node.js: JavaScript on the server

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At the end of this lecture, you should be able to …

- **Explain** the main ideas behind `node.js`
- **Implement** basic network functionality with `node.js`
- **Explain** the difference between `node.js`, `NPM` & `Express`
- **Create** a fully working Web application (focus on TODO app) that has client- and server-side interactivity
- **Implement** client/server communication via `JSON`
- **Implement** client-side code using Ajax

Lecture 1

A reminder before we start

Web servers and clients

Lecture 1

(1) HTTP request

(2) HTTP response

- display
- execute
- music player
- Acrobat Reader

- Wait for data requests
- Answer thousands of clients simultaneously
- Host **web resources**

- Clients are most often Web browsers
- **Telnet**

Web resource: any kind of content with an identity, including static files (e.g. text, images, video), software programs, Web cam gateway, etc.

HTTP response message

```
HTTP/1.1 200 OK
Date: Fri, 01 Aug 2014 13:35:55 GMT
Content-Type: text/html; charset=utf-8
Content-Length: 5994
Connection: keep-alive
Set-Cookie: fe_typo_user=d5e20a55a4a92e0;
path=/; domain=tudelft.nl
[....]
Server: TU Delft Web Server

....
....
```

start line

header fields

name:value

body (optional)

What is node.js?

node.js in its own words …

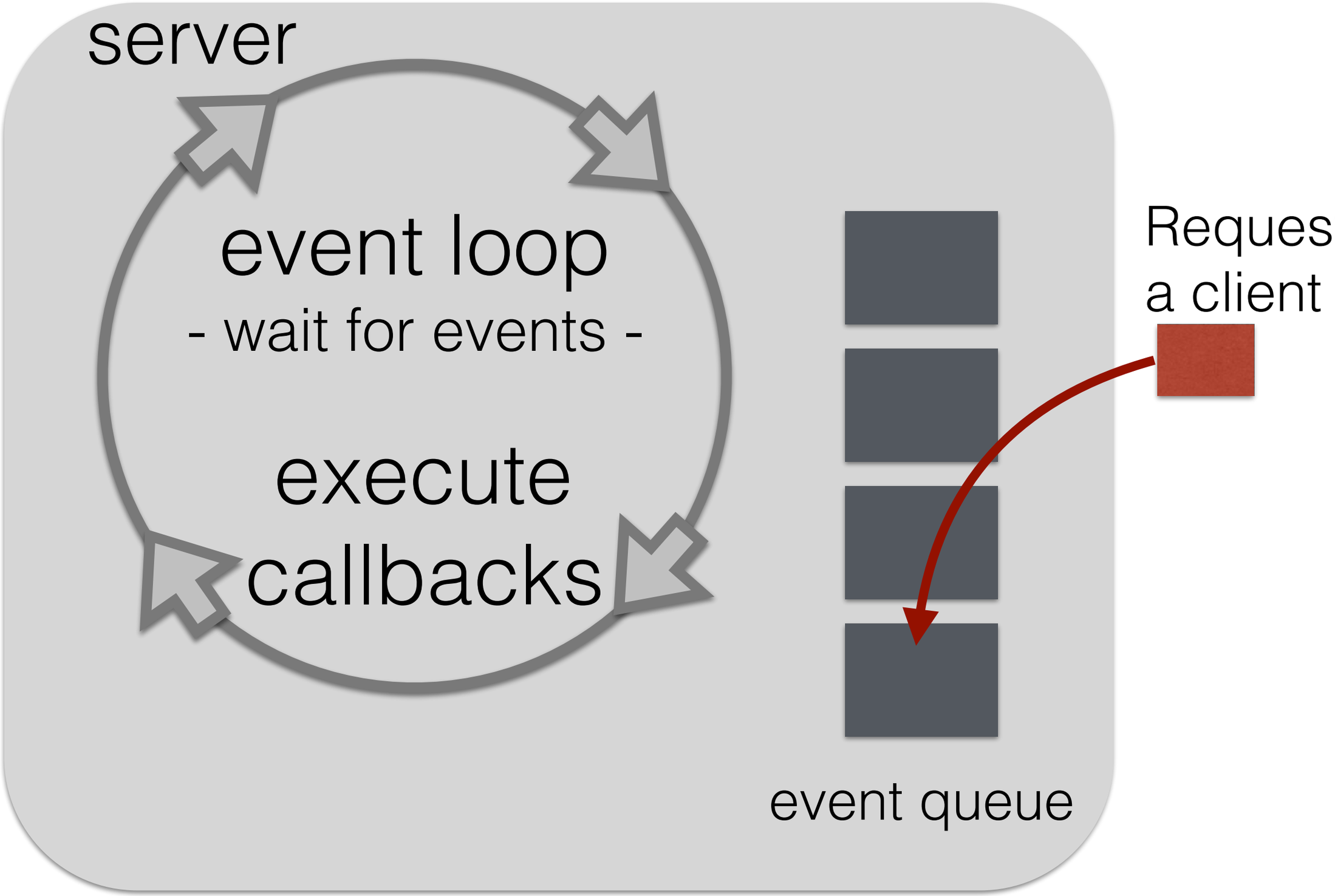
"Node.js® is a platform **built on Chrome's JavaScript runtime** for easily building **fast**, **scalable network** applications.

Node.js uses an **event-driven**, **non-blocking I/O** model that makes it lightweight and efficient, perfect for **data-intensive real-time applications** that run across distributed devices."

History of node.js

- Google's JavaScript execution engine (**V8**) was open-sourced in 2008
- node.js builds on V8 and was released in **2009**
- **node.js' package manager** (`npm`) was released in 2011
  - **200,000** packages [**npm**]
  - **158,000** packages [**CPAN**]
- December 2014: **io.js**
- May 2015: **io.js merges back** with node.js

node.js is event-driven



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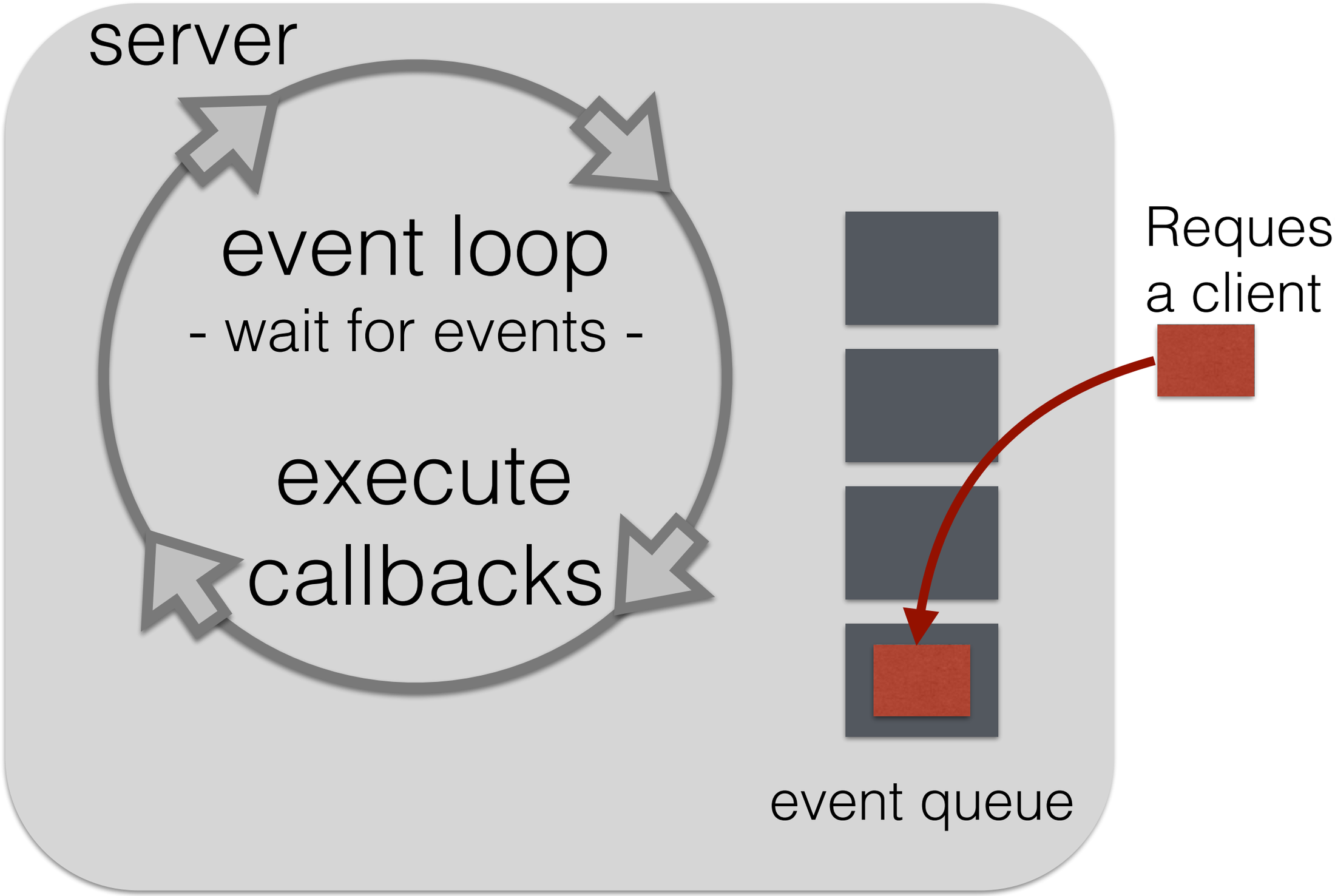

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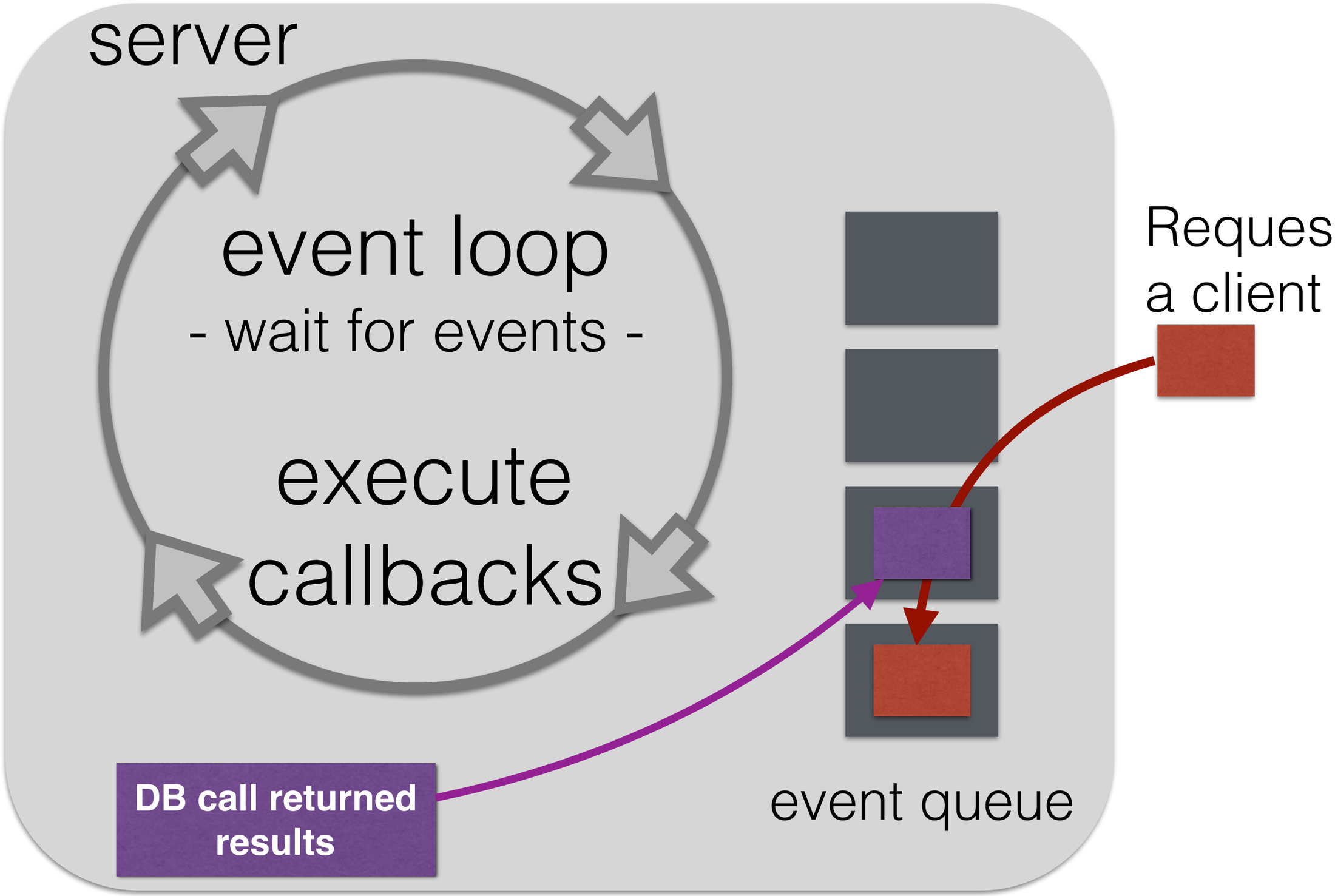

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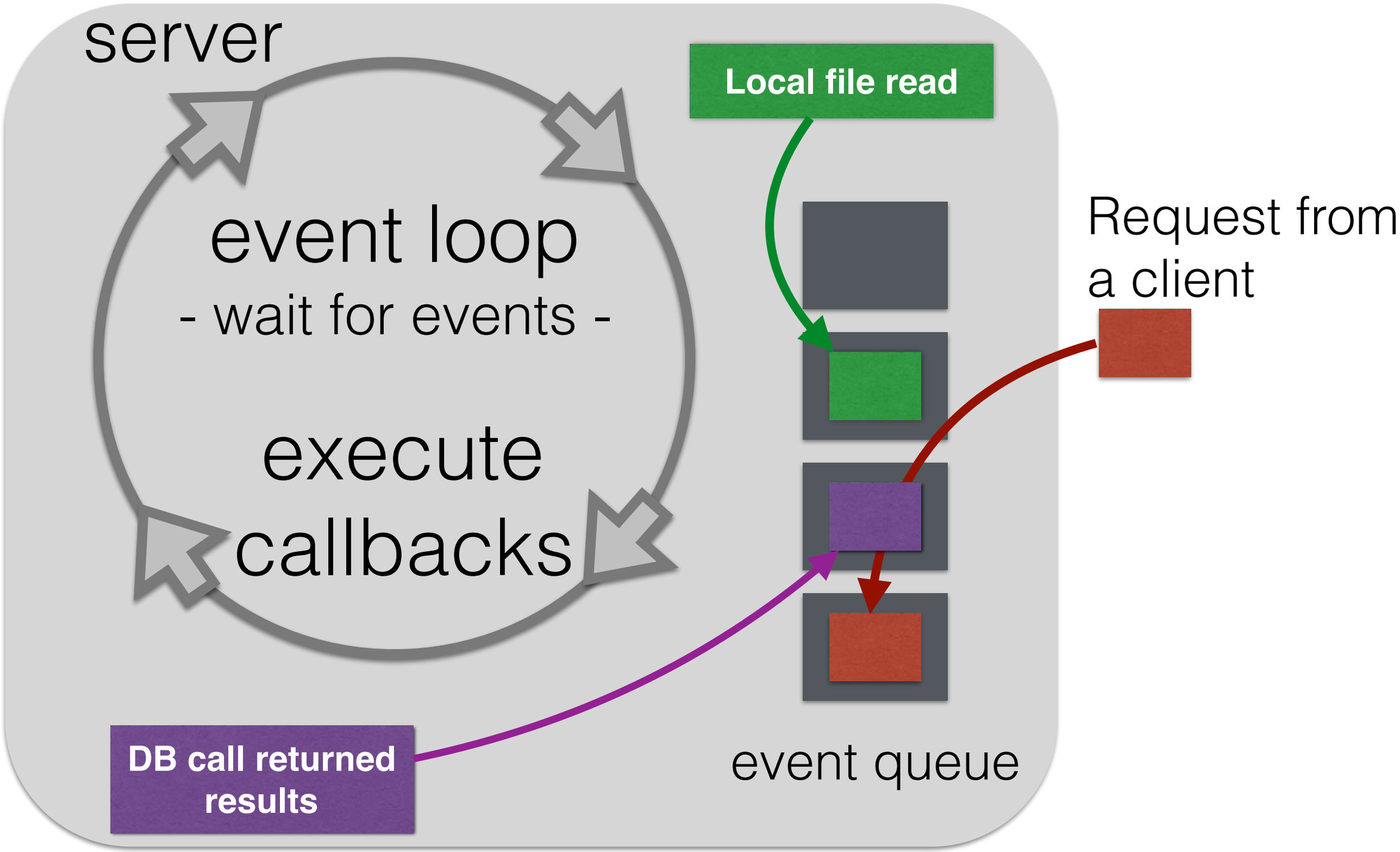

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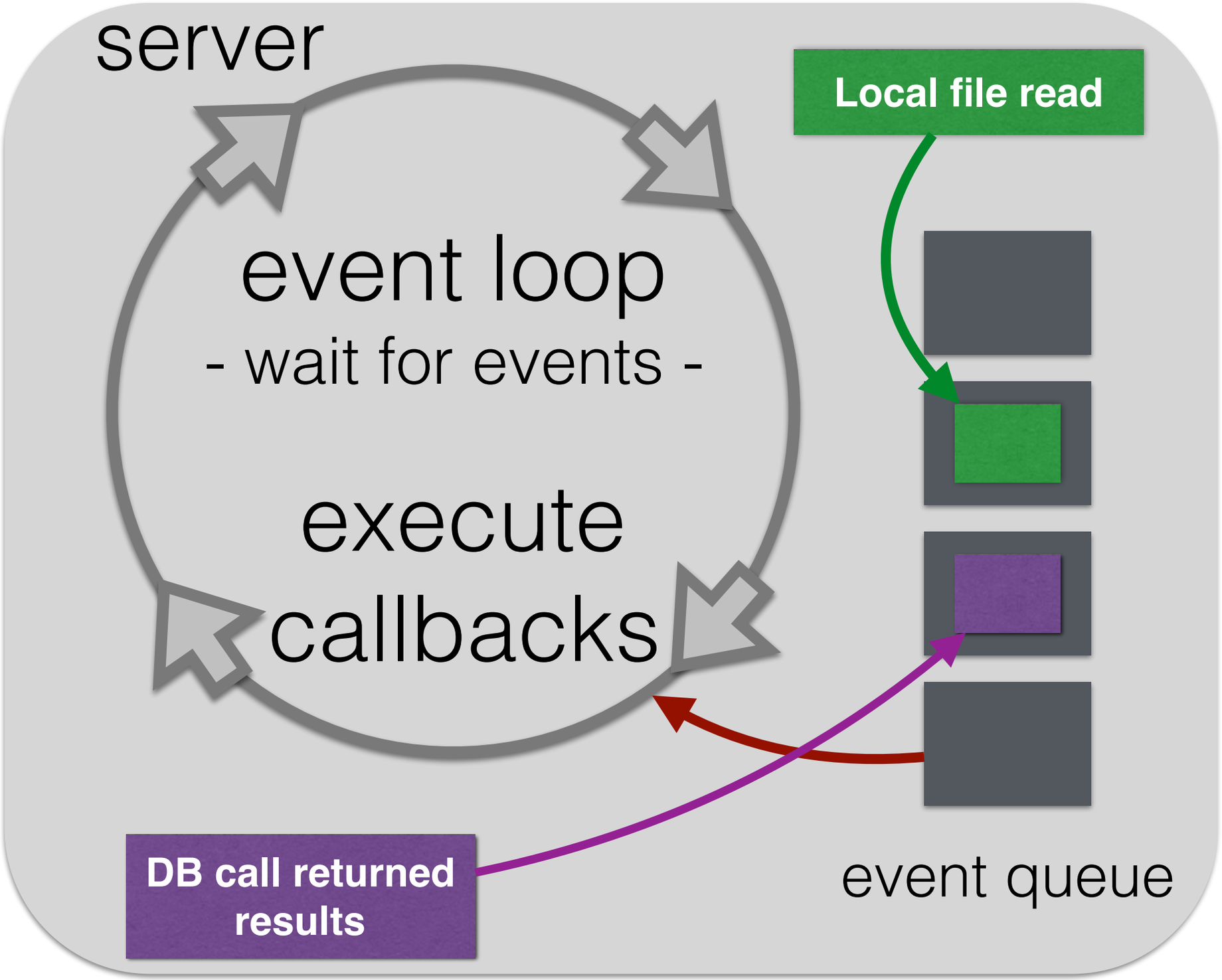

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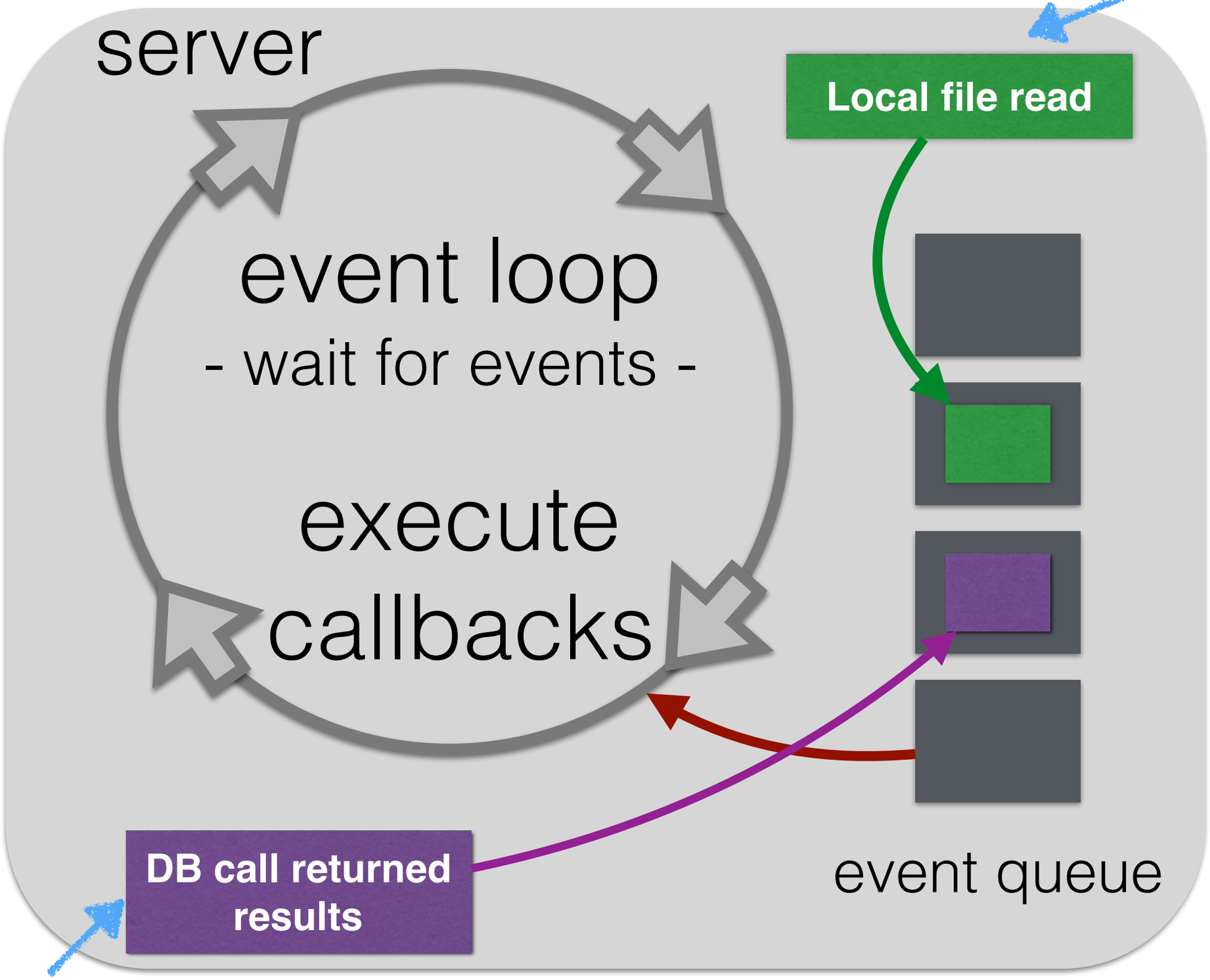
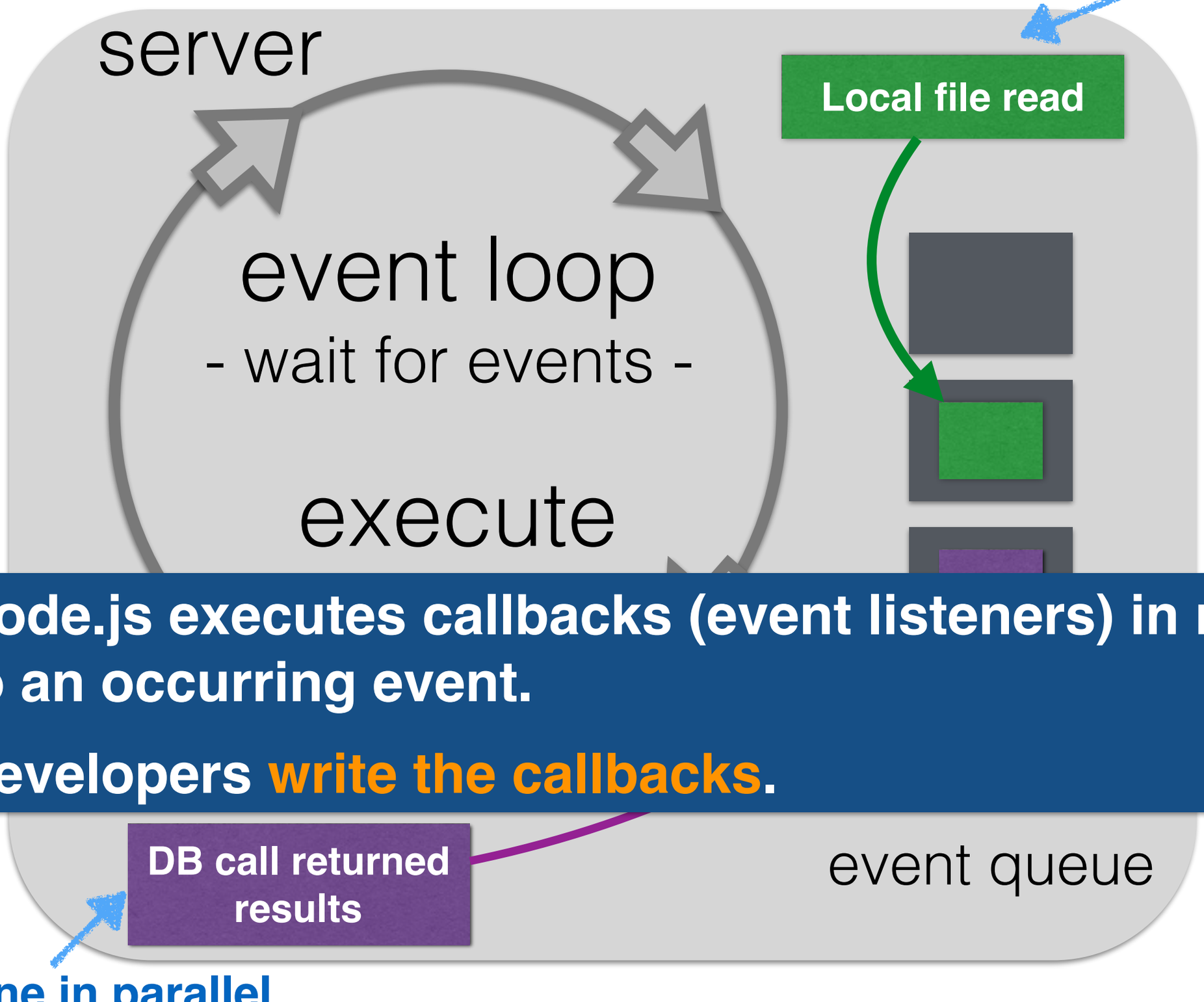


node.js is event-driven

done in parallel



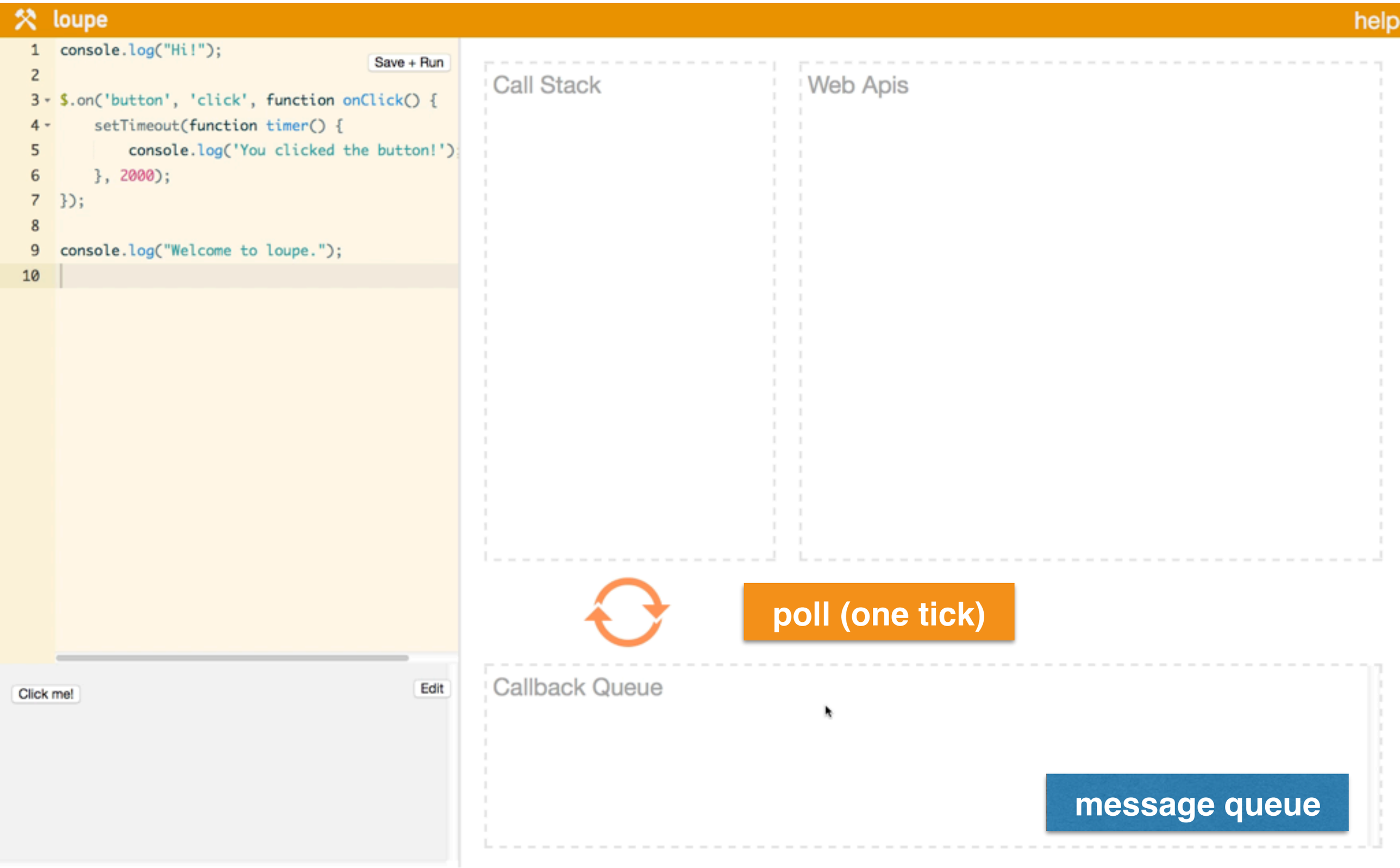
Node.js executes callbacks (event listeners) in response to an occurring event.

Developers write the callbacks.

done in parallel

It is actually a bit more complicated than that …

http://latentflip.com/loupe/



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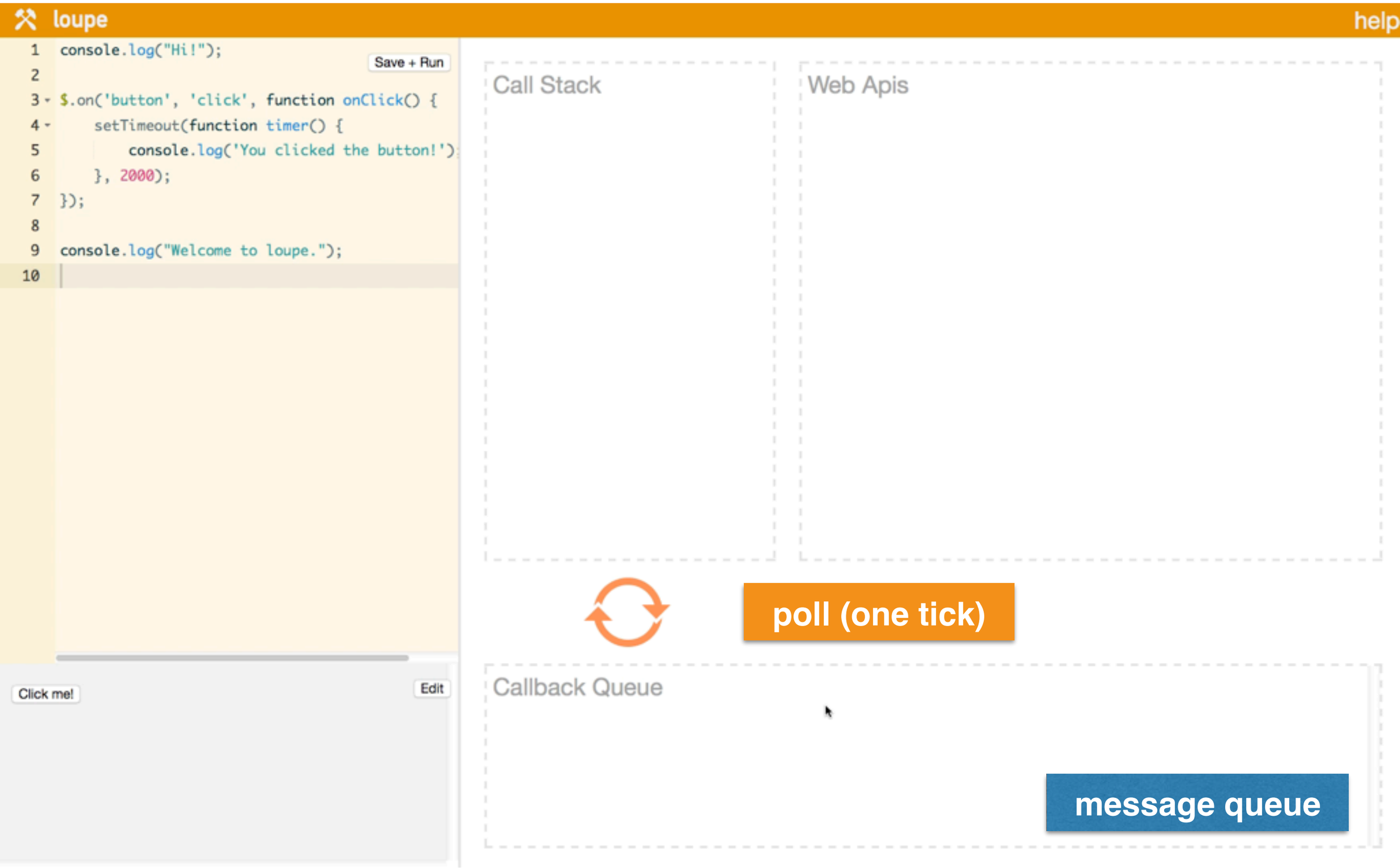

node.js: single-threaded but highly parallel

- **I/O bound programs**: programs constrained by data access (adding more CPUs or main memory will not lead to large speedups)

- Many tasks might require **waiting time**
  - Waiting for a database to return results
  - Waiting for a third party Web service
  - Waiting for connection requests

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`node.js` is designed with these use cases in mind.

node.js: single-threaded but highly parallel

Blocking I/O (database example)

Non-blocking I/O

node.js: single-threaded but highly parallel

Blocking I/O (database example)

(1) read request

(2) process request & access the database

(3) **wait** for the database to return data and process it

(4) process the next request

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(2) process request & access the database

(3) **wait** for the database to return data and process it

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Non-blocking I/O

(1) read request

(2) process request and make a **callback** to access the database

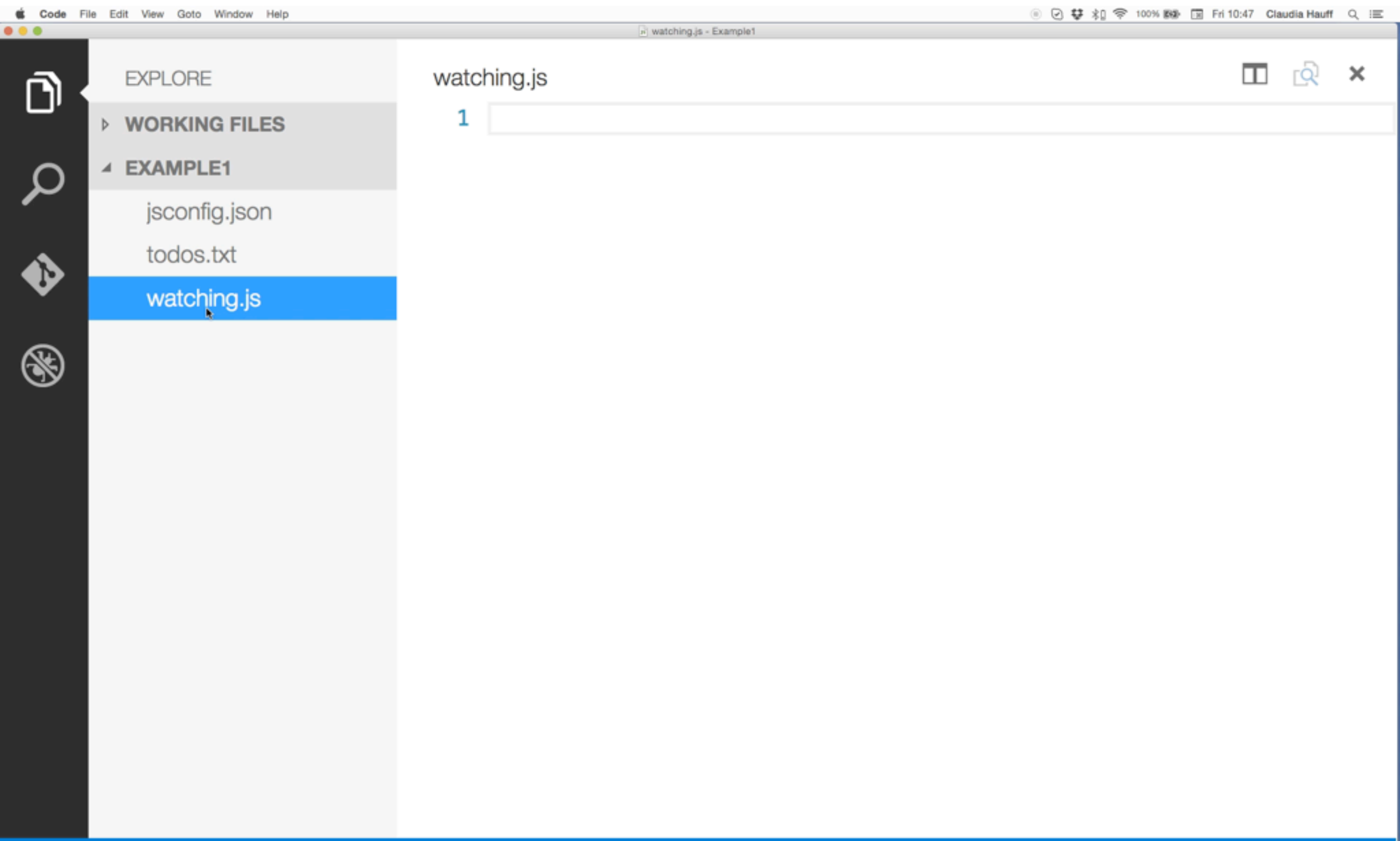
(3) do other things

(4) when the callback returns, process it

The first code examples

Example 1

Visual Studio Code (open-source, for all platforms)



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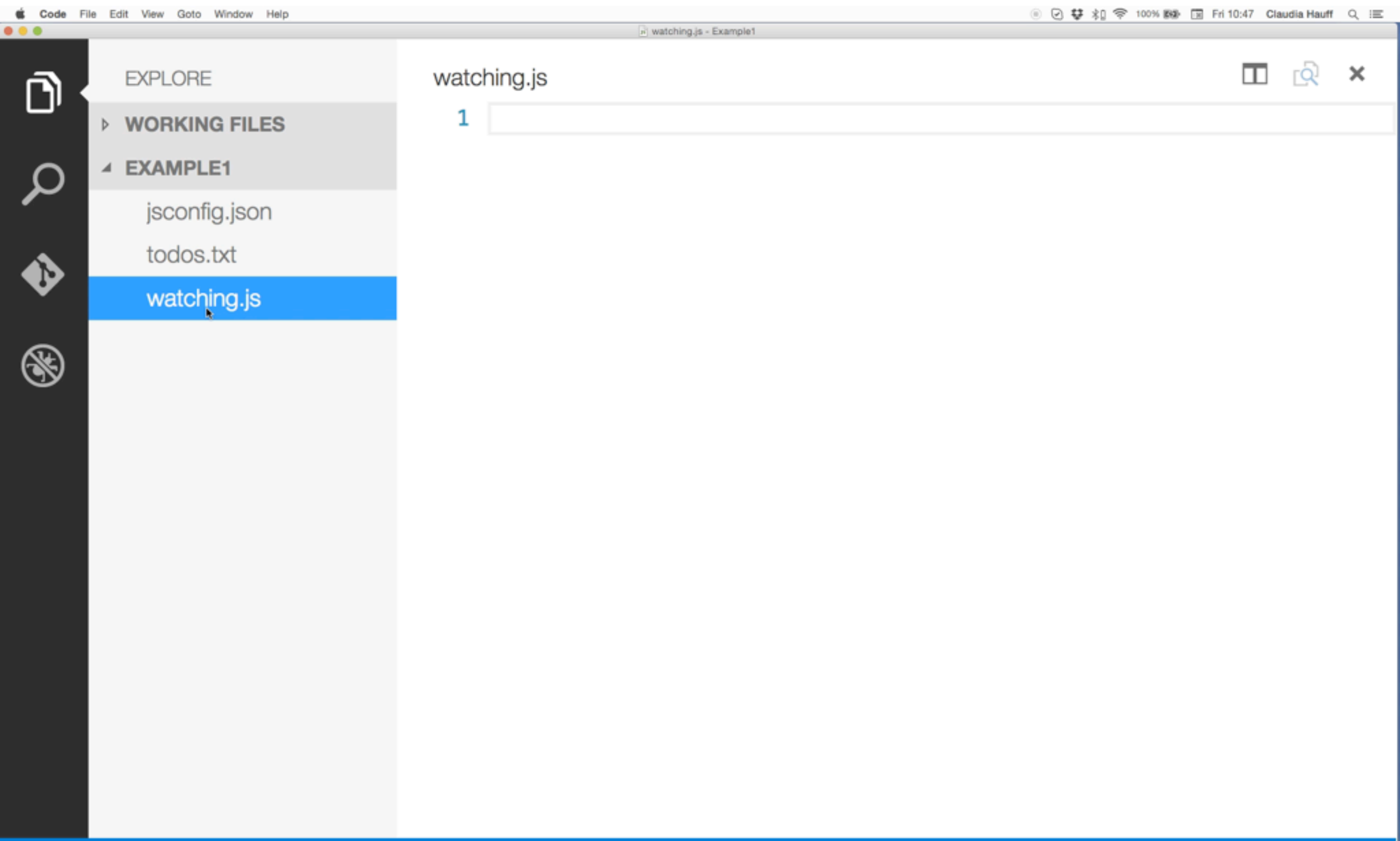

Example: watch a file for changes

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Assumption: file to watch exists!

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read-only reference to a value; **`var`** can be used too

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Self-contained piece of code that provides reusable functionality.

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polls ‘todos.txt’ **for changes**

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anonymous function

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anonymous function

asynchronous

Executed immediately after the **setup** of the callback

Assumption: file to watch exists!

0:31

Does `require()` use synchronous or asynchronous access?

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0:35

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3  //function declaration
4  function six(){
5    return 6;
6  }
7
8  var y = seven()
9
10 //function expression
11 var seven = function(){
12   return 7;
13 }
14
15 console.log(x+""+y);
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What is the console output when executing this Javascript code snippet?

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Declarations are processed before any code is executed (the hoisting principle).

Declarations are hoisted to the top.

Expressions are not hoisted.

0:31

```
1 var bar = 12;
2
3 function X(){
4  bar = 6;
5  var bar;
6 }
7 console.log(bar);
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flickr@isolino

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Networking with node.js

- Built specifically for **networked programming** (not just Web programming!)
- node.js has built-in support for **low-level** socket connections (TCP sockets)
- TCP socket connections have **two endpoints**
  1. **binds** to a numbered port
  2. **connects** to a port

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Analogous example: phone lines.

One phone binds to a phone number.

Another phone tries to call that phone.

If the call is answered, a connection is established.

Example: low-level networking with node.js

Task: Server informs connected clients about changes to file `todos.txt`.

`todos.txt`

`tcp.js`

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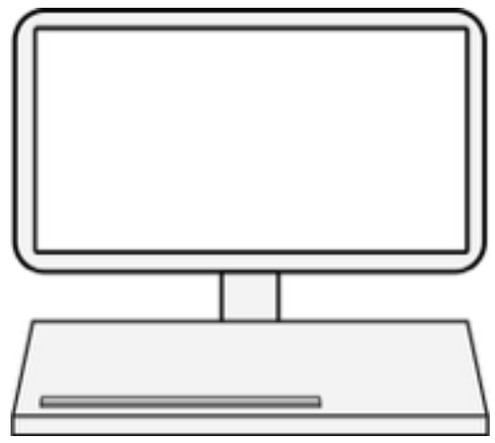

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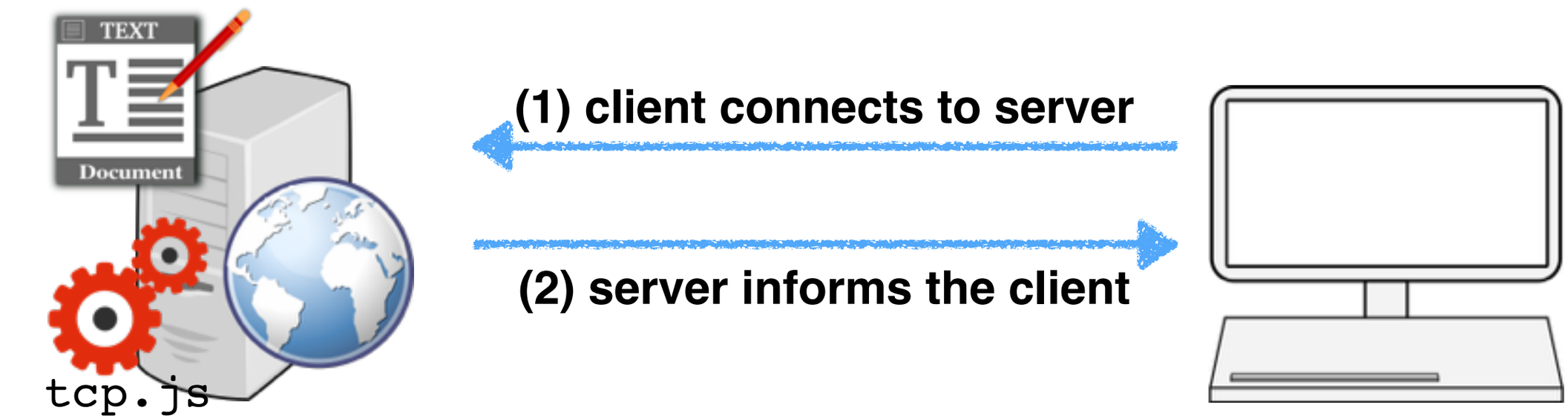


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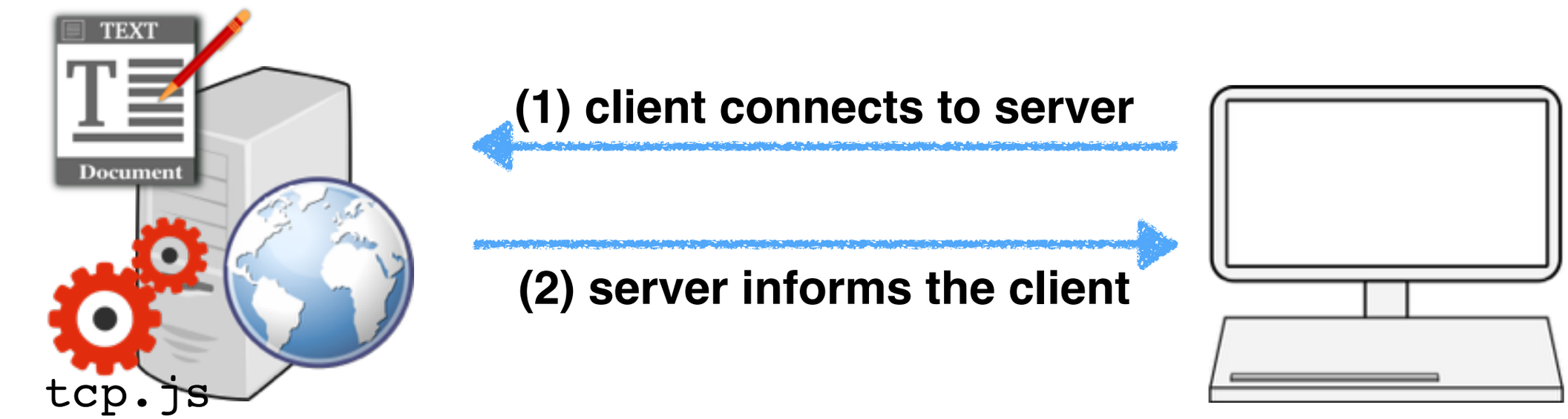


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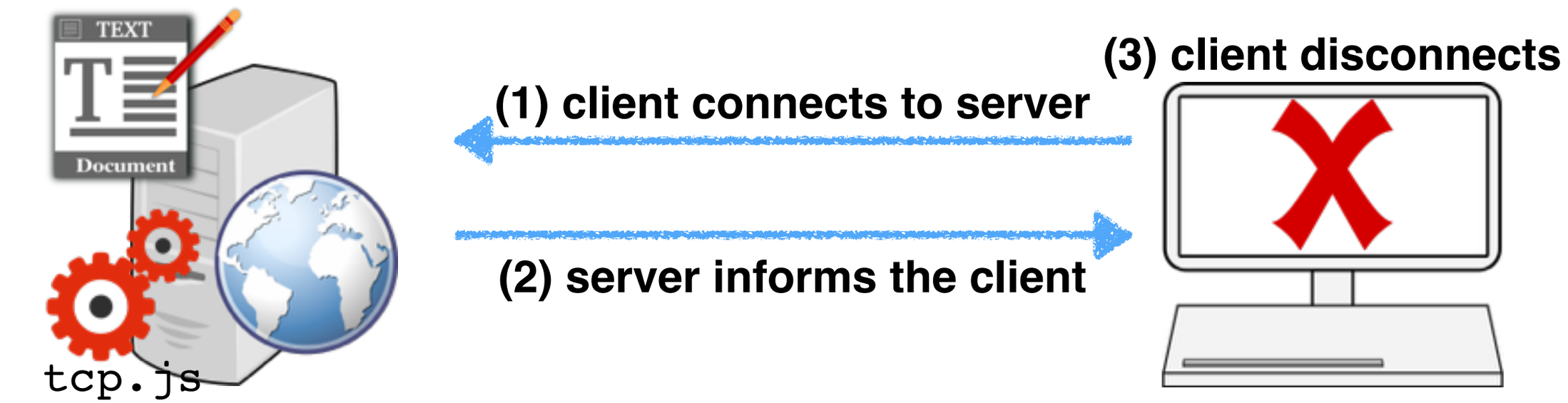


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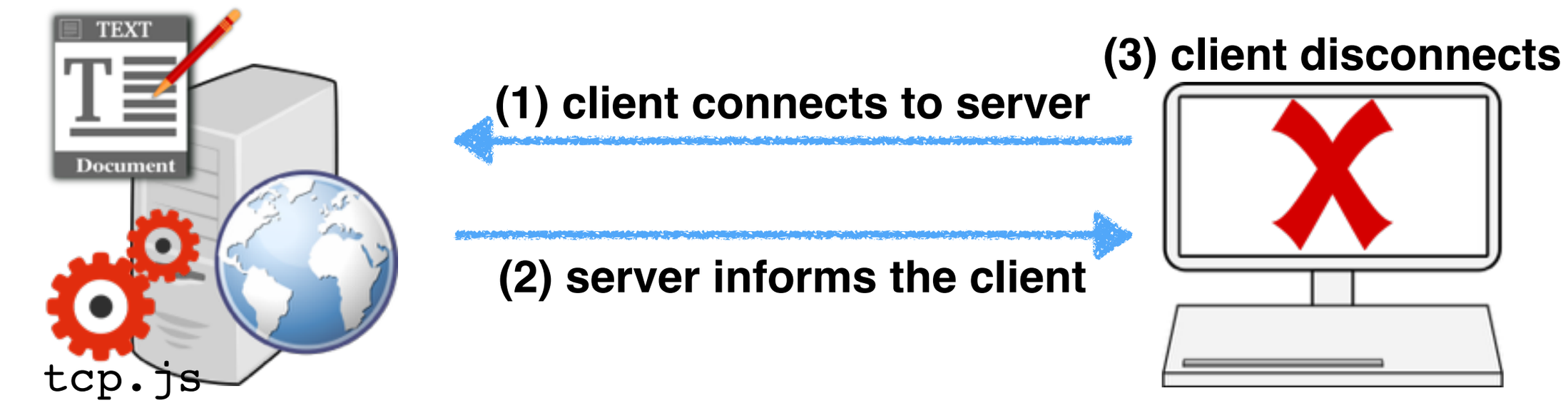


```
server:~ $
Listening for subscribers …
Subscriber connected.
Subscriber disconnected.
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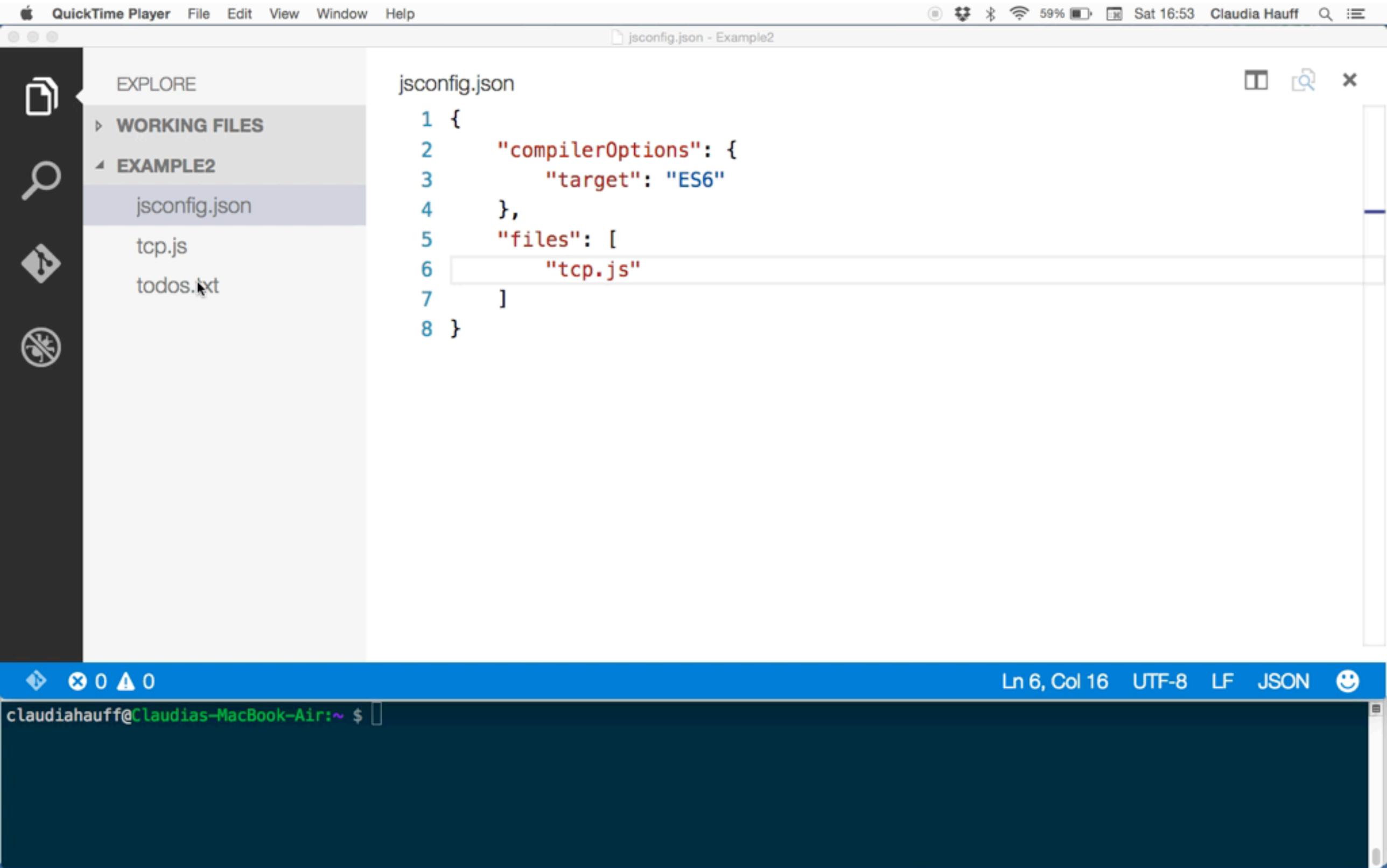
```

Example 2

Example: low-level networking with node.js



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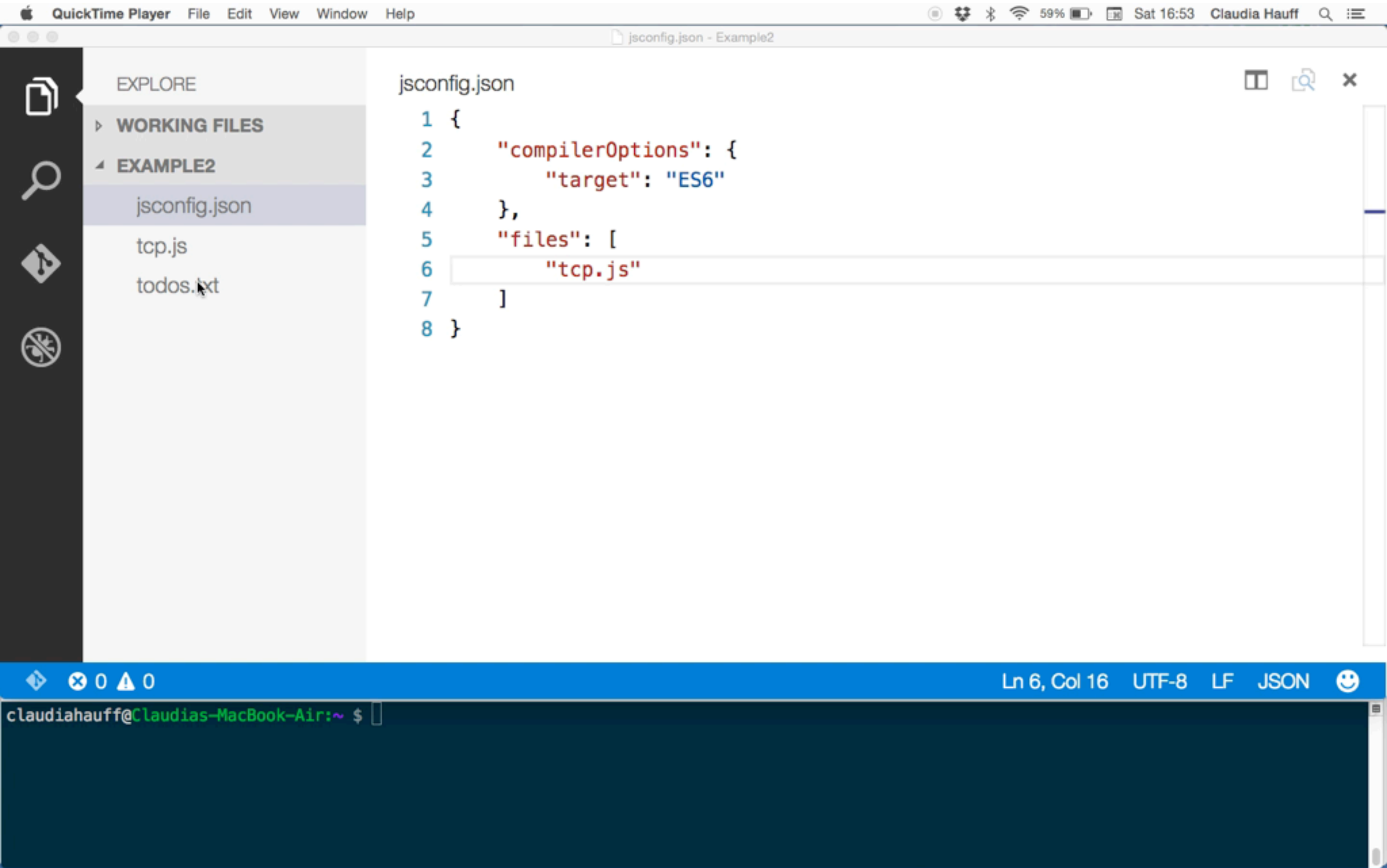

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6     // use connection object for data transfer
7   });
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bind to port 5432

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4     net = require('net'),
5     filename = "todos.txt",
6     server = net.createServer(function(connection)
7     {
8        console.log('Subscriber connected.');
9        connection.write("Now watching “ + filename +
10                          “ for changes...\n");
11       // watcher setup
12       var watcher = fs.watch(filename, function() {
13          connection.write("File '" + filename + "'
14                      changed: " + Date.now() + "\n");
15       });
16       // cleanup
17       connection.on('close', function() {
18          console.log('Subscriber disconnected.');
19          watcher.close();
20       });
21    });
22 server.listen(5432, function() {
23    console.log('Listening for subscribers...');
24 });
```

client-side output

server-side output

Example: low-level networking with node.js

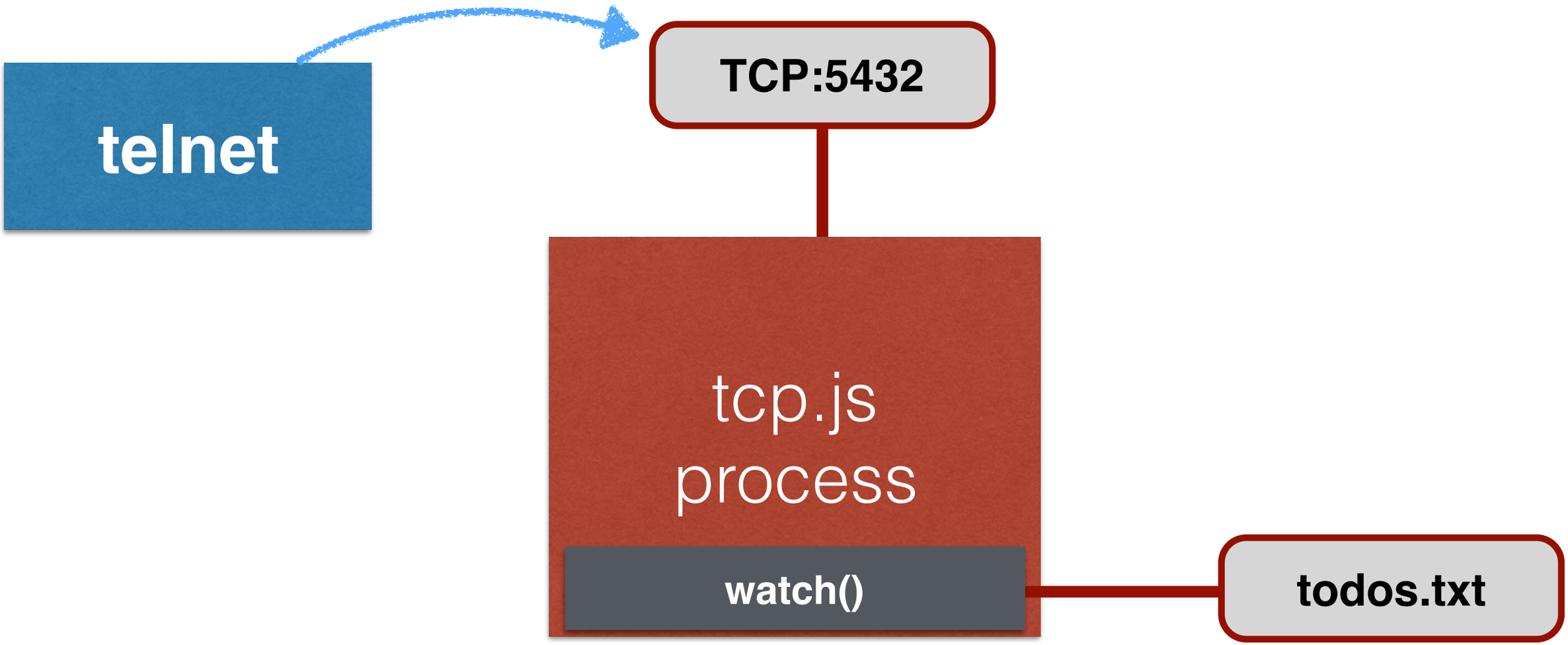
Start the **server** on the command line: **`$ node --harmony tcp.js`**
Client terminal: `$ telnet localhost 5432`

```
5    filename = "todos.txt",
6    server = net.createServer(function(connection)
7    {
8        console.log('Subscriber connected.');
9        connection.write("Now watching “ + filename +
10                          “ for changes...\n");
11       // watcher setup
12       var watcher = fs.watch(filename, function() {
13           connection.write("File '" + filename + "'
14                       changed: " + Date.now() + "\n");
15       });
16       // cleanup
17       connection.on('close', function() {
18           console.log('Subscriber disconnected.');
19           watcher.close();
20       });
21   });
22 server.listen(5432, function() {
23   console.log('Listening for subscribers...');
24 });
```

client-side output

server-side output

Low-level networking with node.js

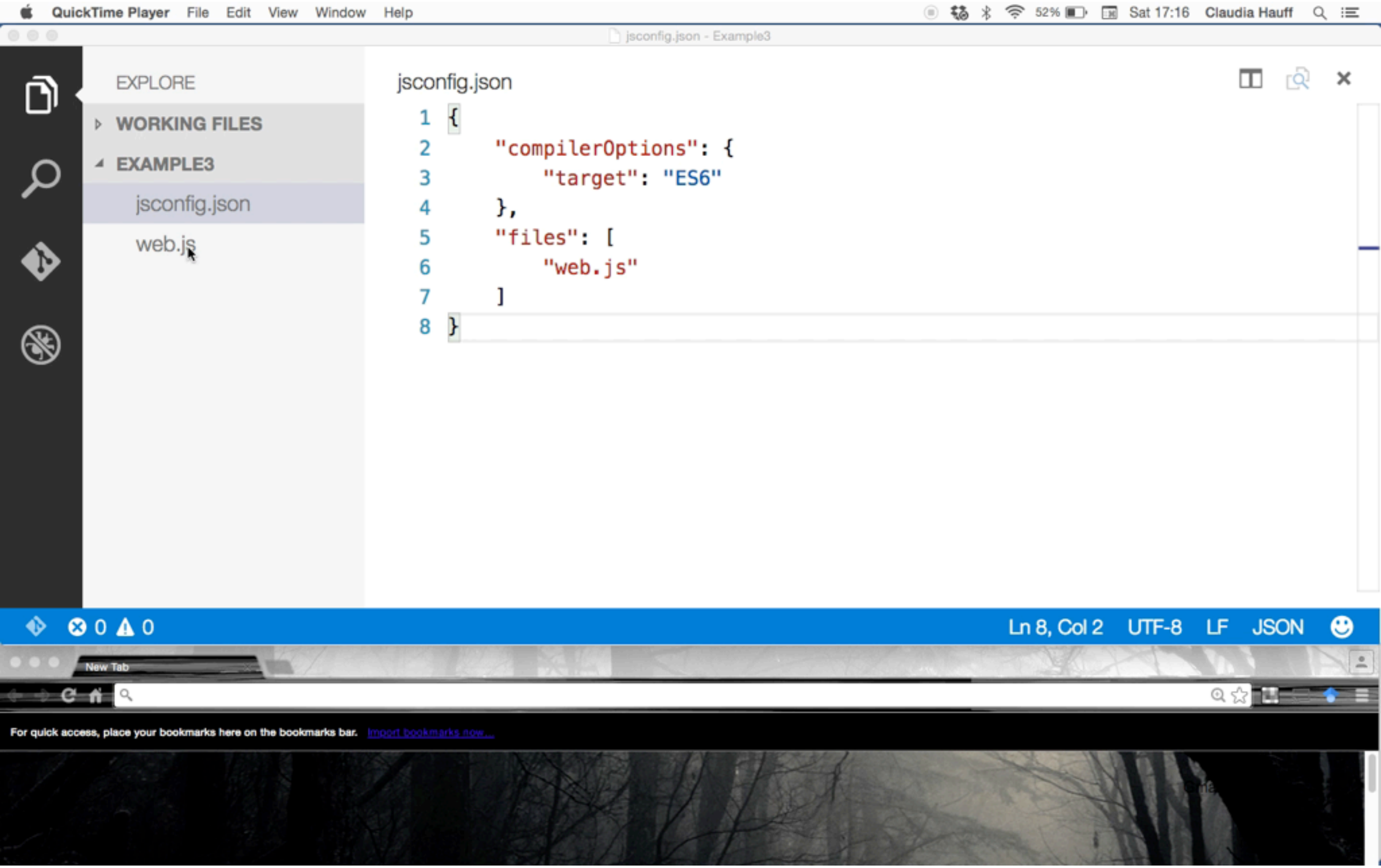


Using node.js to create a Web server

node.js is **not** a Web server. It provides **functionality** to implement one!

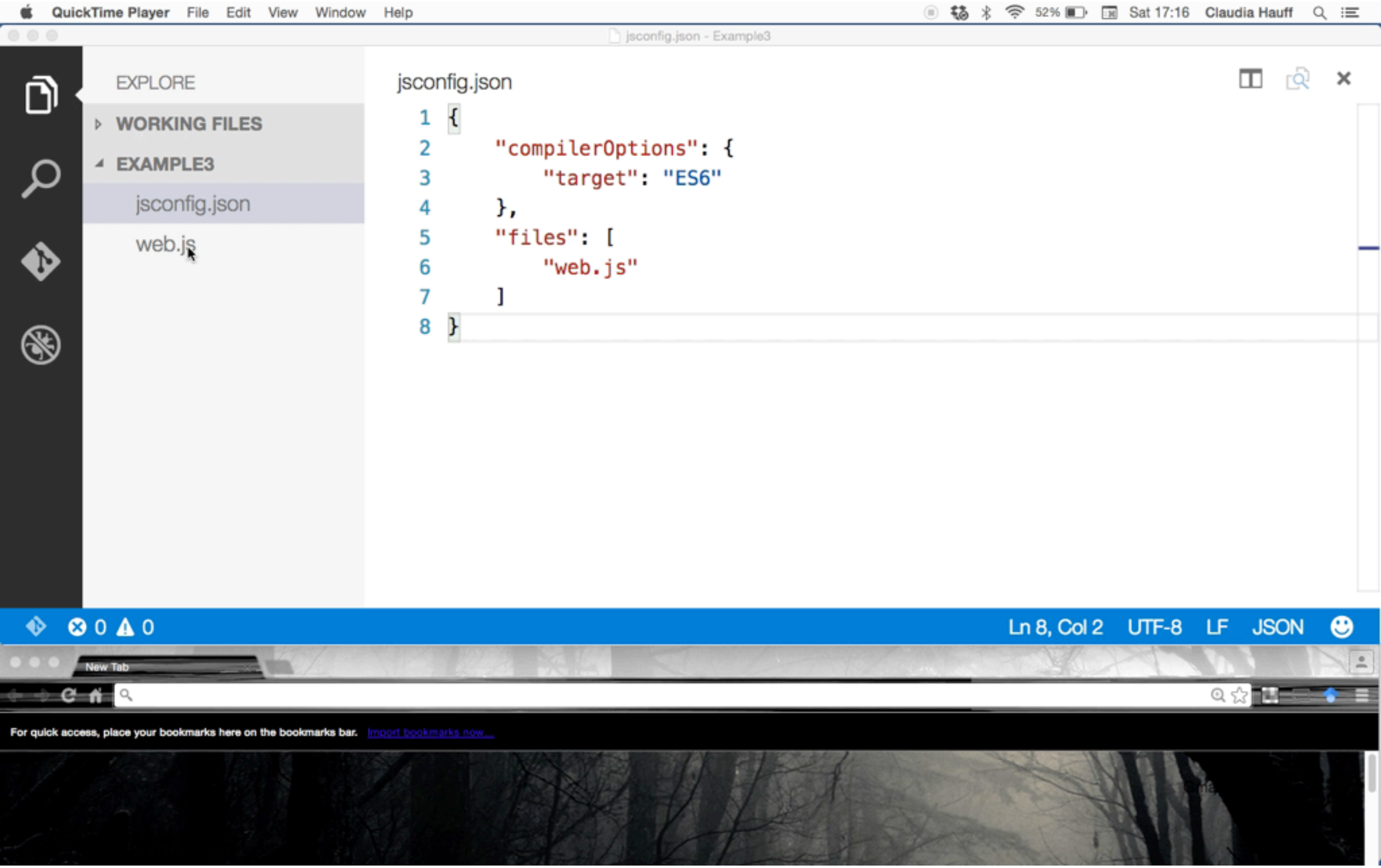
Example 3

“Hello World” in the browser



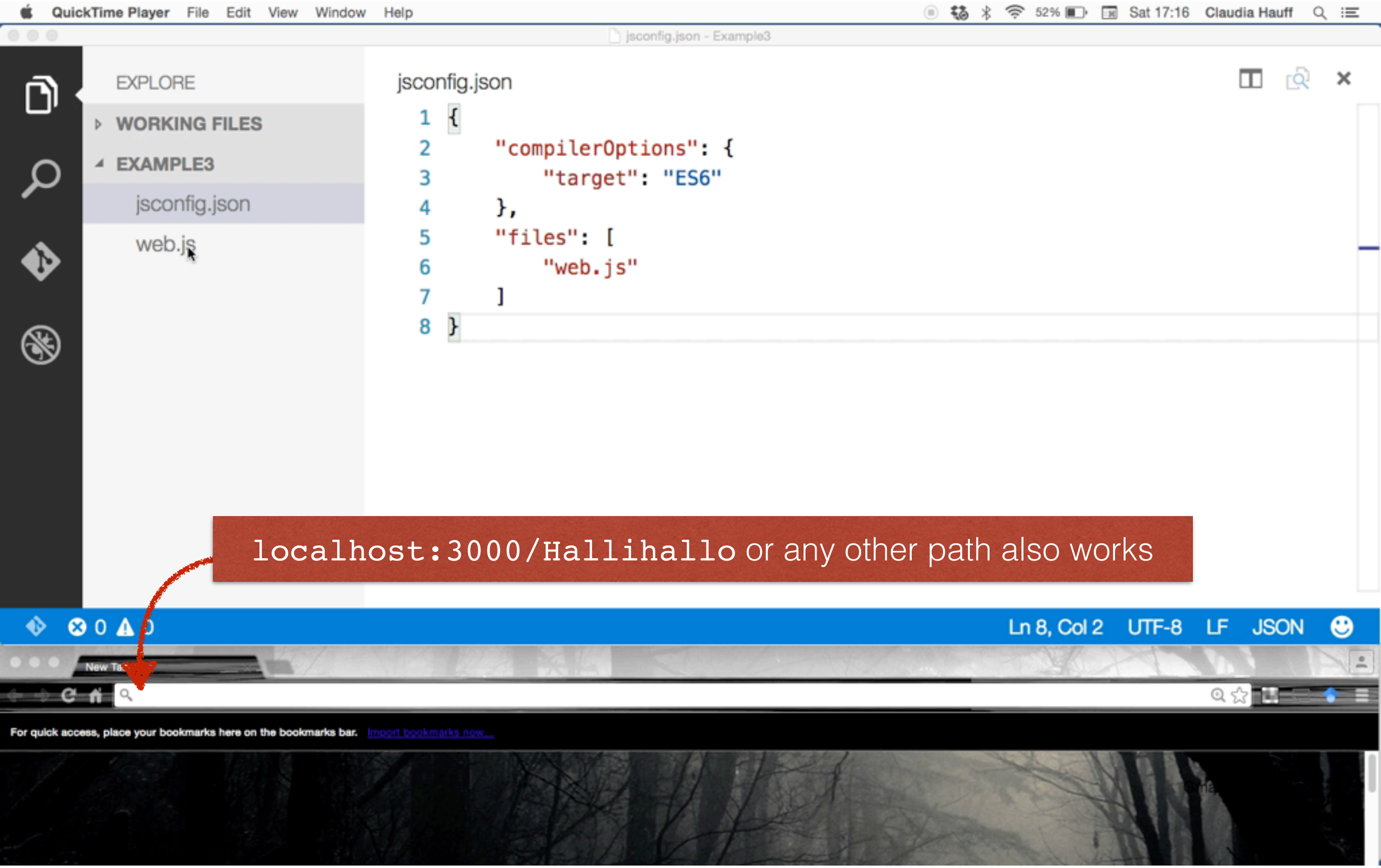
Example 3

“Hello World” in the browser



Example 3

“Hello World” in the browser



The “Hello World” of node.js

```
1 var http = require(“http");
2 var server;
3
4 server = http.createServer(function (req, res) {
5    res.writeHead(200, {"Content-Type":
6                                  "text/plain"});
7    res.end("Hello World!”);
8    console.log(“HTTP response sent”);
9 });
10
11 server.listen(3000);
12 console.log("Server listening on port 3000");
```

The “Hello World” of node.js

node.js http module

```
1  var http = require(“http");
2  var server;
3
4  server = http.createServer(function (req, res) {
5     res.writeHead(200, {"Content-Type":
6                                    "text/plain"});
7     res.end("Hello World!”);
8     console.log(“HTTP response sent”);
9  });
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11 server.listen(3000);
12 console.log("Server listening on port 3000");
```

The “Hello World” of node.js

node.js http module

Create a Web server

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1 var http = require(“http");
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The “Hello World” of node.js

node.js http module

Create a **Web server**

A callback: what to do if a request comes in

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The “Hello World” of node.js

node.js http module

Create a **Web server**

A callback: what to do if a request comes in

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```

Create a **HTTP response** & send it

The “Hello World” of node.js

node.js http module

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7    res.end("Hello World!”);
8    console.log(“HTTP response sent”);
9  });
10
11 server.listen(3000);
12 console.log("Server listening on port 3000");
```

Create a **Web server**

A callback: what to do if a request comes in

Create a **HTTP response** & send it

Start the **server** on the command line: **`$ node web.js`**
Open the browser (**client**) at: http://localhost:3000

The “Hello World” of node.js

```
1 var http = require(“http");
2 var server;
3
4 var sentCounter = 0;
5
6 server = http.createServer(function (req, res) {
7     res.writeHead(200, {"Content-Type":
8                   "text/plain"});
9     res.end("Hello World!");
10    sentCounter++;
11    console.log(sentCounter+" HTTP responses sent
12                             in total");
13 });
14
15 var port = 2345;
16 server.listen(port);
17 console.log("Server listening on port “ + port);
```

The “Hello World” of node.js

```
1  var http = require(“http");
2  var server;
3
4  var sentCounter = 0;
5
6  server = http.createServer(function (req, res) {
7      res.writeHead(200, {"Content-Type":
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```

This is standard JavaScript. We can add variables, functions, objects…

The “Hello World” of node.js

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16 server.listen(port);
17 console.log("Server listening on port “ + port);
```

This is standard JavaScript. We can add variables, functions, objects…

HTTP **request** object

The “Hello World” of node.js

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2  var server;
3
4  var sentCounter = 0;
5
6  server = http.createServer(function (req, res) {
7      res.writeHead(200, {"Content-Type":
8                     "text/plain"});
9      res.end("Hello World!");
10     sentCounter++;
11     console.log(sentCounter+" HTTP responses sent
12                                in total");
13 });
14
15 var port = 2345;
16 server.listen(port);
17 console.log("Server listening on port “ + port);
```

This is standard JavaScript. We can add variables, functions, objects…

HTTP **response** object

HTTP **request** object

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4  var sentCounter = 0;
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7      res.writeHead(200, {"Content-Type":
8                     "text/plain"});
9      res.end("Hello World!");
10     sentCounter++;
11     console.log(sentCounter+" HTTP responses sent
12                                in total");
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15 var port = 2345;
16 server.listen(port);
17 console.log("Server listening on port “ + port);
```

This is standard JavaScript. We can add variables, functions, objects…

HTTP **response** object

HTTP **request** object

Are we sending an object? Yes and no (JSON)

The “Hello World” of node.js

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17 console.log("Server listening on port “ + port);
```

This is standard JavaScript. We can add variables, functions, objects…

HTTP **response** object

HTTP **request** object

Are we sending an object? Yes and no (JSON)

Any port number between 1024 and 49151 is fine.

A little refactoring …

```
1  var http = require("http"),
2  var server;
3
4  var simpleHTTPResponder = function (req, res) {
5   res.writeHead(200, {"Content-Type":
6                       "text/plain"});
7   sentCounter++;
8   res.end("'Hello World' for the "+sentCounter+".
9           time!");
10   console.log(sentCounter+" HTTP responses sent
11               in total");
12 }
13
14 var sentCounter = 0;
15
16 server = http.createServer(simpleHTTPResponder);
17
18 var port = process.argv[2];
19 server.listen(port);
20 console.log("Server listening on port "+port);
```

A little refactoring …

```
1  var http = require("http"),
2  var server;
3
4  var simpleHTTPResponder = function (req, res) {
5   res.writeHead(200, {"Content-Type":
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7   sentCounter++;
8   res.end("'Hello World' for the "+sentCounter+".
9           time!");
10   console.log(sentCounter+" HTTP responses sent
11               in total");
12 }
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14 var sentCounter = 0;
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16 server = http.createServer(simpleHTTPResponder);
17
18 var port = process.argv[2];
19 server.listen(port);
20 console.log("Server listening on port "+port);
```

function as parameter

command line parameter

Using URLs for routing

```
1  var http = require("http");
2  var url = require('url');
3  var server;
4
5  var simpleHTTPResponder = function (req, res) {
6    var url_parts = url.parse(req.url, true);
7    if(url_parts.pathname == "/greetme") {
8       res.writeHead(200, {"Content-Type":
9                     "text/plain"});
10      var query = url_parts.query;
11      if( query["name"]!=undefined) {
12         res.end("Greetings "+query["name"]);
13      }
14      else { res.end("Greetings Anonymous”); }
15   }
16   else {
17      res.writeHead(404,{"Content-Type":
18                    "text/plain"});
19      res.end("Only /greetme is implemented.");
20   }
21 }
22
23 server = http.createServer(simpleHTTPResponder);
24 var port = process.argv[2];
25 server.listen(port);
```

Using URLs for routing

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1  var http = require("http");
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23 server = http.createServer(simpleHTTPResponder);
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```

if the **pathname** is **`/greetme`** we greet

Using URLs for routing

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15   }
16   else {
17      res.writeHead(404,{"Content-Type":
18                    "text/plain"});
19      res.end("Only /greetme is implemented.");
20   }
21 }
22
23 server = http.createServer(simpleHTTPResponder);
24 var port = process.argv[2];
25 server.listen(port);
```

if the **pathname** is **`/greetme`** we greet

we can **extract params** from the **URL**

Using URLs for routing

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23 server = http.createServer(simpleHTTPResponder);
24 var port = process.argv[2];
25 server.listen(port);
```

if the **pathname** is **`/greetme`** we greet

we can **extract params** from the **URL**

otherwise send back a **404 error**

Example 4

URL routing

QuickTime Player File Edit View Window Help — 26% — Sat 19:26 — Claudia Hauff

routing.js - Example3

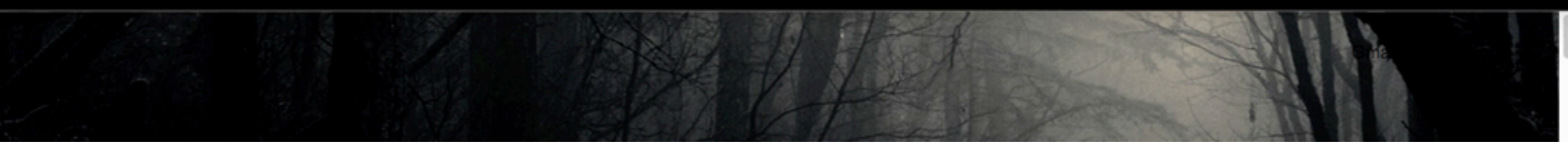
EXPLORE

- WORKING FILES
- EXAMPLE3
  - .vscode
    - launch.json
  - jsconfig.json
  - routing.js

routing.js

```
2     url = require('url'),
3     server;
4
5 var simpleHTTPResponder = function (req, res) {
6     var url_parts = url.parse(req.url, true);
7     if (url_parts.pathname === "/greetme") {
8         res.writeHead(200, {
9             "Content-Type": "text/plain"
10        });
11        var query = url_parts.query;
12        if (query["name"] !== undefined) {
13            res.end("Greetings " + query["name"]);
14        }
15        else {
16            res.end("Greetings Anonymous");
17        }
18    }
19    else {
20        res.writeHead(404, {
21            "Content-Type": "text/plain"
22        });
23        res.end("Only /greetme is implemented!");
24    }
25 };
26 server = http.createServer(simpleHTTPResponder);
27 var port = 3000;
28 server.listen(port, function () {
29     console.log("Server listening on port " + port);
30 });
31
```

0 0 — Ln 1, Col 1 — UTF-8 — LF — JavaScript



Example 4

URL routing

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routing.js - Example3

EXPLORE

- WORKING FILES
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  - .vscode
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routing.js

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7     if (url_parts.pathname === "/greetme") {
8         res.writeHead(200, {
9             "Content-Type": "text/plain"
10        });
11        var query = url_parts.query;
12        if (query["name"] !== undefined) {
13            res.end("Greetings " + query["name"]);
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17        }
18    }
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22        });
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25 };
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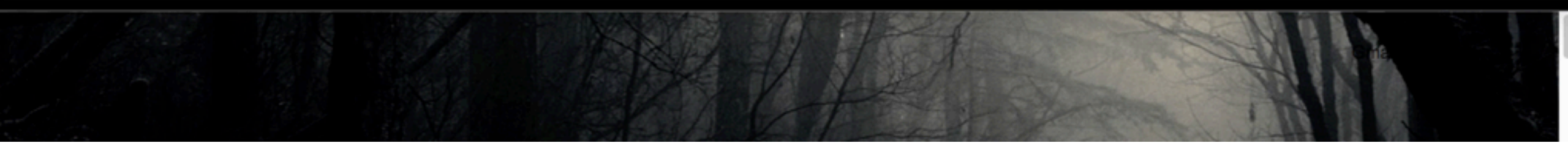

Example 4

URL routing

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routing.js - Example3

EXPLORE

- WORKING FILES
- EXAMPLE3
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  - jsconfig.json
  - routing.js

routing.js

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4
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9             "Content-Type": "text/plain"
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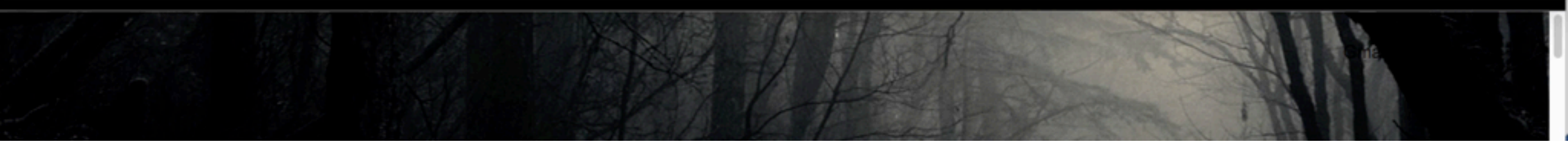
30 });
31
```

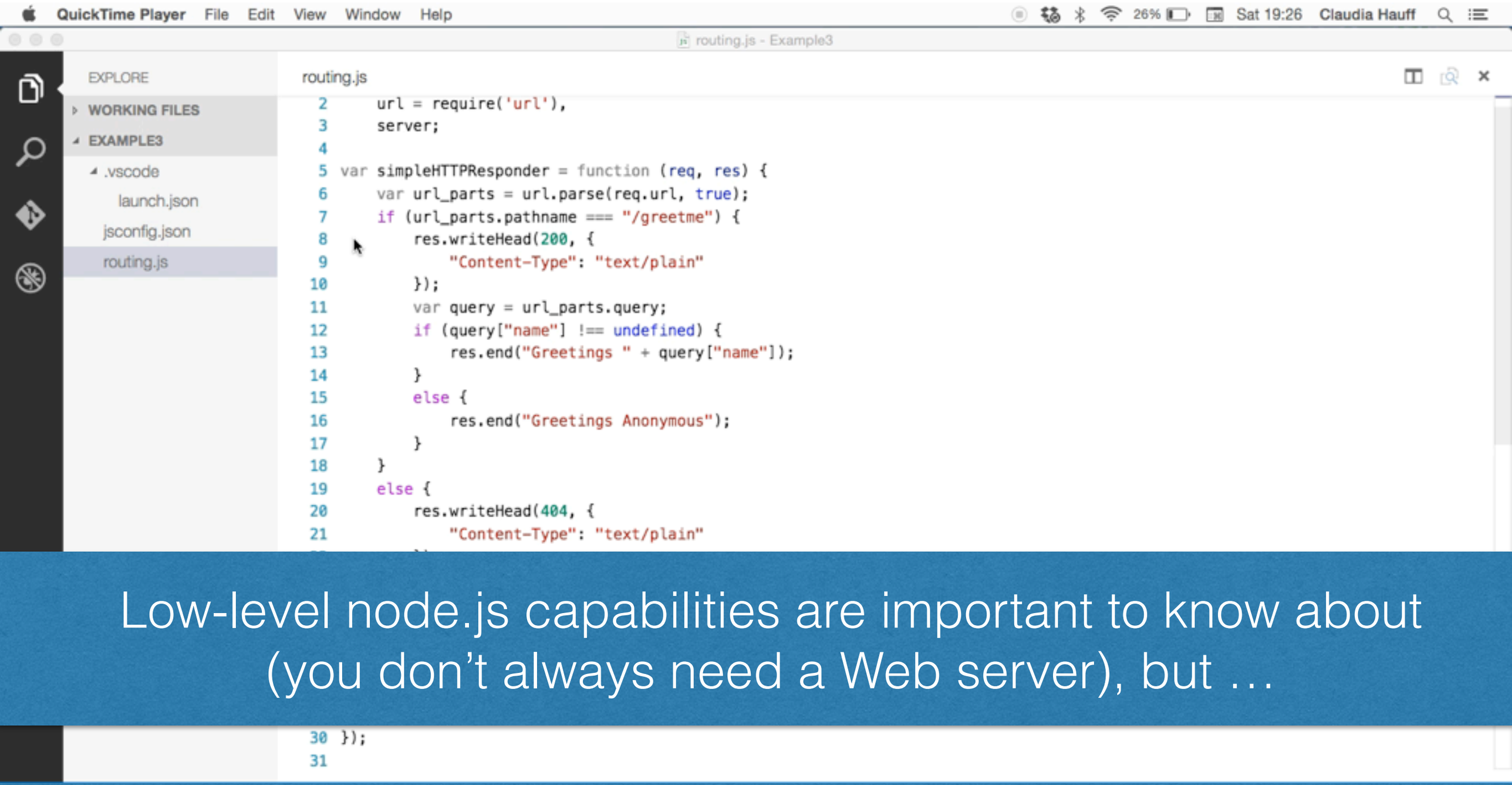
Low-level node.js capabilities are important to know about (you don't always need a Web server), but …

0 0 — Ln 1, Col 1 — UTF-8 — LF — JavaScript



Example 4

URL routing



Low-level node.js capabilities are important to know about (you don't always need a Web server), but …

Tedious to write an HTTP server this way.
How do you send CSS files and images?

0:35

Executing this node.js code yields which console output?

```
1  var fs = require('fs');
2  var n;
3
4  function f() {
5    // asynchronous
6    fs.readFile('n.txt', function(err, content) {
7      n = parseInt(content); //n.txt contains 42
8      n++;
9    })
10 }
11
12 f();
13 console.log(n);
```

0:35

Executing this node.js code yields which console output?

```
1  var fs = require('fs');
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12 f();
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```

0:35

Executing this node.js code yields which console output?

```
1  var fs = require('fs');
2
3  function f(done) {
4      fs.readFile('n.txt', function(err,
5                  fileContents) {
6          var n = parseInt(fileContents); //n.txt
7                                          //contains 42
8          n++;
9          done(n);
10     });
11 }
12
13 f(function(n){
14     console.log(n);
15 });
```

0:35

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10     });
11 }
12
13 f(function(n){
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```

0:35

Executing this node.js code yields which console output?

```
1 const fs = require('fs');
2 var file1 = "file1";//assume the file exists
3 var file2 = "file2";//assume the file exists
4
5 var exists1;
6 var exists2;
7
8 fs.exists(file1, function (exists) {
9  if (exists)
10     exists1 = true;
11 });
12
13 fs.exists(file2, function (exists) {
14  if(exists)
15     exists2 = true;
16 });
17
18 console.log(exists1+"/"+exists2);
```

`fs.exists()` is asynchronous; it tests whether the given file exists; callback argument contains either `true` (exists) or `false` (does not exist)

0:35

Executing this node.js code yields which console output?

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1 const fs = require('fs');
2 var file1 = "file1";//assume the file exists
3 var file2 = "file2";//assume the file exists
4
5 var exists1;
6 var exists2;
7
8 fs.exists(file1, function (exists) {
9  if (exists)
10     exists1 = true;
11 });
12
13 fs.exists(file2, function (exists) {
14  if(exists)
15     exists2 = true;
16 });
17
18 console.log(exists1+"/"+exists2);
```

`fs.exists()` is asynchronous; it tests whether the given file exists; callback argument contains either `true` (exists) or `false` (does not exist)

0:35

Executing this node.js code yields which console output?

```
1 const fs = require('fs');
2 var file1 = "file1";//assume the file exists
3 var file2 = "file2";//assume the file exists
4
5 var exists1;
6 var exists2;
7
8 if(fs.existsSync(file1)){
9  exists1 = true;
10 };
11
12 if(fs.existsSync(file2)) {
13  exists2 = true;
14 };
15
16 console.log(exists1+"/"+exists2);
```

`fs.existsSync()`: synchronous version of `fs.exists()`. Returns `true` if the file exists, `false` otherwise.

0:35

Executing this node.js code yields which console output?

```
1 const fs = require('fs');
2 var file1 = "file1";//assume the file exists
3 var file2 = "file2";//assume the file exists
4
5 var exists1;
6 var exists2;
7
8 if(fs.existsSync(file1)){
9  exists1 = true;
10 };
11
12 if(fs.existsSync(file2)) {
13  exists2 = true;
14 };
15
16 console.log(exists1+"/"+exists2);
```

`fs.existsSync()`: synchronous version of `fs.exists()`. Returns `true` if the file exists, `false` otherwise.

Express

Express

- node.js has a **small core** code base
- node.js comes with some **core modules included** (like http)
- Express is not one of them (but we have **NPM**)

```
$ npm install express
```

a collection of code with a public interface

node package manager

Express

- node.js has a **small core** code base
- node.js comes with some **core modules included** (like http)
- Express is not one of them (but we have **NPM**)

```
$ npm install express
```

a collection of code with a public interface

node package manager

"The Express module creates a **layer on top of the core http module** that handles a lot of **complex things** that we don't want to handle ourselves, like **serving up static** HTML, CSS, and client-side JavaScript files." **(Web course book, Ch. 6)**

The “Hello World” of Express

```
1 var express = require("express");
2 var url = require("url");
3 var http = require("http");
4 var app;
5
6 var port = process.argv[2];
7 app = express();
8 http.createServer(app).listen(port);
9
10 app.get("/greetme", function (req, res) {
11  var query = url.parse(req.url, true).query;
12  var name = ( query["name"]!=undefined) ?
13                                  query[“name"] : "Anonymous";
14  res.send("Greetings "+name);
15 });
16
17 app.get("/goodbye", function (req, res) {
18  res.send("Goodbye you!");
19});
```

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app object is our way to use Express’ abilities

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URL “route” set up

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URL “route” set up

another route

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app object is our way to use Express’ abilities

URL “route” set up

another route

Express creates HTTP headers for us

Express and HTML …

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16            ");
17 });
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Express and HTML …

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```

error-prone, **not maintainable**, fails at anything larger than a toy project.

Express and its static file server

- **Static files**: files that are not created/changed on the fly
  - CSS
  - JavaScript (client-side)
  - HTML
  - Images, video, etc.

- A single line of code is sufficient to serve static files:
  `app.use(express.static(__dirname + "/static"));`

- Express always **first** checks the static files for a given route - if not found, the dynamic routes are checked

a static files are contained in this directory

How to build a Web application

Development strategy

```
todo-server.js
client/
    index.html
    html/
        =>error.html
        =>addtodo.html
images/
    =>background.png
    =>logo.png
css/
    =>layout.css
    =>style.css
javascript/
    =>client-app.js
```

Development strategy

- Develop the **client-side code** (HTML, CSS, JavaScript)

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Development strategy

- Develop the **client-side code** (HTML, CSS, JavaScript)
- Place all files into some directory (e.g. `/client`) **on the server**

```
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- Develop the **client-side code** (HTML, CSS, JavaScript)
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- Develop the **client-side code** (HTML, CSS, JavaScript)
- Place all files into some directory (e.g. `/client`) **on the server**
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Development strategy

- Develop the **client-side code** (HTML, CSS, JavaScript)
- Place all files into some directory (e.g. `/client`) **on the server**
- Define the **node.js server code** in a *.js file using Express
- Set **Express' static file path** to the directory of step 2
- Add interactivity between client and server via **Ajax** and **JSON**

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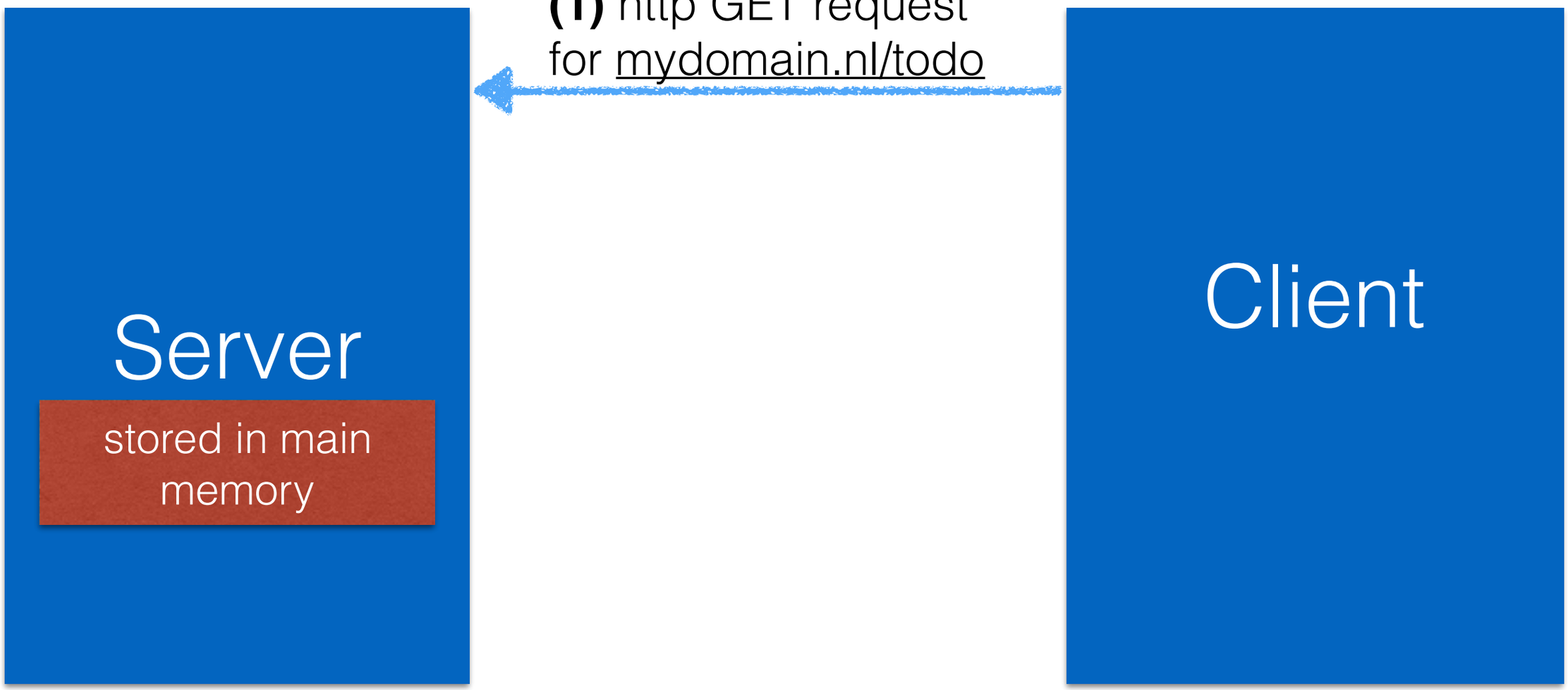
    index.html
    html/
        =>error.html
        =>addtodo.html
images/
    =>background.png
    =>logo.png
css/
    =>layout.css
    =>style.css
javascript/
    =>client-app.js
```

TODO Web app flow

TODO Web app flow



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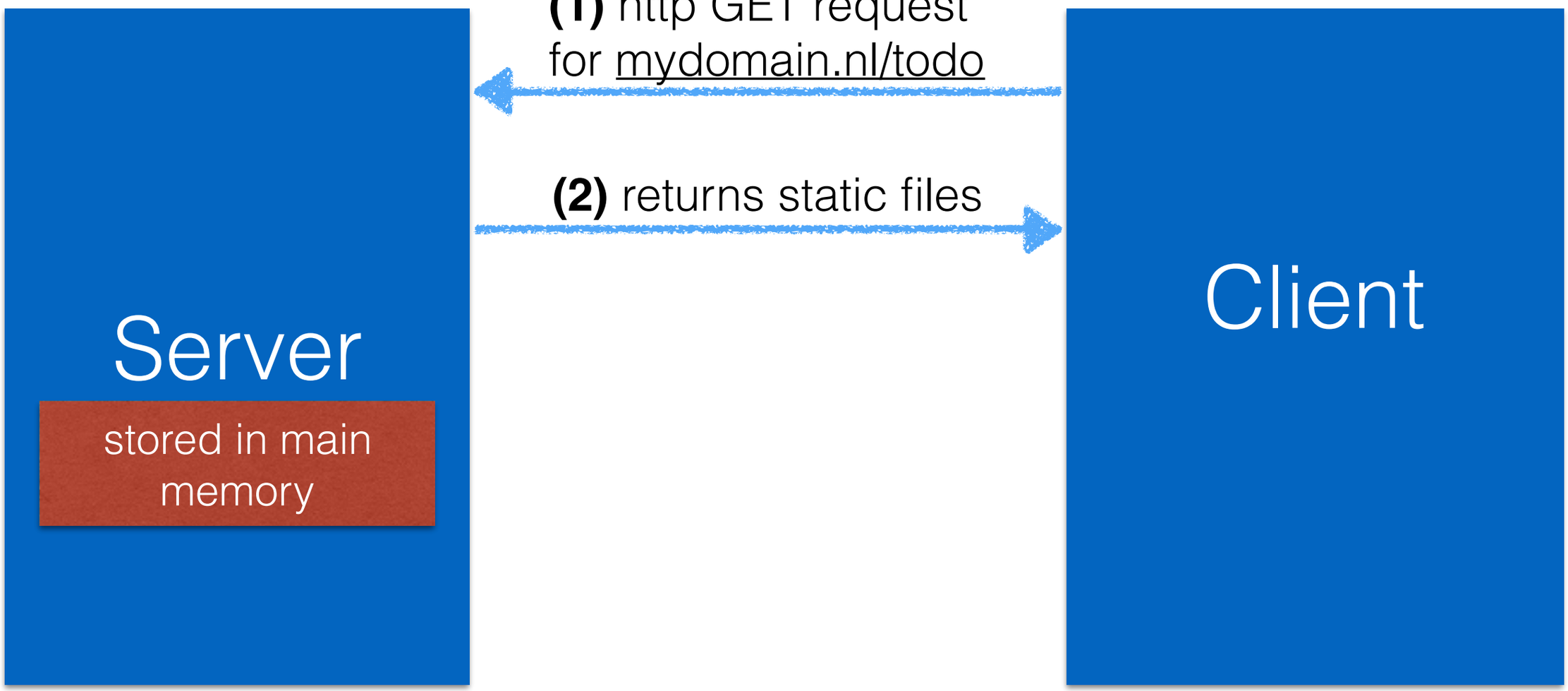

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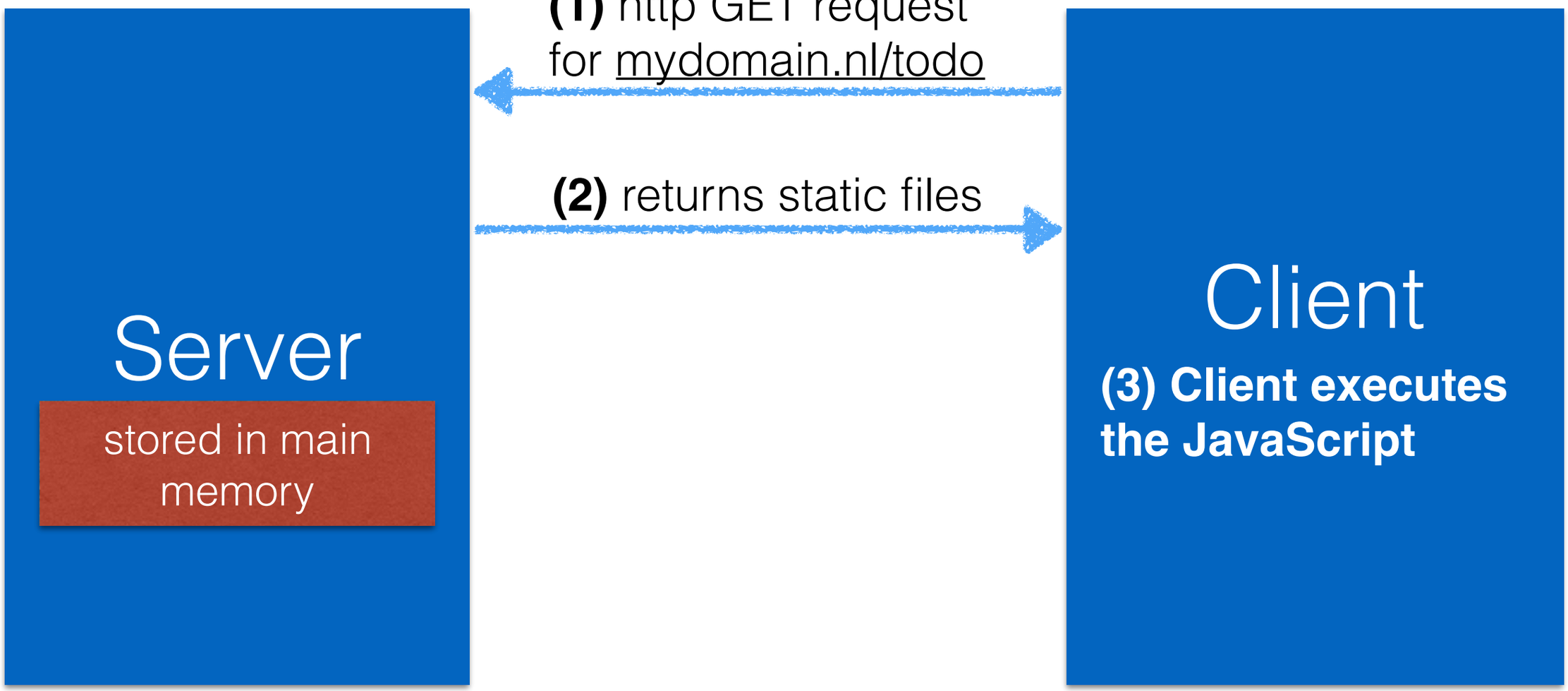

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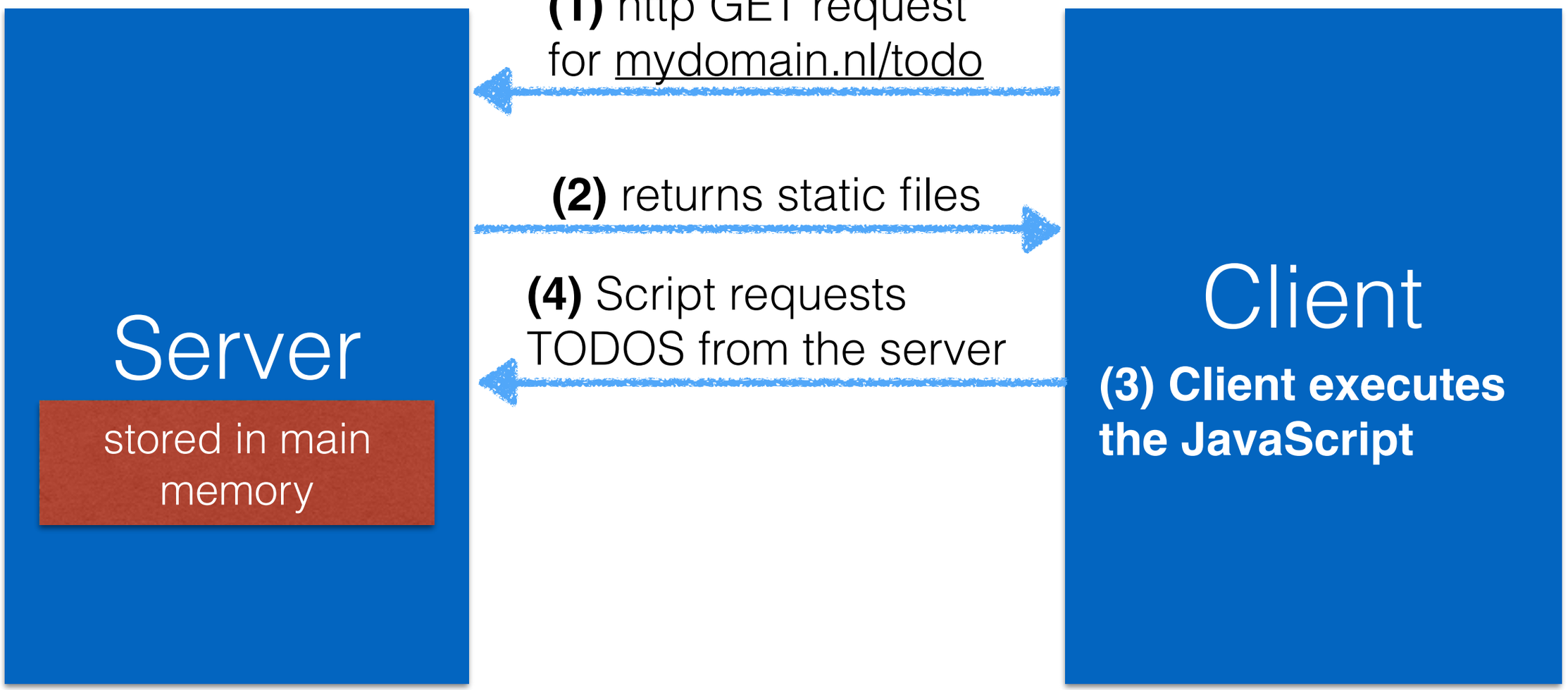

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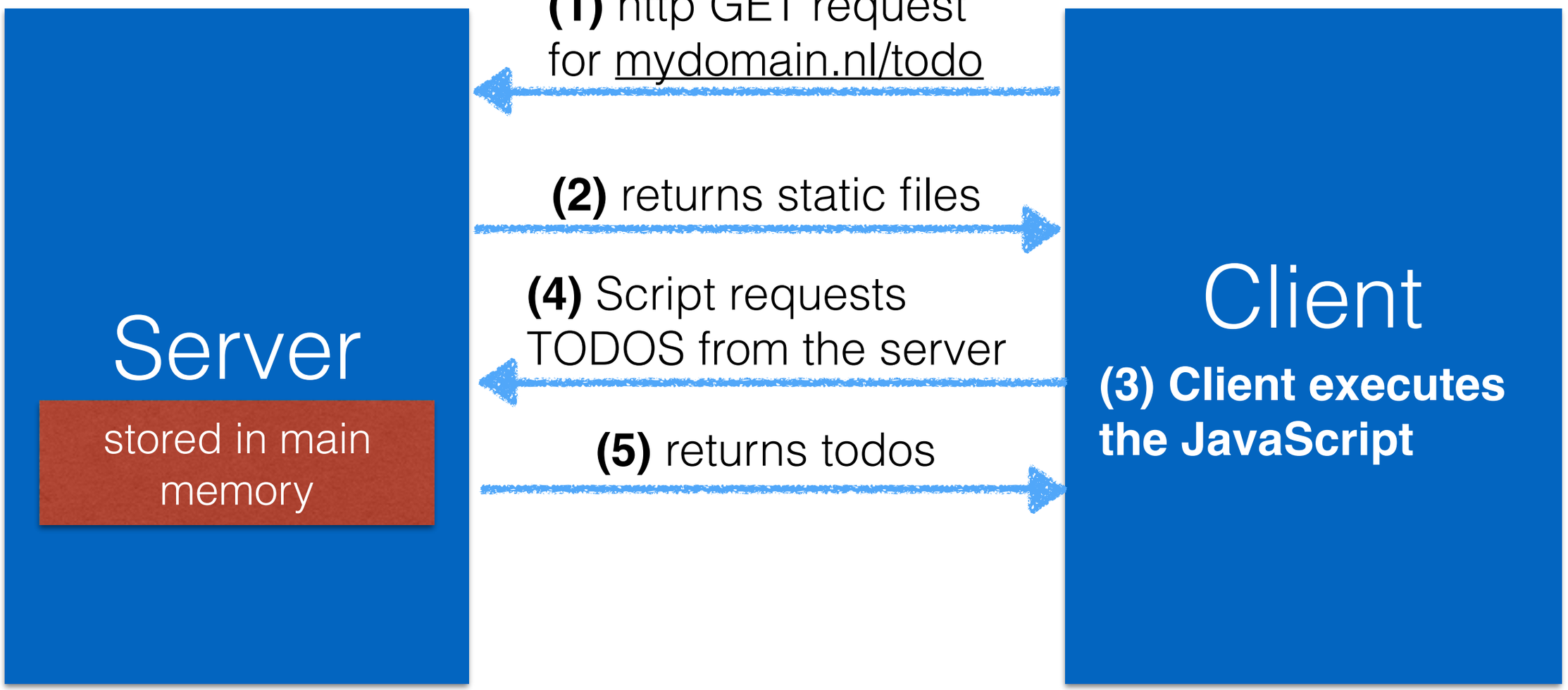

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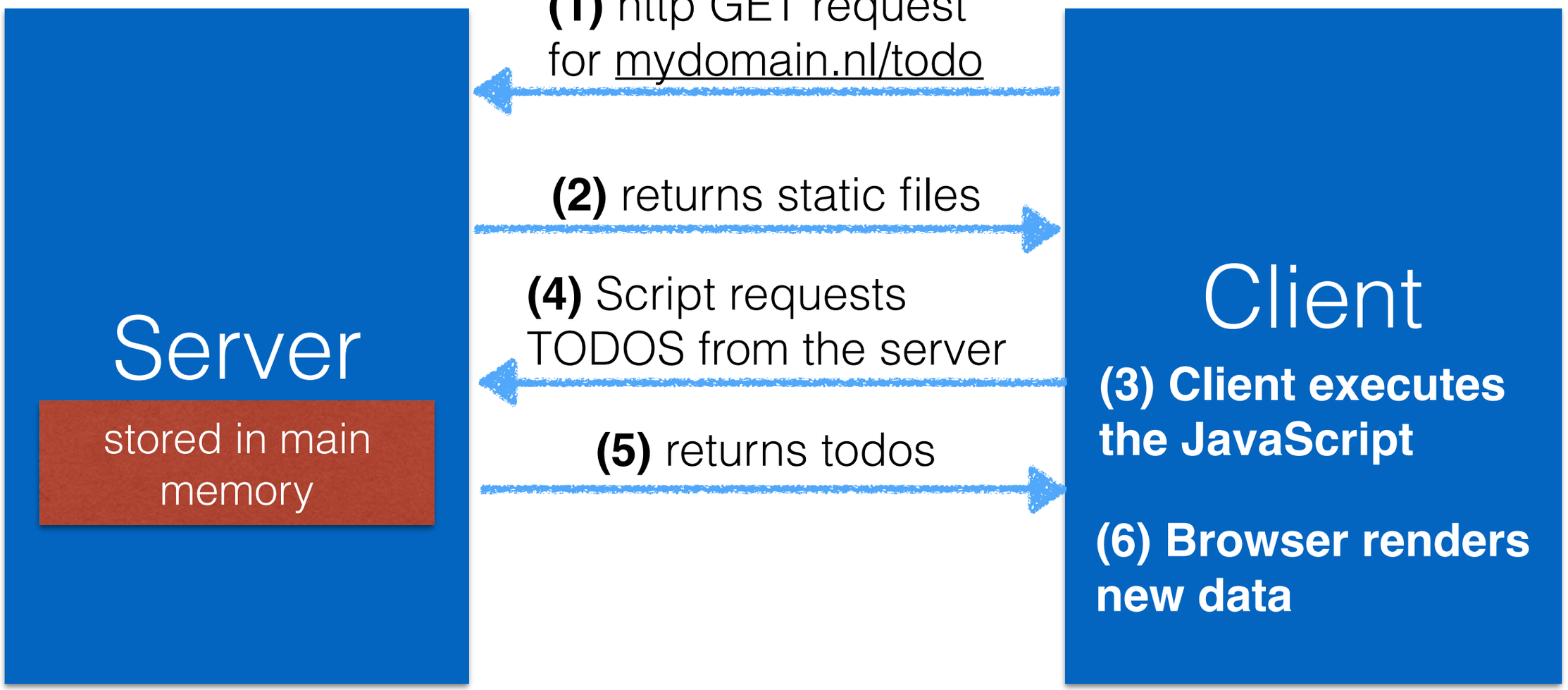

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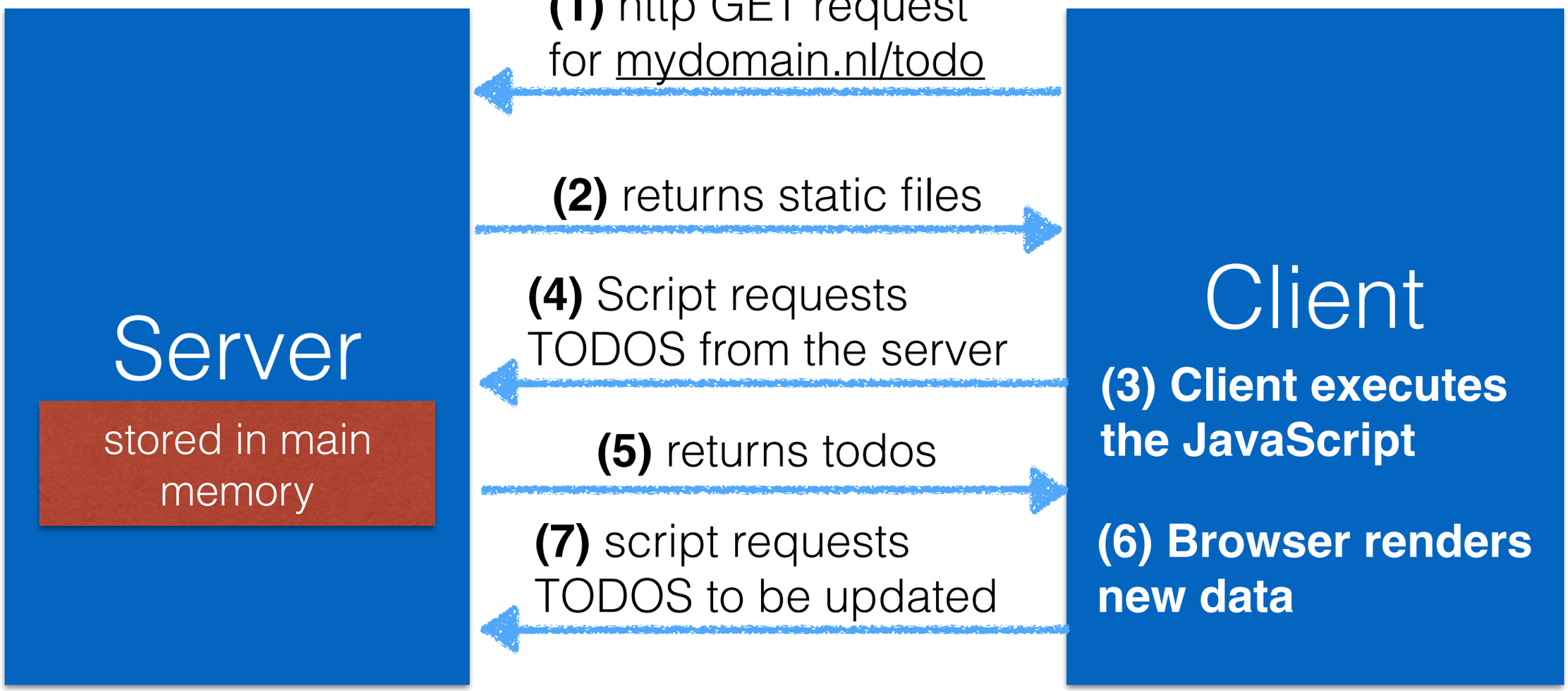

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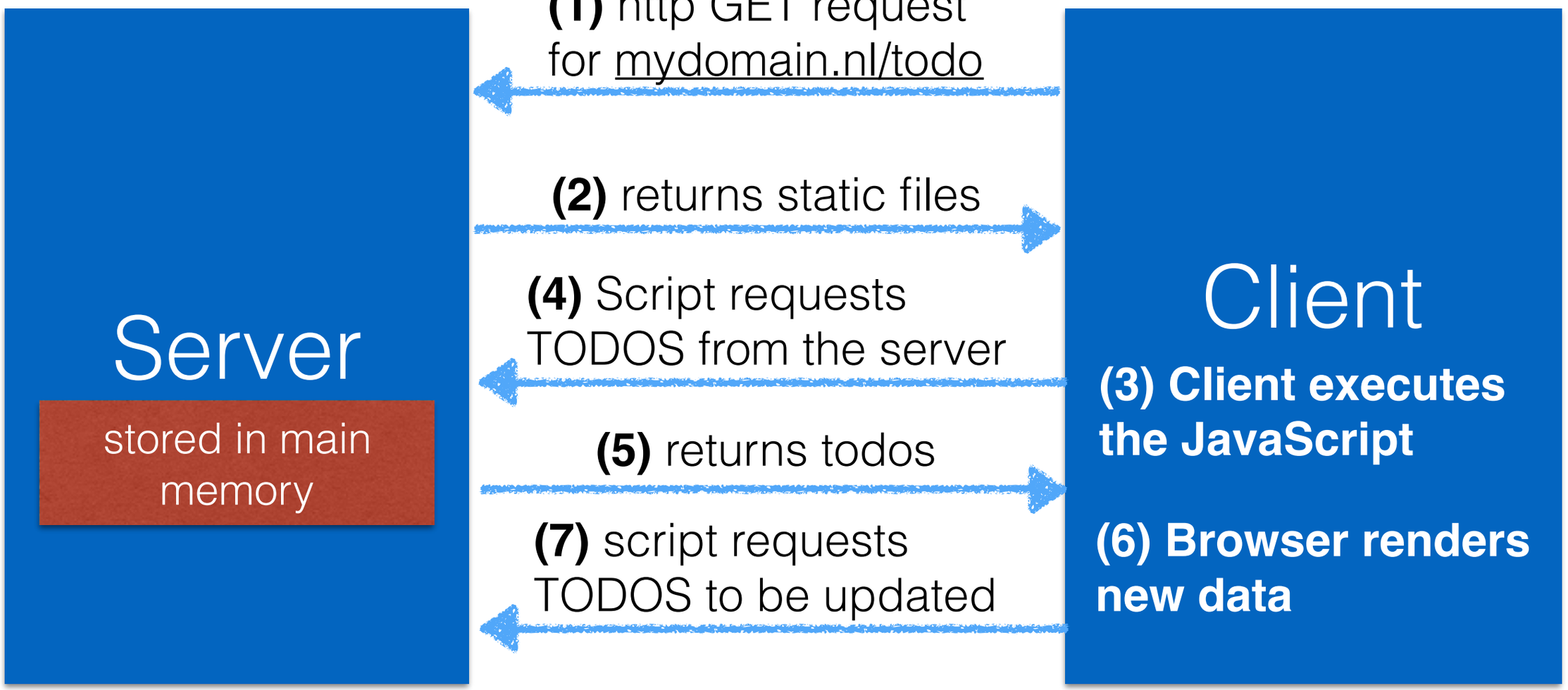

stored in a database (next time)

JSON: exchanging data between the client and server

Exchanging data: JSON

JavaScript Object Notation

- In early (earlier) years, **XML** was used as data exchange format - well defined but not easy to handle
- Developed by **Douglas Crockford**
- XML is often too **bulky** in practice; JSON is much **smaller** than XML
- JSON can be fully parsed using **built-in JavaScript** commands
- JavaScript objects can be turned into JSON with a call

JSON vs. XML

```xml
<!--?xml version="1.0"?-->
<timezone>
  <location></location>
  <offset>1</offset>
  <suffix>A</suffix>
  <localtime>20 Jan 2014 02:39:51</localtime>
  <isotime>2014-01-20 02:39:51 +0100</isotime>
  <utctime>2014-01-20 01:39:51</utctime>
  <dst>False</dst>
</timezone>
```

XML

```json
{
  "timezone": {
    "offset": "1",
    "suffix": "A",
    "localtime": "20 Jan 2014 02:39:51",
    "isotime": "2014-01-20 02:39:51 +0100",
    "utctime": "2014-01-20 01:39:51",
    "dst": "False"
  }
}
```

JSON

JSON vs. JavaScript Objects

- JSON: all object property names must be enclosed in quotes

- JSON objects **do not have functions** as properties

- Any JavaScript object can be transformed into JSON via `JSON.stringify`

On the server: sending JSON

```
1 var express = require("express");
2 var url = require("url");
3 var http = require("http");
4 var app;
5
6 var port = process.argv[2];
7 app = express();
8 http.createServer(app).listen(port);
9
10 var todos = [];
11 var t1 = { message : "Maths homework due",
12            type : 1, deadline : "12/12/2014"};
13 var t2 = { message : "English homework due",
14            type : 3, deadline : "20/12/2014"};
15 todos.push(t1);
16 todos.push(t2);
17
18 app.get("/todos", function (req, res) {
19  res.json(todos);
20 });
```

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1 var express = require("express");
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in-memory todos

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19  res.json(todos);
20 });
```

in-memory todos

Send **JSON** to **client**

On the server: todo updating

```
1 app.get("/addtodo", function (req, res) {
2  var url_parts = url.parse(req.url, true);
3  var query = url_parts.query;
4  if(query["message"]!==undefined) {
5     var tx = { message: query["message"],
6                type: query["type"],
7                deadline : query[“deadline"]};
8     todos.push(tx);
9     res.end("Todo added successfully");
10    console.log("Added "+tx.message);
11 }
12 else
13 {
14    res.end("Error: missing message parameter");
15 }
16 });
```

On the server: todo updating

```
1  app.get("/addtodo", function (req, res) {
2   var url_parts = url.parse(req.url, true);
3   var query = url_parts.query;
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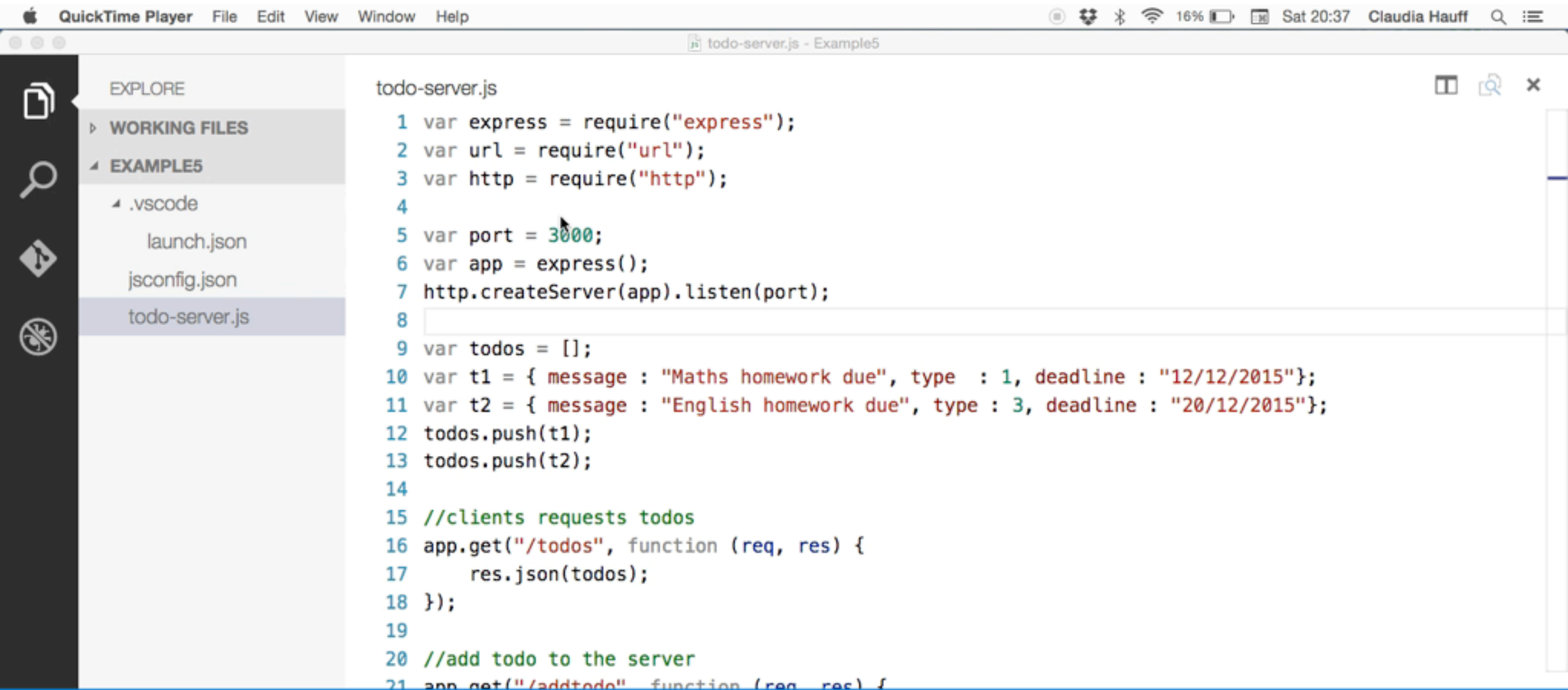
is message a key in the **query**?

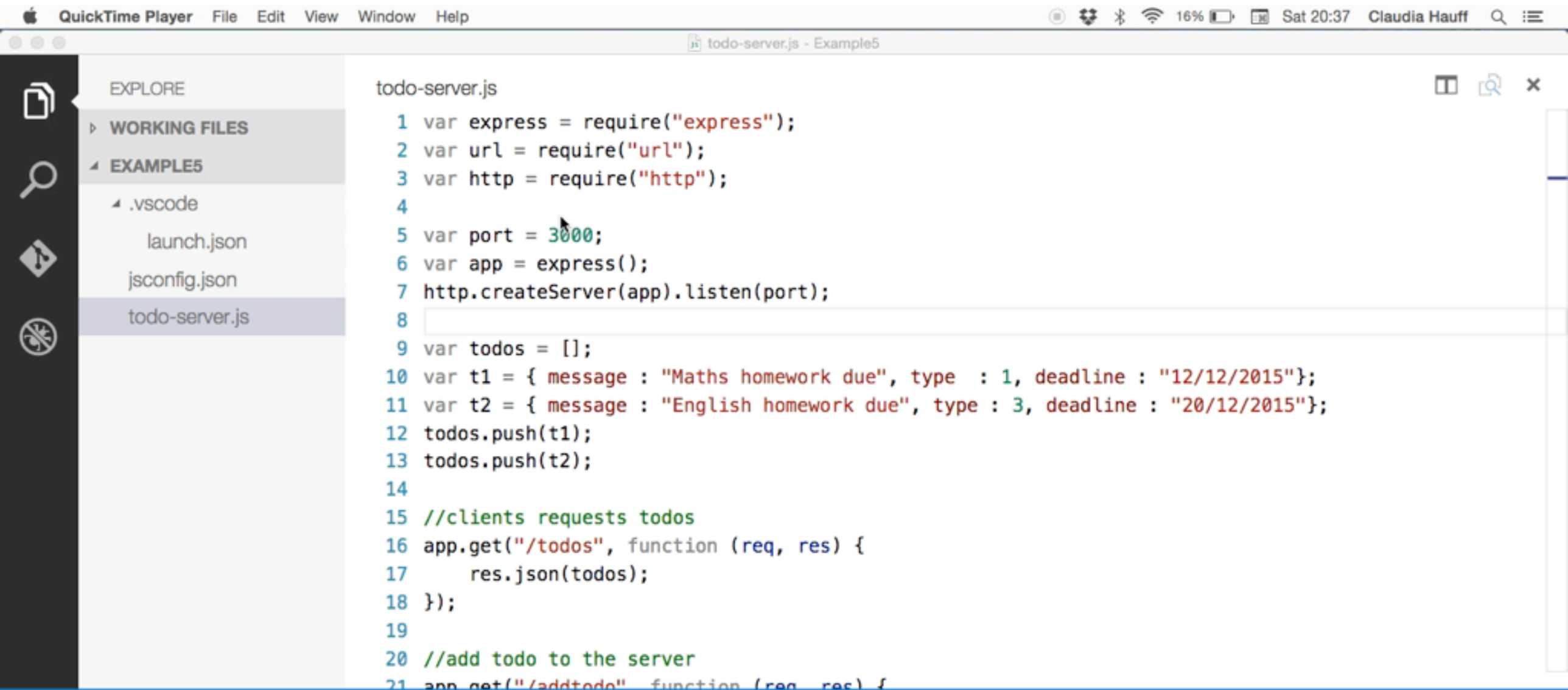
Example 5

Sending json & todo updating



Example 5

Sending json & todo updating



Ajax: dynamic updating on the client

Ajax

XML only in the name

Asynchronous JavaScript and XML

- Ajax is a **JavaScript mechanism** that enables the dynamic loading of content without having to refetch/ reload the page manually
- Ajax: technology to **inject** new data into an existing web page (not a language or a product)
- You see this technology every day: chats, endless scrolling

0:35

How does an Ajax request appear to a Web server?

A. An Ajax request looks like any other http request.

B. An Ajax request is not sent via http, but instead via atp, the *Ajax transfer protocol*.

C. An Ajax request always has to be sent as part of an HTML `<form>`.

D. An Ajax request is never sent to a Web server, the reply is generated by the browser cache.

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Imagine building a chat application using Ajax. How is the browser notified of new messages to display?

A. Ajax allows the server to push http responses to the client.
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- Ajax: technology to **inject** new data into an existing web page (not a language or a product)
- You see this technology every day: chats, endless scrolling
- Ajax revolves around **`XMLHttpRequest`**, a JavaScript object
- **jQuery hides all complexity, makes Ajax calls easy**

On the client: basic HTML

jQuery way

```
1  <!doctype html>
2  <html>
3      <head>
4          <title>Plain text TODOs</title>
5          <script src="http://code.jquery.
6                       com/jquery-1.11.1.js"
7                       type="text/javascript"></script>
9          <script src="javascript/client-app.js"
10                      type="text/javascript"></script>
12     </head>
13     <body>
14       <main>
15          <section id="todo-section">
16             <p>My list of TODOS:</p>
17             <ul id="todo-list">
18             </ul>
19          </section>
20       </main>
21     </body>
22 </html>
```

On the client: basic HTML

jQuery way

Load the JavaScript files, **start with jQuery**

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22 </html>
```

Load the JavaScript files, **start with jQuery**

Define where the TODOs will be added.

On the client: JavaScript

jQuery way

```
1  var main = function () {
2   "use strict";
3
4   var addTodosToList = function (todos) {
5      var todolist = document.getElementById("todo-list");
6
7      for (var key in todos) {
8           var li = document.createElement("li");
9           li.innerHTML = "TODO: “+todos[key].message;
10          todolist.appendChild(li);
11     }
12  };
13
14  $.getJSON("todos", addTodosToList);
15 }
16 $(document).ready(main);
```

when the document is loaded, execute main()

On the client: JavaScript

jQuery way

Callback: define what happens when a todo object is available

```
1  var main = function () {
2   "use strict";
3
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6
7      for (var key in todos) {
8            var li = document.createElement("li");
9            li.innerHTML = "TODO: “+todos[key].message;
10           todolist.appendChild(li);
11     }
12  };
13
14   $.getJSON("todos", addTodosToList);
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16 $(document).ready(main);
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On the client: JavaScript

jQuery way

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10           todolist.appendChild(li);
11     }
12  };
13
14   $.getJSON("todos", addTodosToList);
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```

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On the client: JavaScript

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```

Callback: define what happens when a todo object is available

Dynamic insert of list elements into the DOM

this is Ajax

when the document is loaded, execute main()

Example 6

Ajax

Code File Edit View Goto Window Help — 87% — Sat 22:27 — Claudia Hauff

index.html - Example6

EXPLORE

WORKING FILES
- index.html client
- client-app.js client/java...
- todo-server.js

EXAMPLE6
- .vscode
- client
  - html
  - javascript
    - client-app.js
    - index.html
  - jsconfig.json
  - todo-server.js

index.html client

```
1  <!doctype html>
2  <html>
3
4  <head>
5      <title>Plain text TODOs</title>
6      <script src="http://code.jquery.com/jquery-1.11.1.js" type="text/javascript"></script>
7      <script src="javascript/client-app.js" type="text/javascript"></script>
8  </head>
9
10 <body>
11     <main>
12         <section id="todo-section">
13             <p>My list of TODOS:</p>
14             <ul id="todo-list">
15             </ul>
16         </section>
17     </main>
18 </body>
19 </html>
```

2 0 — Ln 9, Col 1 — UTF-8 — LF — HTML

Example 6

Ajax

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2 0 — Ln 9, Col 1 — UTF-8 — LF — HTML

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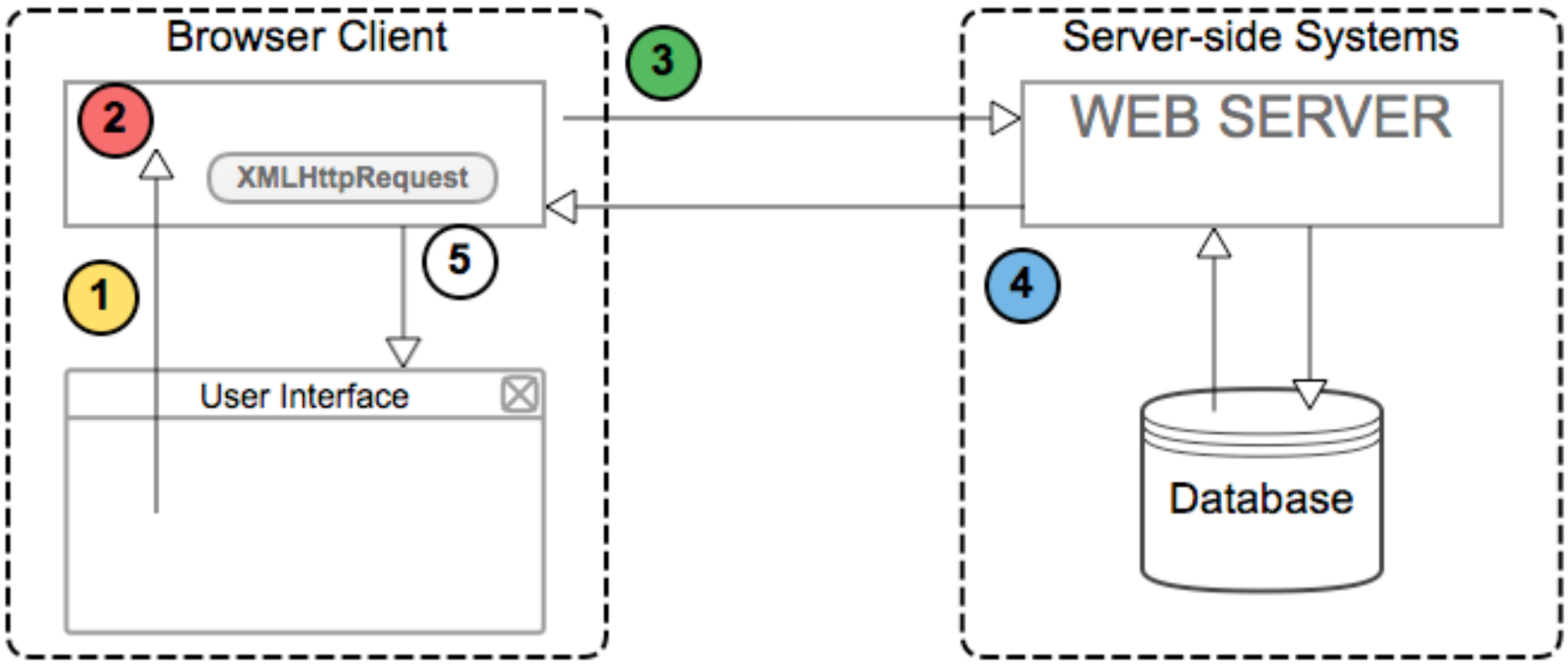
We now have a fully functioning Web app!

Ajax: how does it work?

1. Web browser creates a **`XMLHttpRequest`** object
2. `XMLHttpRequest` **requests data** from a Web server
3. **Data is sent back** from the server
4. On the client, **JavaScript code injects the data** into the page

Ajax: how does it work?



1. JavaScript call
2. XMLHttpRequest
3. HTTP request
4. Data returns
5. HTML & CSS data

Without Ajax …

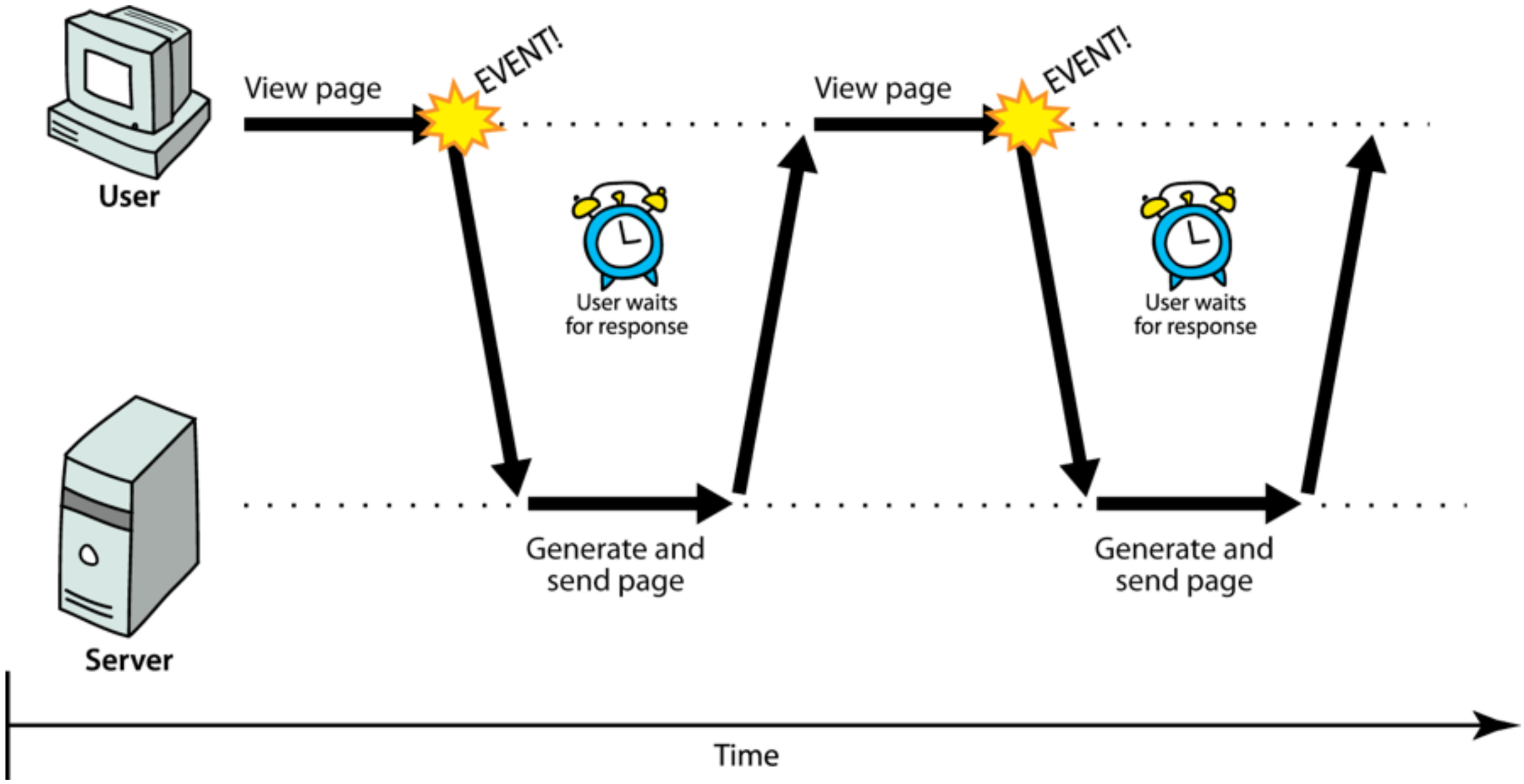


Image source: Web Programming Step by Step

Ajax works differently

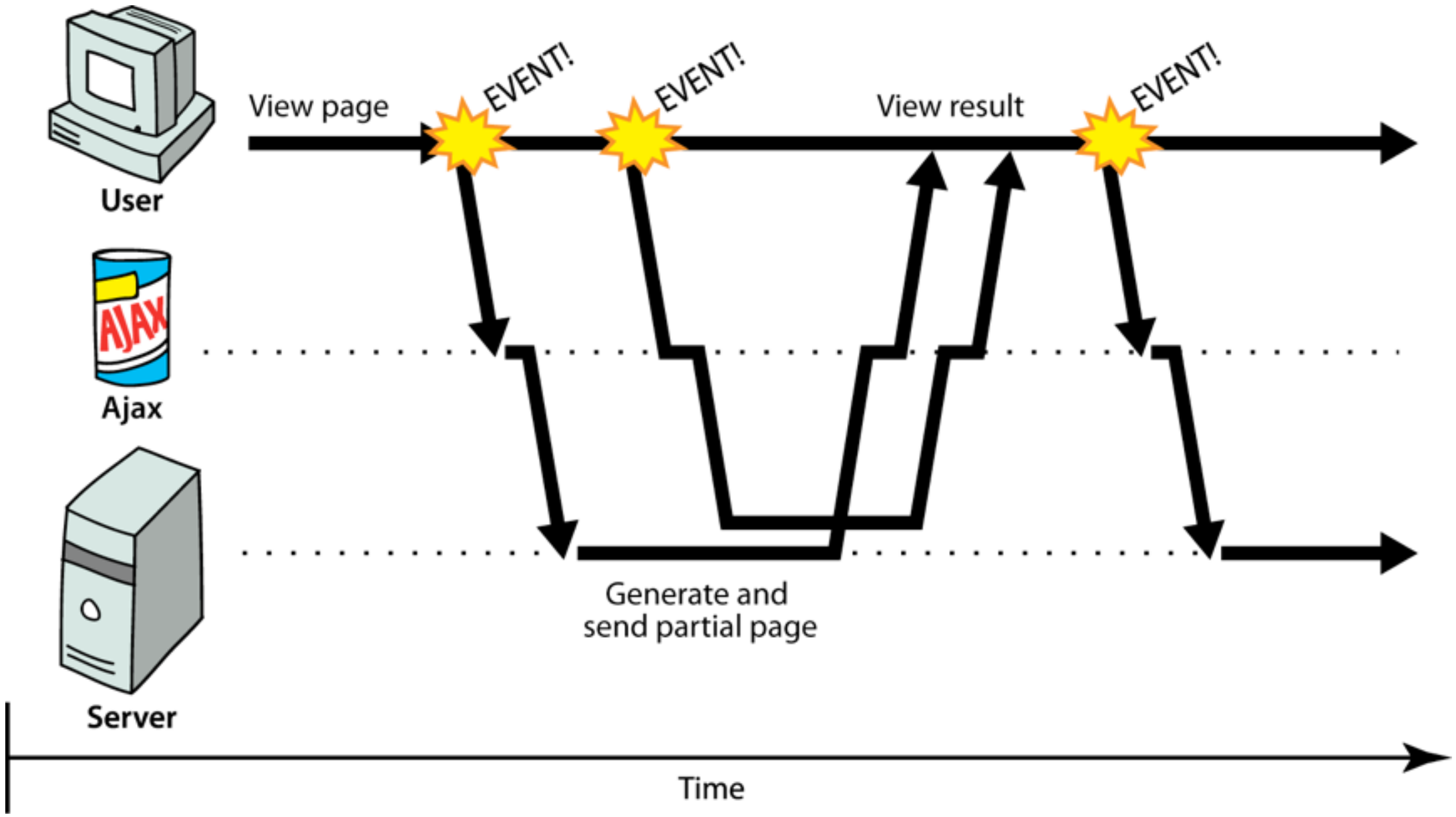


Image source: Web Programming Step by Step

Ajax: synchronous request

plain JS

```
1 //IE6 and prior IE versions use Microsoft.
2 XMLHTTP instead
3 var ajax = new XMLHttpRequest();
4
5 //retrieve data from URL (file) of interest
6 //false parameter: synchronous request
7 ajax.open('GET', 'example.txt', false);
8 ajax.send(null);
9
10 //response data in ajax.responseText
11 document.getElementById('ttExampleText').value
12                                 = ajax.responseText;
```

line of code is executed after line 7/8 are executed.

Ajax: an asynchronous request

plain JS

```
1  var ajax = new XMLHttpRequest();
2
3  //function to be called when the data has
4  arrived
5  ajax.onreadystatechange = function() {
6
7     //the only state we care about
8     if(ajax.readyState==4) {
9        /*
10        * process received data
11        */
12    }
13 }; //end of function
14
15 ajax.open("GET", "url", true); //true indicates
16                                 //asynchronous request
17
18 ajax.send(null);
```

Ajax: an asynchronous request

plain JS

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18 ajax.send(null);
```

event `onreadystatechange` is fired when the status of the request changes.

Ajax security

- Conveniently we always requested data from "our" Web server
- **Security restriction of Ajax**: can only fetch files from the same Web server as the calling page (*Same-origin policy*)
  - Same origin when protocol, port, and host are the same for two pages
- Ajax **cannot** be executed from a Web page stored locally on disk

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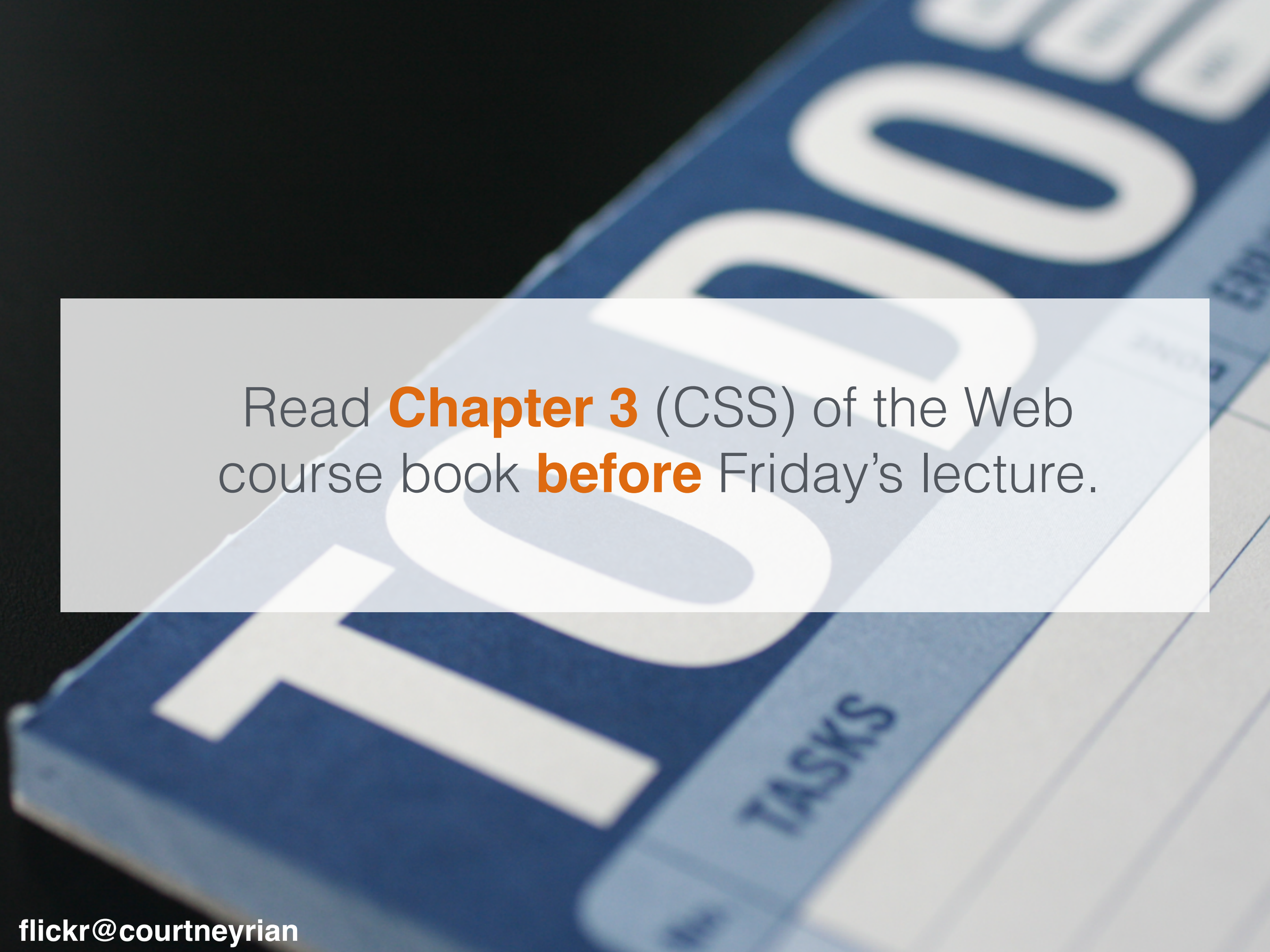
the course book explains how to get around this restriction (not recommended)

Read **Chapter 3** (CSS) of the Web course book **before** Friday's lecture.



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End of Lecture