Enterprise Programming 2

Lesson 02: HTTP and REST

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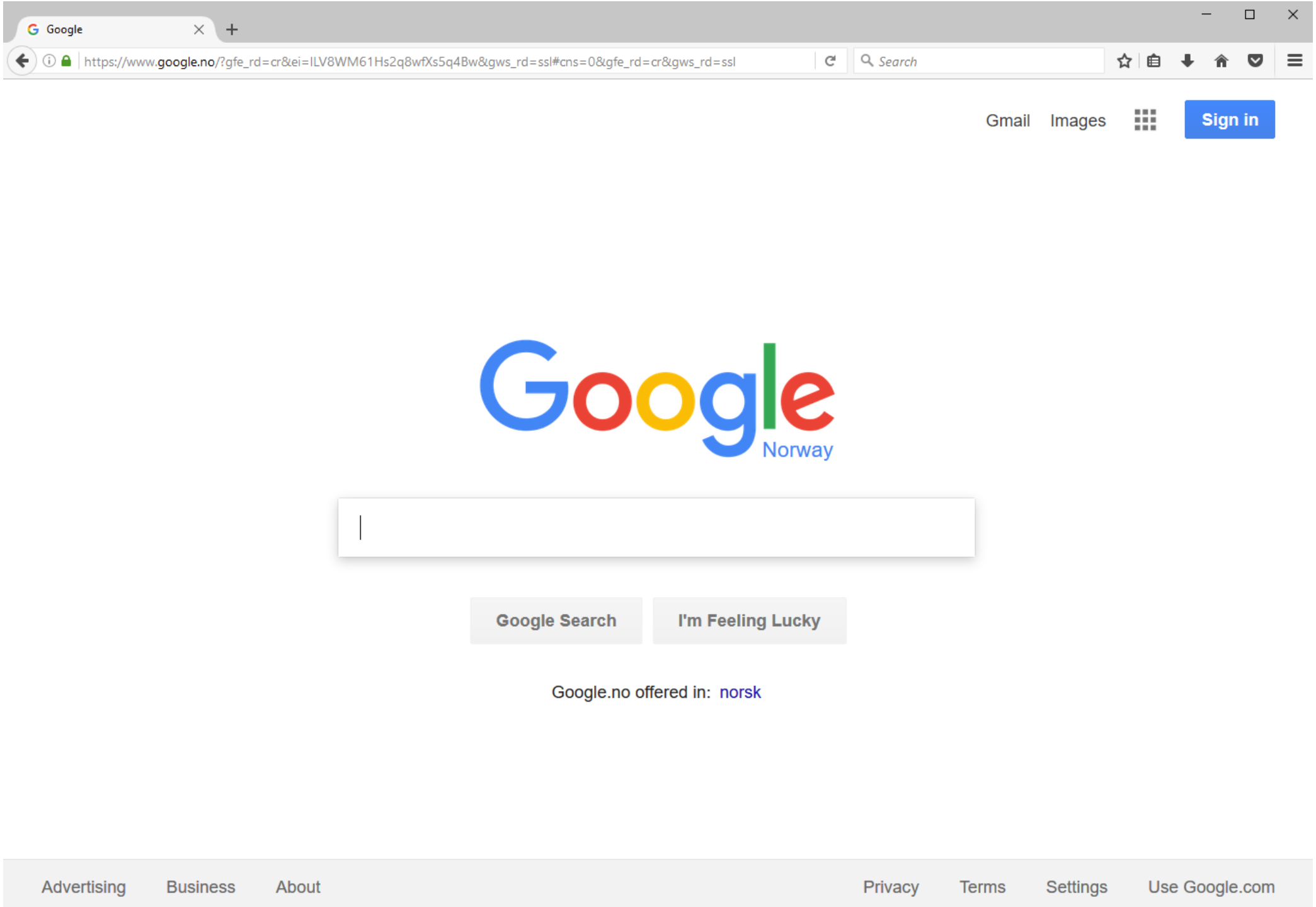
Goals

- Refresh knowledge of HTTP protocol
- Refresh knowledge of REST APIs
- Learn how to build a REST API with SpringBoot and Kotlin

HTTP


Google
https://www.google.no/?gfe_rd=cr&ei=ILV8WM61Hs2q8wfXs5q4Bw&gws_rd=ssl#cns=0&gfe_rd=cr&gws_rd=ssl
Search
Gmail
Images
Sign in
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Norway
Google Search
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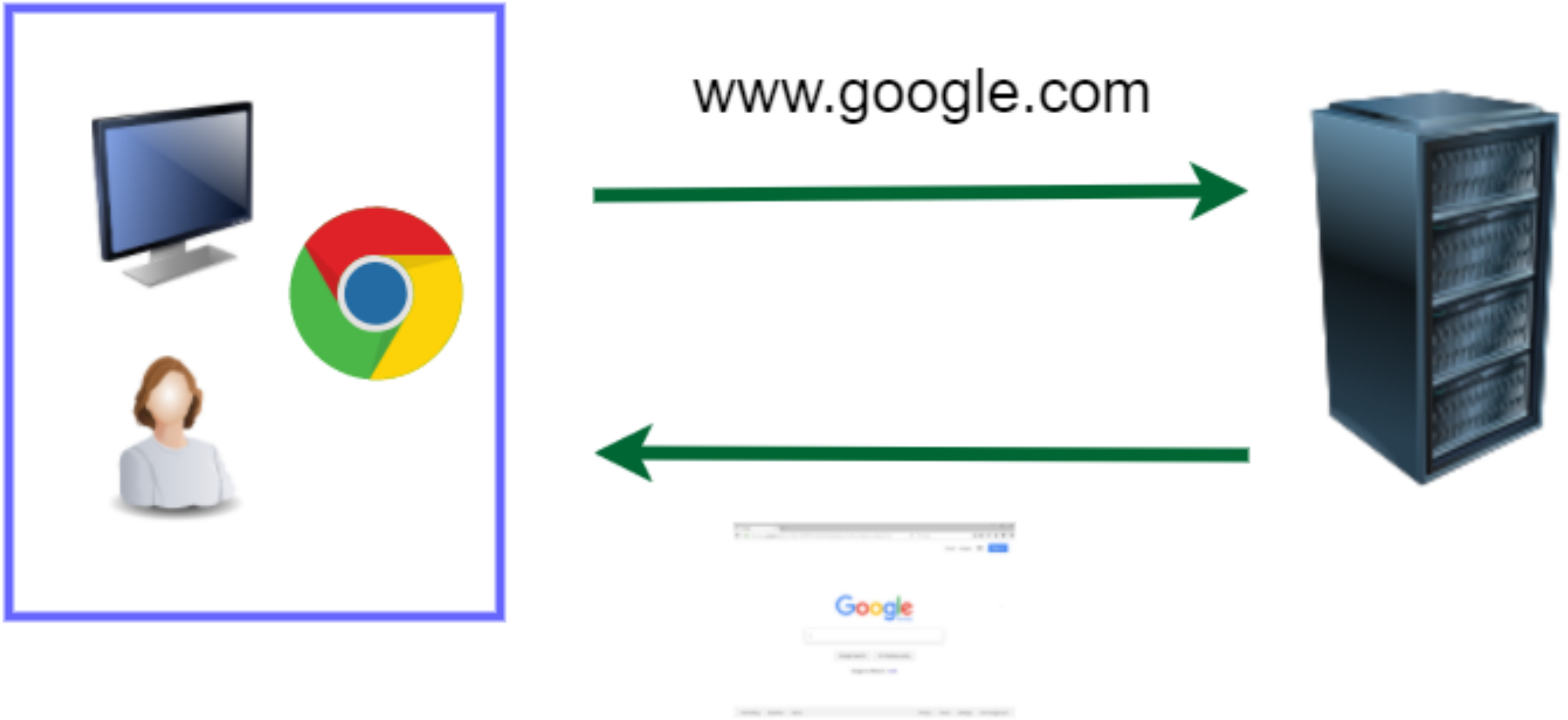
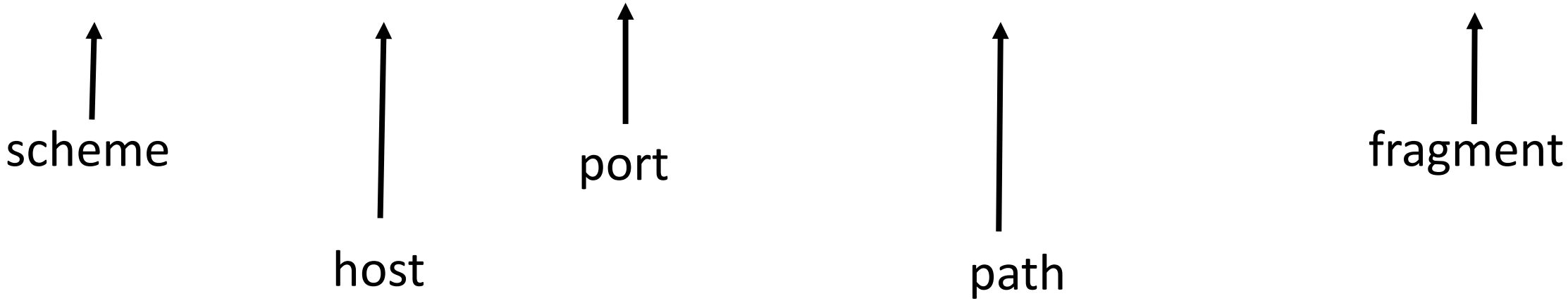
Advertising
Business
About
Privacy
Terms
Settings
Use Google.com



Send a HTTP request over TCP, and get back a HTML page which will be visualized in the browser

URL (Uniform Resource Locator)

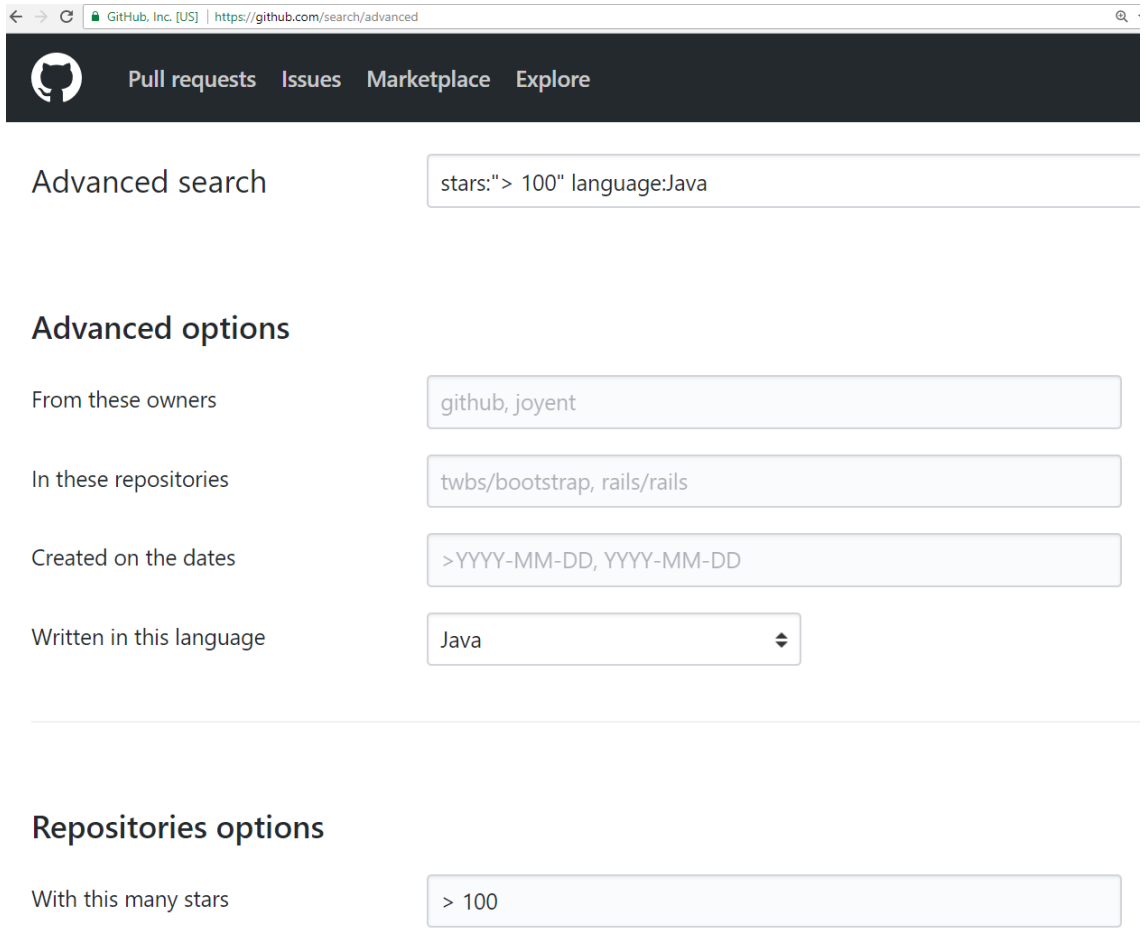
- Reference to a web resource and how to retrieve it
- **scheme:[//[user:password@]host[:port]][/]path[?query][#fragment]**
- https://en.wikipedia.org:443/wiki/Uniform_Resource_Locator#Syntax

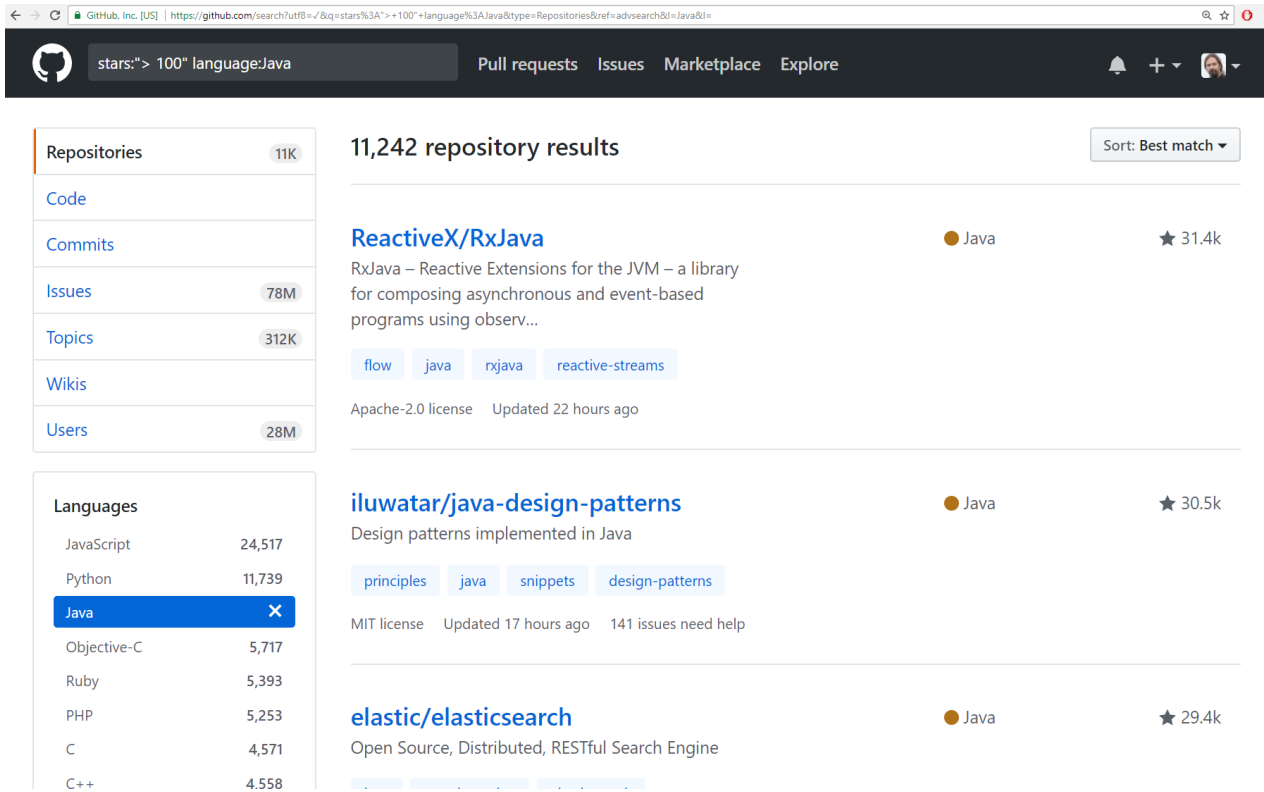


Cont.

- **Scheme**: how to access the resource
  - http, https, file, ftp, etc.
- **Host**: the name of the server, or directly its numeric IP address
- **Port**: the listening port you will connect to on the remote server
- **Path**: identifies the resource, usually in a hierarchical format
  - Eg, /a/b/c
- **Query**: starting with “?”, list of <key>=<value> properties, separated by “&”
  - eg https://github.com/search**?q=java&type=Repositories&ref=searchresults**
- **Fragment**: identifier of further resource, usually inside the main you requested
  - Eg, a section inside an HTML page

- https://github.com/search?utf8=%E2%9C%93&q=stars%3A%22%3E+100%22+language%3AJava&type=Repositories&ref=advsearch&l=Java&l=
- The asked page/resource is **/search**, where it is retrieved in different ways based on the list of query "?" parameters



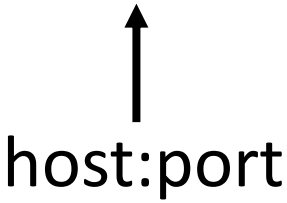


URI (Uniform Resource Identifier)

- String of characters used to identify a resource
- A URL is a URI:
  - Exactly same format
  - In URL, the resource is typically located on a network
  - Given a URL, you should be able to access the resource, which is not necessarily true for URI
- The distinction between URL and URI is conceptually very thin
  - Most people use the two terms interchangeably

TCP not Enough

https://en.wikipedia.org:443/wiki/Uniform_Resource_Locator



- Host and port are needed to establish a TCP connection
- But what data should we send to specify that we want to retrieve the HTML page at that location?

HTTP History

- Protocol Used to specify structure of messages
- Started at CERN in 1989
- 1995: version 0.9
- 1996: version 1.1
- 1999: “updates” to 1.1
- 2014: more “updates” to 1.1
- 2015: version 2.0

Http Versioning: What a Mess!!!

- HTTP is one the **worst** examples of versioning done **wrong**
- Changing specs and semantics over 18 years, but still keeping the same version number **1.1**!!!
- Why? To support the largest number of browsers, even very old ones
- Not many people realized there was an update in 2014… you might still find quite a few libraries/tools that wrongly use the 1999 version

RFC (Request for Comments)

Technically, a RFC is not a “standard” yet, but it is de-facto in practice

- RFC 7230, HTTP/1.1: Message Syntax and Routing
- RFC 7231, HTTP/1.1: Semantics and Content
- RFC 7232, HTTP/1.1: Conditional Requests
- RFC 7233, HTTP/1.1: Range Requests
- RFC 7234, HTTP/1.1: Caching
- RFC 7235, HTTP/1.1: Authentication
- RFC 7540, HTTP/2
- Etc.
- *When working with web services, it is fundamental to understand all the low level details of HTTP*

HTTP 1.1 vs 2

- v2 is quite recent (2015), and still not so common
- Unless otherwise stated, we will just deal with v1.1
- From user's perspective, v2 is like v1.1
  - Same methods/verbs, just better optimization / performance improvement
  - More like adding functionalities, not replacing it
- Main visible difference: v1.1 is "text" based, whereas v2 has its own byte format (less space, but more difficult to read/parse for humans)

HTTP Messages: 3 Main Parts

- First line specifying the action you want to do, eg GET a specific resource
- Set of *headers* to provide extra meta-info
  - eg in which format you want the response: JSON? Plain Text? XML?
  - In which language? Norwegian? English?
- (Optional) Body: can be anything.
  - Request: usually to provide user data, eg, login/password in a submitted form
  - Response: the actual resource that is retrieved, eg a HTML page

First line

- <METOD> <RESOURCE> <PROTOCOL> \r\n
- Ex.: GET / HTTP/1.1
  - <method> **GET**
  - <resource> **/**
  - <protocol> **HTTP/1.1**
- A resource can be anything
  - html, jpeg, json, xml, pdf, etc.
- A resource is identified by its *path*
  - Recall URI, and such path is same as file-system on Mac/Linux, where "/" is the root

Different kinds of Methods

- **GET**: to retrieve a resource
- **POST**: to send data (in the HTTP body), and/or create a resource
- **PUT**: to replace an existing resource with a new one
- **PATCH**: to do a partial update on an existing resource
- **DELETE**: to delete a resource
- **HEAD**: like a GET, but only return headers, not the resource data
- OPTIONS: to check what methods are available on a resource
- TRACE: for debugging
- CONNECT: tunneling connection through proxy

Method Semantics

- Each of the methods has a clear semantics
  - Eg GET does retrieve a resource, whereas DELETE should delete it
- But *how* the application server does handle them is completely up to it
  - Eg, an application server could delete a resource when a GET is executed

Verbs should not be in paths

- Given a resource “/x.html”
- **Wrong**: GET on “www.foo.org/x.html/delete” to delete “x.html”
  - Here the resource would be “/x.html/delete”
- Also wrong to use query, eg “www.foo.org/x.html*?method=delete*”
- Paths should represent/identify resources, and NOT actions on those

Idempotent Methods

RFC 7231: “A request method is considered *idempotent* if the intended effect on the server of multiple identical requests with that method is the same as the effect for a single such request...

… if a client sends a … request and the underlying connection is closed before any response is received, then the client can establish a new connection and retry the idempotent request.”

Which methods are idempotent?

GET 

POST 

DELETE 

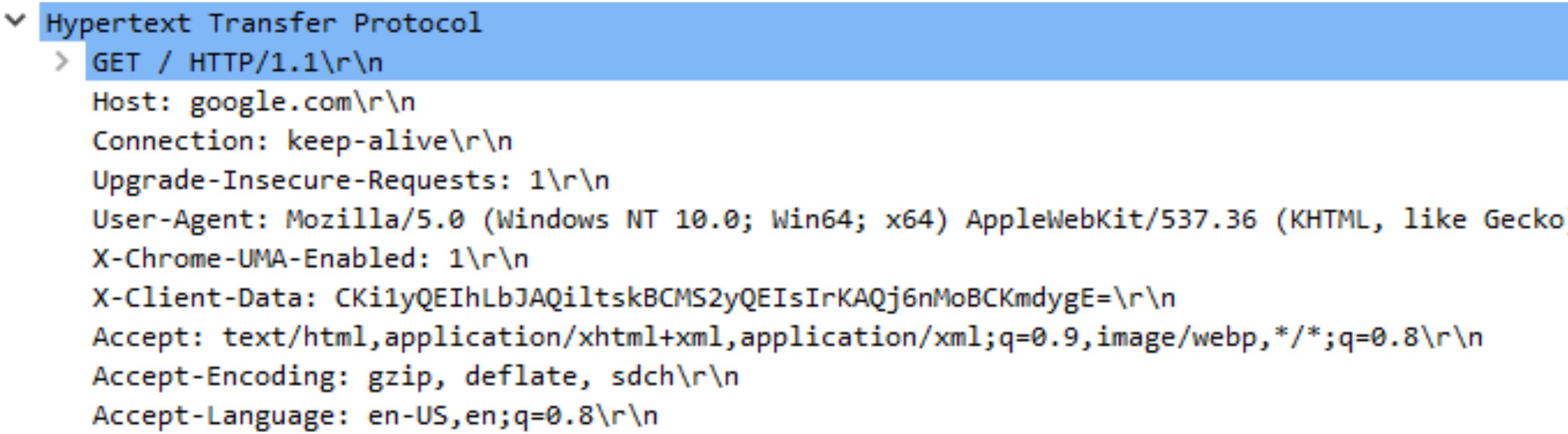
PUT 

PATCH 

HEAD 

Headers

- Extra meta-information, besides Method/Resource
- Pairs <key>:<value>
- For example:
  - In which format am I expecting the resource? HTML? JSON?
  - In which language do I want it?
  - Who am I? (important for user authentication)
  - Should the TCP connection be kept alive, or should it be closed after this HTTP request?
  - Etc.

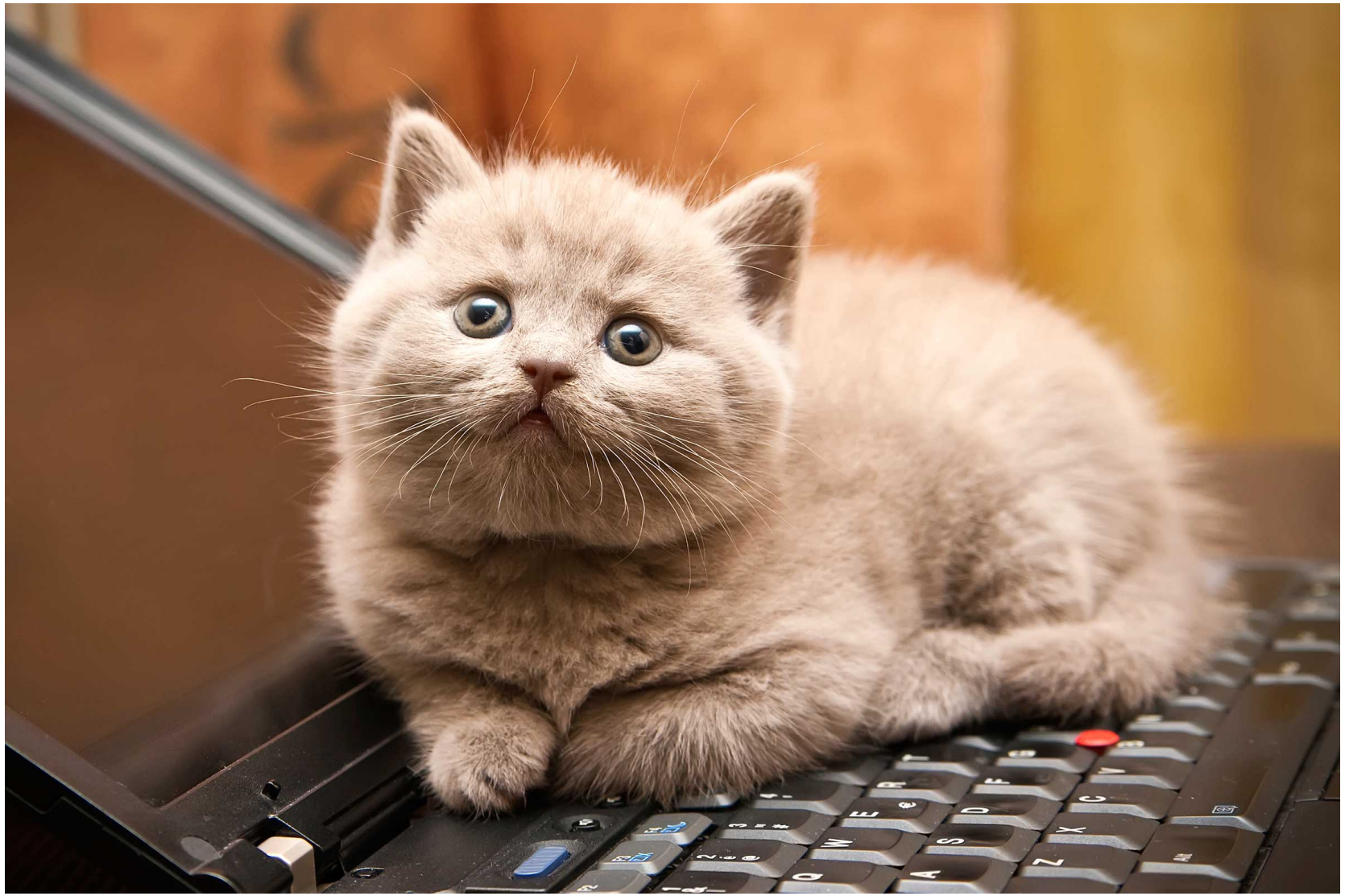


- Request for *www.google.com* in a browser (eg Chrome)
- Recall, you can use WireShark or Chrome Developer Tools
- Several HTTP headers: eg, including preferred format and language

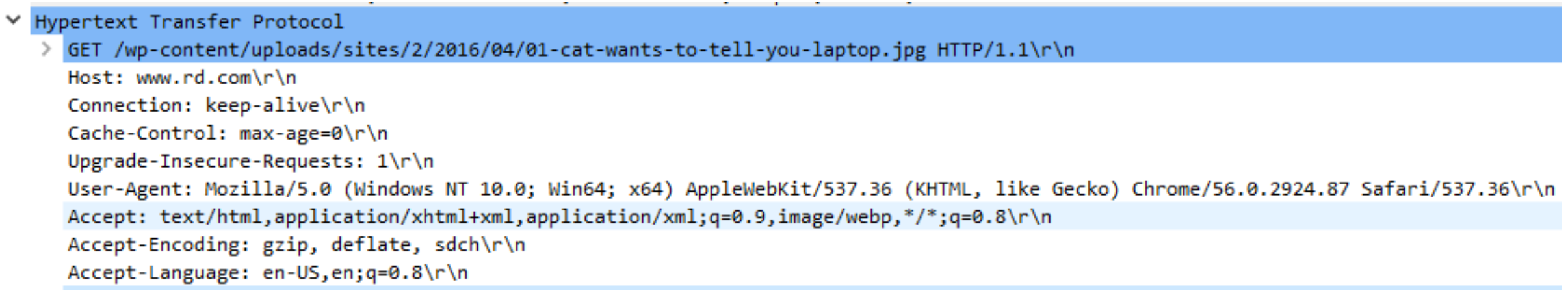
HTTP Body

- After last header, there must be an empty line
- Any data after that, if any, would be part of the payload, ie HTTP body
- Request: needed for **POST**, **PUT** and **PATCH**
- Response: needed for **GET** (also the other methods “might” have body, but **HEAD**)

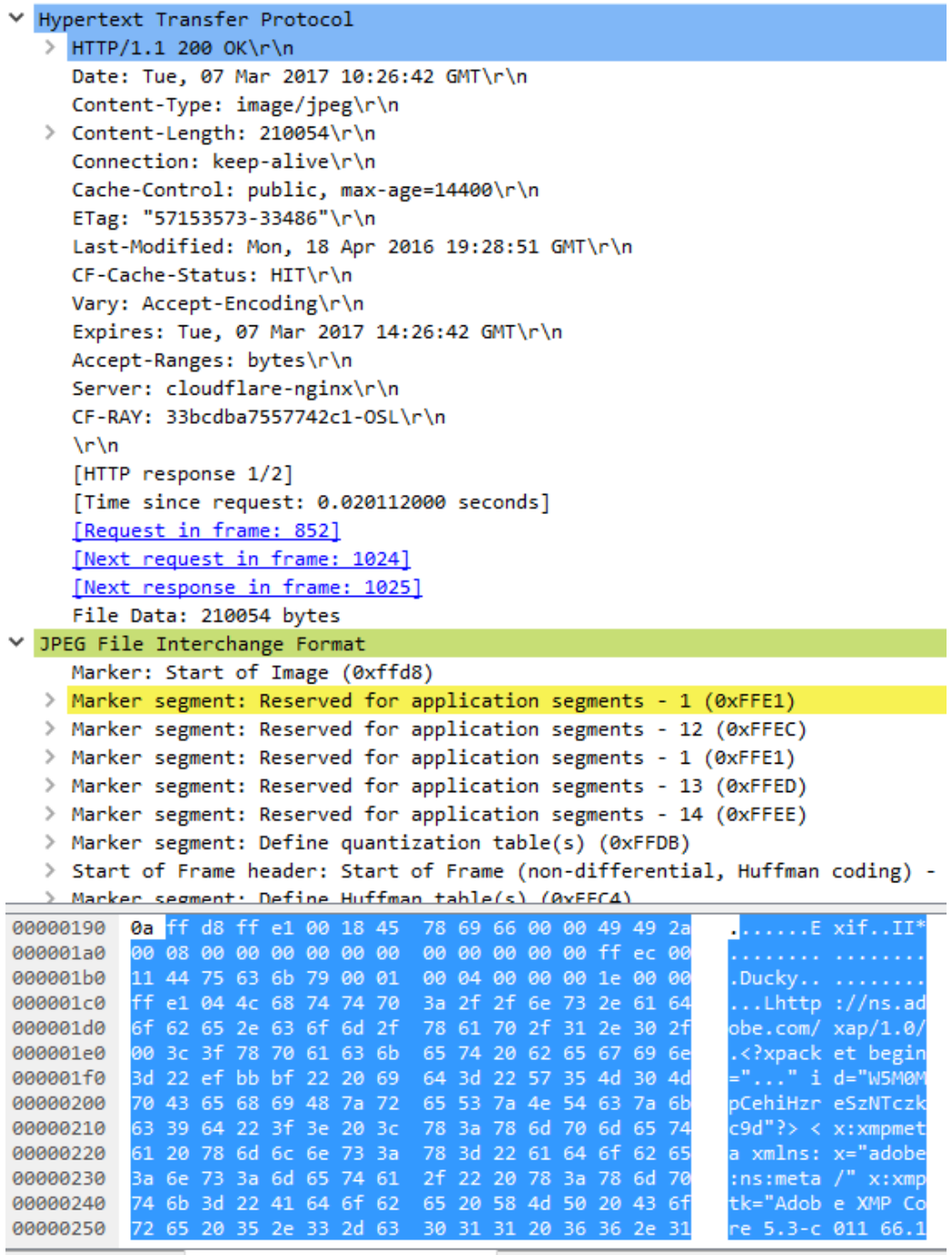
http://*www.rd.com*/**wp-content/uploads/sites/2/2016/04/01-cat-wants-to-tell-you-laptop.jpg**



GET with no body



Have a look at the “Accept” header… there is no “jpg” there, why?



- In this case, payload is in JPEG format
- "Content-type" header:
  - need to specify the format, eg JPEG. Note this is necessary because what requested by user ("Accept") might be a list, and also server might return something different
- "Content-length" header:
  - Essential, otherwise HTTP parser cannot know when payload is finished
- Cache handling: headers like "Cache-Control", "ETag", "Last-Modified", etc.
  - If visiting page for second time, no need to re-download image if hasn't changed

HTTP Response

- Same kind of headers and body as HTTP request
- Only first line does differ
- <PROTOCOL> <STATUS> <DESCRIPTION>
  - Eg, “HTTP/1.1 200 OK”
    - Note: only 1 space “ ” between the tags, I added extras just for readability
- When making a request, a lot of things could happen on server, and the “status” is used to say what happened

HTTP Status Codes

- 3 digit number, divided into “families”
- 1xx: informational, interim response
- 2xx: success
- 3xx: redirection
- 4xx: user error
- 5xx: server error

2xx Success

- **200**: OK
- **201**: resource created
- **202**: accepted, but not completed (eg, background operation)
- **204**: no content (eg, as result of PUT or DELETE)

3xx Redirection

- Note: the semantics of these codes is a "**mess**", being changing with different "updates" of HTTP 1.1… and being left in an inconsistent state
- **301** permanent redirection
  - If X redirects to Y, then client will never ask for X again, and go straight for Y
- **302** temporary redirection
  - "May" change verb, eg from POST to GET
- **307** temporary redirection, but same verb
  - Eg, a POST stays a POST
- "*Location*" header: URI of where we should redirect

User clicks on form

POST /questions

Create a new resource, with "id=9", f.ex.

302 Found
location: /questions/9

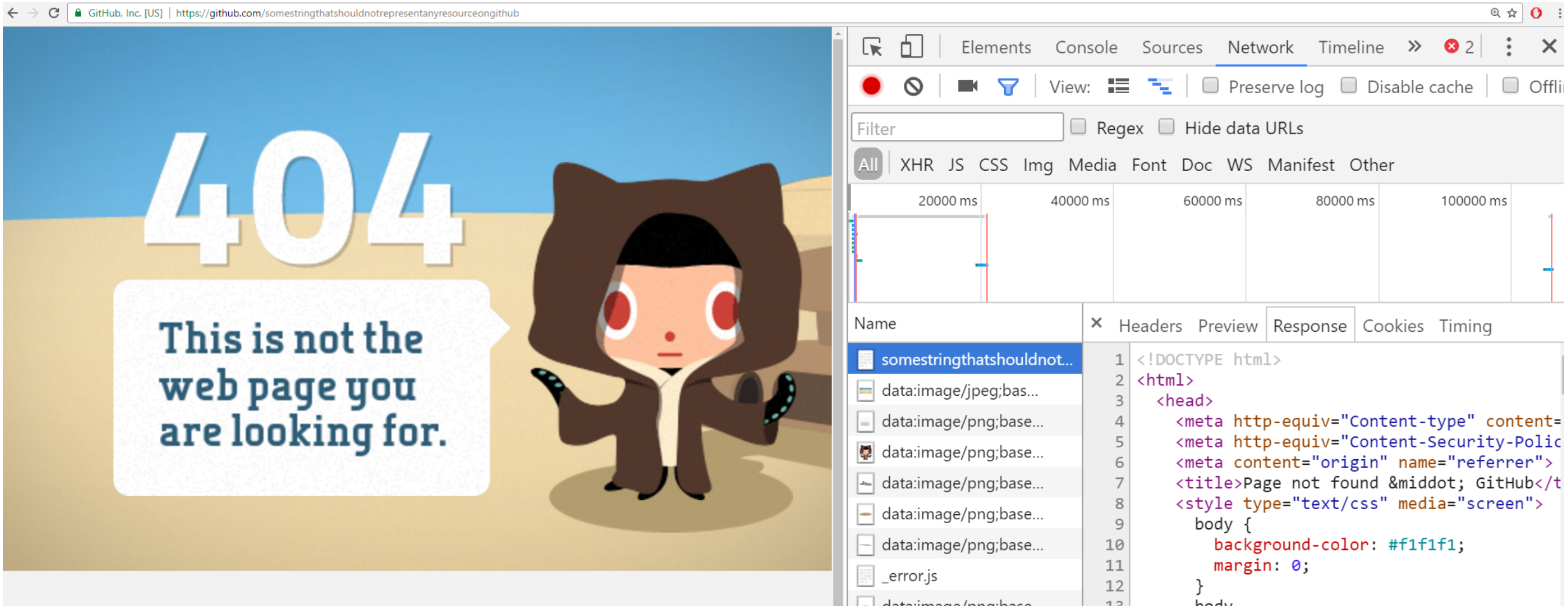
Browser follows the redirect automatically

GET /questions/9

4xx User Error

- **400**: bad request (generic error code)
- **401**: unauthorized (user not authenticated)
- **403**: forbidden (authenticated but lacking authorization, or not accessible regardless of auth)
  - Note: RFC 7231/7235 are rather ambiguous/confusing when it comes to define authentication/authorization, and differences between 401 and 403
- **404**: not found (likely the most famous HTTP status code)
- **405**: method not allowed (eg doing DELETE on a read-only resource)
- **415**: unsupported media type (eg sending XML to JSON-only server)

Even if error (eg 404), response can have a body, eg an HTML page to display



5xx Server Error

- 500: Internal Server Error
  - Often, a bug, eg an exception in the business logic (like a NPE), that propagates to the application server will be handled with a 500 response
    - Note: if whole application server does crash, then you get no response…
  - Required external services have problems, eg database connection failed
- 503: Service Unavailable
  - Eg, overloaded of requests, or scheduled downtime for maintenance

HTTPS (HTTP Secure)

- Encrypted version of HTTP, using Transport Layer Security (TLS)
- Usually on port 443 instead of 80
- URIs are the same as in HTTP (just the “scheme” does change)
- Note, the whole HTTP messages are encrypted, **but still using TCP**
  - this means it is still possible to find out the IP address and port of remote server, although cannot decipher the actual sent messages
  - this issue can be avoided by going through proxy networks like TOR , or any VPN provider (but this latter would know what you visit)

RESTful APIs

RESTful APIs

- **Re**presentational **S**tate **T**ransfer (REST)
- Most common type of web services
- Access to set of resources using HTTP
- REST is *not a protocol*, but just architectural guidelines on how to define HTTP endpoints
  - Example: should not delete a resource when answering a GET, but no one will stop you from implementing an API that does that
- Introduced in a PhD thesis in 2000

API Reference

This API reference is organized by resource type. Each resource type has one or more data representations and one or more methods.

Resource types

Files

For Files Resource details, see the resource representation page.

Method	HTTP request	Description
URIs relative to https://www.googleapis.com/drive/v2, unless otherwise noted		
get	`GET /files/fileId`	Gets a file's metadata by ID.
insert	`POST https://www.googleapis.com/upload/drive/v2/files` and `POST /files`	Insert a new file.
patch	`PATCH /files/fileId`	Updates file metadata. This method supports patch semantics.
update	`PUT https://www.googleapis.com/upload/drive/v2/files/fileId` and `PUT /files/fileId`	Updates file metadata and/or content.
copy	`POST /files/fileId/copy`	Creates a copy of the specified file.

Getting started with the REST API

The foundation of all digital integrations with LinkedIn

The REST API is the heart of all programatic interactions with LinkedIn. All other methods of interacting, such as the JavaScript and Mobile SDKs, are simply wrappers around the REST API to provide an added level of convienence for developers. As a result, even if you are doing mobile or JavaScript development, it's still worth taking the time to familiarize yourself with how the REST API works and what it can do for you.

API methods

by section | by oauth scope

account

/api/v1/me oauth
/api/v1/me/blocked oauth
/api/v1/me/friends oauth
/api/v1/me/karma oauth
/api/v1/me/prefs oauth
/api/v1/me/trophies oauth
/prefs/blocked oauth
/prefs/friends oauth
/prefs/messaging oauth
/prefs/trusted oauth
/prefs/*where* oauth

captcha

/api/needs_captcha oauth

flair

/api/clearflairtemplates oauth
/api/deleteflair oauth
/api/deleteflairtemplate oauth
/api/flair oauth
/api/flairconfig oauth

This is automatically-generated documentation for the reddit API.

The reddit API and code are open source. Found a mistake or interested in helping us improve? Have a gander at api.py and send us a pull request.

Please take care to respect our API access rules.

overview

listings

Many endpoints on reddit use the same protocol for controlling pagination and filtering. These endpoints are called Listings and share five common parameters: `after` / `before`, `limit`, `count`, and `show`.

Listings do not use page numbers because their content changes so frequently. Instead, they allow you to view slices of the underlying data. Listing JSON responses contain `after` and `before` fields which are equivalent to the "next" and "prev" buttons on the site and in combination with `count` can be used to page through the listing.

The common parameters are as follows:

- `after` / `before` - only one should be specified. these indicate the fullname of an item in the listing to use as the anchor point of the slice.
- `limit` - the maximum number of items to return in this slice of the listing.
- `count` - the number of items already seen in this listing. on the html site, the builder uses this to determine when to give values for `before` and `after` in the response.

Twitter Developer Documentation

REST APIs

The REST APIs provide programmatic access to read and write Twitter data. Create a new Tweet, read user profile and follower data, and more. The REST API identifies Twitter applications and users using OAuth; responses are in JSON format.

If your intention is to monitor or process Tweets in real-time, consider using the Streaming API instead.

Overview

Below are some documents that will help you get going with the REST APIs as quickly as possible

- API Rate Limiting
- API Rate Limits
- Working with Timelines
- Using the Twitter Search API
- Finding Tweets about Places
- Uploading Media
- Reference Documentation

Default entities and retweets

REST Constraints

1. Uniform Interface
2. Stateless
3. Cacheable
4. Client-Server
5. Layered System
6. Code on demand (optional)

1: Uniform Interface

- Resource-based, identified by a URI
- The actual resource could be anything
  - e.g., rows in a SQL database, or image files on disk
- Client sees a *representation* of the resource, and the same resource can be given in different formats
  - eg, XML, JSON and TXT
- Hypermedia as the Engine of Application State (HATEOAS)
  - Resources connected by links… but hardly anyone uses it…

2: Stateless

- Resources could be stored in databases or files
- But the web service itself should be stateless
- This means that all info to process a request should come with the request itself
  - eg, as HTTP headers
- Consequence examples:
  - can restart process of web service at any time
  - horizontal scalability: can have 2 more instances of same service, does not matter which one is answering and in which order

3: Cacheable

- Cacheable: avoid making a request if previous retrieved data is still valid
- Very important for scalability
- Resources should define if they are cacheable or not, and how

4: Client–Server

- Clear cut between clients and servers
- Client only sees the URIs and the representation (eg JSON), but no internal details of server
  - eg does not even know if resource is stored in a database or on file
- Server does not know how data used on clients
- Consequence: clients and servers can be developed/updated independently, as long as URIs/representation are the same

5: Layered System

- For clients, should not matter if there is any intermediary on the way to the server
- Typical example: *reversed proxy*
  - eg, used for load balancing and access policy enforcement

6: Code on Demand (optional)

- Servers can temporarily extend or customize the functionality of a client by transferring executable code
  - eg, transfer JavaScript code
- Among the constraints that define REST, this is optional

The Term “REST”

- Most APIs out there are called REST by their developers…
- … but “technically”, they aren’t
- For example, nearly *no one* uses HATEOAS
- So, nowadays, REST loosely means: “*A web API where resources are hierarchically structured with URIs, and operations follow the semantics of the HTTP verbs/methods*”

Example for a Product Catalog

- Full URLs, eg **www.foo.com/products**
- GET **/products**
  - (return all available products)
- GET **/products?k=v**
  - (return all available products filtered by some custom parameters)
- POST **/products**
  - (create a new product)
- GET **/products/{id}**
  - (return the product with the given id)
- GET **/products/{id}/price**
  - (return the price of a specific product with a given id)
- DELETE **/products/{id}**
  - (delete the product with the given id)

Resource Hierarchy

- Consider the resource: **/users/3457/items/42/description**
- **/users**: resource representing a set of users
- **/3457**: a specific user with that given id among the set of users */users*
- **/items**: a set of items belonging to the user 3457
- **/42***:* a specific item with id 42 that the user 3457 owns
- **/description**: among the different properties/fields of item 42, just consider its *description*

Cont.

- *GET **/users/3457/items/42/description***
- It means: retrieve the description of item with id 42, which belongs to the user with id 3456
- But what about *GET **/items/42/description*** ???
- “Technically”, they would be 2 *different* resources, because there are two different URIs
- But in practice, they are the same

Backend Representation

- ***/users/3457/items/42/description***
- Could be two different tables in a SQL database, eg *Users* and *Items*
- Or could be a single JSON file on disk…
- or the REST API just collects such data from two other different web services…
- or whatever you fancy…
- Point is, for the client this does not matter at all!

Available URIs

- 1st) *GET **/users/3457/itemIds***
- 2nd) *GET **/items/42/description***
- It means: first retrieve the ids of all items belonging to user 3457. Then, to get description for a specific one of them with id 42, make a second GET
- But in the 2nd GET, what if we rather used ***/users/3457/items/42/description*** ???

Cont.

- 1st) *GET* ***/users/3457/itemIds***
- 2nd) *GET* ***/items/42/description***
- 3rd) *GET* ***/users/3457/items/42/description***
- Whether the 2nd or the 3rd (or both) endpoint is needed depends on how clients will typically interact with the API
  - do they need to access to items regardless of their user owners?
- Point is: you need to *implement* a handler for each endpoint

Path Elements

- ***/users/3457/items/42/description***
- How does a client know that ***/users*** and ***/items*** are collections/sets but not ***/description*** ?
- “Technically”, each of those tokens are path elements, with no specific semantics
- Client has to read the documentation of the API
- However, to make things simpler, it is a convention to use *plural* names for set resources

Resource Filtering

- Assume you want to retrieve all users that are in Norway
- 1st) *GET **/users/inNorway***
- Problem is, what if you still want to retrieve single users by id?
- 2nd) *GET **/users/{id}***
  - Where {} just represents a variable matching any single path element input
- Ambiguity: here ***/users/inNorway*** would be matched by both endpoints
  - ie, *inNorway* could be treated as a user id

Cont.

- 1st) *GET* ***/users/inNorway***
- 2nd) *GET* ***/users/byId/{id}***
- Here there would be no ambiguity, but…
- … what would be the semantics of the intermediate resource ***/users/byId*** ???
- Paths in the URIs should represent resources, and not actions on them

Cont.

- 1st) *GET **/users?country=norway***
- 2nd) *GET **/users/{id}***
- When we want to apply a filter to get a subset of a collection, then we use *query parameters*
  - recall URIs: start with “?”, followed by pairs <key>=<value>
- Extra benefit: we can later add extra filter options (e.g., *ageMin=18*), without altering the routing of requests to the endpoint ***/users***

Resource Creation

- *POST **/users***
  - POST operation on a collection
  - Payload used to create new element added to the collection
  - Response will have *Location* HTTP header telling where to find the newly created resource, eg *Location:/users/42*
- *PUT **/users/42***
  - PUT operation directly on the URI of the new resource
  - Need to specify id

Cont.

- Which one to use? POST or PUT?
- When id is chosen by server (eg linked to an id from SQL database), you need POST
- If you use PUT, client must choose the id, and it must be *unique*
  - otherwise, you would just overwrite an existing resource

PUT vs POST

- *1st) GET /users/42* => Response 404
- *2nd) PUT /users/42*
- This would make no sense, because:
  1. Not going to do hundreds of GETs until find one with 404 Not Found
  2. Two HTTP requests in sequence are not necessarily atomic, eg, before PUT is executed, someone else could have create the resource, and you would just then overwrite it

Cont.

- 1st) *POST* ***/users*** *=>* Location: */users/42*
- 2nd) *PUT* ***/users/42/address***
- Assume you create a new user with a POST operation, but without an *address*
- You could then want to create the *address* resource directly by using a PUT
  - point is that the resource does not have an id in itself, but rather the id is in a path element ancestor
- However, most of the time you would not expose each single field of an object as its own URI endpoint, but rather do a PATCH
  - eg, *PATCH /users/42*

Resource Representation

- 1st) *GET /users/42*
- 2nd) *GET /users/42**.json***
- 3rd) *GET /users/42**.xml***
- For what you know, the REST service could store users in a SQL database or a CSV file
- What you get is a *representation* of a resource, which can be in different formats, based on client's needs
- But what's the problem here?

Cont.

- 1st) *GET /users/42*
- 2nd) *GET /users/42**.json***
- 3rd) *GET /users/42**.xml***
- Because the URIs are different, they are technically 3 *different* resources
  - whether they map to the same entity on the backend is another story…
- A URI has no concept of type: adding a "*.json*" extension does NOT change the semantics

Cont.

- *GET **/users/42***
- You should avoid type extensions on your resources
  - although you might see many APIs doing it…
- Choosing among different types should be based on HTTP headers like *Accept*
  - eg, "*Accept: application/json*"
- If a client asks for a specific representation (eg XML), that does not mean that the server would support it
- If Accept missing, or generic */*, server would just use the default representation (e.g., JSON)

Spring

Spring Framework

- Open-source, first released in 2002
- Framework to develop enterprise/web applications
- Supported/developed by *Pivotal Software*
- Started as a lightweight alternative to Java Enterprise Edition (JEE)
- Now quite complex, but shares/reuses many aspects of JEE
- Probably one of the frameworks/libraries with the best documentation out there
  - eg, see https://spring.io

Why the name “Spring”?

Spring is what comes after the “*winter*” of JEE…

Spring vs SpringBoot

- Spring has *many*, *many* modules, like for handling databases, web pages, web services, etc.
- To *wire* together a Spring application, there might be the need to set up a lot of configurations
- *SpringBoot* (2012): part of Spring
- Provides *convention over configuration*
  - ie, default, reasonable configurations
  - eg, if you have H2 embedded database as dependency in *pom.xml*, SpringBoot will automatically start it and configure Hibernate for it
- Can write up a full functional enterprise application very quickly

Popularity

- Spring is arguably the most popular framework to develop backend enterprise applications
- However, like JEE, it has a learning curve, as you need to have a clear understanding of ***dependency injection*** and ***proxy classes***
- The JDK also has other more lightweight alternatives, like *DropWizard*
  - less “magic”, but more boilerplate and less functionalities…

Spring In This Course

- Spring is simply huge…
- Only going to see/use a small subset
- *Spring-Web*: to create REST APIs
- *Spring-Data*: used to access SQL databases
- *Spring-Cloud*: to handle *microservices*

REST With SpringBoot

- You will NOT have a "*main*" method from which you call your code directly
- *SpringBoot* will start a servlet to handle HTTP calls, eg *Tomcat*
- You will need to write method handlers for the different HTTP calls your API supports
- *SpringBoot* will automatically scan your code to search for the methods handling HTTP calls

Spring Beans

- Classes that are handled specially by Spring
- When *SpringBoot* starts, it will scan your code for beans, and initialize them
- Beans are identified by *annotations:*
  - *@RestController*: class handling HTTP requests
  - *@Service*: bean providing generic business logic
  - *@Repository:* bean dealing with database access
  - etc.
- You do NOT instantiate bean classes (eg with *new* keyword), it is *SpringBoot* that create them

```
@RestController
class BookRest{

    @GetMapping(path = ["/books"])
    fun getAll(): ResponseEntity<List<BookDto>> { ...
```

- Example: *SpringBoot* will create bean for class *BookRest*, because marked as *@RestController*
- The method *getAll* will be the handler for all the HTTP requests for URL */books*, as marked with *@GetMapping*
  - when *Tomcat* receives a GET for */books*, it will call this method to get the results to send back

Entry Point

- You need a class annotated with *@SpringBootApplication*
  - It will be the entry point of your application
- *SpringBoot* will automatically scan all the classes on your *classpath* (ie your own classes and all third-party dependencies) to check which beans to start
- Be CAREFUL of package names: by default, if *@SpringBootApplication* is in package X.Y.Z, it will scan only X.Y.Z and sub-packages
  - ie, X.Y.Z.W is OK, whereas X.Y will be ignored

Spring's "Magic"

- When starting a *SpringBoot* application, might be difficult to understand what is going on
  - no clear link from "*main*" method to your code, and you never instantiate beans directly
- What started and initialized depends on *@annotations,* and what libraries are on your classpath
  - eg, with *Spring-Web,* a *Tomcat* server will be automatically started
- Besides knowing the semantics of different *@annotations,* there are 2 extremely important concepts: **proxy classes** and **dependency injection**

Proxy Classes

- When having an annotated class *Foo*, and *SpringBoot* creates a bean for it, it is NOT going to be a direct instance of *Foo*, but rather a *proxy*
- A proxy for *Foo* is a class that **extends** *Foo*, where all methods can be enhanced
- A proxy can have a code before and after the original methods of *Foo* (all methods are overridden)
  - example: methods marked with *@Transactional* will automatically start and then commit transactions

Anatomy of a Proxy Class

The proxy would be automatically generated by Spring at runtime

```
public class Foo {

    public String someMethod(){
        return "foo";
    }
}
```

```
public class FooProxy extends Foo{
    private final Foo original;

    public FooProxy(Foo original) {
        this.original = original;
    }

    @Override
    public String someMethod(){
        // do something before, eg start a transaction
        String result = original.someMethod();
        //do something after, eg, commit the transaction
        return result;
    }
}
```

Dependency Injection (DI)

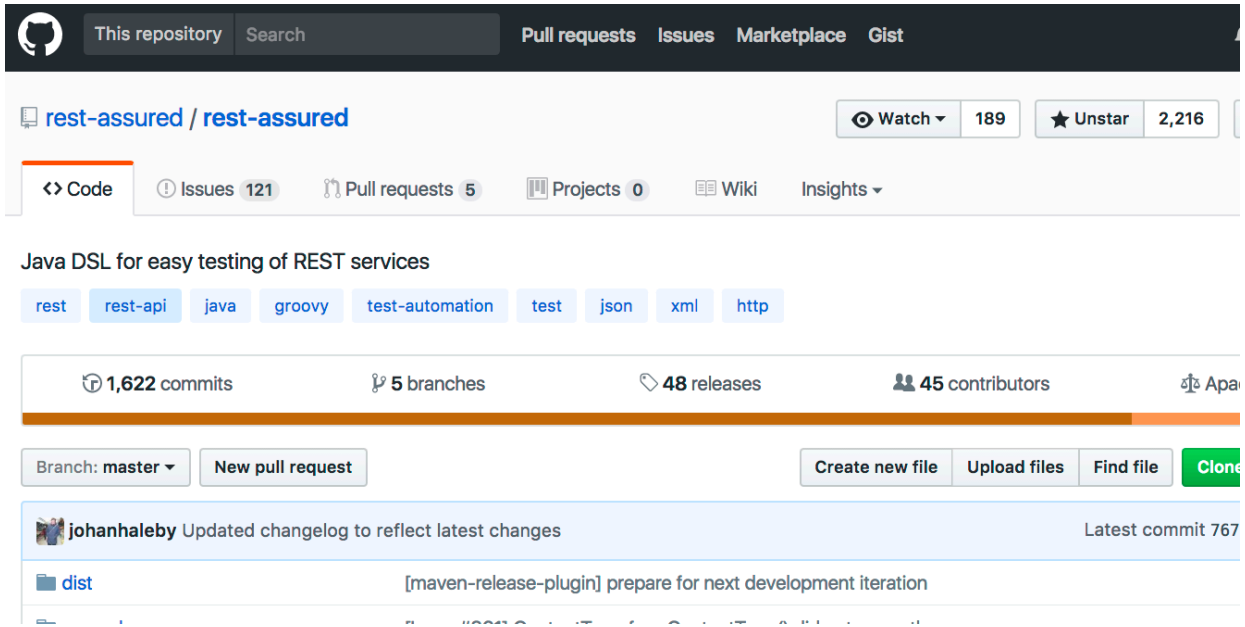
- What if a bean *A* needs to call functionality of a bean *B*?
- *A* cannot create an instance of *B*
- *A* has to ask *SpringBoot* to get an instance of *B*
- 2 methods for DI
- *Field Injection*: fields marked with *@Autowired* will be automatically initialized after the bean is created, using *Reflection*
  - eg, *@Autowired private B b;*
- *Constructor Injection*:
  - reference of *B* passed directly in the constructor of *A*, where Spring provides the right value when creating a bean for *A*

Configurations

- *SpringBoot* provides sensible default configurations based on what present on your *classpath*
- If you need to do modifications, those will be in a *application.properties* or *application.yml* file
  - those are the same, just in different formats
  - ".properties": pairs <property-name>=<value>
  - ".yml"/".yaml": YAML (YAML Ain't Markup Language)
- See following for list of properties:
  - https://docs.spring.io/spring-boot/docs/current/reference/html/common-application-properties.html

E2E Testing of REST APIs

- Do HTTP calls, read responses
  - Specialized libraries, eg in Java the popular **RestAssured**
- Setup database states
  - *before*: add test data
  - *after*: clean state
- There can also be other environment entities to handle
  - eg, connection to other services




```
@Test
public void test0() throws Exception {

        given().header("Authorization", "ApiKey user")
                .accept("*/*")
                .get("www.foo.com/api/v1/media_files/42")
               .then()
                .statusCode(200);
}
```

Git Repository Modules

- *NOTE: most of the explanations will be directly in the code as comments, and not here in the slides*
- **advanced/example-news**
- **advanced/rest/news-rest**
- Study relevant sections in RFC-7230 and RFC-7231
- Study relevant sections in *RESTful Service Best Practices*