# Automatic Sampling and Analysis of YouTube Data

## The YouTube API

Julian Kohne
Johannes Breuer
M. Rohangis Mohseni

2022-02-21

## How Can We Get Data From Websites?

Theoretically, we could gather all the information manually by clicking on the things that are interesting to us and copy/pasting them. However, this is tedious and time-consuming. **We want a way of automatizing this task**. The solution to our problem is…

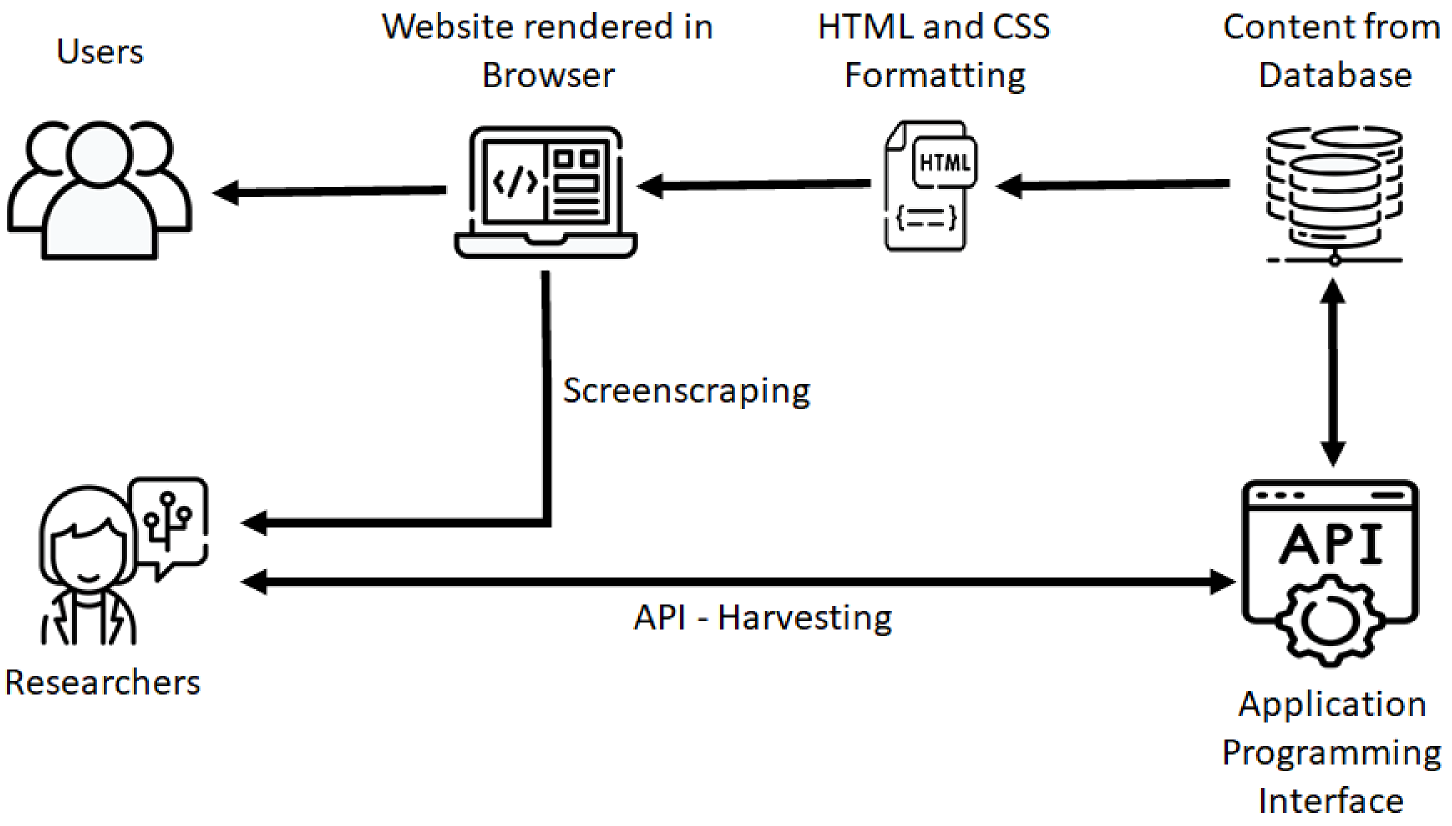
Web scraping. There are two different approaches:

1. **Screen scraping:** Getting the HTML-code out of your browser, parsing & formatting it, then analyzing the data
2. **API harvesting:** Sending requests directly to the database and only getting back the information that you want and need

## The Structure of Data on *YouTube*

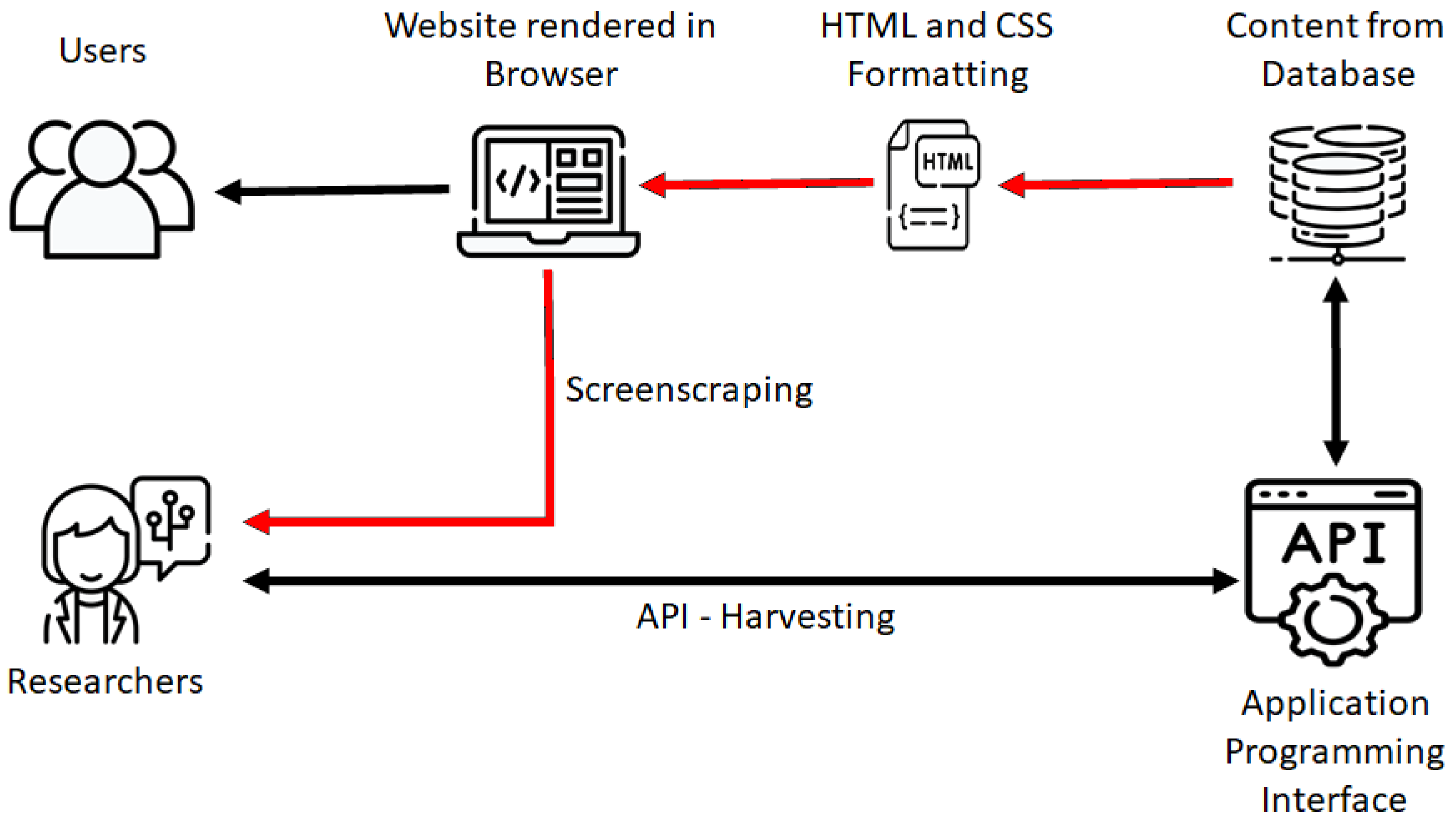
- All data on *YouTube* is stored in a MySQL database
- The website itself is an HTML page, which loads content from this database
- The HTML is rendered by a web browser so the user can interact with it
- Through interacting with the rendered website, we can either retrieve content from the database or send information to the database
- The YouTube website is
  - built in HTML
  - uses CSS for the "styling"
  - dynamically loads content using Ajax from the database

## Interaction With the Data

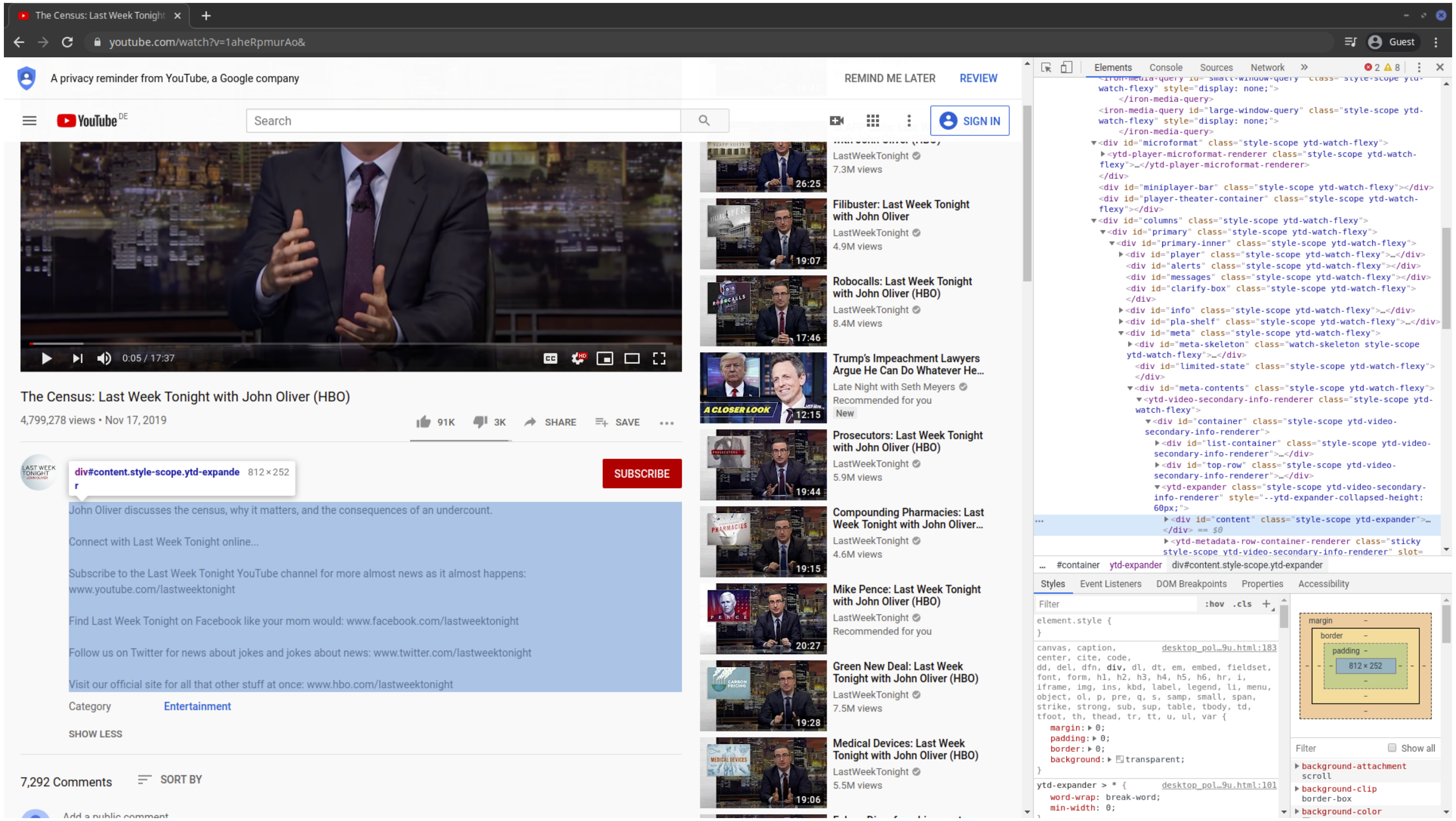


## Screen Scraping

- Screen scraping means that we download the HTML text file, which contains the content we are interested in but also a lot of unnecessary clutter that describes how the website should be rendered by the browser



## Screen Scraping



The Census: Last Week Tonight with John Oliver (HBO)

4,799,278 views • Nov 17, 2019

div#content.style-scope.ytd-expander 812×252

John Oliver discusses the census, why it matters, and the consequences of an undercount.

Connect with Last Week Tonight online...

Subscribe to the Last Week Tonight YouTube channel for more almost news as it almost happens: www.youtube.com/lastweektonight

Find Last Week Tonight on Facebook like your mom would: www.facebook.com/lastweektonight

Follow us on Twitter for news about jokes and jokes about news: www.twitter.com/lastweektonight

Visit our official site for all that other stuff at once: www.hbo.com/lastweektonight

Category Entertainment

```
    <iron-media-query id="large-window-query" class="style-scope ytd-watch-flexy" style="display: none;">
      </iron-media-query>
  ▼<div id="microformat" class="style-scope ytd-watch-flexy">
    ▶<ytd-player-microformat-renderer class="style-scope ytd-watch-flexy">…</ytd-player-microformat-renderer>
    </div>
    <div id="miniplayer-bar" class="style-scope ytd-watch-flexy"></div>
    <div id="player-theater-container" class="style-scope ytd-watch-flexy"></div>
  ▼<div id="columns" class="style-scope ytd-watch-flexy">
    ▼<div id="primary" class="style-scope ytd-watch-flexy">
      ▼<div id="primary-inner" class="style-scope ytd-watch-flexy">
        ▶<div id="player" class="style-scope ytd-watch-flexy">…</div>
         <div id="alerts" class="style-scope ytd-watch-flexy"></div>
         <div id="messages" class="style-scope ytd-watch-flexy"></div>
         <div id="clarify-box" class="style-scope ytd-watch-flexy">
         </div>
        ▶<div id="info" class="style-scope ytd-watch-flexy">…</div>
        ▶<div id="pla-shelf" class="style-scope ytd-watch-flexy">…</div>
        ▼<div id="meta" class="style-scope ytd-watch-flexy">
          ▶<div id="meta-skeleton" class="watch-skeleton style-scope ytd-watch-flexy">…</div>
           <div id="limited-state" class="style-scope ytd-watch-flexy">
           </div>
          ▼<div id="meta-contents" class="style-scope ytd-watch-flexy">
            ▼<ytd-video-secondary-info-renderer class="style-scope ytd-watch-flexy">
              ▼<div id="container" class="style-scope ytd-video-secondary-info-renderer">
                ▶<div id="list-container" class="style-scope ytd-video-secondary-info-renderer">…</div>
                ▶<div id="top-row" class="style-scope ytd-video-secondary-info-renderer">…</div>
                ▼<ytd-expander class="style-scope ytd-video-secondary-info-renderer" style="--ytd-expander-collapsed-height: 60px;">
                  ▶<div id="content" class="style-scope ytd-expander">…</div> == $0
                  ▶<ytd-metadata-row-container-renderer class="sticky style-scope ytd-video-secondary-info-renderer" slot=
```

## Screen Scraping

- To automatically obtain data, we can use a so-called GET request
- A GET request is an HTTP method for asking a server to send a specific resource (usually an HTML page) back to your local machine. It is implemented in many different libraries, such as curl.
- This is the basic principle that all the scraping packages are built on
- We will not use this directly and will let the higher-level applications handle this under the hood

## Screen Scraping - Examples

- Via the console in Linux or MacOS (saves html to a file)

```
curl "https://www.youtube.com/watch?v=1aheRpmurAo/" >
YT.html
```

- Online, using the code from above

```
curl "https://www.youtube.com/watch?v=1aheRpmurAo/"
```

- In `R`

```
# Warning about incomplete final line can (usually) be ignored
library(curl)
html_text <-
readLines(curl("https://www.youtube.com/watch?v=1aheRpmurAo/"))
```

## Screen Scraping: Advantages

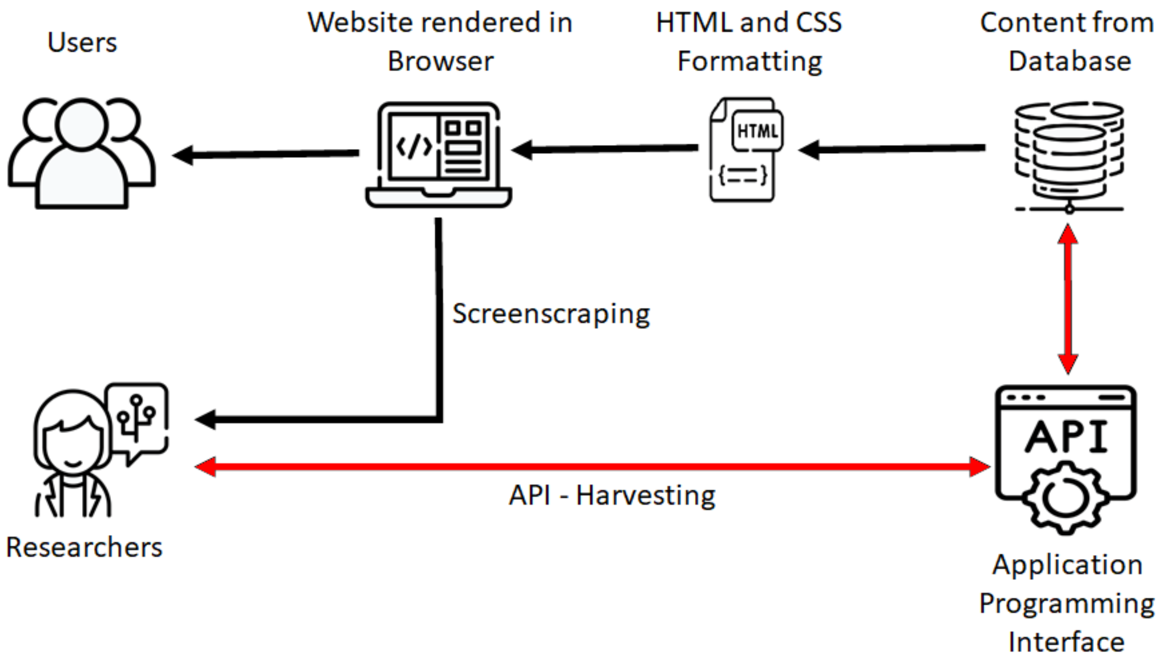
- You can access everything that you are able to access from your browser
- You are (theoretically) not restricted in how much data you can get
- (Theoretically) Independent from API-restrictions

## Screen Scraping: Disadvantages

- Extremely tedious to get information out of HTML-pages
- You have to manually look up the Xpaths/CSS/HTML containers to get specific information
- Reproducibility: The website might be tailored to stuff in your cache, cookies, accounts etc.
- There is no guarantee that even pages that look the same have the same underlying HTML structure
- You have to manually check the website and your data to make sure that you get what you want
- If the website changes anything in their styling, your scripts probably won't work anymore
- Legality depends on country

## API Harvesting

- An **Application Programming Interface**...
  - is a system built for developers
  - directly communicates with the underlying database(s)
  - is a voluntary service provided by the platform
  - controls what information is accessible, to whom, how, and in which quantities



## Using APIs

- APIs can be used to/for:
    - embed content in other applications
    - create bots that do something automatically
    - scheduling/moderation for content creators
    - collect data for (market) research purposes
- Not every website has their own API. However, most large social media services do, e.g.:
    - Facebook
    - Twitter
    - Instagram
    - Wikipedia
    - Google Maps

## API Harvesting - Examples

- From the console
  (API Key needs to be added before execution)

  ```
  curl "https://www.googleapis.com
      /youtube/v3/search?
      part=snippet&q=Brexit&
      key=INSERT-API-KEY-HERE"
  ```

- Online, using code from above (API Key needs to be added before execution)

- In `R` (API Key needs to be added before execution, data needs to be converted to JSON format)

  ```
  library(curl)
  library(jsonlite)
  api_response <- fromJSON(curl("https://www.googleapis.com/
                                youtube/v3/search?
                                part=snippet&q=Brexit&
                                key=INSERT-API-KEY-HERE"))
  ```

## Advantages of API Harvesting

- No need to interact with HTML files, you only get the information you asked for
- The data you get is already nicely formatted (usually JSON files)
- You can be confident that what you do is legal (if you adhere to the Terms of Service and respect data privacy and copyright regulations)

## Disadvantages of API Harvesting

- Not every website/service has an API
- You can only get what the API allows you to get
- There are often restricting quotas (e.g., daily limits)
- Terms of Service can restrict how you may use the data (e.g., with regard to sharing or publishing it)
- There is no standard language to make queries, you have to check the documentation
- Not every API has a (good) documentation

## Screen Scraping vs. API-Harvesting

If you can, use an API, if you must, use Screen Scraping instead

## The YouTube API

## Platform APIs

- To find an API for a given website, Programmable Web is a good starting point
- Fortunately, *YouTube* has its own, well-documented APIs that developers can use to interact with their database (most *Google* services do)
- We will use the YouTube Data API in this workshop

## Let's Check Out the *YouYube* API!

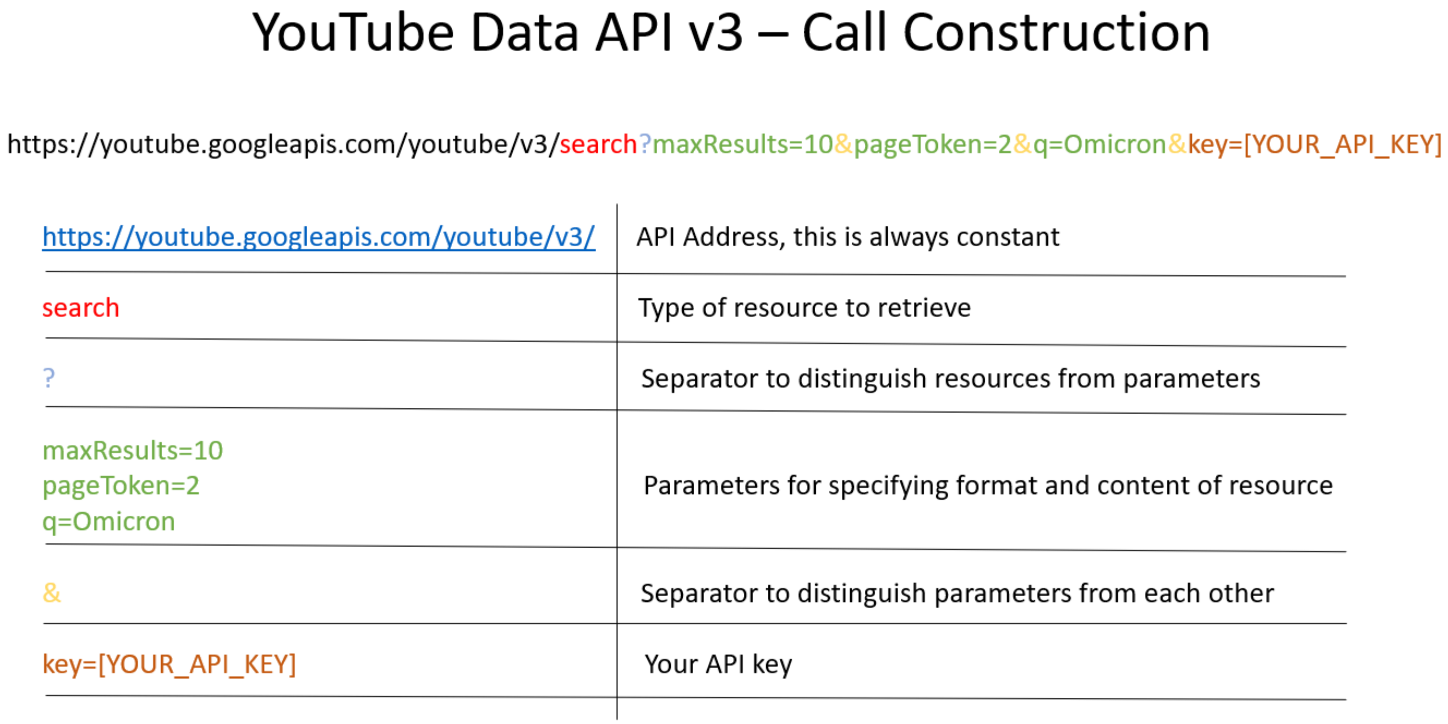
- Google provides a sandbox for their API that we can use to get a grasp of how it operates
- We can, for example, use our credentials to search for videos with the keyword "Brexit"
- Example
- Keep in mind: We have to log in with the *Google* account we used to create the app for accessing the API
- What we get back is a JSON-formatted response with the information we requested in the API sandbox

## API Key vs. OAuth2.0

- There are two different ways to authenticate with the YouTube API
  - API Key: Text string identifying the app and user, grants access to public data
  - OAuth2.0: Token created from Client secret and Client ID, grants access to everything the user can access
- For most API calls, the API key is enough
- the `tuber` package for `R`, however, uses OAuth2.0 authentification because you can also use it to, e.g., change your account information from `R`

## Constructing API calls

We can construct all calls to the API according to the following logic



YouTube Data API v3 – Call Construction

https://youtube.googleapis.com/youtube/v3/search?maxResults=10&pageToken=2&q=Omicron&key=[YOUR_API_KEY]

| | |
|---|---|
| https://youtube.googleapis.com/youtube/v3/ | API Address, this is always constant |
| search | Type of resource to retrieve |
| ? | Separator to distinguish resources from parameters |
| maxResults=10<br>pageToken=2<br>q=Omicron | Parameters for specifying format and content of resource |
| & | Separator to distinguish parameters from each other |
| key=[YOUR_API_KEY] | Your API key |

## Excursus: What is JSON?

- Java Script Object Notation
- Language-independent data format (like .csv)
- Like a nested List of Key:Value pairs
- Standard data format for many APIs and web applications
- Better than tabular formats (.csv / .tsv) for storing large quantities of data by not declaring missing data
- Represented in `R` as a list of lists that typically needs to be transformed into a regular dataframe (this can be tedious but, luckily, there are packages and functions for handling this, such as `jsonlite`)

## Excursus: What is `JSON`?

```
'{
  "first name": "John",
  "last name": "Smith",
  "age": 25,
  "address": {
    "street address": "21 2nd Street",
    "city": "New York",
    "postal code": "10021"
  },
  "phone numbers": [
    {
      "type": "home",
      "number": "212 555-1234"
    },
    {
      "type": "mobile",
      "number": "646 555-4567"
    }
  ],
  "sex": "male"
}'
```

## Important *YouTube* API Parameters

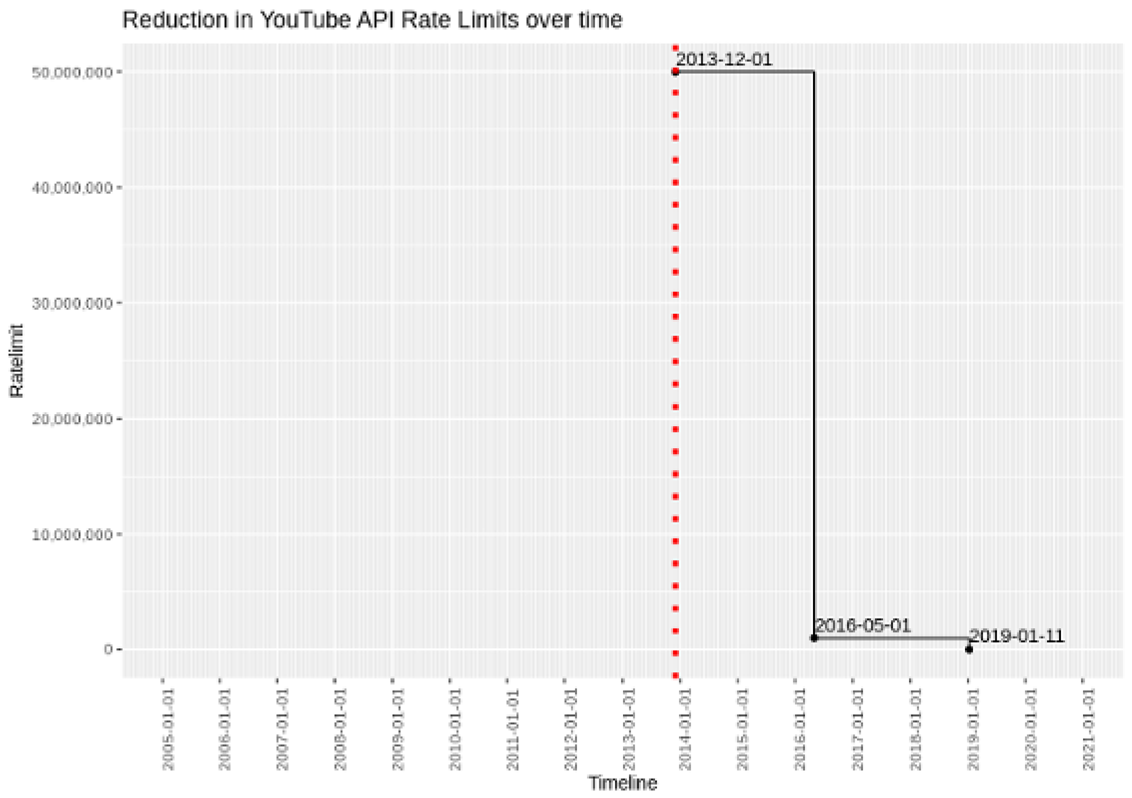
- All possible resources for the *YouTube* API are listed here
- For our workshop, the most important resources will be `search`, `Comments`, `CommentThreads`, and `videos`
- **NB**: Some information is only visible to owners of a channel or author of a video
- Not all information is necessarily available for all videos (e.g., live videos)
- Public data requires an API key, getting user data requires OAuth2.0 authentication

## Using the API from R

- We can simplify the process of interacting with the YouTube API by using a dedicated `R` package
- The package handles the authentication with our credentials and translates `R` commands into API calls
- It also simplifies the JSON response to a standard dataframe automatically for many requests
- In essence, we can run `R` commands and get nicely formatted API results back
- For this workshop, we will mostly use the tuber package, and also briefly explore the vosonSML package

## API Rate Limits

- With the API, you have a limit of how much data you can get
- The daily quota limit has constantly decreased significantly over the last decade



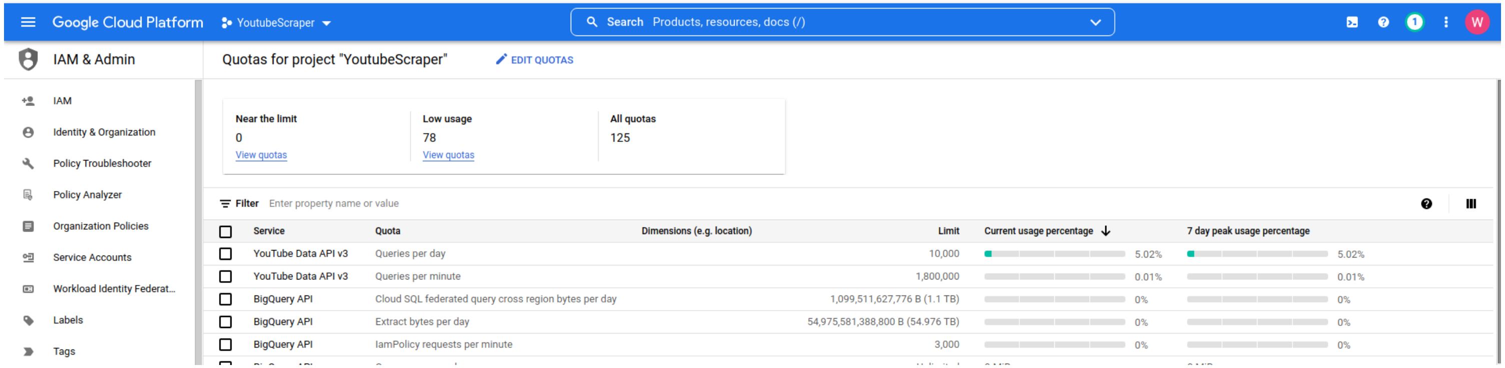
## API Rate Limits

- Currently (02.2022), you have a quota of **10.000** units per day
- Each request (even invalid ones) costs a certain amount of units
- There are two factors influencing the quota cost of each request:
  - different types of requests (e.g., write operation: 50 units; video upload: 1600 units)
  - how many parts the requested resource has (playlist:2 ; channel:6 ; video:10)
- **You should only request parts that you absolutely need to make the most of your units. We will talk about this in more detail in the data collection session.**

**NB: Sending incorrect requests can also deplete your daily quota**

## API Rate Limits

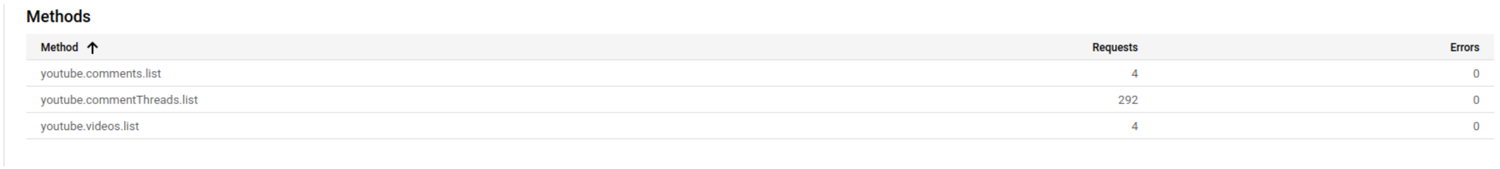
- You can check the rate limits in the *YouTube* API Documentation
- You can see how much of your quota you have already used up in the *Google* Developer Console



Quotas for project "YoutubeScraper"

| Near the limit | Low usage | All quotas |
|---|---|---|
| 0 | 78 | 125 |
| View quotas | View quotas | |

| Service | Quota | Dimensions (e.g. location) | Limit | Current usage percentage | 7 day peak usage percentage |
|---|---|---|---|---|---|
| YouTube Data API v3 | Queries per day | | 10,000 | 5.02% | 5.02% |
| YouTube Data API v3 | Queries per minute | | 1,800,000 | 0.01% | 0.01% |
| BigQuery API | Cloud SQL federated query cross region bytes per day | | 1,099,511,627,776 B (1.1 TB) | 0% | 0% |
| BigQuery API | Extract bytes per day | | 54,975,581,388,800 B (54.976 TB) | 0% | 0% |
| BigQuery API | IamPolicy requests per minute | | 3,000 | 0% | 0% |



Methods

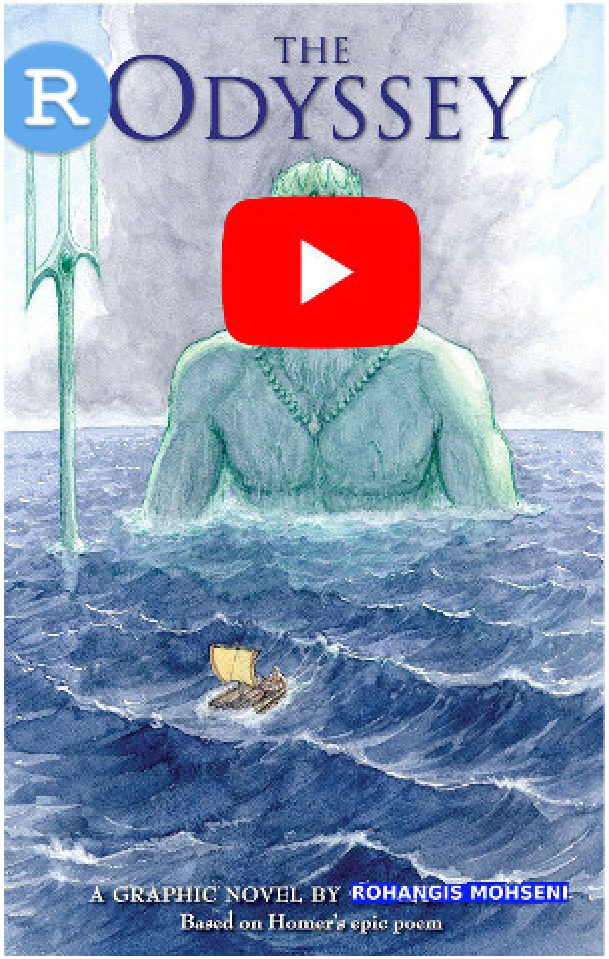
| Method | Requests | Errors |
|---|---|---|
| youtube.comments.list | 4 | 0 |
| youtube.commentThreads.list | 292 | 0 |
| youtube.videos.list | 4 | 0 |

## Exceeding the API Rate Limit

Once you reach your rate limit, the API will start to send back the following response until your rate limit is reset

```
{
  "error": {
    "code": 403,
    "message": "The request cannot be completed because you have exceeded you
    "errors": [
      {
        "message": "The request cannot be completed because you have exceedec
        "domain": "youtube.quota",
        "reason": "quotaExceeded"
      }
    ]
  }
}
```

## Can I Increase my Rate Limit? A "Short" Story


THE
RODYSSEY
A GRAPHIC NOVEL BY ROHANGIS MOHSENI
Based on Homer's epic poem

## Trying to Raise the *YouTube* API Quota

- Study that needed large datasets in a short amount of time
- RQ: Is there a u-shaped relationship between success and number of uploads?
- Sample: 600 popular channels (identified via SocialBlade)
- Request for higher quota (October 11, 2019)
- Problem: Same application form for (web) apps and research
- Hard to figure what applies to research and what to write into the form
- Experience: Stuck in an infinite loop with e-mails from *Google* support on this issue

## Any questions?

## Exercise time 🏋️‍♀️💪🏃🚴

Solutions