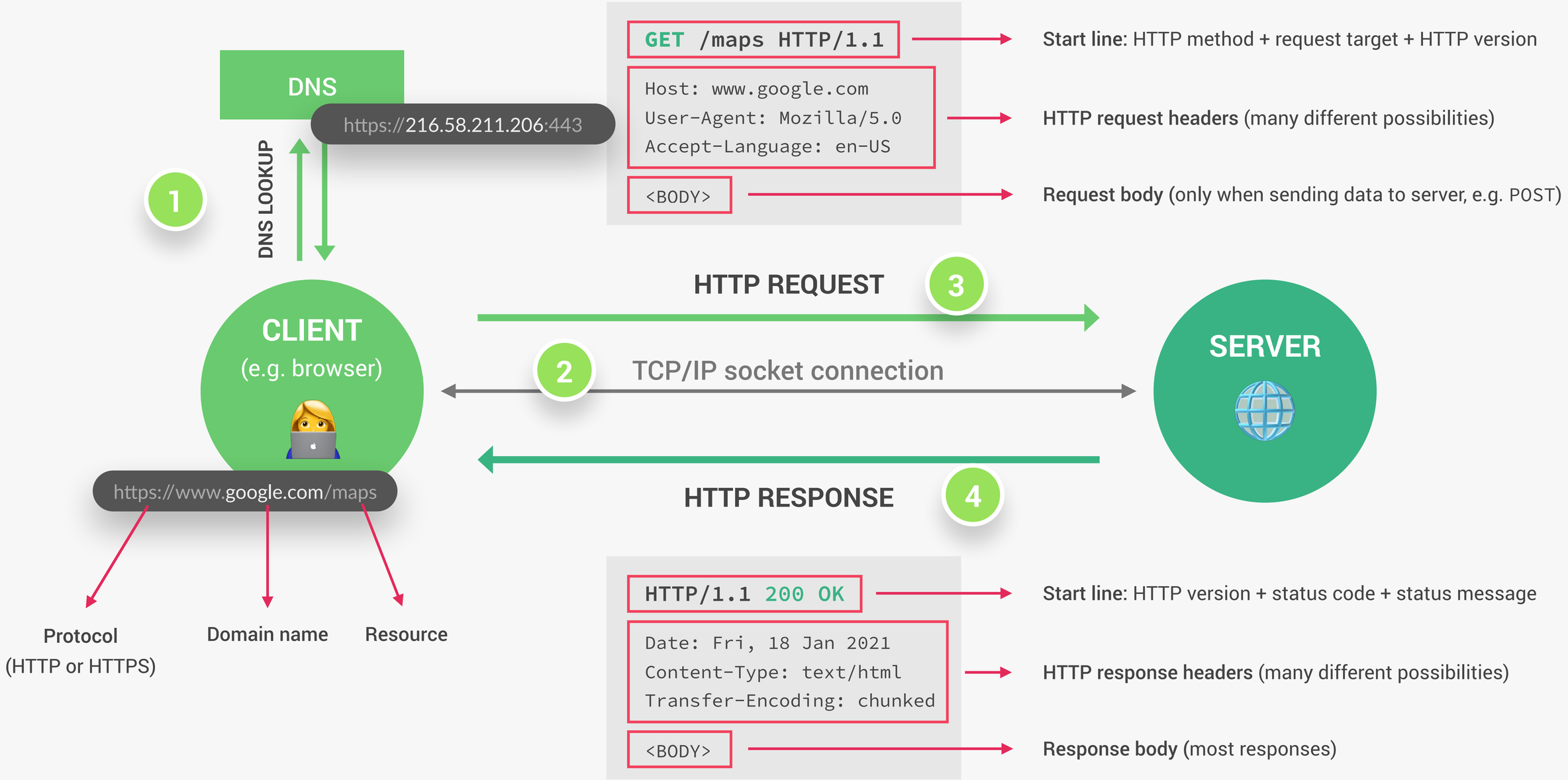
AN OVERVIEW OF HOW THE WEB WORKS

WHAT HAPPENS WHEN WE ACCESS A WEBPAGE

👉 **Request-response model** or **Client-server architecture**



WHAT HAPPENS WHEN WE ACCESS A WEBPAGE



WHAT HAPPENS WHEN WE ACCESS A WEBPAGE


```
GET /maps HTTP/1.1
```

Start line: HTTP method + request target + HTTP version

```
Host: www.google.com
User-Agent: Mozilla/5.0
Accept-Language: en-US
```

HTTP request headers (many different possibilities)

```
<BODY>
```

Request body (only when sending data to server, e.g. `POST`)

5

`index.html` is the first to be loaded

👇

Scanned for assets: JS, CSS, images

👇

Process is repeated for each file

```
HTTP/1.1 200 OK
```

Start line: HTTP version + status code + status message

```
Date: Fri, 18 Jan 2021
Content-Type: text/html
Transfer-Encoding: chunked
```

HTTP response headers (many different possibilities)

```
<BODY>
```

Response body (most responses)

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

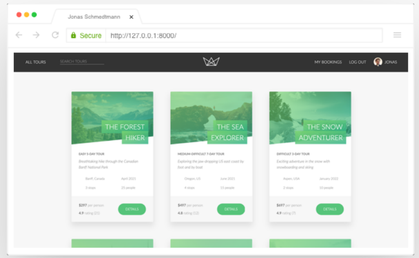
INTRODUCTION TO BACK-END WEB DEVELOPMENT

LECTURE

FRONT-END VS. BACK-END WEB DEVELOPMENT

FRONT-END AND BACK-END

FRONT-END



BROWSER

BACK-END

WEB SERVER

HTTP Server

App

Files

DATABASE

PostgreSQL

MySQL

php

FRONT-END STACK

HTML

CSS

JS

BACK-END STACK

node

mongoDB

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

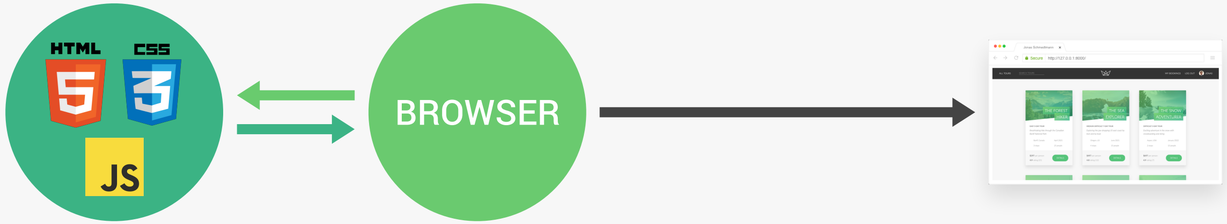
INTRODUCTION TO BACK-END WEB DEVELOPMENT

LECTURE

STATIC VS DYNAMIC VS API

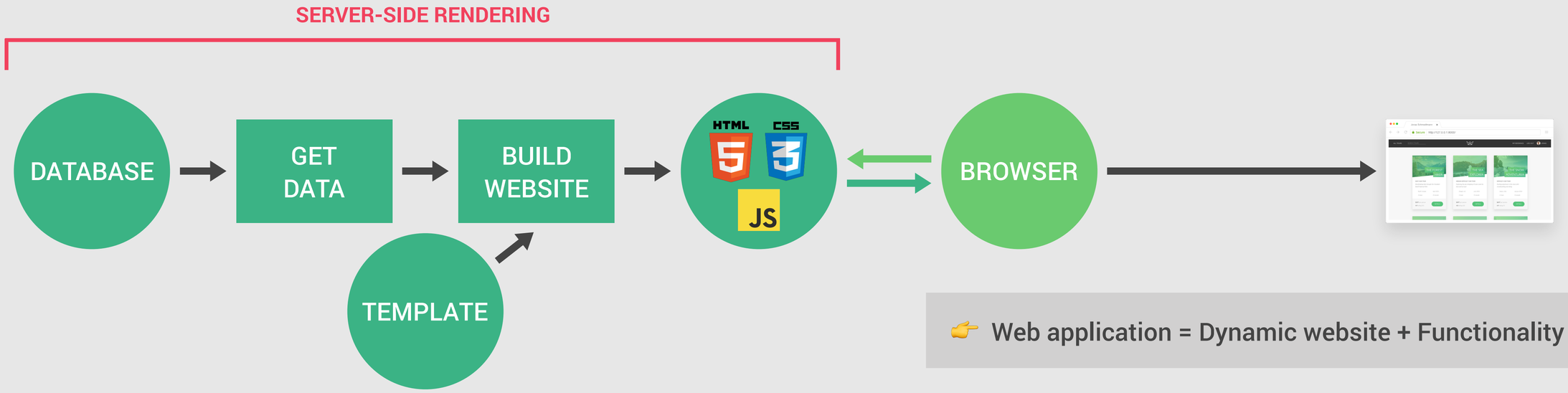
STATIC WEBSITES VS DYNAMIC WEBSITES

STATIC



👉 JavaScript ≠ Dynamic

DYNAMIC



👉 Web application = Dynamic website + Functionality

DYNAMIC WEBSITES VS API-POWERED WEBSITES

DYNAMIC

API

THIS COURSE 🚀😍

SERVER-SIDE RENDERED

CLIENT-SIDE RENDERED

DATABASE → GET DATA → BUILD WEBSITE (+ TEMPLATE) → HTML CSS JS → BROWSER

BUILDING API

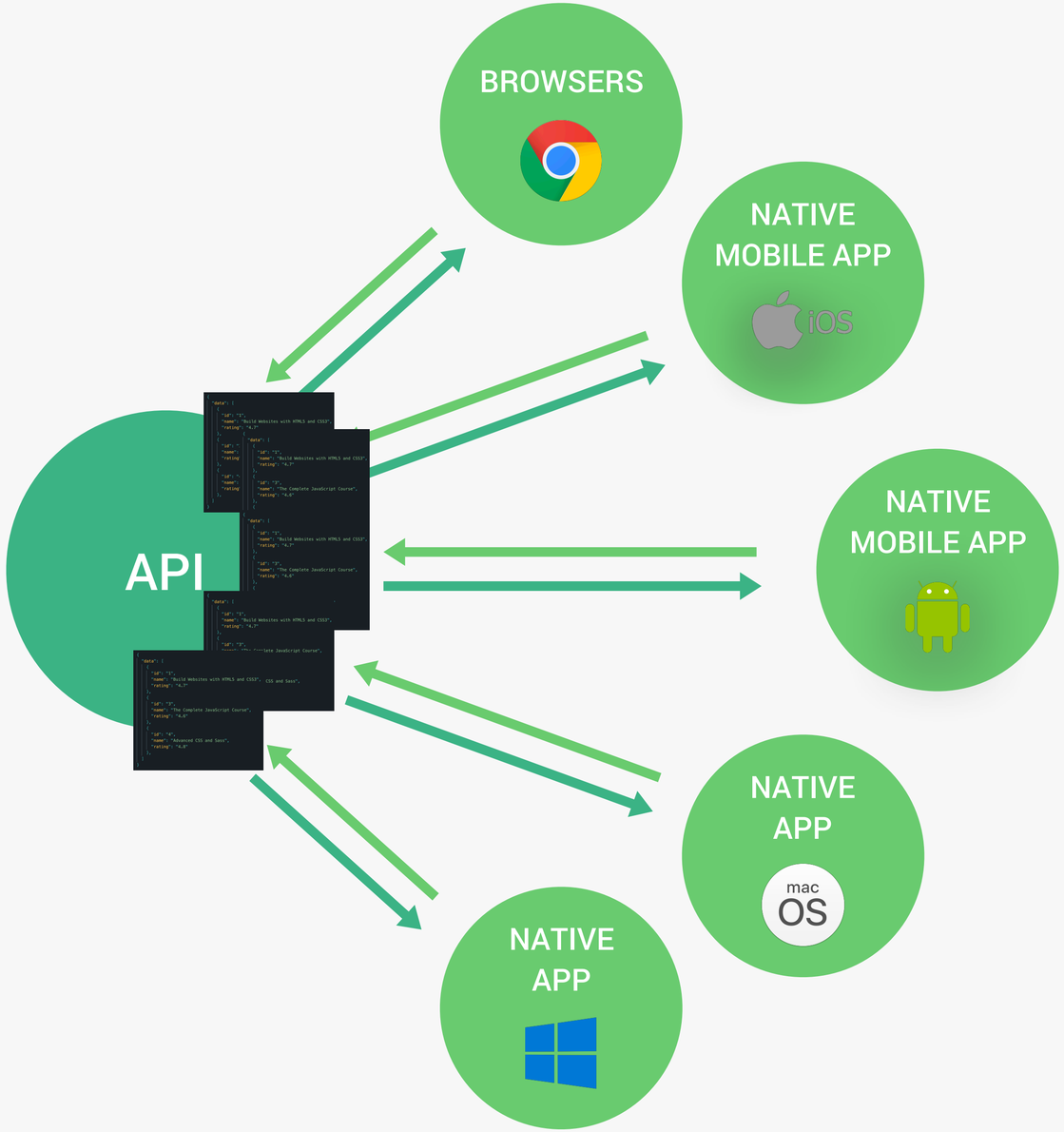
CONSUMING API

DATABASE → GET DATA → JSON → BROWSER → BUILD WEBSITE (+ TEMPLATE)

ONE API, MANY CONSUMERS

https://www.jonas.io/api/myCourseData


```
{
  "data": [
    {
      "id": "1",
      "name": "Build Websites with HTML5 and CSS3",
      "rating": "4.7"
    },
    {
      "id": "3",
      "name": "The Complete JavaScript Course",
      "rating": "4.6"
    },
    {
      "id": "4",
      "name": "Advanced CSS and Sass",
      "rating": "4.8"
    },
  ]
}
```

SECTION 4 — HOW NODE.JS WORKS: A LOOK BEHIND THE SCENES

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

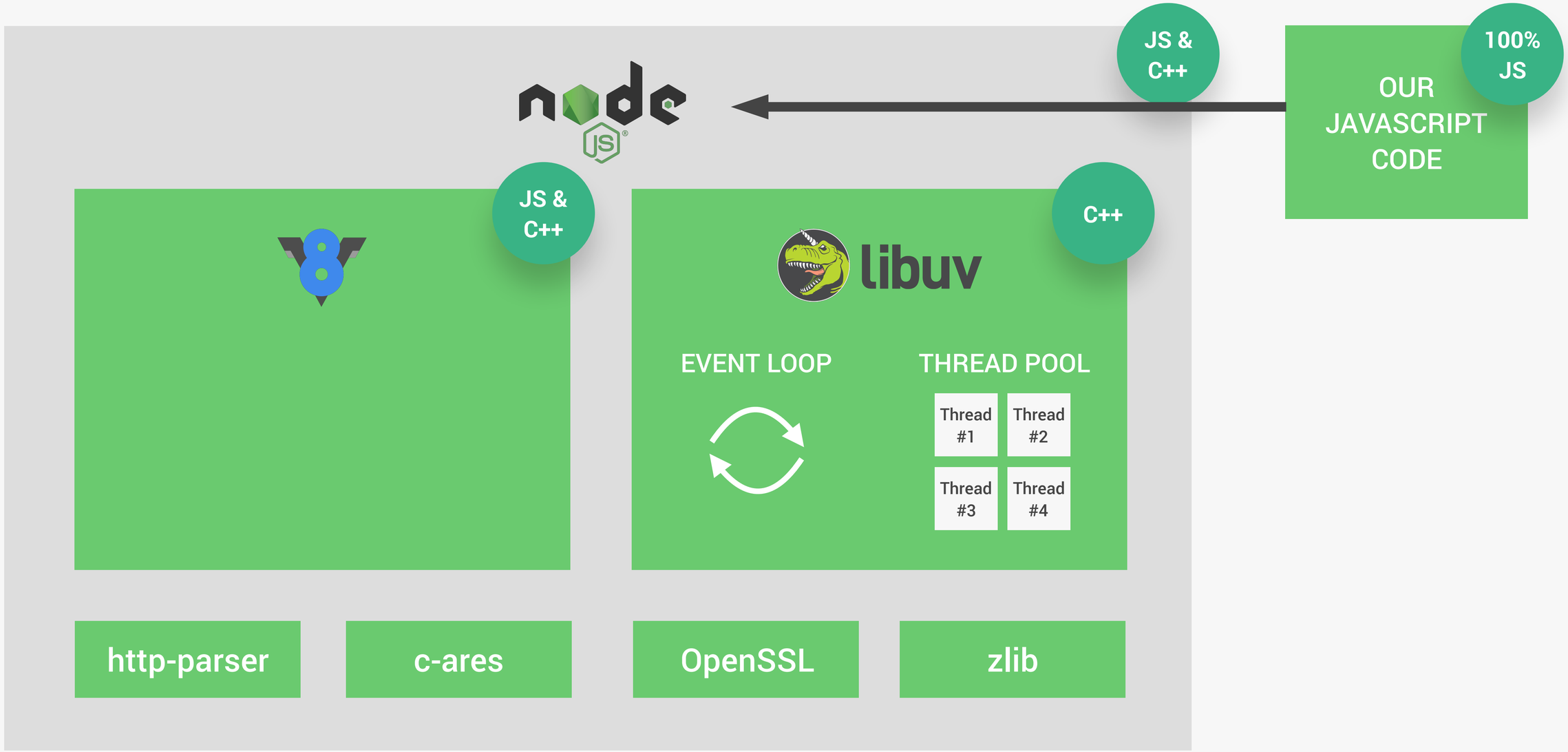
SECTION

HOW NODE.JS WORKS: A LOOK BEHIND THE SCENES

LECTURE

NODE, V8, LIBUV AND C++

THE NODE.JS ARCHITECTURE BEHIND THE SCENES



JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

HOW NODE.JS WORKS: A LOOK BEHIND THE SCENES

LECTURE

PROCESSES, THREADS AND THE THREAD POOL

NODE PROCESS AND THREADS

NODE.JS PROCESS (Instance of a program in execution on a computer)

SINGLE THREAD (Sequence of instructions)

Initialize program

↓

Execute “top-level” code

↓

Require modules

↓

Register event callbacks

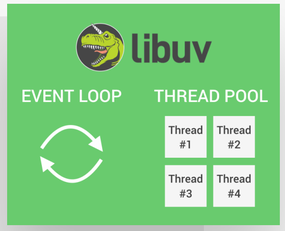
↓

START EVENT LOOP

OFFLOADING

THREAD POOL

Thread #1	Thread #2
Thread #3	Thread #4



THREAD POOL:

- 👉 Additional 4 threads (or more)
- 👉 Offload work from the event loop
- 👉 Handle heavy (“expensive”) tasks:
  - 👉 File system APIs
  - 👉 Cryptography
  - 👉 Compression
  - 👉 DNS lookups

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

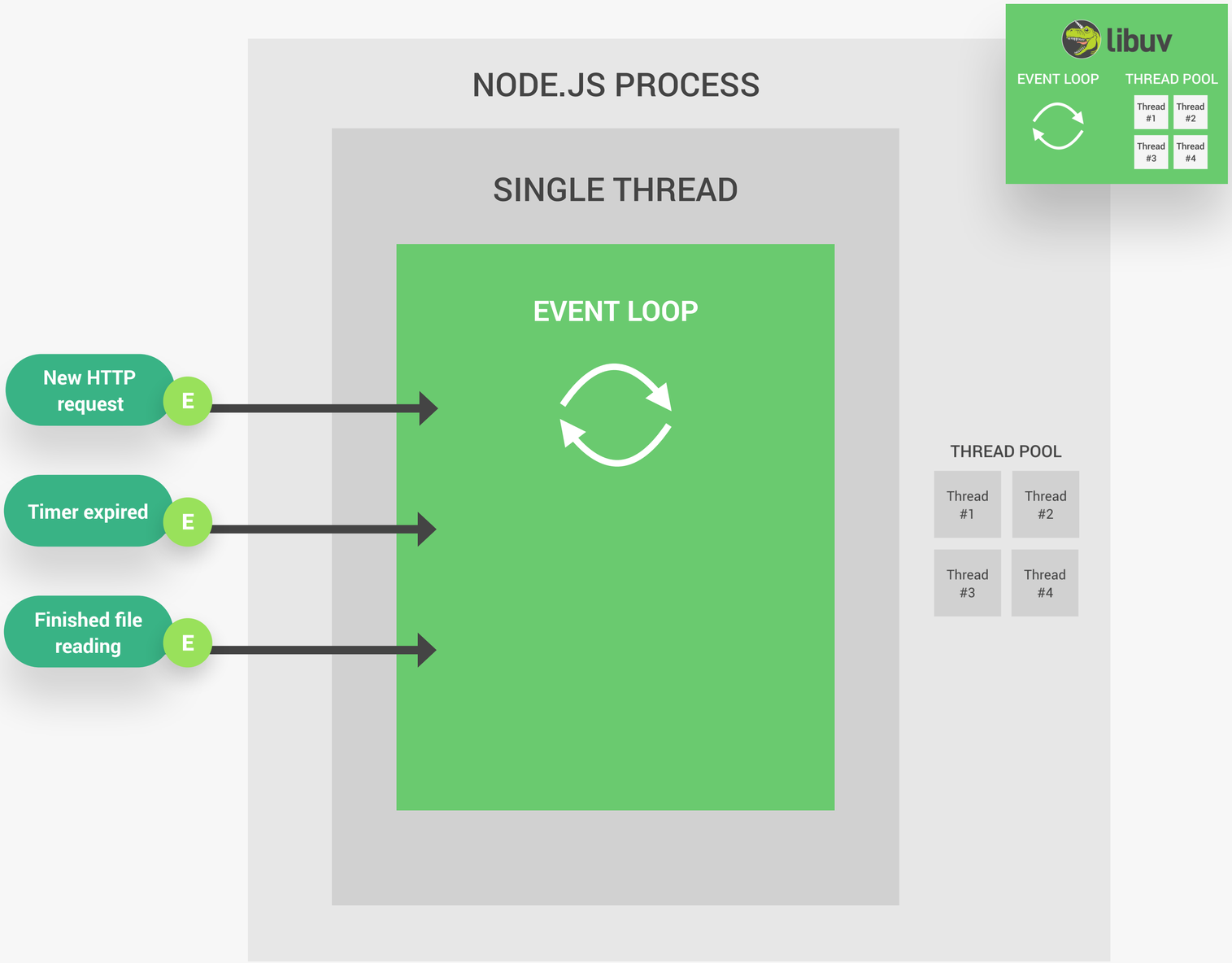
SECTION

HOW NODE.JS WORKS: A LOOK BEHIND THE SCENES

LECTURE

THE NODE.JS EVENT LOOP

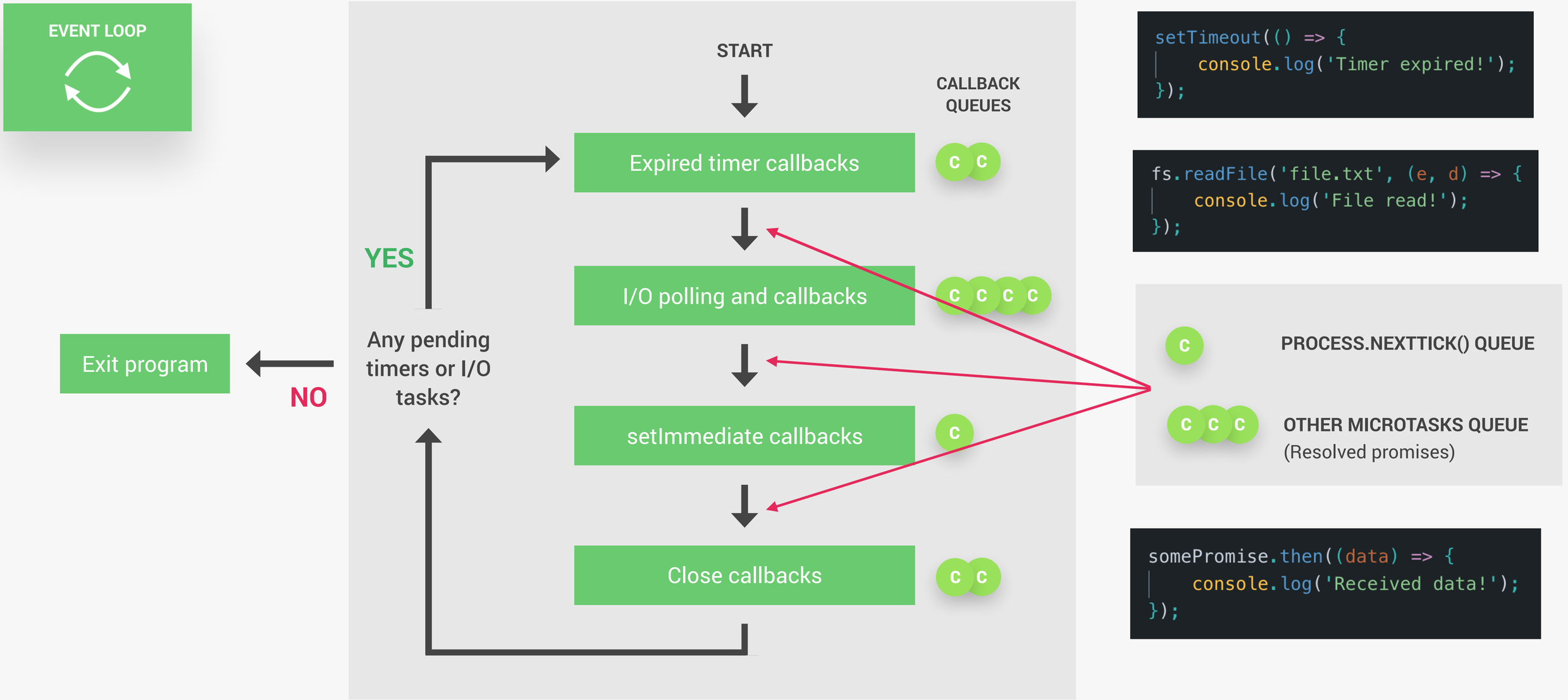
THE HEART OF NODE.JS: THE EVENT LOOP



EVENT LOOP:

- 👉 All the application code that is inside **callback functions** (non-top-top-level code)
- 👉 Node.js is build around callback functions
- 👉 Event-driven architecture:
  - 👉 Events are emitted
  - 👉 Event loops picks them up
  - 👉 Callbacks are called
- 👉 Event loop does **orchestration**

THE EVENT LOOP IN DETAIL

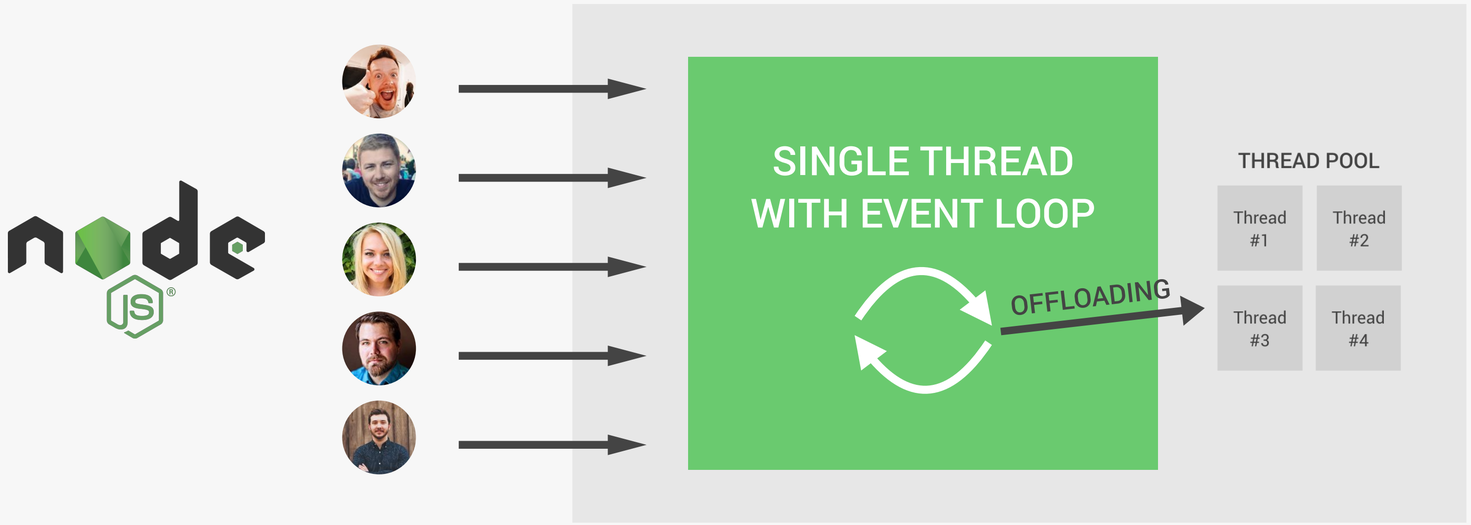


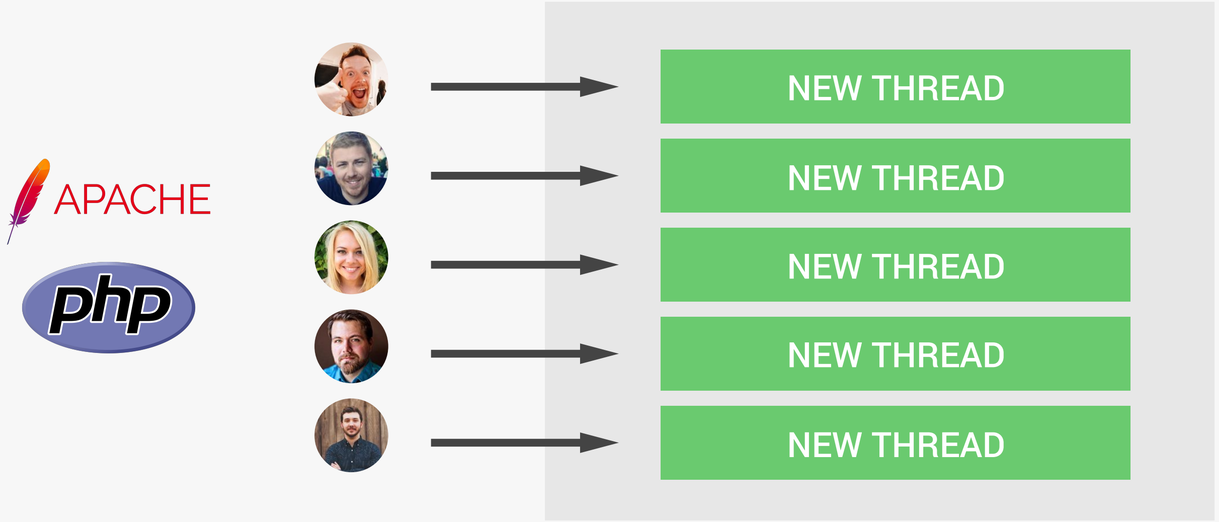

```
setTimeout(() => {
    console.log('Timer expired!');
});
```

```
fs.readFile('file.txt', (e, d) => {
    console.log('File read!');
});
```

```
somePromise.then((data) => {
    console.log('Received data!');
});
```

SUMMARY OF THE EVENT LOOP: NODE VS. OTHERS





DON'T BLOCK!

- 👉 Don’t use **sync** versions of functions in `fs`, `crypto` and `zlib` modules in your callback functions
- 👉 Don’t perform complex calculations (e.g. loops inside loops)
- 👉 Be careful with `JSON` in large objects
- 👉 Don’t use too complex regular expressions (e.g. nested quantifiers)

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

HOW NODE.JS WORKS: A LOOK BEHIND THE SCENES

LECTURE

EVENTS AND EVENT-DRIVEN ARCHITECTURE

THE EVENT-DRIVEN ARCHITECTURE

OBSERVER PATTERN

Event emitter → EMITS EVENTS → Event listener → CALLS → Attached callback function

EMITTER

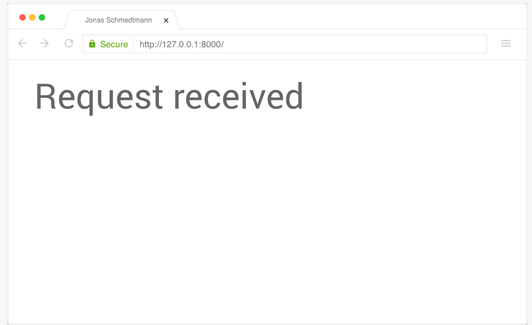
NEW REQUEST ON SERVER

127.0.0.1:8000

'request' event

LISTENER

```
const server = http.createServer();
server.on('request', (req, res) => {
    console.log('Request received');
    res.end('Request received');
});
```



👉 Instance of `EventEmitter` class

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

HOW NODE.JS WORKS: A LOOK BEHIND THE SCENES

LECTURE

INTRODUCTION TO STREAMS

WHAT ARE STREAMS?

STREAMS

Used to process (read and write) data piece by piece (chunks), without completing the whole read or write operation, and therefore without keeping all the data in memory.

NETFLIX YouTube

- 👉 Perfect for handling large volumes of data, for example videos;
- 👉 More efficient data processing in terms of memory (no need to keep all data in memory) and time (we don't have to wait until all the data is available).

NODE.JS STREAMS FUNDAMENTALS

👉 Streams are instances of the `EventEmitter` class!

	DESCRIPTION 👇	EXAMPLE 👇	IMPORTANT EVENTS 👇	IMPORTANT FUNCTIONS 👇
READABLE STREAMS	Streams from which we can read (consume) data	👉 `http` requests 👉 `fs` read streams	👉 `data` 👉 `end`	👉 `pipe()` 👉 `read()`
WRITABLE STREAMS	Streams to which we can write data	👉 `http` responses 👉 `fs` write streams	👉 `drain` 👉 `finish`	👉 `write()` 👉 `end()`
DUPLEX STREAMS	Streams that are both readable and writable	👉 `net` web socket	CONSUME STREAMS	
TRANSFORM STREAMS	Duplex streams that transform data as it is written or read	👉 `zlib` Gzip creation		

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

HOW NODE.JS WORKS: A LOOK BEHIND THE SCENES

LECTURE

HOW REQUIRING MODULES REALLY WORKS

THE COMMONJS MODULE SYSTEM

- 👉 Each JavaScript file is treated as a separate module;
- 👉 Node.js uses the **CommonJS module system**: `require()`, `exports` or `module.exports`;
- 👉 **ES module system** is used in browsers: `import`/`export`;
- 👉 There have been attempts to bring ES modules to node.js (`.mjs`).

```
require('test-module');
```

Where does it come from?

WHAT HAPPENS WHEN WE REQUIRE() A MODULE

```
require('test-module');
```

RESOLVING & LOADING → WRAPPING → EXECUTION → RETURNING EXPORTS → CACHING

👉 **Core modules**

```
require('http');
```

👉 **Developer modules**

```
require('./lib/controller');
```

👉 **3rd-party modules (from NPM)**

```
require('express');
```

PATH RESOLVING: HOW NODE DECIDES WHICH MODULE TO LOAD

1. Start with **core modules**;
2. If begins with ‘`./`‘ or ‘`../`‘ 👉 Try to **load developer module**;
3. If no file found 👉 Try to **find folder** with `index.js` in it;
4. Else 👉 Go to **`node_modules/`** and try to find module there.

WHAT HAPPENS WHEN WE REQUIRE() A MODULE

```
require('test-module');
```

Where does it come from?

```
(function (exports, require, module, __filename, __dirname) {
    // Module code lives here...
});
```

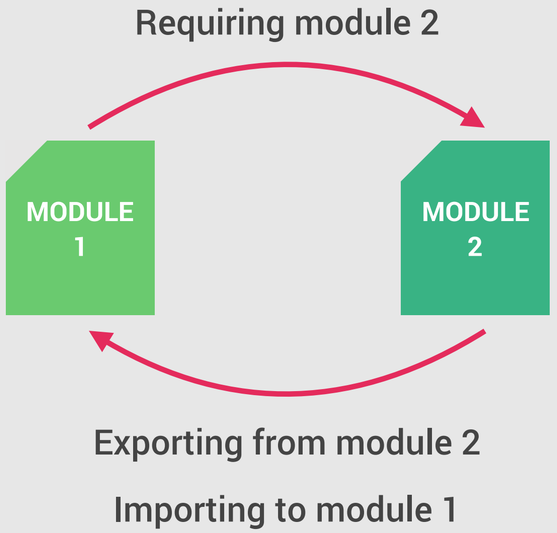
- 👉 **`require`**: function to require modules;
- 👉 **`module`:** reference to the current module;
- 👉 **`exports`**: a reference to `module.exports`, used to export object from a module;
- 👉 **`__filename`**: absolute path of the current module's file;
- 👉 **`__dirname`**: directory name of the current module.

WHAT HAPPENS WHEN WE REQUIRE() A MODULE

```
require('test-module');
```

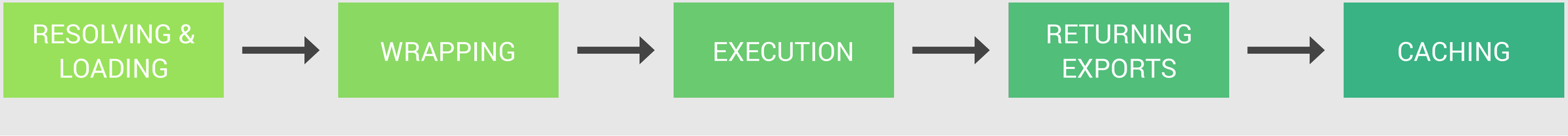
RESOLVING & LOADING → WRAPPING → EXECUTION → RETURNING EXPORTS → CACHING

- 👉 `require` function returns **exports** of the required module;
- 👉 `module.exports` is the returned object (important!);
- 👉 Use `module.exports` to export one single variable, e.g. one class or one function (`module.exports = Calculator`);
- 👉 Use `exports` to export multiple named variables (`exports.add = (a, b) => a + b`);
- 👉 This is how we import data from one module into another;



WHAT HAPPENS WHEN WE REQUIRE() A MODULE

```
require('test-module');
```



SECTION 6 — EXPRESS: LET'S START BUILDING THE NATOURS API!

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

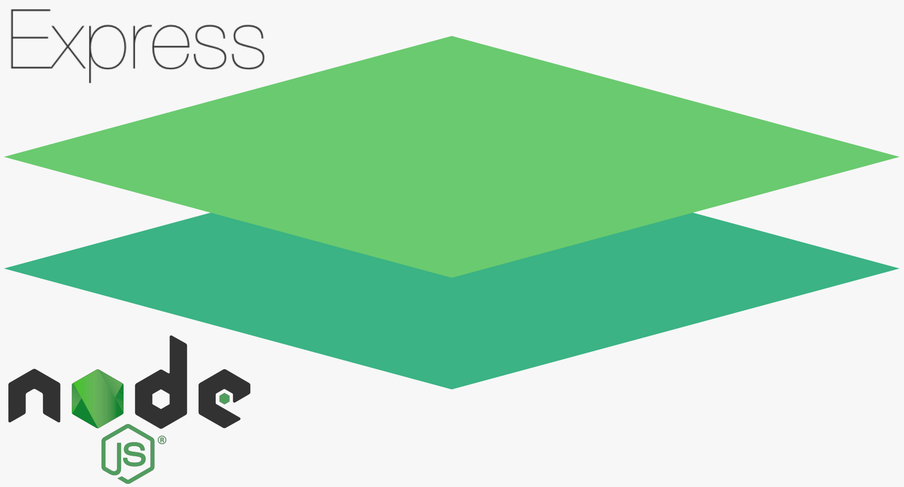
SECTION

EXPRESS: LET'S START BUILDING THE NATOURS API!

LECTURE

WHAT IS EXPRESS?

WHAT IS EXPRESS, AND WHY USE IT?



- 👉 Express is a minimal node.js framework, a higher level of abstraction;
- 👉 Express contains a very robust set of features: **complex routing**, **easier handling of requests and responses**, **middleware**, **server-side rendering**, etc.;
- 👉 Express allows for rapid development of node.js applications: *we don't have to re-invent the wheel*;
- 👉 Express makes it easier to organize our application into the MVC architecture.

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

EXPRESS: LET'S START BUILDING THE NATOURS API!

LECTURE

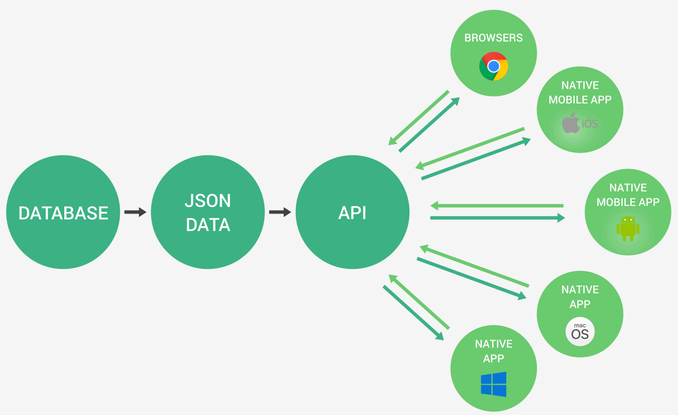
APIS AND RESTFUL API DESIGN

WHAT IS AN API ANYWAY?

API

Application **P**rogramming **I**nterface: a piece of software that can be used by another piece of software, in order to allow applications to talk to each other.

👉 Web APIs



👉 But, “Application” can be other things:

- 👉 Node.js’ `fs` or `http` APIs (“node APIs”);
- 👉 Browser’s DOM JavaScript API;
- 👉 With object-oriented programming, when exposing methods to the public, we’re creating an API;
- 👉 ...

THE REST ARCHITECTURE

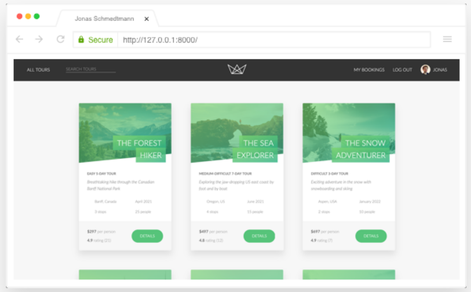
1. Separate API into logical **resources**
2. Expose structured, **resource-based URLs**
3. Use **HTTP methods** (verbs)
4. Send data as **JSON** (usually)
5. Be **stateless**

THE REST ARCHITECTURE

1. Separate API into logical **resources**
2. Expose structured, **resource-based URLs**
3. Use **HTTP methods** (verbs)
4. Send data as **JSON** (usually)
5. Be **stateless**

👉 **Resource:** Object or representation of something, which has data associated to it. Any information that can be **named** can be a resource.

`tours` `users` `reviews`



URL

`https://www.natours.com/addNewTour`

ENDPOINT

`/getTour`

`/updat`

BAD 👎

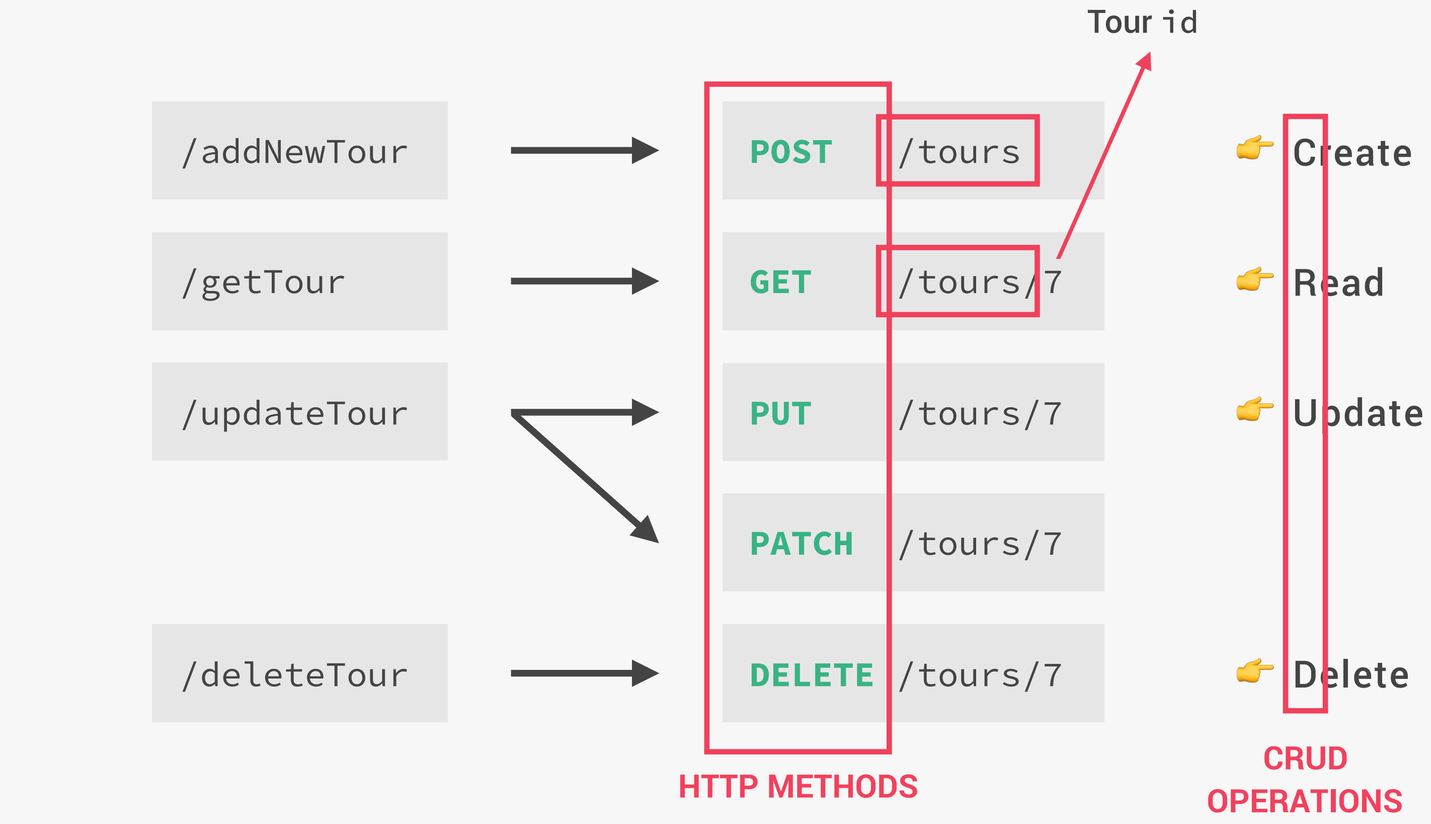
`/getToursByUser`

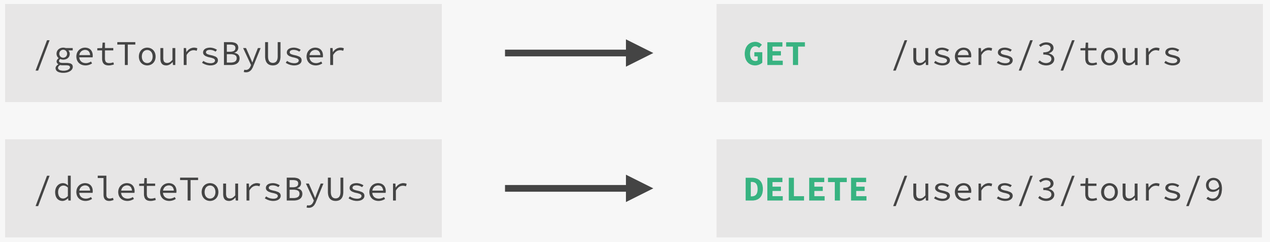
`/deleteToursByUser`

👉 Endpoints should contain **only resources** (nouns), and use **HTTP methods** for actions!

THE REST ARCHITECTURE

1. Separate API into logical **resources**
2. Expose structured, **resource-based URLs**
3. Use **HTTP methods** (verbs)
4. Send data as **JSON** (usually)
5. Be **stateless**





👉 Possibilities are endless!

THE REST ARCHITECTURE

1. Separate API into logical **resources**
2. Expose structured, **resource-based URLs**
3. Use **HTTP methods** (verbs)
4. Send data as **JSON** (usually)
5. Be **stateless**

RESPONSE FORMATTING

👉 **JSend**

👉 **JSON:API**

👉 **OData JSON Protocol**

👉 **...**

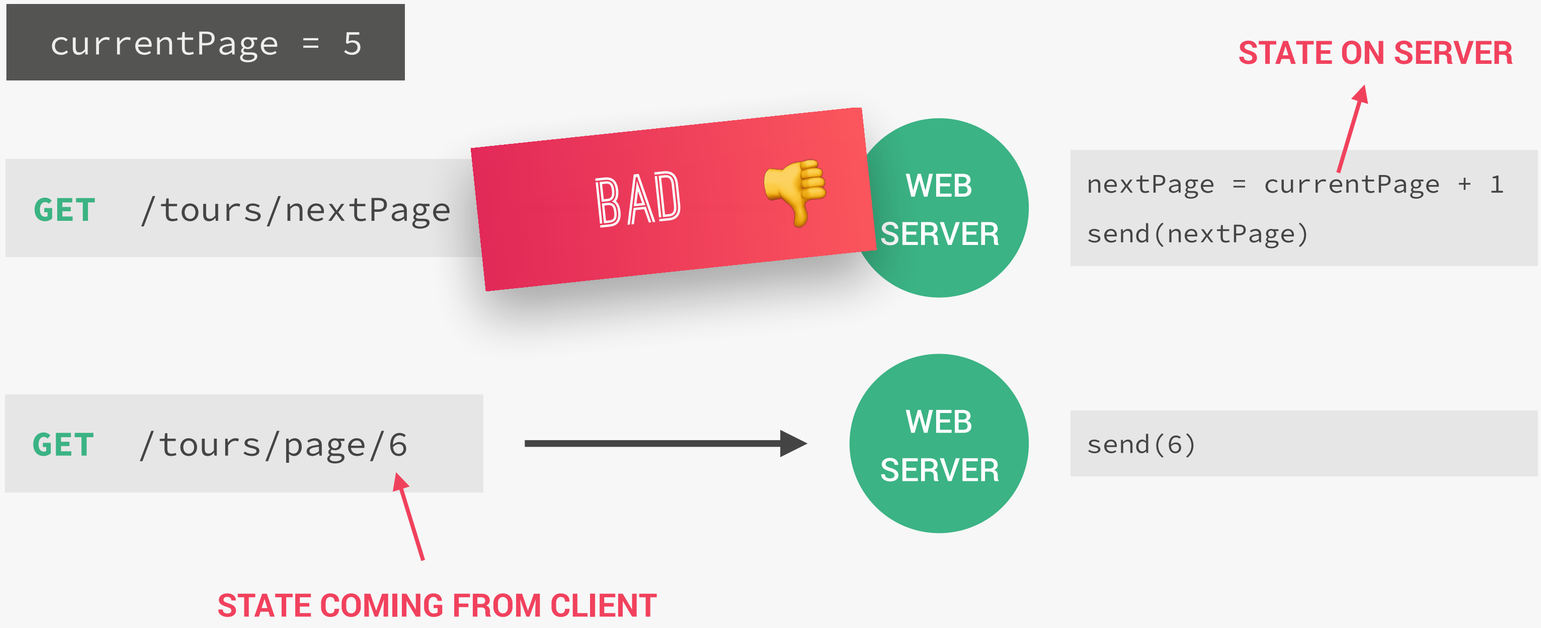
https://www.natours.com/tours/5

THE REST ARCHITECTURE

1. Separate API into logical **resources**
2. Expose structured, **resource-based URLs**
3. Use **HTTP methods** (verbs)
4. Send data as **JSON** (usually)
5. Be **stateless**

👉 **Stateless RESTful API:** All state is handled **on the client**. This means that each request must contain **all** the information necessary to process a certain request. The server should **not** have to remember previous requests.

👉 **Examples of state:** `loggedIn` `currentPage`



JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

EXPRESS: LET'S START BUILDING THE NATOURS API!

LECTURE

MIDDLEWARE AND THE REQUEST-RESPONSE CYCLE

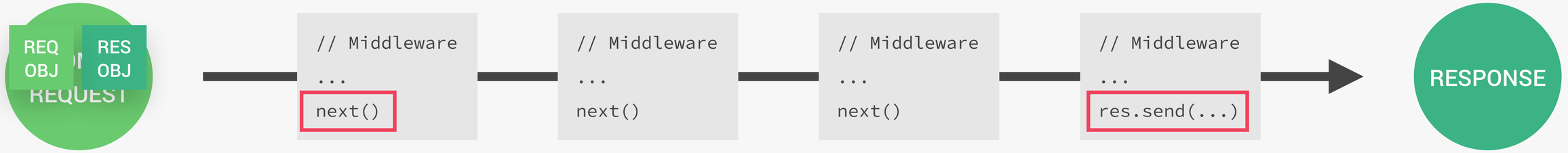
THE ESSENCE OF EXPRESS DEVELOPMENT: THE REQUEST-RESPONSE CYCLE

👉 *"Everything is middleware" (even routers)*

👉 *"Pipeline"*

👉 **Order as defined in the code!**

MIDDLEWARE STACK



👉 **E.g:** parsing body

👉 **E.g:** logging

👉 **E.g:** setting headers

👉 **E.g:** router

REQUEST-RESPONSE CYCLE

SECTION 7 — INTRODUCTION TO MONGODB

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

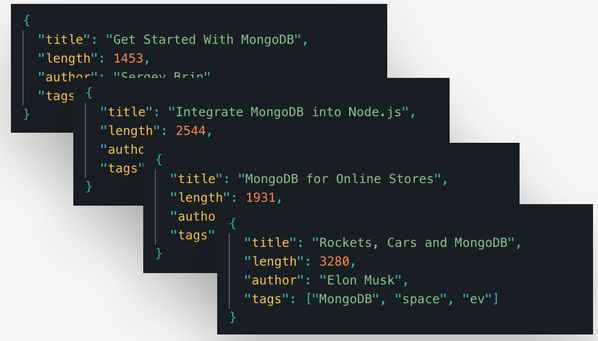
SECTION

INTRODUCTION TO MONGODB

LECTURE

WHAT IS MONGODB?

MONGODB: AN OVERVIEW



DATABASE

COLLECTIONS

(“Tables”)

DOCUMENTS

(“Rows”)

👉 **NoSQL**

`blog`	`post`
`users`	`user`
`reviews`	`review`

WHAT IS MONGODB?

MONGODB

"MongoDB is a document database with the scalability and flexibility that you want with the querying and indexing that you need"

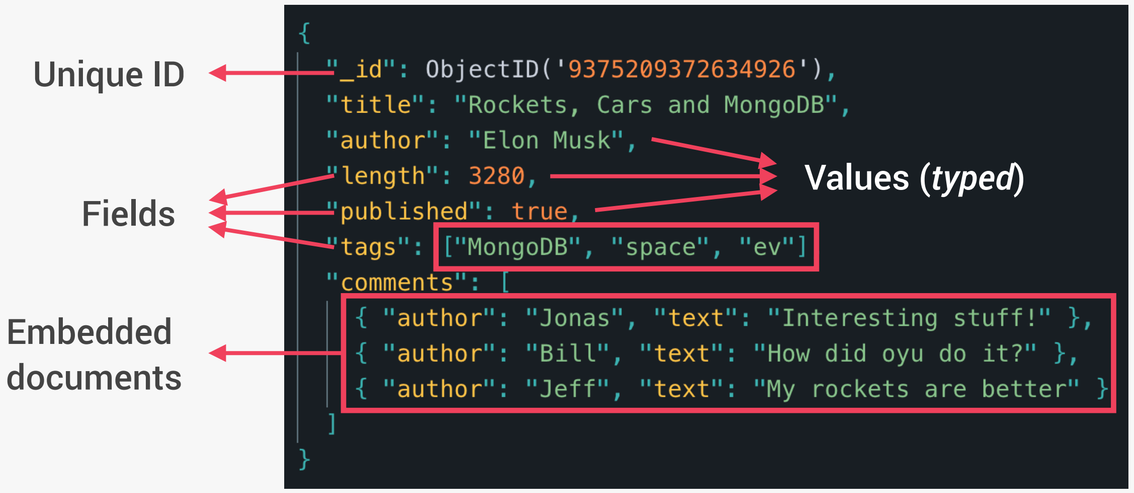
KEY MONGODB FEATURES:

- 👉 **Document based:** MongoDB stores data in documents (field-value pair data structures, NoSQL);
- 👉 **Scalable:** Very easy to distribute data across multiple machines as your users and amount of data grows;
- 👉 **Flexible:** No document data schema required, so each document can have different number and type of fields;
- 👉 **Performant:** Embedded data models, indexing, sharding, flexible documents, native duplication, etc.
- 👉 Free and open-source, published under the SSPL License.

DOCUMENTS, BSON AND EMBEDDING

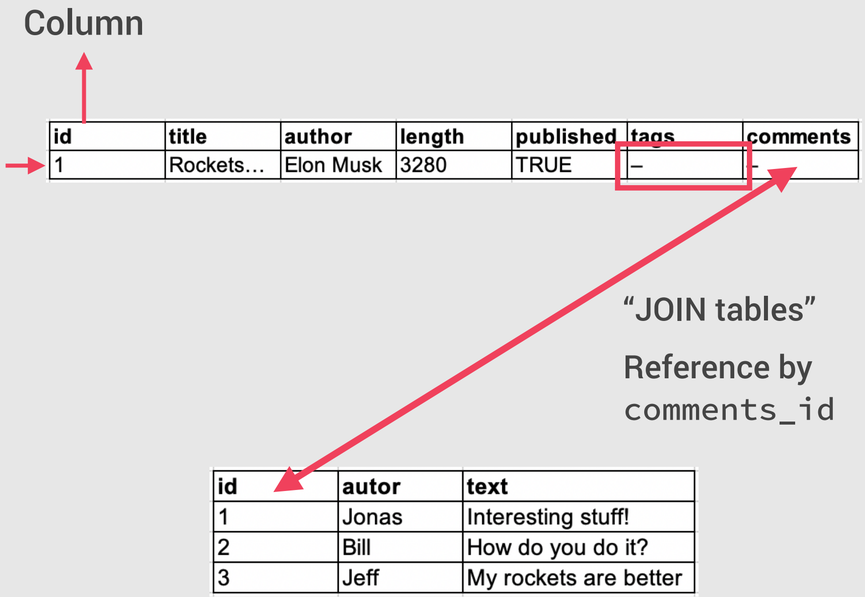
DOCUMENT STRUCTURE

👉 **BSON:** Data format MongoDB uses for data storage. Like JSON, **but typed**. So MongoDB documents are typed.



👉 **Embedding/Denormalizing:** Including related data into a single document. This allows for quicker access and easier data models (it's not always the best solution though).

RELATIONAL DATABASE



👉 **Data is always normalized**

SECTION 8 — USING MONGODB WITH MONGOOSE

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

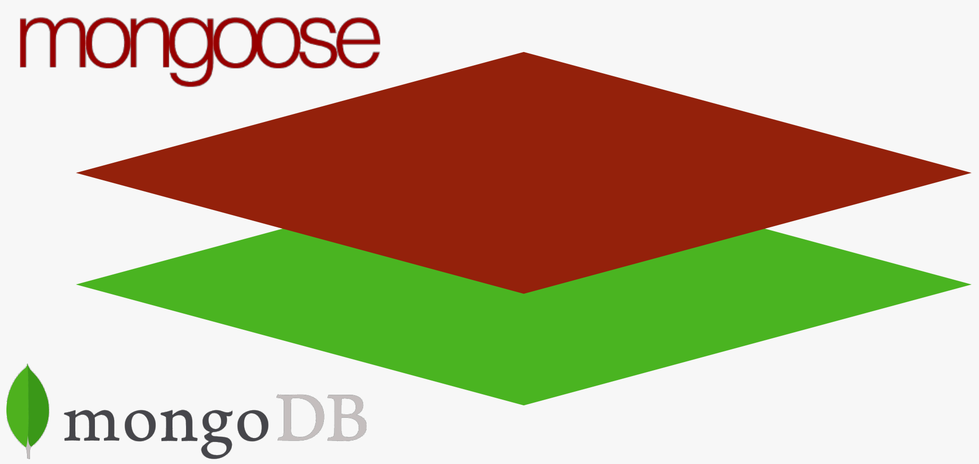
SECTION

USING MONGODB WITH MONGOOSE

LECTURE

WHAT IS MONGOOSE?

WHAT IS MONGOOSE, AND WHY USE IT?



- Mongoose is an Object Data Modeling (ODM) library for MongoDB and Node.js, a higher level of abstraction;
- Mongoose allows for rapid and simple development of mongoDB database interactions;
- Features: schemas to model data and relationships, easy data validation, simple query API, middleware, etc;
- **Mongoose schema:** where we model our data, by describing the structure of the data, default values, and validation;
- **Mongoose model:** a wrapper for the schema, providing an interface to the database for CRUD operations.

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

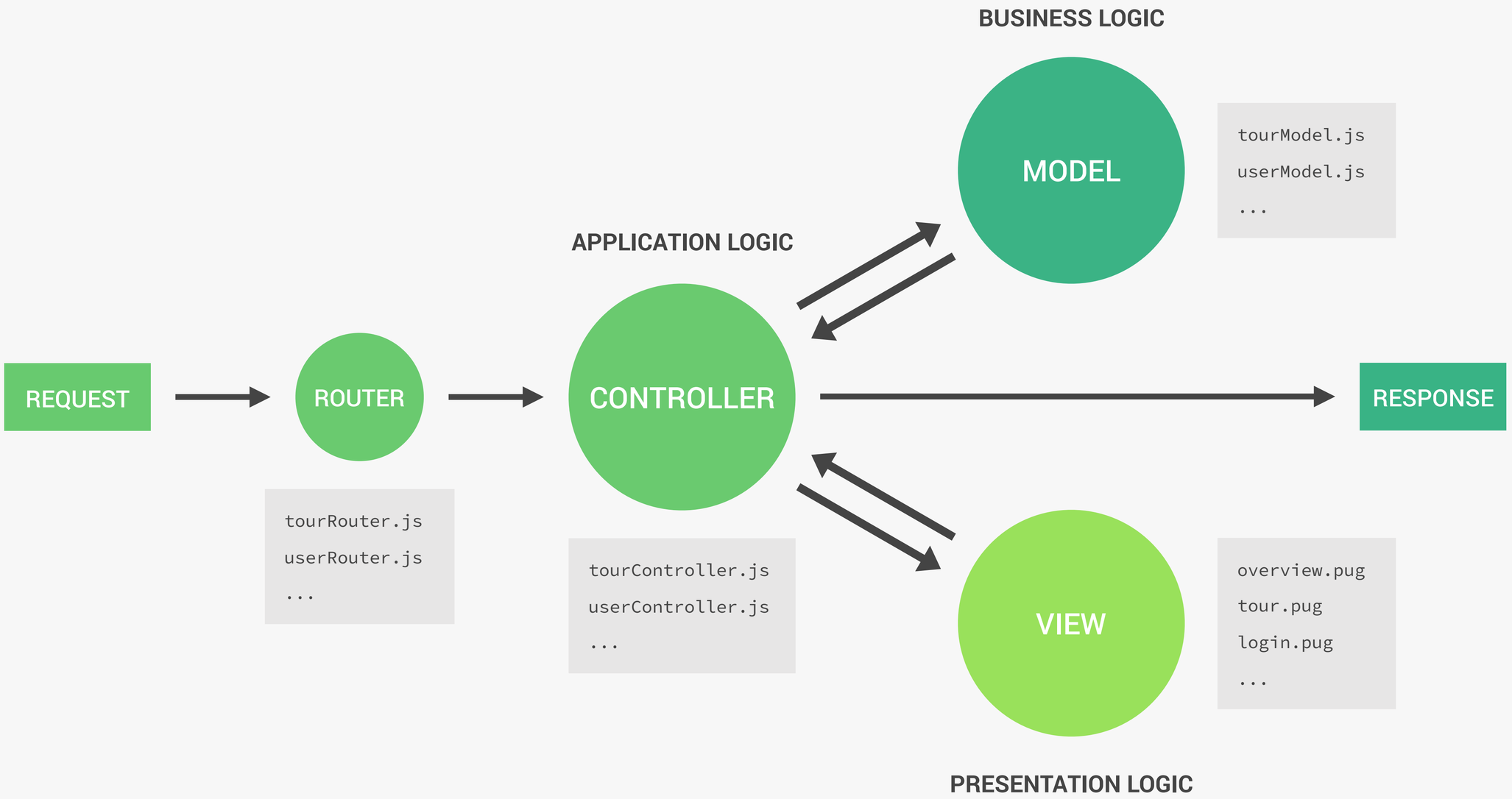
SECTION

USING MONGODB WITH MONGOOSE

LECTURE

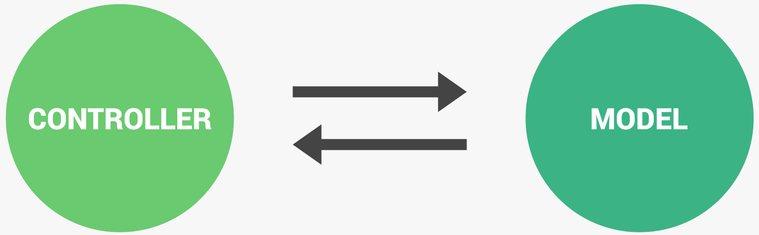
INTRO TO BACK-END ARCHITECTURE: MVC, TYPES OF LOGIC, AND MORE

MVC ARCHITECTURE IN OUR EXPRESS APP



APPLICATION VS. BUSINESS LOGIC

APPLICATION LOGIC



BUSINESS LOGIC

- 👉 Code that is only concerned about the application's implementation, not the underlying business problem we're trying to solve (e.g. showing and selling tours);
- 👉 Concerned about managing requests and responses;
- 👉 About the app's more technical aspects;
- 👉 Bridge between model and view layers.

- 👉 Code that actually solves the business problem we set out to solve;
- 👉 Directly related to business rules, how the business works, and business needs;
- 👉 Examples:
  - 👉 Creating new tours in the database;
  - 👉 Checking if user's password is correct;
  - 👉 Validating user input data;
  - 👉 Ensuring only users who bought a tour can review it.

👉 **Fat models/thin controllers:** offload as much logic as possible into the models, and keep the controllers as simple and lean as possible.

SECTION 9 — ERROR HANDLING WITH EXPRESS

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

ERROR HANDLING WITH EXPRESS

LECTURE

AN OVERVIEW OF ERROR HANDLING

ERROR HANDLING IN EXPRESS: AN OVERVIEW

OPERATIONAL ERRORS

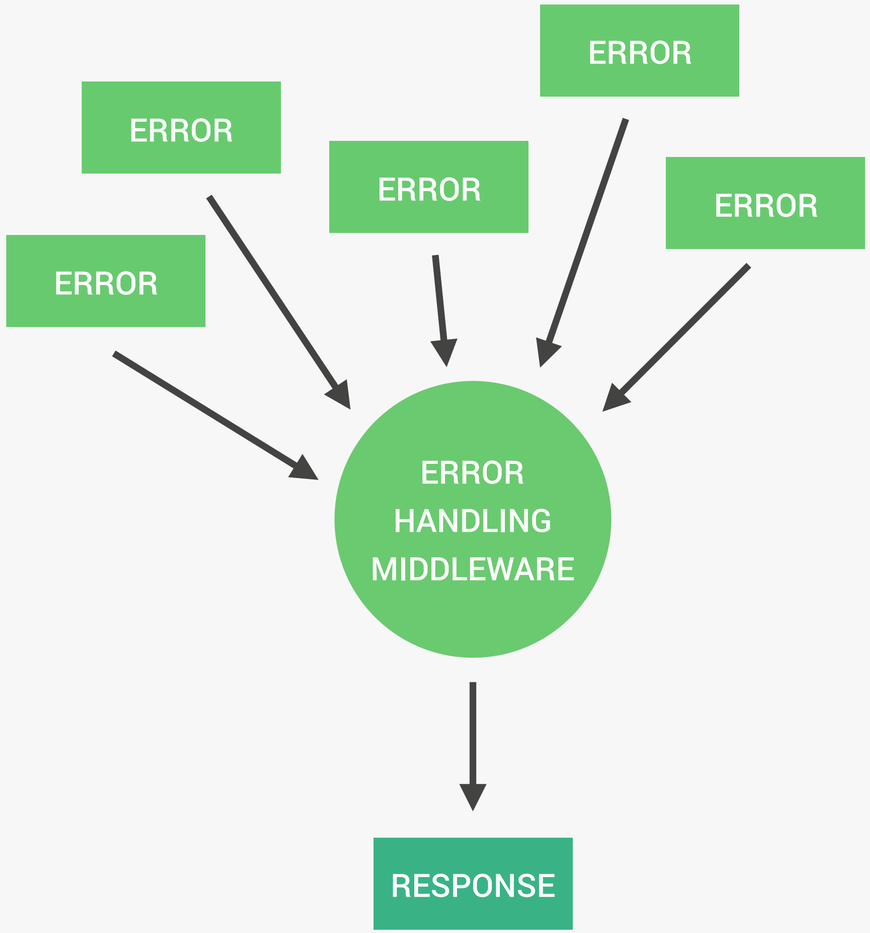
Problems that we can predict will happen at some point, so we just need to handle them in advance.

- 👉 Invalid path accessed;
- 👉 Invalid user input (validator error from mongoose);
- 👉 Failed to connect to server;
- 👉 Failed to connect to database;
- 👉 Request timeout;
- 👉 Etc...

PROGRAMMING ERRORS

Bugs that we developers introduce into our code. Difficult to find and handle.

- 👉 Reading properties on `undefined`;
- 👉 Passing a number where an object is expected;
- 👉 Using `await` without `async`;
- 👉 Using `req.query` instead of `req.body`;
- 👉 Etc...



SECTION 10 — AUTHENTICATION, AUTHORIZATION AND SECURITY

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

AUTHENTICATION, AUTHORIZATION AND SECURITY

LECTURE

HOW AUTHENTICATION WITH JWT WORKS

HOW JSON WEB TOKEN (JWT) AUTHENTICATION WORKS

CLIENT

SERVER

LOGIN

1 `POST /login {email, password}`

HTTPS

2 If user && password,
Create unique JWT

SECRET

eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJpZCI6IjVjNzY4NWFlNGRhNWQ1NmYxZmY3MzU2MSJ9.UDDSyCLKrn38DQ03QgkGVFfobPFbWDYmb0dgsc5Yd-Y

3 JWT

4 **Store JWT** (cookie or localStorage)

ACCESS

5 `GET /someProtectedRoute` JWT

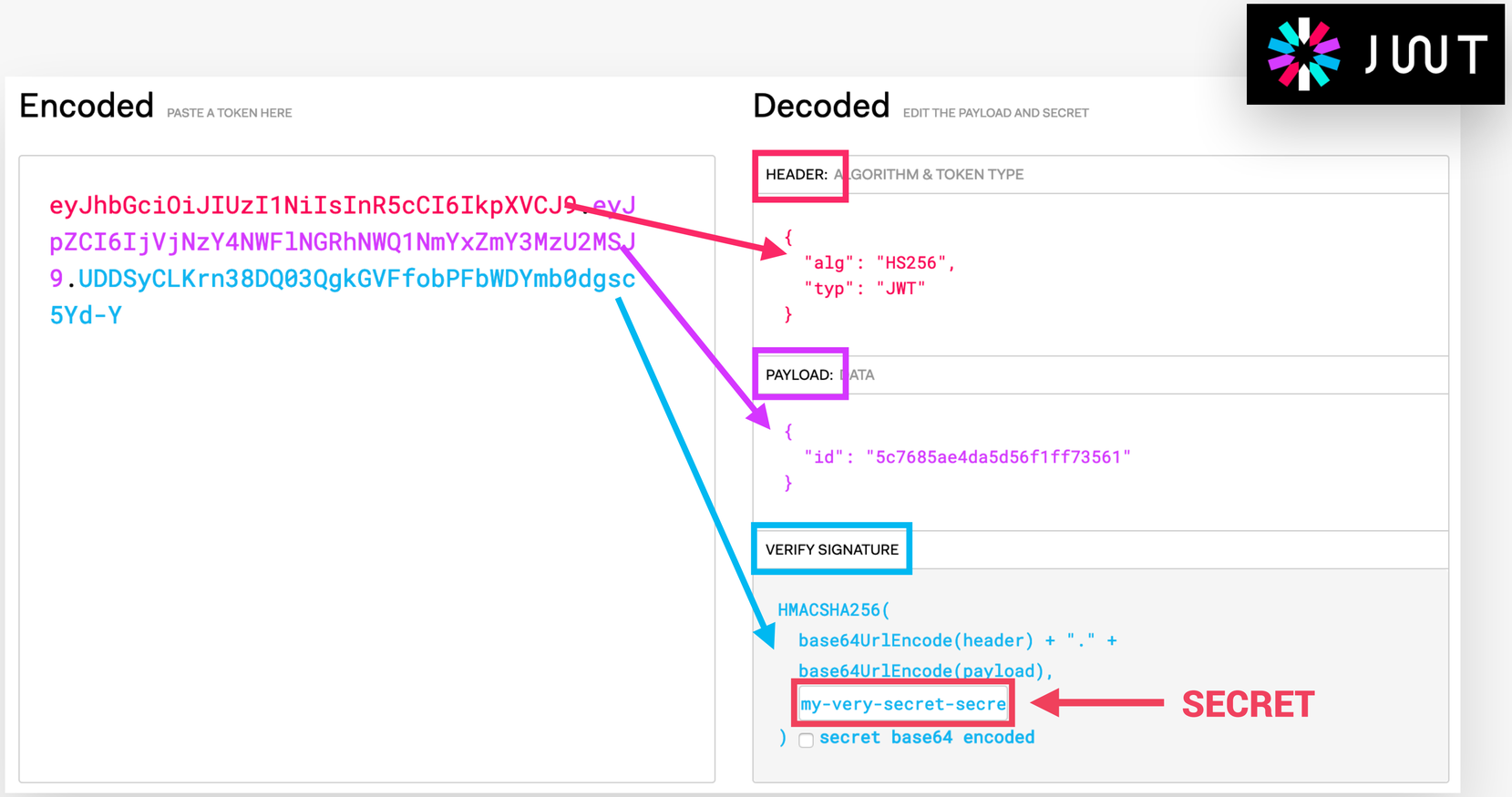
HTTPS

6 If **Valid JWT**,
Allow access

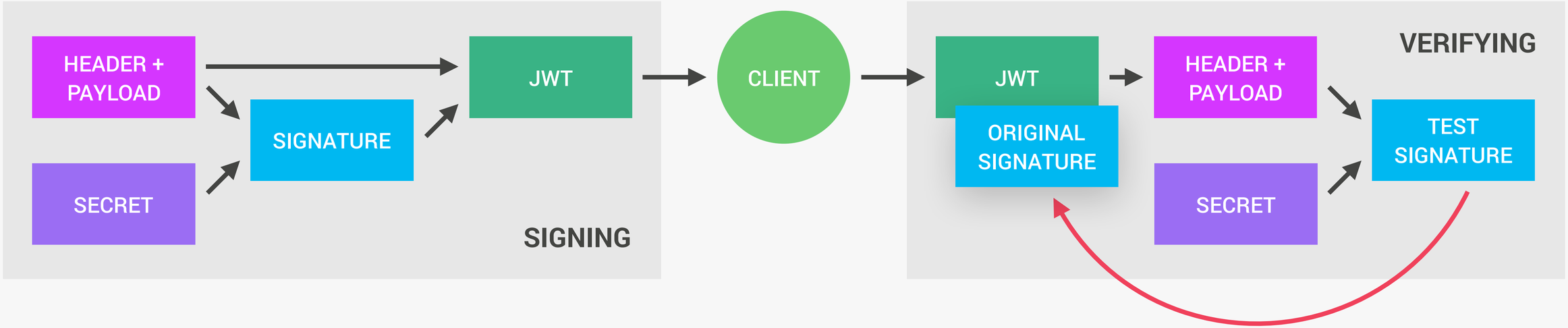
PROTECTED DATA

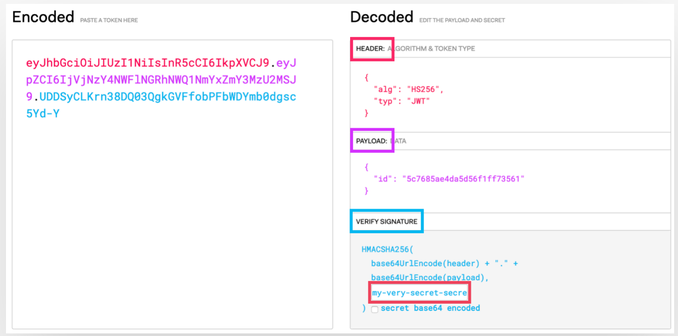
7

WHAT A JWT LOOKS LIKE



HOW SIGNING AND VERIFYING WORKS





`test signature === signature` 👉 Data has not been modified 👉 **Authenticated**

`test signature !== signature` 👉 Data has been modified 👉 **Not authenticated**

👉 Without the secret, one will be able to manipulate the JWT data, because they cannot create a valid signature for the new data!

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

AUTHENTICATION, AUTHORIZATION AND SECURITY

LECTURE

SECURITY BEST PRACTICES

SECURITY BEST PRACTICES AND SUGGESTIONS

👉 COMPROMISED DATABASE

- ✅ Strongly encrypt passwords with salt and hash (`bcrypt`)
- ✅ Strongly encrypt password reset tokens (SHA 256)

👉 BRUTE FORCE ATTACKS

- ✅ Use `bcrypt` (to make login requests slow)
- ↘️ Implement rate limiting (`express-rate-limit`)
- ⚛️ Implement maximum login attempts

👉 CROSS-SITE SCRIPTING (XSS) ATTACKS

- ↘️ Store JWT in HTTPOnly cookies
- ↘️ Sanitize user input data
- ↘️ Set special HTTP headers (`helmet` package)

👉 DENIAL-OF-SERVICE (DOS) ATTACK

- ↘️ Implement rate limiting (`express-rate-limit`)
- ↘️ Limit body payload (in `body-parser`)
- ✅ Avoid evil regular expressions

👉 NOSQL QUERY INJECTION

- ✅ Use `mongoose` for MongoDB (because of SchemaTypes)
- ↘️ Sanitize user input data

👉 OTHER BEST PRACTICES AND SUGGESTIONS

- ✅ Always use HTTPS
- ✅ Create random password reset tokens with expiry dates
- ✅ Deny access to JWT after password change
- ✅ Don’t commit sensitive config data to Git
- ✅ Don’t send error details to clients
- ⚛️ Prevent Cross-Site Request Forgery (`csurf` package)
- ⚛️ Require re-authentication before a high-value action
- ⚛️ Implement a blacklist of untrusted JWT
- ⚛️ Confirm user email address after first creating account
- ⚛️ Keep user logged in with refresh tokens
- ⚛️ Implement two-factor authentication
- ↘️ Prevent parameter pollution causing Uncaught Exceptions

SECTION 11 — MODELLING DATA AND ADVANCED MONGOOSE

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

MODELLING DATA AND ADVANCED MONGOOSE

LECTURE

MONGODB DATA MODELLING

"DATA... WHAT? 🤔"

DATA MODELLING

Real-world scenario

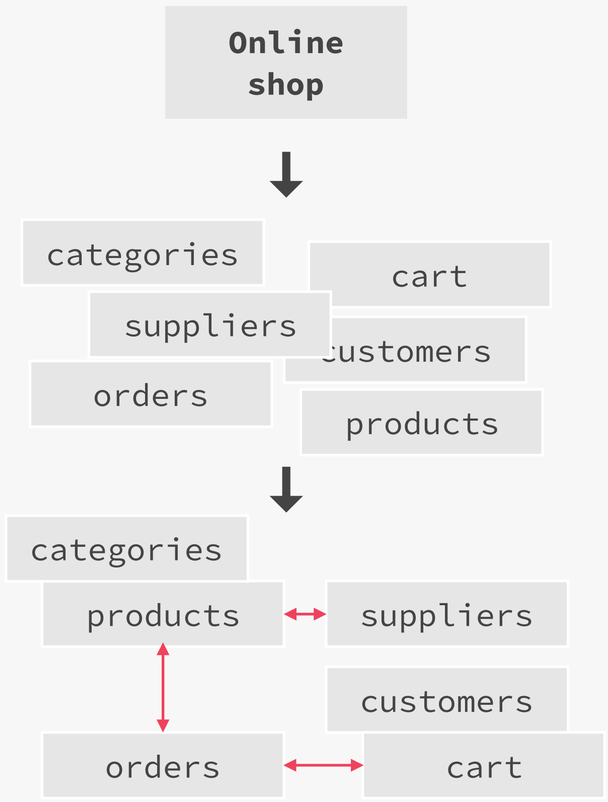
↓

Unstructured data

↓

Structured, logical data model

Example 👇



1. Different types of **relationships** between data
2. **Referencing**/normalization vs. **embedding**/denormalization
3. **Embedding** or **referencing** other documents?
4. **Types** of referencing

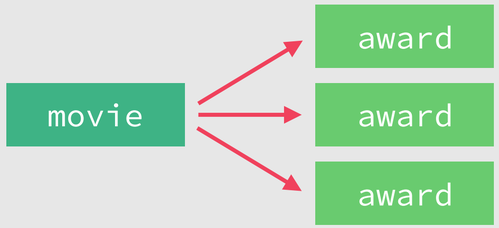
1. TYPES OF RELATIONSHIPS BETWEEN DATA

1:1

*(**1** movie can only have **1** name)*

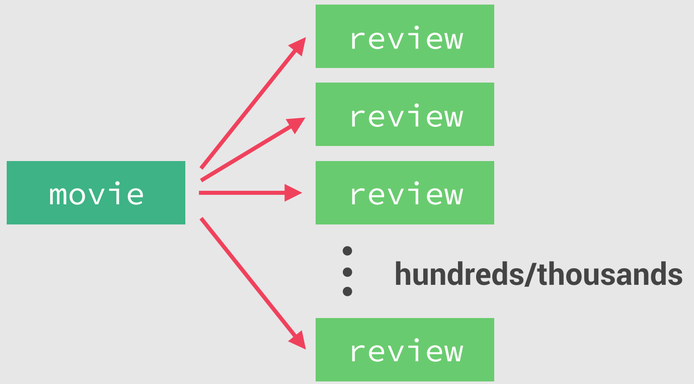
1:MANY

👉 **1:FEW**

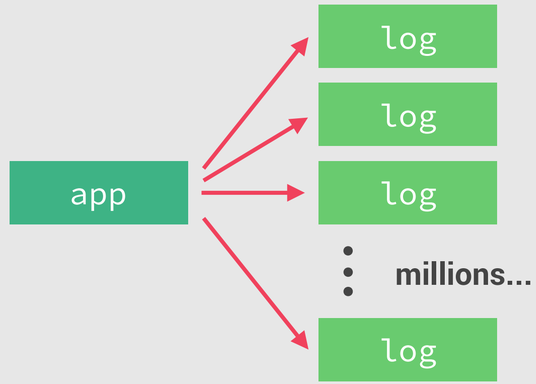


*(**1** movie can win **many** awards)*

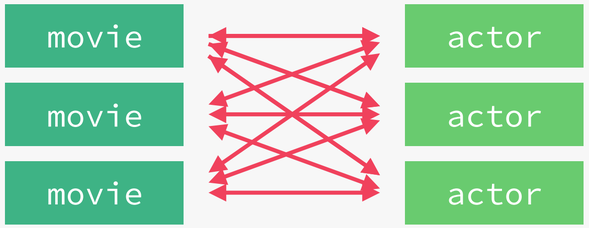
👉 **1:MANY**



👉 **1:TON**



MANY:MANY



*(One movie can have **many** actors, but one actor can also play in **many** movies)*

2. REFERENCING VS. EMBEDDING

REFERENCED / NORMALIZED

movie

```
{
  "_id": ObjectID('222'),
  "title": "Interstellar",
  "releaseYear": 2014,
  "actors": [
    ObjectID('555'),
    ObjectID('777')
  ]
}
```

Referencing (child)

actor

```
{
  "_id": ObjectID('555'),
  "name": "Matthew McConaughey",
  "age": 50,
  "born": "Uvalde, USA"
}
```

actor

```
{
  "_id": ObjectID('777'),
  "name": "Anne Hathaway",
  "age": 37,
  "born": "NYC, USA"
}
```

EMBEDDING/
DENORMALIZATION

REFERENCING /
NORMALIZATION

EMBEDDED / DENORMALIZED

```
{
  "_id": ObjectID('222'),
  "title": "Interstellar",
  "releaseYear": 2014,
  "actors": [
    {
      "name": "Matthew McConaughey",
      "age": 50,
      "born": "Uvalde, USA"
    },
    {
      "name": "Anne Hathaway",
      "age": 37,
      "born": "NYC, USA"
    }
  ]
}
```

Main document

Embedded documents

movie

👍 Performance: it's easier to query each document on its own

👎 We need 2 queries to get data from referenced document

👍 Performance: we can get all the information in one query

👎 Impossible to query the embedded document on its own

3. WHEN TO EMBED AND WHEN TO REFERENCE? A PRACTICAL FRAMEWORK

👉 Combine all 3 criteria to take decision!

	EMBEDDING	REFERENCING
1 RELATIONSHIP TYPE (How two datasets are related to each other)	👉 1:FEW 👉 1:MANY	👉 1:MANY 👉 1:TON 👉 MANY:MANY
2 DATA ACCESS PATTERNS (How often data is read and written. Read/write ratio)	👉 Data is mostly **read** 👉 Data does **not** change quickly 👉 (**High** read/write ratio) `Movies + Images`	👉 Data is **updated** a lot 👉 (**Low** read/write ratio) `Movies + Reviews`
3 DATA CLOSENESS (How "much" the data is related, how we want to query)	👉 Datasets **really** belong together `User + Email Addresses`	👉 We frequently need to query both datasets **on their own** `Movies + Images`

`Movies + Images (100)` ?

4. TYPES OF REFERENCING

CHILD REFERENCING

app

```
{
  "_id": ObjectID('23'),
  "app": "My Movie Database",
  "logs": [
    ObjectID('1'),
    ObjectID('2'),
    // ... Millions of ObjectID
    ObjectID('28273927')
  ]
}
```

2M

log

```
{
  "_id": ObjectID('1'),
  "type": "error",
  "timestamp": 1412184926
}
```

log

```
{
  "_id": ObjectID('28273927'),
  "type": "error",
  "timestamp": 1412844672
}
```

👉 1:FEW

PARENT REFERENCING

app

```
{
  "_id": ObjectID('23'),
  "app": "My Movie Database"
}
```

log

```
{
  "_id": ObjectID('1'),
  "app": ObjectID('23'),
  "type": "error",
  "timestamp": 1412184926
}
```

log

```
{
  "_id": ObjectID('28273927'),
  "app": ObjectID('23'),
  "type": "error",
  "timestamp": 141284...
}
```

BEST SOLUTION

👉 1:MANY

👉 1:TON

TWO-WAY REFERENCING

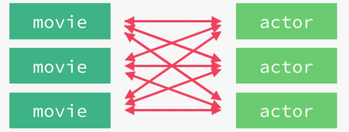
movie

```
{
  "_id": ObjectID('23'),
  "title": "Interstellar",
  "releaseYear": 2014,
  "actors": [
    ObjectID('67'),
    // ... and many more
  ]
}
```

actor

```
{
  "_id": ObjectID('67'),
  "name": "Matthew McConaughey",
  "age": 50,
  "movies": [
    ObjectID('23'),
    // ... and many more
  ]
}
```

👉 MANY:MANY



SUMMARY 🥳

- 👉 The most important principle is: Structure your data to **match the ways that your application queries and updates data**;
- 👉 In other words: Identify the questions that arise from your **application's use cases** first, and then model your data so that the **questions can get answered** in the most efficient way;
- 👉 In general, **always favor embedding**, unless there is a good reason not to embed. Especially on 1:FEW and 1:MANY relationships;
- 👉 A 1:TON or a MANY:MANY relationship is usually a good reason to **reference** instead of embedding;
- 👉 Also, favor **referencing** when data is updated a lot and if you need to frequently access a dataset on its own;
- 👉 Use **embedding** when data is mostly read but rarely updated, and when two datasets belong intrinsically together;
- 👉 Don't allow arrays to grow indefinitely. Therefore, if you need to normalize, use **child referencing** for 1:MANY relationships, and **parent referencing** for 1:TON relationships;
- 👉 Use **two-way referencing** for MANY:MANY relationships.

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

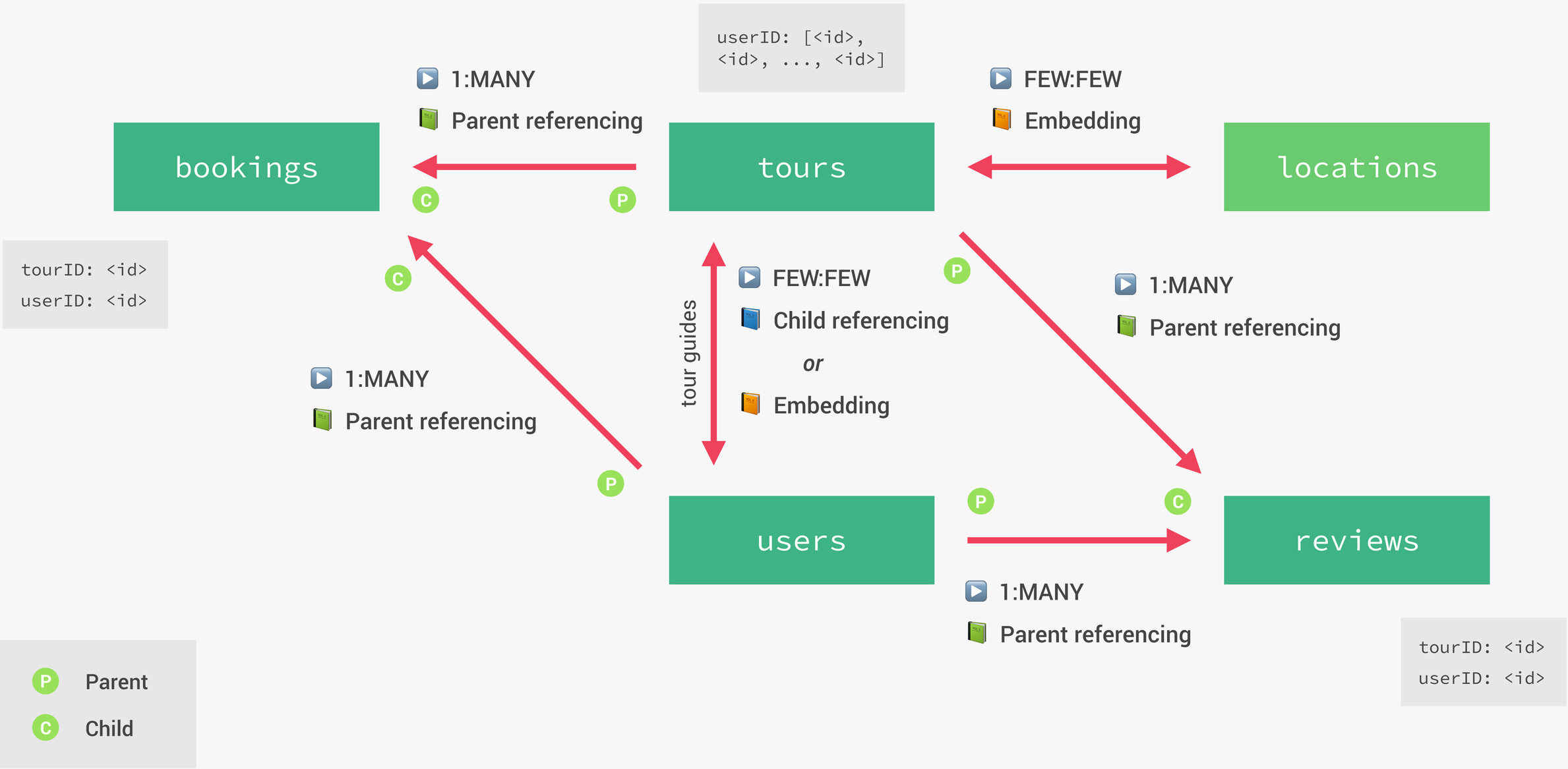
SECTION

MODELLING DATA AND ADVANCED MONGOOSE

LECTURE

DESIGNING OUR DATA MODEL

THE NATOURS DATA MODEL



SECTION 13 — ADVANCED FEATURES: PAYMENTS, EMAIL, FILE UPLOADS

JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

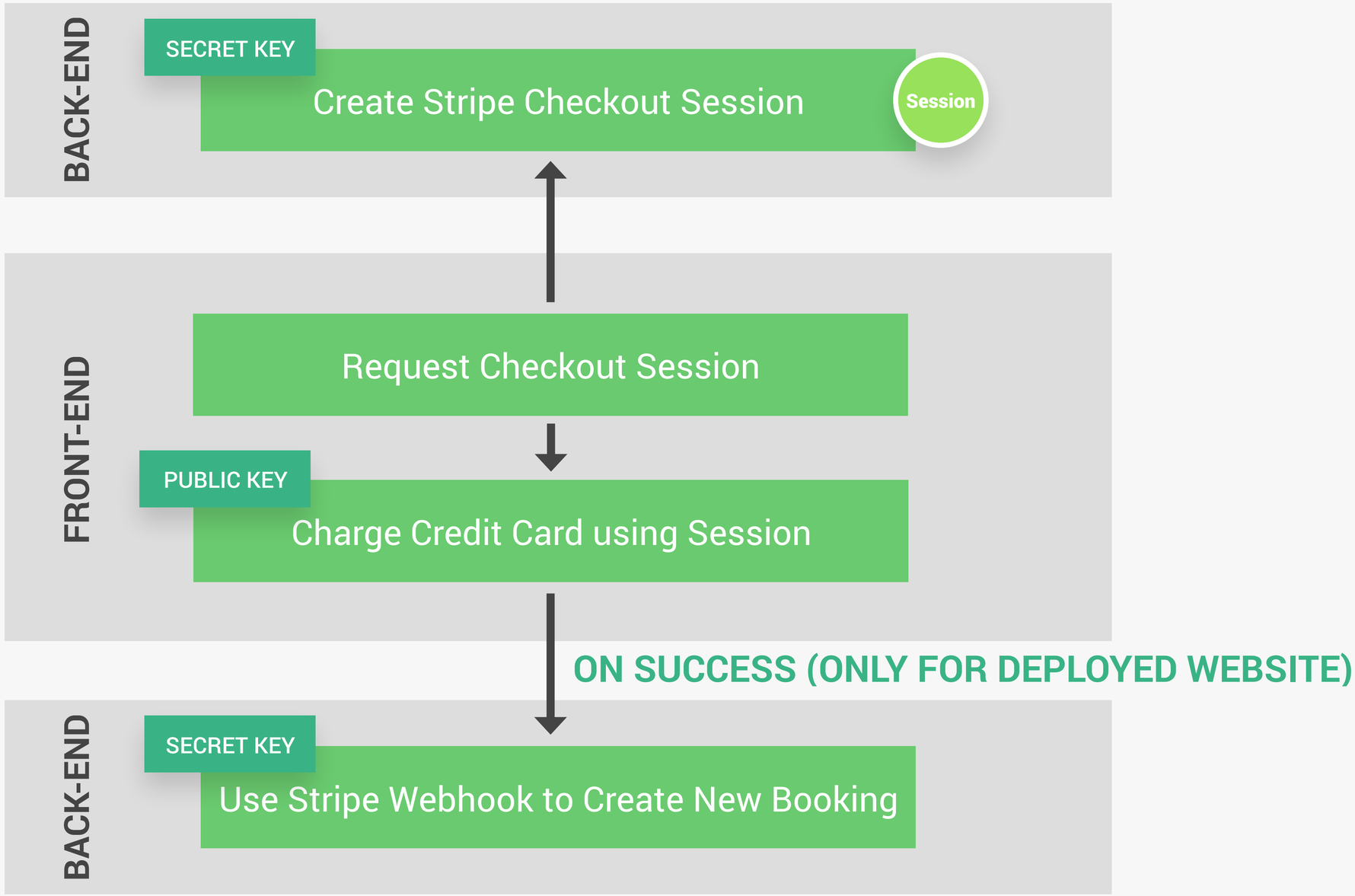
SECTION

ADVANCED FEATURES: PAYMENTS, EMAIL, FILE UPLOADS

LECTURE

CREDIT CARD PAYMENTS WITH STRIPE

STRIPE WORKFLOW



JONAS.IO
SCHMEDTMANN

NODE.JS, EXPRESS & MONGODB

THE COMPLETE BOOTCAMP

@JONASSCHMEDTMAN

SECTION

ADVANCED FEATURES: PAYMENTS, EMAIL, FILE UPLOADS

LECTURE

FINAL CONSIDERATIONS

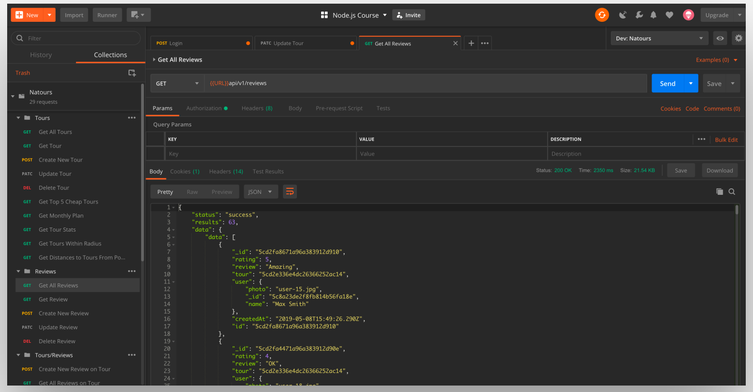
CHALLENGES (API) 🤓

- 👉 Implement restriction that users can only review a tour **that they have actually booked**;

- 👉 Implement nested **booking** routes: `/tours/:id/bookings` and `/users/:id/bookings`;

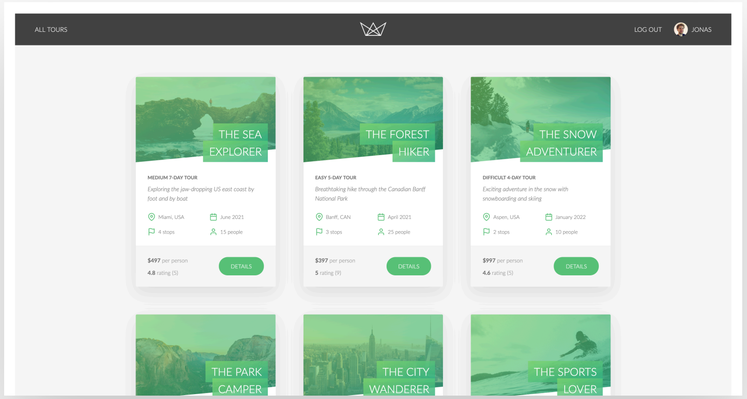
- 👉 **Improve tour dates:** add a `participants` and a `soldOut` field to each date. A date then becomes like an instance of the tour. Then, when a user books, they need to select one of the dates. A new booking will increase the number of participants in the date, until it is booked out (`participants > maxGroupSize`). So, when a user wants to book, you need to check if tour on the selected date is still available;

- 👉 Implement **advanced authentication features**: confirm user email, keep users logged in with refresh tokens, two-factor authentication, etc.



CHALLENGES (WEBSITE) 🤓

- 👉 Implement a **sign up** from, similar to the login form;
- 👉 On the tour detail page, if a user has taken a tour, allow them **add a review directly on the website**. Implement a form for this;
- 👉 **Hide the entire booking section** on the tour detail page if current user has already booked the tour (also prevent duplicate bookings on the model);
- 👉 I**mplement "like tour" functionality**, with favourite tour page;
- 👉 On the user account page, implement the "**My Reviews**" page, where all reviews are displayed, and a user can edit them. *(If you know React ⚛️, this would be an amazing way to use the Natours API and train your skills!);*
- 👉 For administrators, implement all the "**Manage**" pages, where they can CRUD (create, read, update, delete) tours, users, reviews, and bookings.



END