HTTP and curl

https://github.com/heig-vd-dai-course

Web · PDF

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Based on the original course by O. Liechti and J. Ehrensberger.

Objectives

- Understand the basics of HTTP
- Understand the basics of APIs
- Learn how to use curl
- Learn how to design and document a simple API
- Learn how to develop a simple API
- Learn how to use a simple API

Disclaimer

More details for this section in the course material. You can find other resources and alternatives as well.

Disclaimer

- **This is not a course on web development**
- Many many things are not covered
- Focus on HTTP version 1.1
- Javalin used for learning purposes
- For production, use a framework like Quarkus or Spring Boot

Prepare and setup your environment

More details for this section in the course material. You can find other resources and alternatives as well.

curl

- An open source command-line tool
- Used to transfer data using various protocols
  - HTTP/HTTPS
  - FTP
  - etc.
- Used to test APIs

Javalin

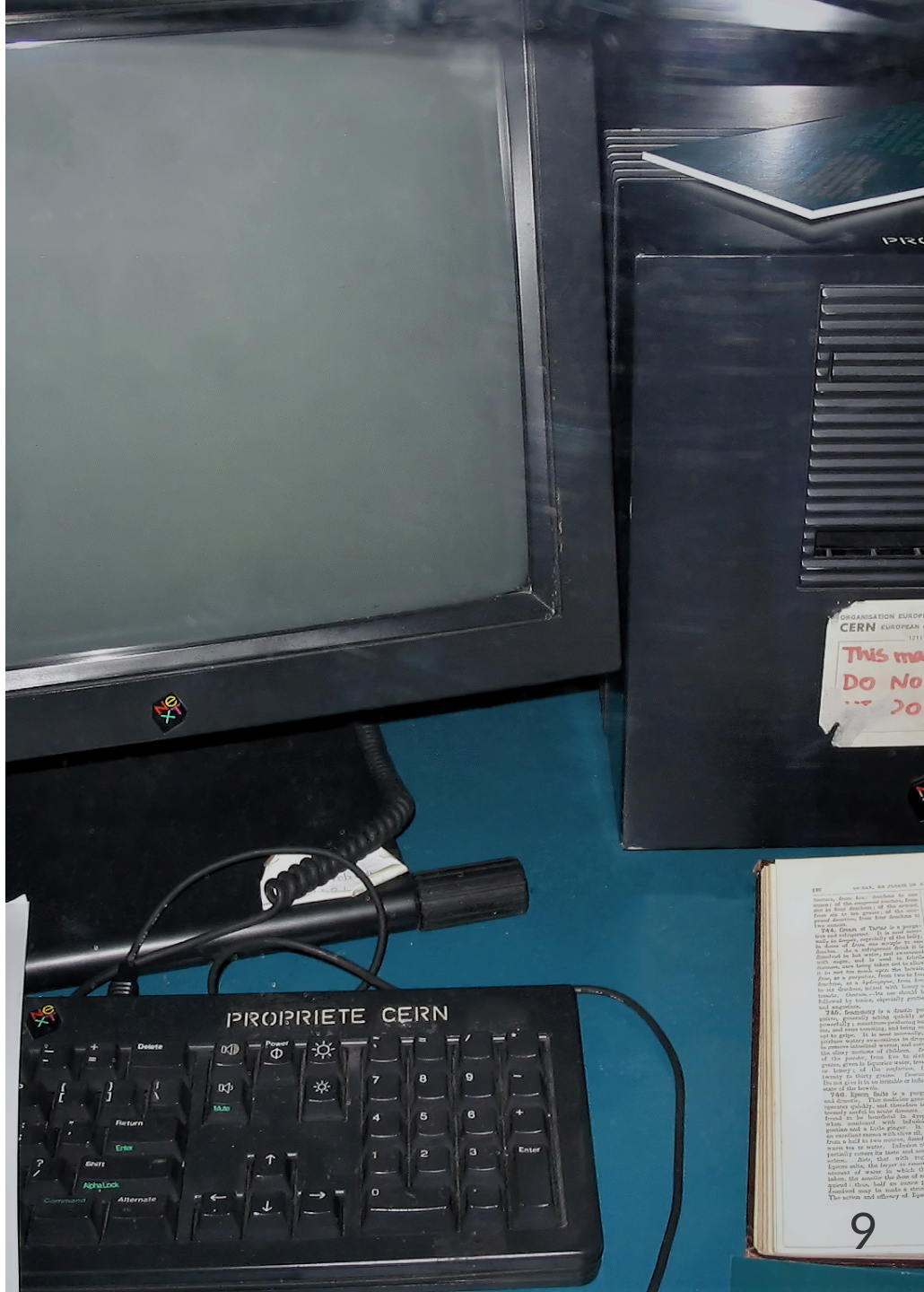
- A lightweight web framework for Java and Kotlin
- Easy to learn and use: perfect for learning purposes
- Production ready but not as powerful as Quarkus or Spring Boot

HTTP

More details for this section in the course material. You can find other resources and alternatives as well.

HTTP

- Initiated by Tim Berners-Lee at CERN in 1989
- First release in 1990 to transfer HyperText Markup Language (HTML) documents
- Built on top of TCP (HTTP/1.0, HTTP/1.1 and HTTP/2.0) or UDP/QUIC (HTTP/3)
- Ports **80** (HTTP) or **443** (HTTPS)



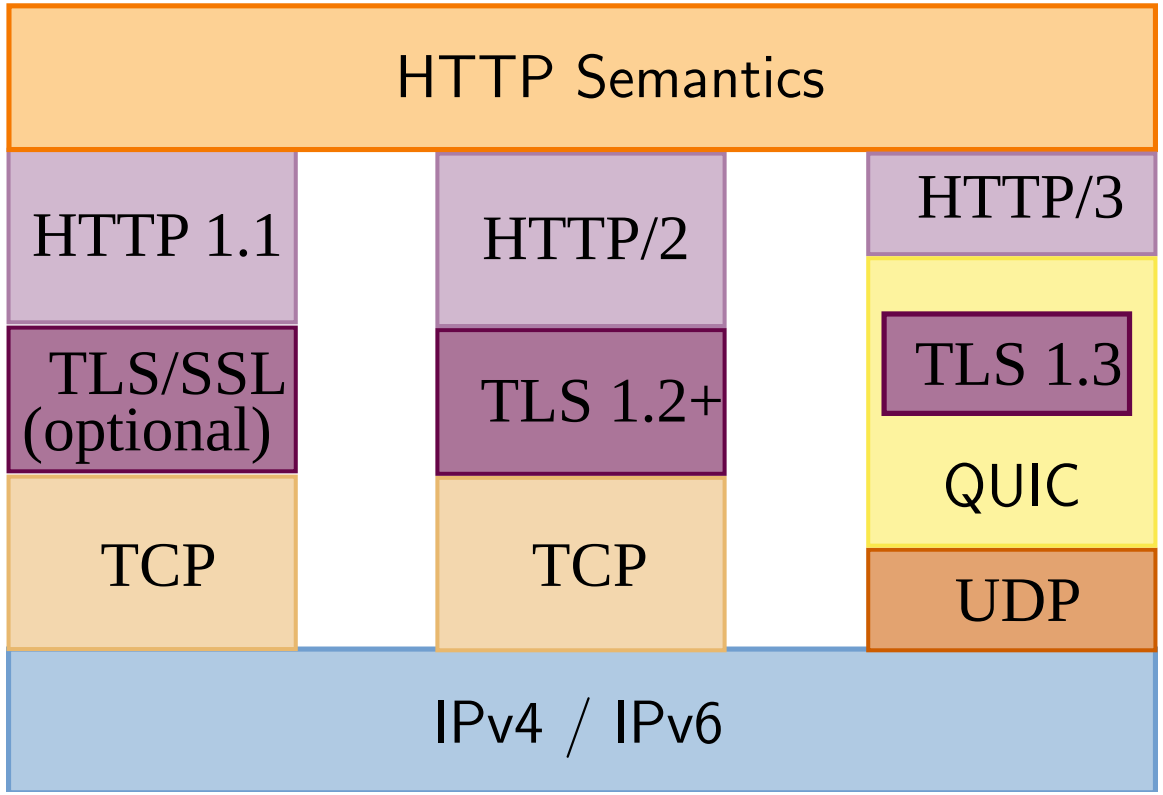
- Hyper Text Transfer Protocol (HTTP) based on TCP
- Application layer protocol with many features
- Used to transfer data between a client (an **user agent**) and a server
- A client can be a web browser, a mobile application, a command-line tool, household appliance, etc.
- The client requests a **resource** from the server

HTTP versions

Multiple versions exist:

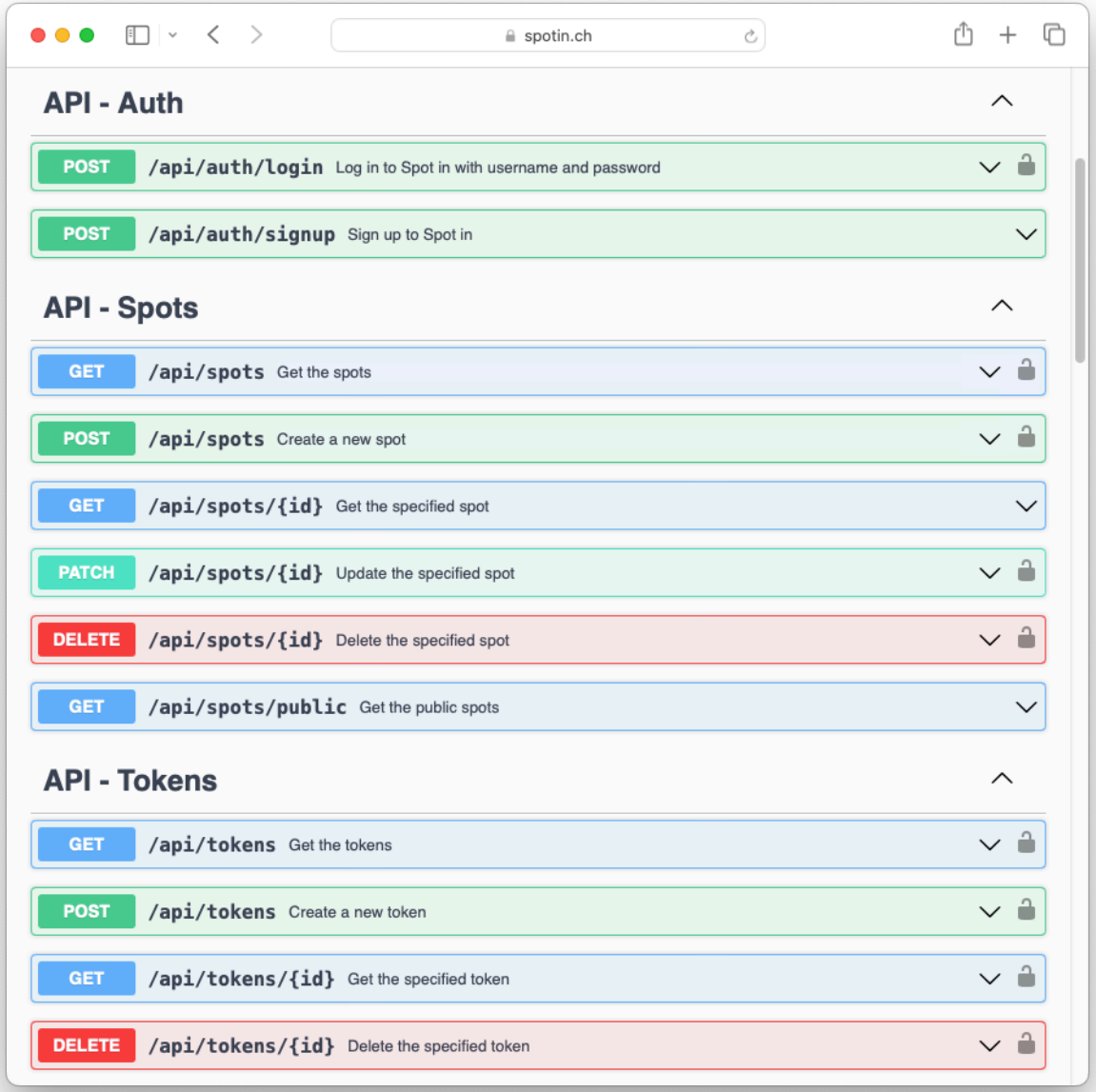
- HTTP/1.0 (1996)
- HTTP/1.1 (1997)
- HTTP/2 (2015)
- HTTP/3 (2022)

The most used version is HTTP/1.1. Each version is to improve performance.



HTTP resources

- A resource is identified by a Uniform Resource Locator (URL)
- A resource can be a file, a document, a video, etc.
- Sometimes called an **endpoint** or a **route**



An example of a URL is the following:

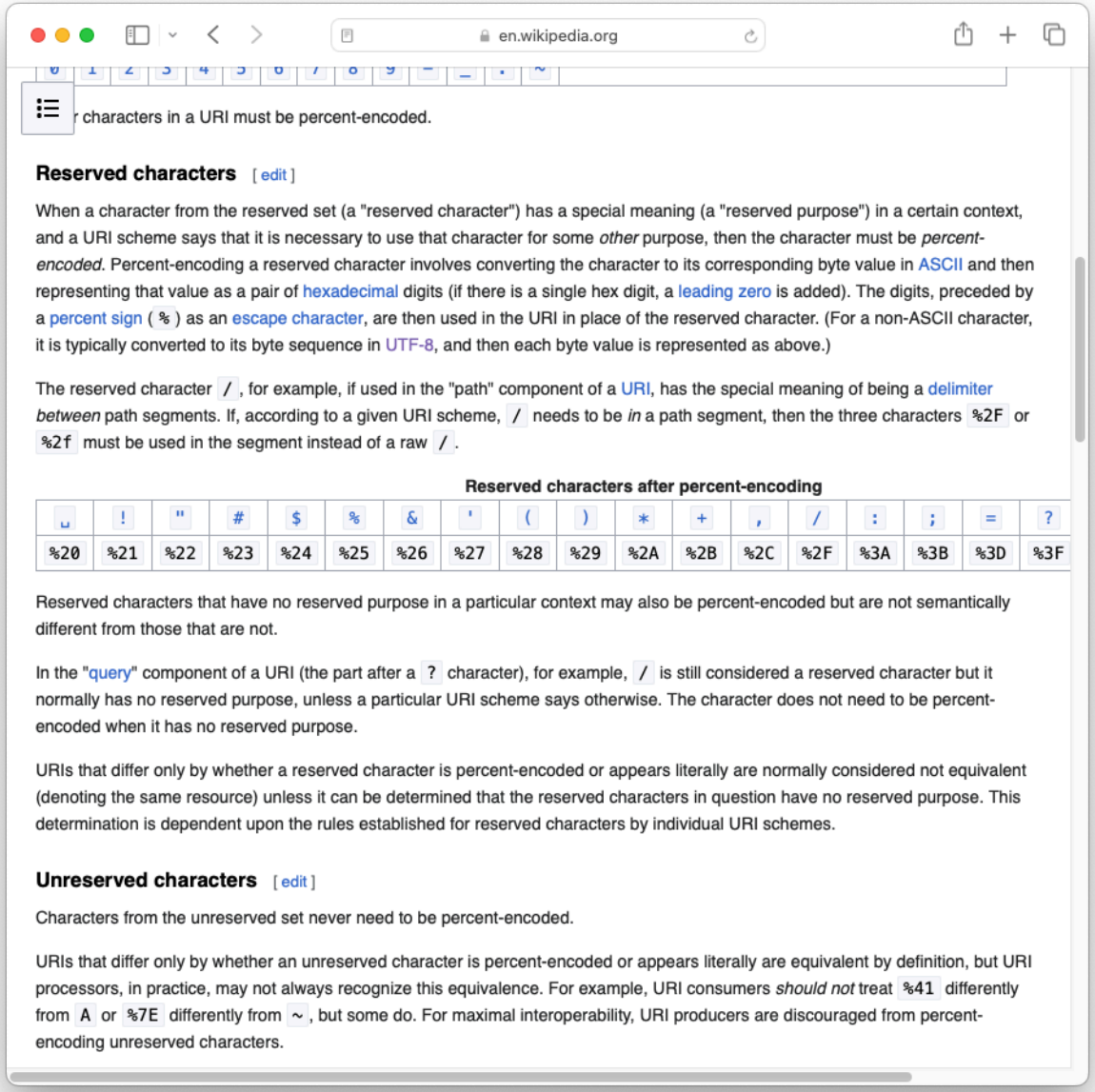
```
https://gaps.heig-vd.ch/consultation/fiches/uv/uv.php?id=6573
```

- Protocol: `http://` or `https://`
- Host: `gaps.heig-vd.ch`
- Port: `:80` or `:443` (optional)
- Path: `/consultation/fiches/uv/uv.php`
- Query parameters: `?id=6573`

This resource returns a HTML document.

URL encoding

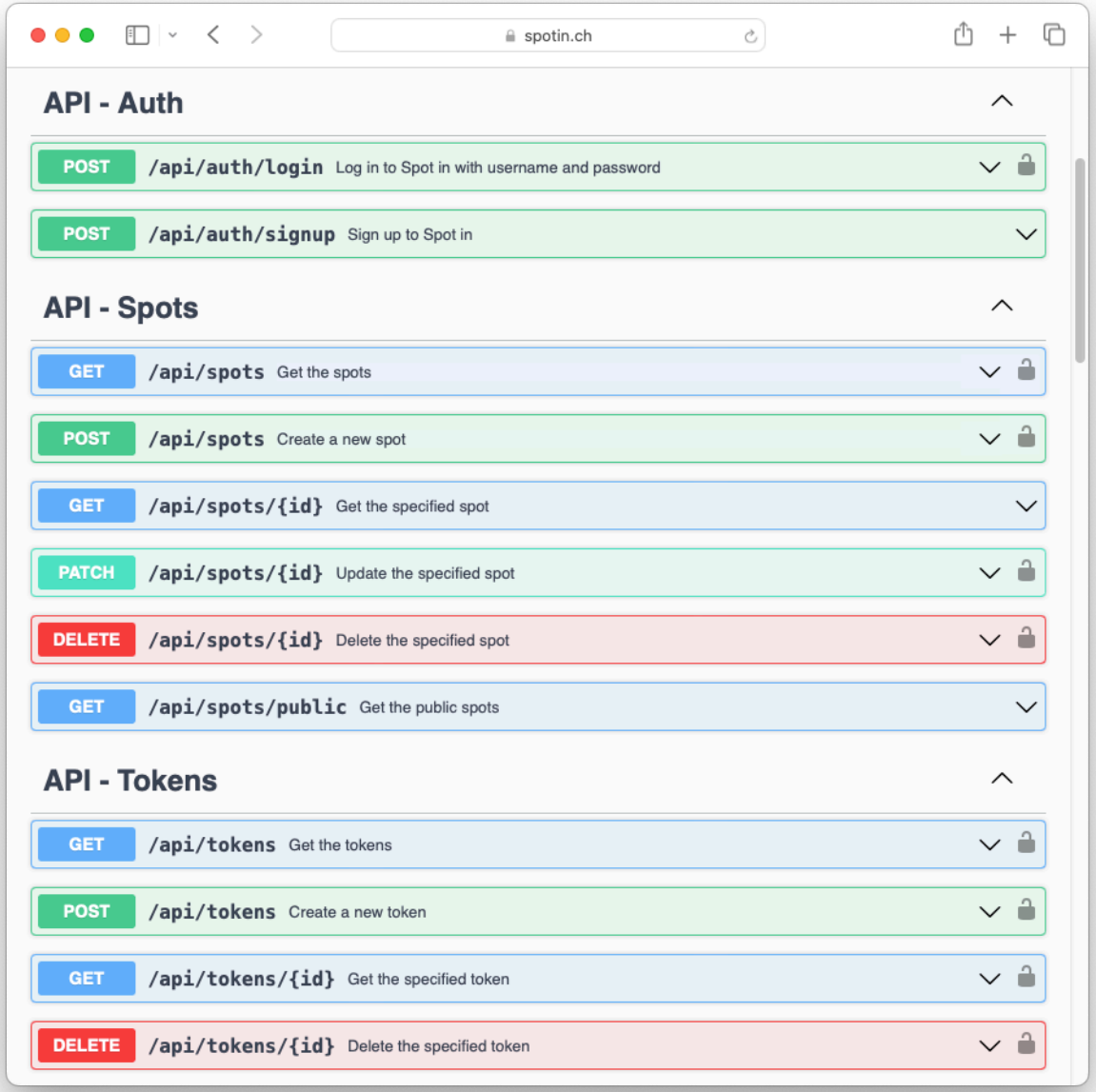
- URLs can only contain a limited set of characters
- Some characters are reserved for special purposes
- Some characters must be encoded: (Space -> `%20`)
- For example, `Hello world` becomes `Hello%20world`



HTTP request methods

- `GET` - Get a resource
- `POST` - Create a resource
- `PATCH` / `PUT` - Update a resource
- `DELETE` - Delete a resource

A browser does `GET` methods by default.



HTTP request and response format

- To request a resource, a client sends a HTTP request to a server
- The server processes the request and sends back a HTTP response

HTTP is based on a **request-response** model.

The HTTP request and response are composed of:

- A **start line** with:
  - The **method**
  - The **URL**
  - The **version**
- **Headers** with metadata
- An **empty line**
- An optional **body** with data

Structure of a HTTP request:

```
<HTTP method> <URL> HTTP/<HTTP version>
<HTTP headers>
<Empty line if there is a body>
<HTTP body (optional)>
```

Structure of a HTTP response:

```
HTTP/<HTTP version> <HTTP status code> <HTTP status message>
<HTTP headers>
<Empty line if there is a body>
<HTTP body>
```

A HTTP request example:

```
GET / HTTP/1
Host: gaps.heig-vd.ch
User-Agent: curl/8.1.2
Accept: */*
```

A HTTP response example:

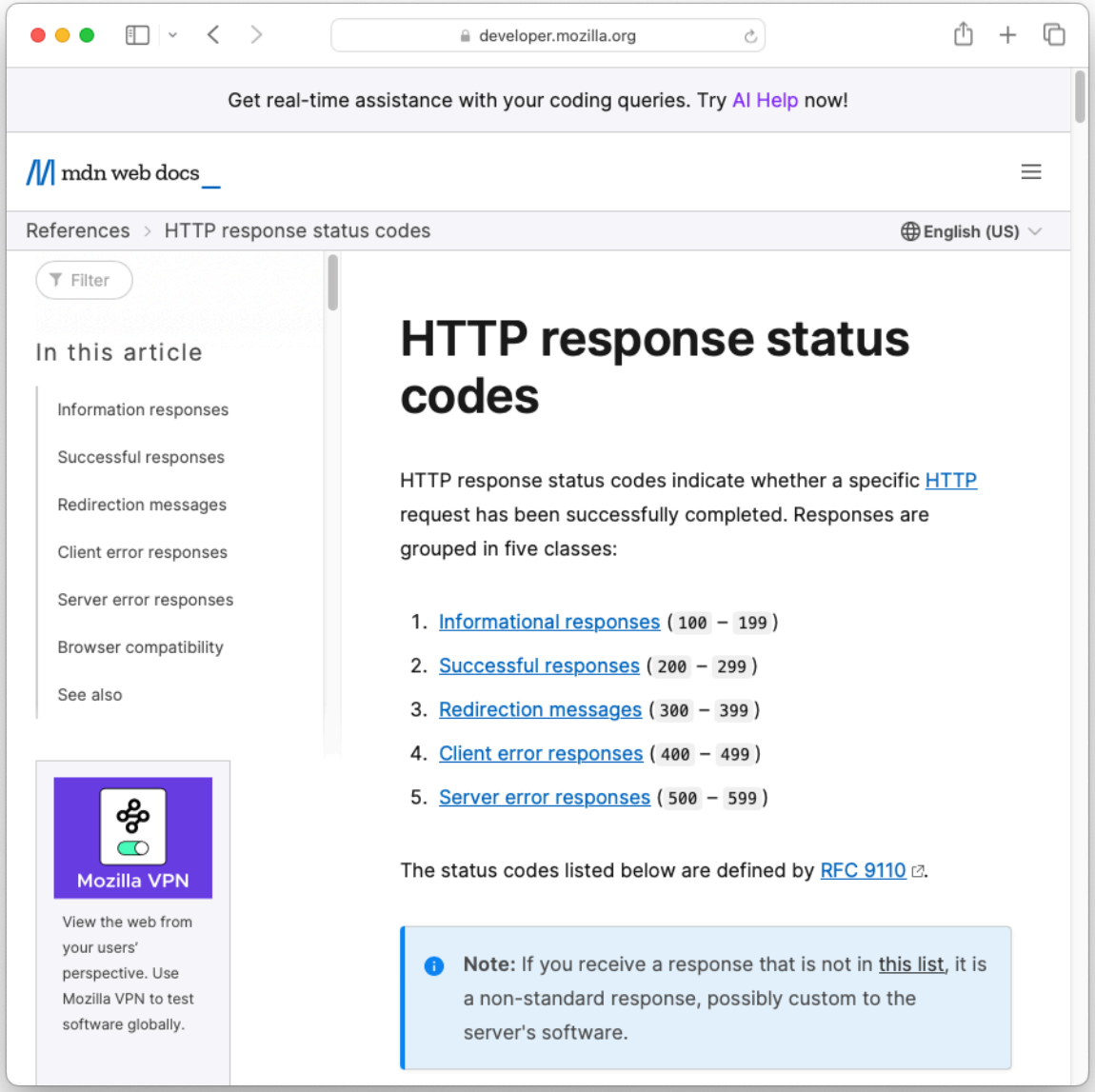
```
HTTP/1.1 200 OK
Content-Type: text/html; charset=ISO-8859-1
Content-Length: 6111

<!DOCTYPE HTML>
...
```

HTTP response status codes

Grouped by categories:

- 1xx: Informational
- 2xx: Success
- 3xx: Redirection
- 4xx: Client error
- 5xx: Server error



HTTP path parameters, query parameters and body

These elements are used to pass data to the server.

Path parameters and query parameters are part of the URL.

Headers are part of the HTTP request or response.

HTTP path parameters

An example of a path parameter is the following:

```
/users/{user-id}
```

The `{user-id}` part is a path parameter.

With values: `/users/123` -> `123` is the user ID.

HTTP query parameters

An example of a query parameter is the following:

```
/users?firstName=John&lastName=Doe
```

The `?` character separates the path from the query parameters.

The `&` character separates query parameters.

Each query parameter is composed of a key and a value.

HTTP body

An example of a HTTP body is the following:

```
HTTP/1.1 200 OK
Content-Type: text/html; charset=ISO-8859-1
Content-Length: 6111

<!DOCTYPE HTML [...]>
<html>

[...]

</html>
```

HTTP headers

HTTP headers are used to pass metadata to/from the server.

- `Accept` - The media types accepted by the client
- `Content-Type` - The media type of the body
- `Content-Length` - The length of the body
- `User-Agent` - The user agent of the client
- `Host` - The host of the server
- `Set-Cookie` - The cookies set by the server

HTTP content negotiation

The `Accept` header is used to negotiate the content type between the client and the server. These are based on the MIME types:

- `Accept: text/html` - HTML
- `Accept: application/json` - JSON
- etc.

The same URL can return different content types based on the `Accept` header.

HTTP sessions

As HTTP is based on the request-response model, each request is independent of the others. This is called a stateless protocol.

This means that the server cannot know/identify who is the author of each request without additional information. Let's take an example:

1. A first user access the homepage of a website
2. A second user access the homepage of the same website

Who is the author of each request?

Why does the server not know who you are?

It is because you have not stated who you are. In other words, you do not have a session with the server.

They are two ways to maintain a session:

- Using a query parameter
- Using cookies

HTTP sessions using a query parameter

A query parameter can be used to maintain a session:

```
C: POST /login
S: 302 Found (redirect to /profile?token=1234567890)
C: GET /profile?token=1234567890
S: 200 OK (profile page)
```

Advantages: Easy to implement.

Disadvantages: The token is visible in the URL (security issue).

HTTP sessions using a cookie

A cookie can be used to maintain a session:

```
C: POST /login
S: 200 OK (set a cookie with the token)
C: GET /profile (the cookie is sent by the client)
S: 200 OK (profile page)
```

Advantages: The token is not visible in the URL (more secure).

Disadvantages: A bit more complex to implement.

Do all websites use sessions?

Not all applications need a session.

For example, a calculator application that waits for a calculation and directly sends the result does not need to keep track of the client:

- Each request is independent of the others
- The server can directly respond to each request

The server does not have to know who is the author of the request: it can send the result directly to the client.

In this case, the server does not need to use HTTP sessions and is,

On the other hand, an e-commerce application where the user can add items to a shopping cart needs to keep track of the client:

- The user can add items to the shopping cart
- The user can remove items from the shopping cart
- The user can buy the items in the shopping cart

The server must know who is the author of each request in order to maintain the shopping cart.

In this case, the server must use HTTP sessions and is, therefore, stateful.

API design

More details for this section in the course material. You can find other resources and alternatives as well.

API design

Developing a web application is not easy.

In order to make it easier, we follow patterns and a set of rules such as an **Application Programming Interface** (API).

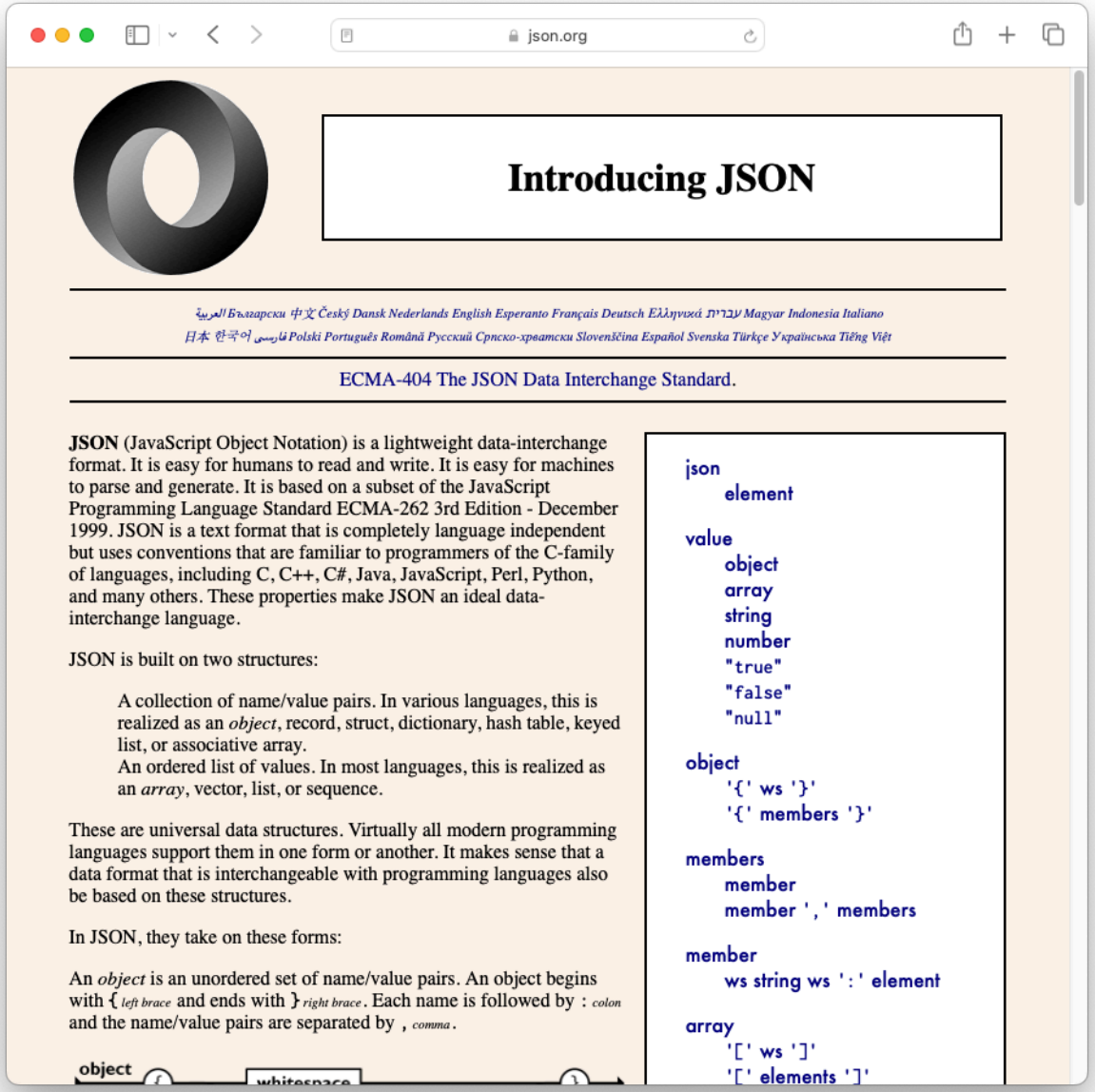
An API is a contract between the client and the server that must be documented.

Most APIs are based on HTTP and exchange data in JSON format, the most used format for APIs.

JSON is an easy to read and write format for humans. It is also easy to parse for computers.

Example of a JSON document:

```
{
        "firstName": "John",
        "lastName": "Doe",
        "age": 42
}
```



Simple APIs with CRUD operations

CRUD stands for:

- **C**reate
- **R**ead
- **U**pdate
- **D**elete

CRUD APIs are used to manage data.

A simple API with CRUD operations to manage users will expose the following endpoints:

- `POST /users` - Create a new user
- `GET /users` - List all users
- `GET /users/{id}` - Read a user
- `PUT /users/{id}` - Update a user
- `PATCH /users/{id}` - Partially update a user
- `DELETE /users/{id}` - Delete a user

REST APIs

A REST API is a set of (strict) rules to design APIs.

The REST pattern is based around a six following principles.

Is is an improvement over CRUD APIs.

Not all APIs are REST APIs but all REST APIs are APIs.

REST APIs are hard to implement correctly. In this course, we will stay with CRUD APIs. We mention REST APIs for completeness.

How to document an API

- Documentation is important for developers as well as users
- An API exposes the features of an application to the outside world
- There exist many tools to document APIs such as OpenAPI
- As these tools are complex, we will use a simple solution: a text file #Define an application protocol

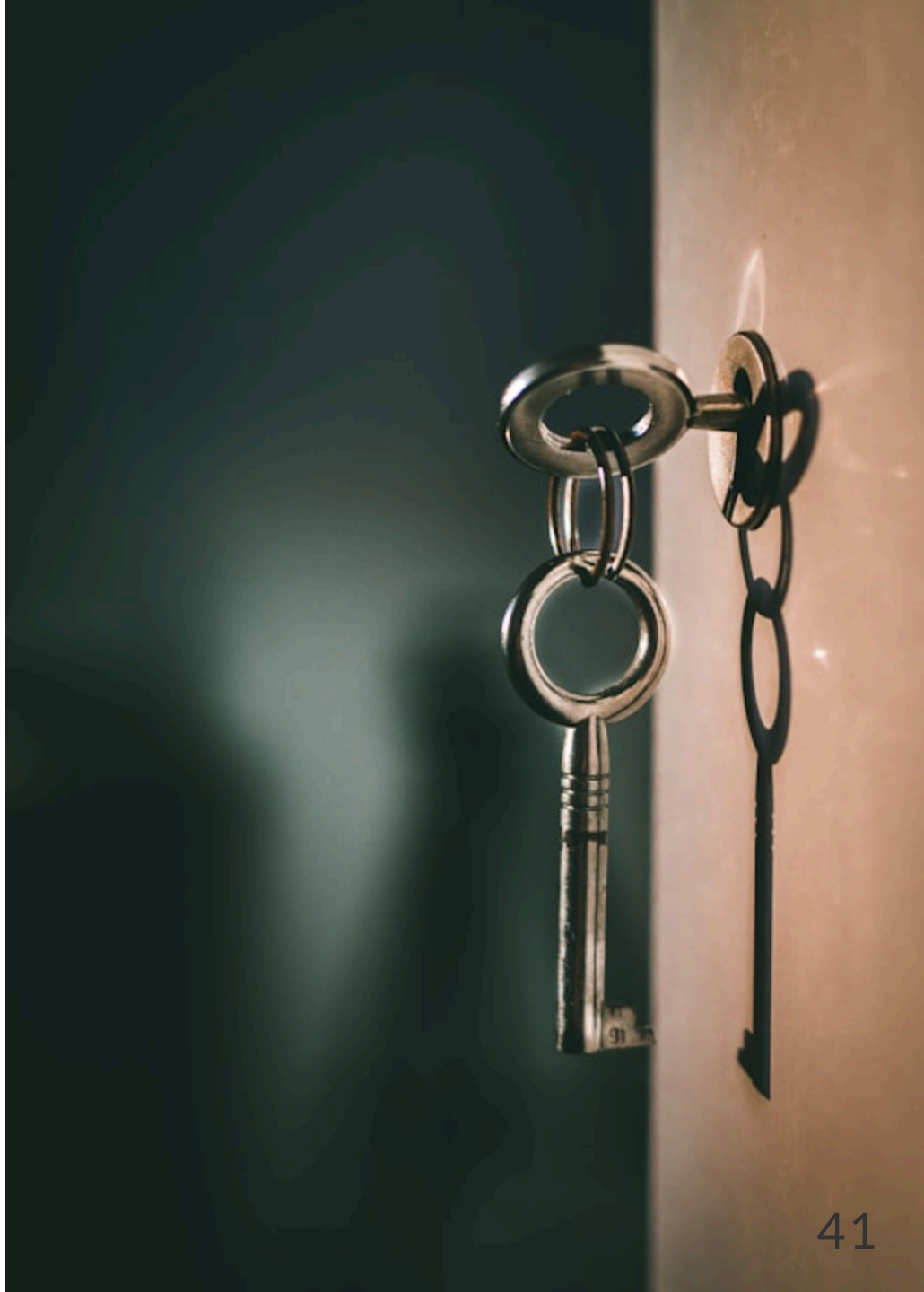
How to persist data

- In the course material, we store data in memory
- Data can be (and should be!) stored in a database
- Out of scope for this course but you can find resources in the course material

How to secure an API

- Not all APIs are public
- Some APIs are private and require authentication
- Out of scope for this course but you can find resources in the course material.

It is more important to understand the basics of how to design, how to develop and how to document an API.



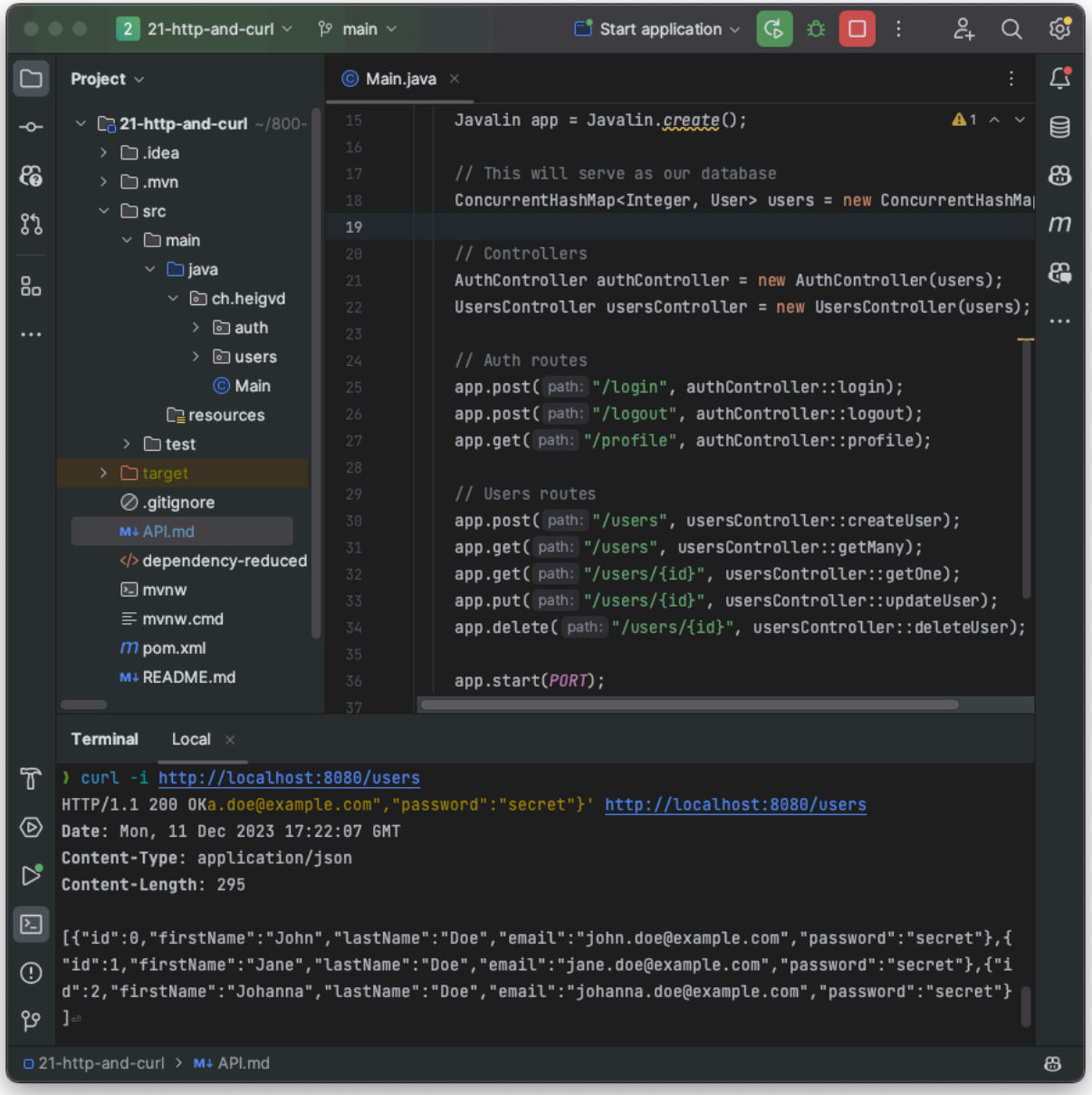
Questions

Do you have any questions?

Practical content

What will you do?

- Try out all the main concepts of HTTP (methods, status codes, headers, JSON, etc.)
- Learn how to use curl
- Build a simple web application to manage users
- Learn how to design and document a simple API



Find the practical content

You can find the practical content for this chapter on GitHub.

Finished? Was it easy? Was it hard?

Can you let us know what was easy and what was difficult for you during this chapter?

This will help us to improve the course and adapt the content to your needs. If we notice some difficulties, we will come back to you to help you.

➡️ GitHub Discussions

You can use reactions to express your opinion on a comment!

What will you do next?

In the next chapter, you will learn the following topics:

- Web infrastructures
  - How to run and maintain web applications on the Internet?
  - How to scale web applications?
  - How to secure web applications?

Sources

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