Web Application Development

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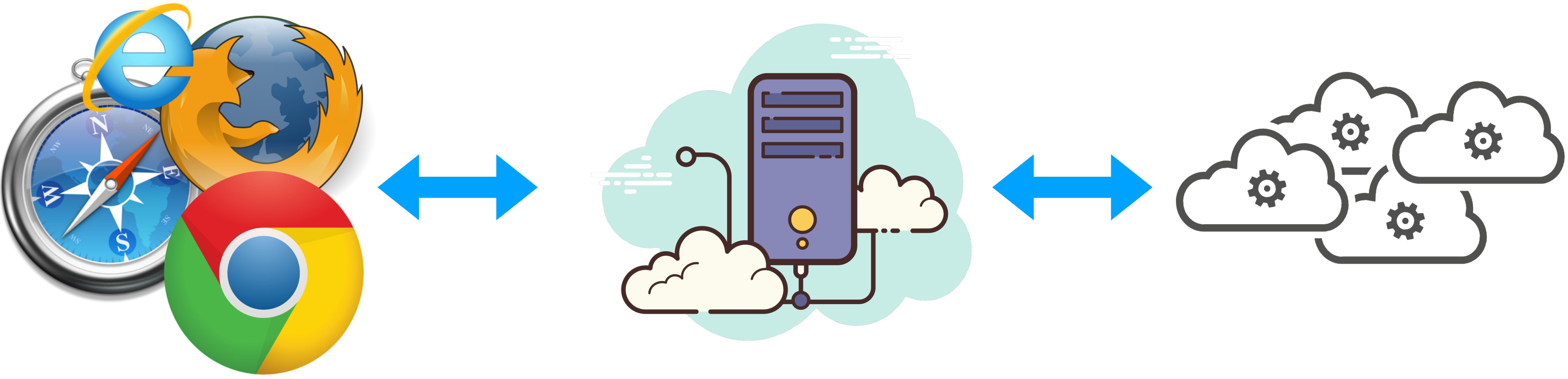
Backend

Web Application Architecture

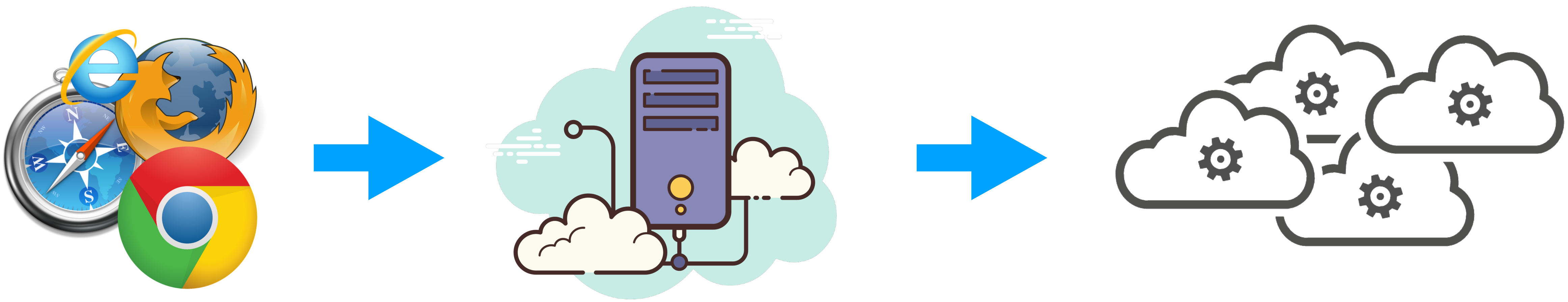


Web browser

Web server

Web application

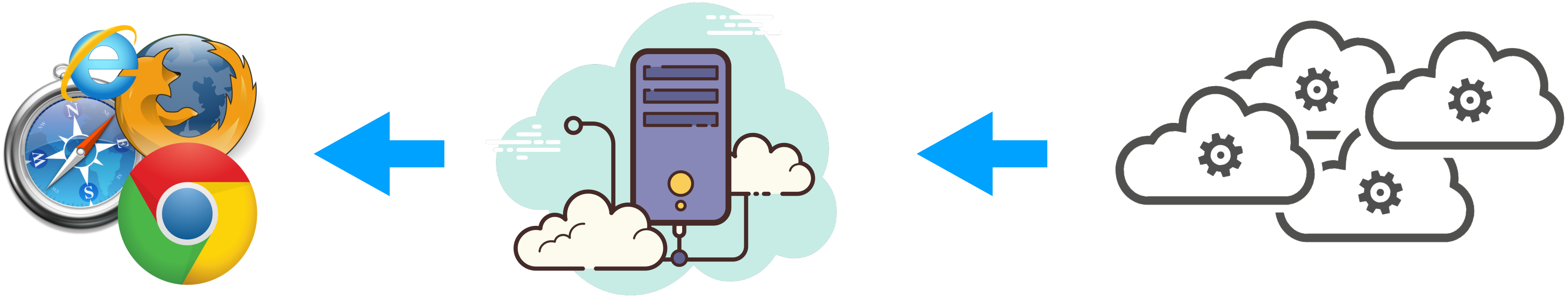
Architecture. Step 1



HTTP request
wad.itmo.xyz/

/ is routed
to an Application

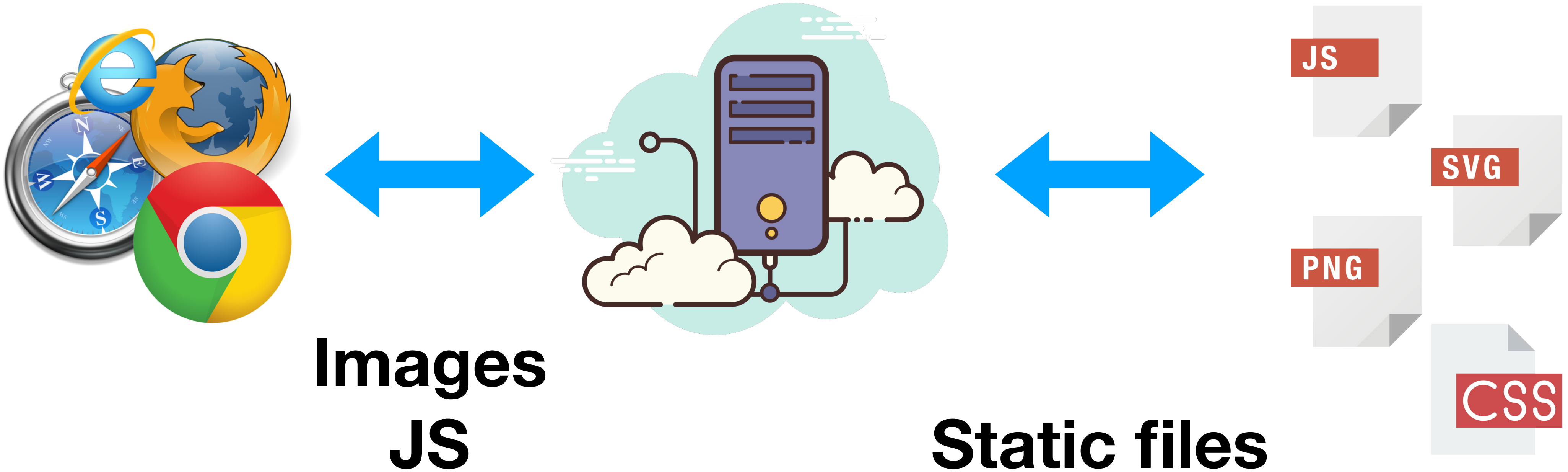
Architecture. Step 2



Send HTML
back to client

Render HTML

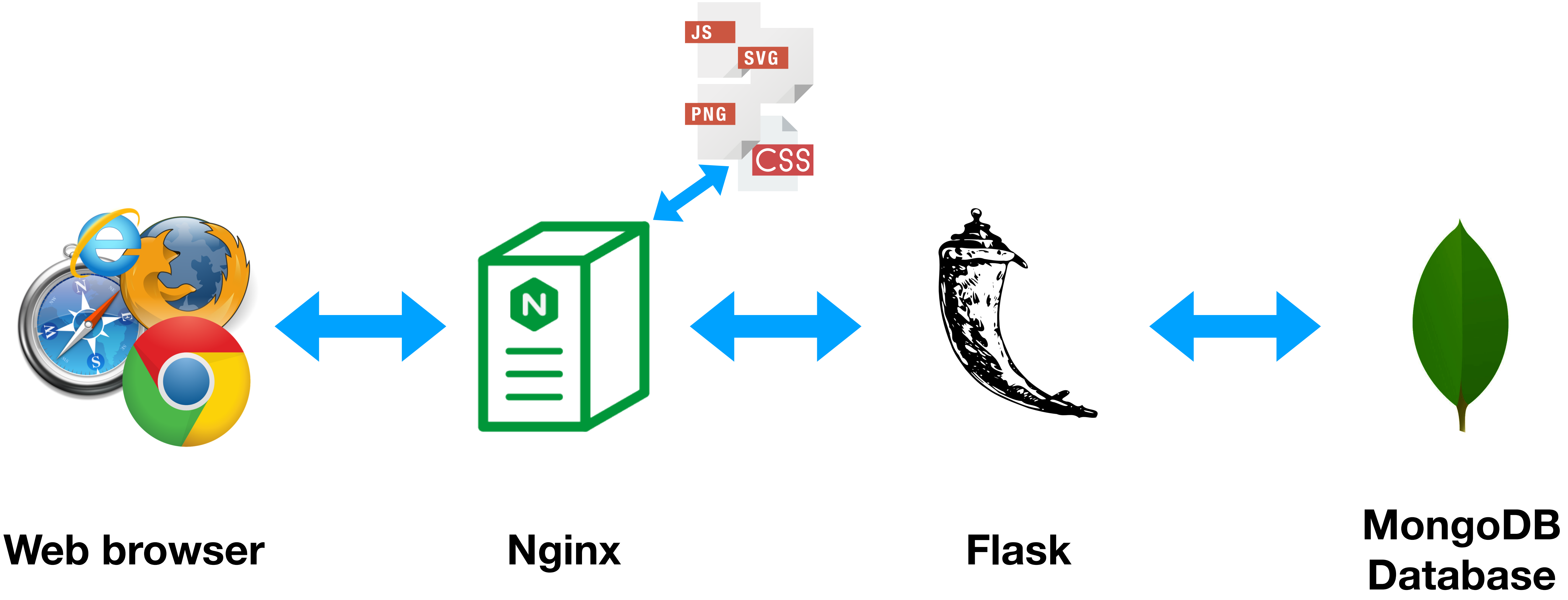
Architecture. Step 3



Images
JS
CSS

Static files

Web Application Architecture



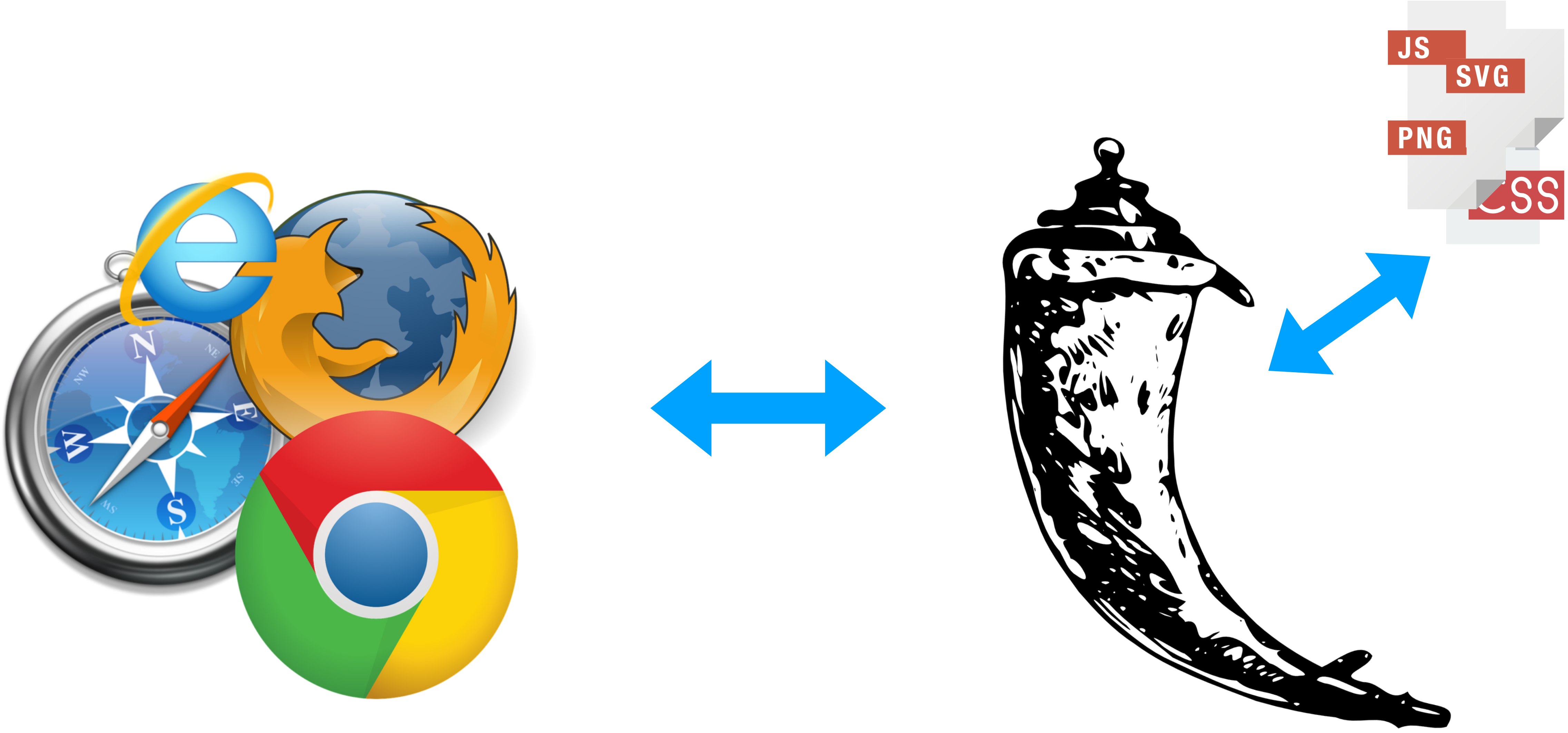
Web browser

Nginx

Flask

MongoDB
Database

Web Application Architecture



Web browser

Flask

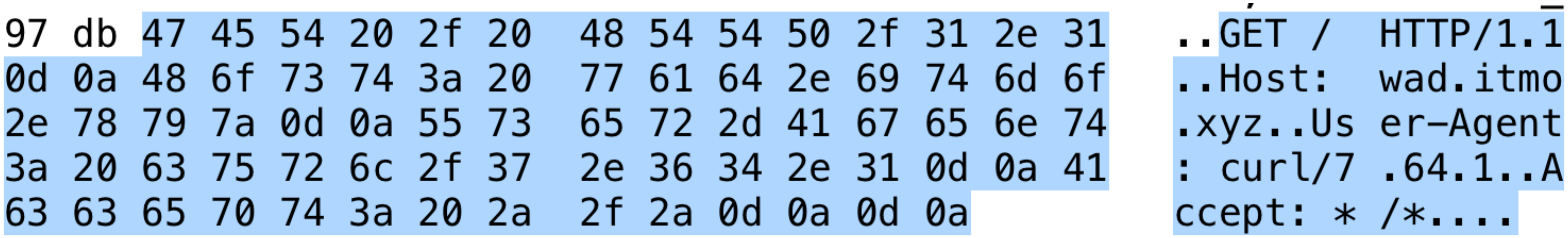
HTTP

HTTP Request

curl http://wad.itmo.xyz -vvv

Method

```
*   Trying 185.199.108.153...
* TCP_NODELAY set
* Connected to wad.itmo.xyz (185.199.108.153) port 80 (#0)
> GET / HTTP/1.1
> Host: wad.itmo.xyz
> User-Agent: curl/7.64.1
> Accept: */*
>
```



```
97 db 47 45 54 20 2f 20  48 54 54 50 2f 31 2e 31   ..GET /  HTTP/1.1
0d 0a 48 6f 73 74 3a 20  77 61 64 2e 69 74 6d 6f   ..Host:  wad.itmo
2e 78 79 7a 0d 0a 55 73  65 72 2d 41 67 65 6e 74   .xyz..Us er-Agent
3a 20 63 75 72 6c 2f 37  2e 36 34 2e 31 0d 0a 41   : curl/7 .64.1..A
63 63 65 70 74 3a 20 2a  2f 2a 0d 0a 0d 0a         ccept: * /*....
```

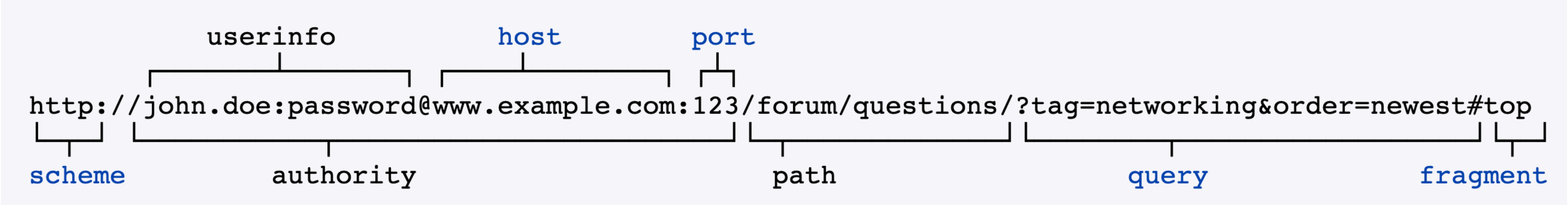
HTTP Response

`curl http://wad.itmo.xyz -vvv`

Status

```
< HTTP/1.1 301 Moved Permanently
< Server: GitHub.com
< Content-Type: text/html
< Location: https://wad.itmo.xyz/
< Content-Length: 162
< Date: Thu, 02 Apr 2020 11:30:02 GMT
<
<html>
<head><title>301 Moved Permanently</title></head>
<body>
<center><h1>301 Moved Permanently</h1></center>
<hr><center>nginx</center>
</body>
</html>
* Connection #0 to host wad.itmo.xyz left intact
* Closing connection 0
```

URI



userinfo host port

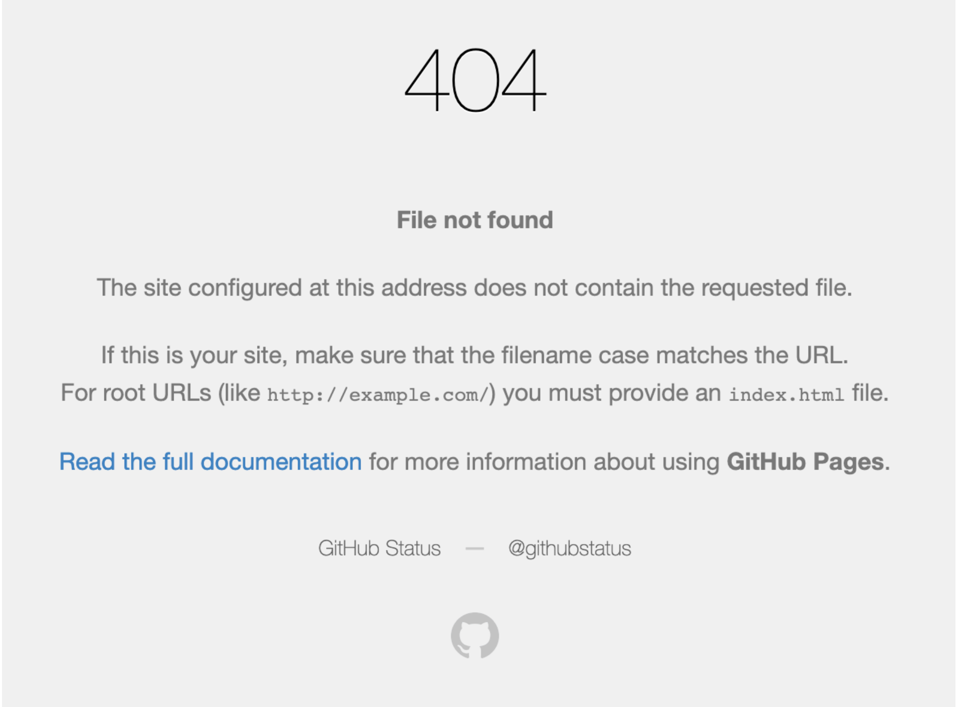
`http://john.doe:password@www.example.com:123/forum/questions/?tag=networking&order=newest#top`

scheme authority path query fragment

https://wad.itmo.xyz/index.html

https://wad.itmo.xyz/

https://wad.itmo.xyz/qwerty →



404

File not found

The site configured at this address does not contain the requested file.

If this is your site, make sure that the filename case matches the URL.
For root URLs (like `http://example.com/`) you must provide an `index.html` file.

Read the full documentation for more information about using **GitHub Pages**.

GitHub Status — @githubstatus

HTTP Status codes

https://en.wikipedia.org/wiki/List_of_HTTP_status_codes

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

- 200 OK
- 301 Moved Permanently
- 400 Bad Request
- 401 Unauthorized
- 403 Forbidden
- 404 Not Found
- 500 Internal Server Error
- 502 Bad Gateway
- 504 Gateway Timeout.

HTTP Headers

https://en.wikipedia.org/wiki/List_of_HTTP_header_fields

Request

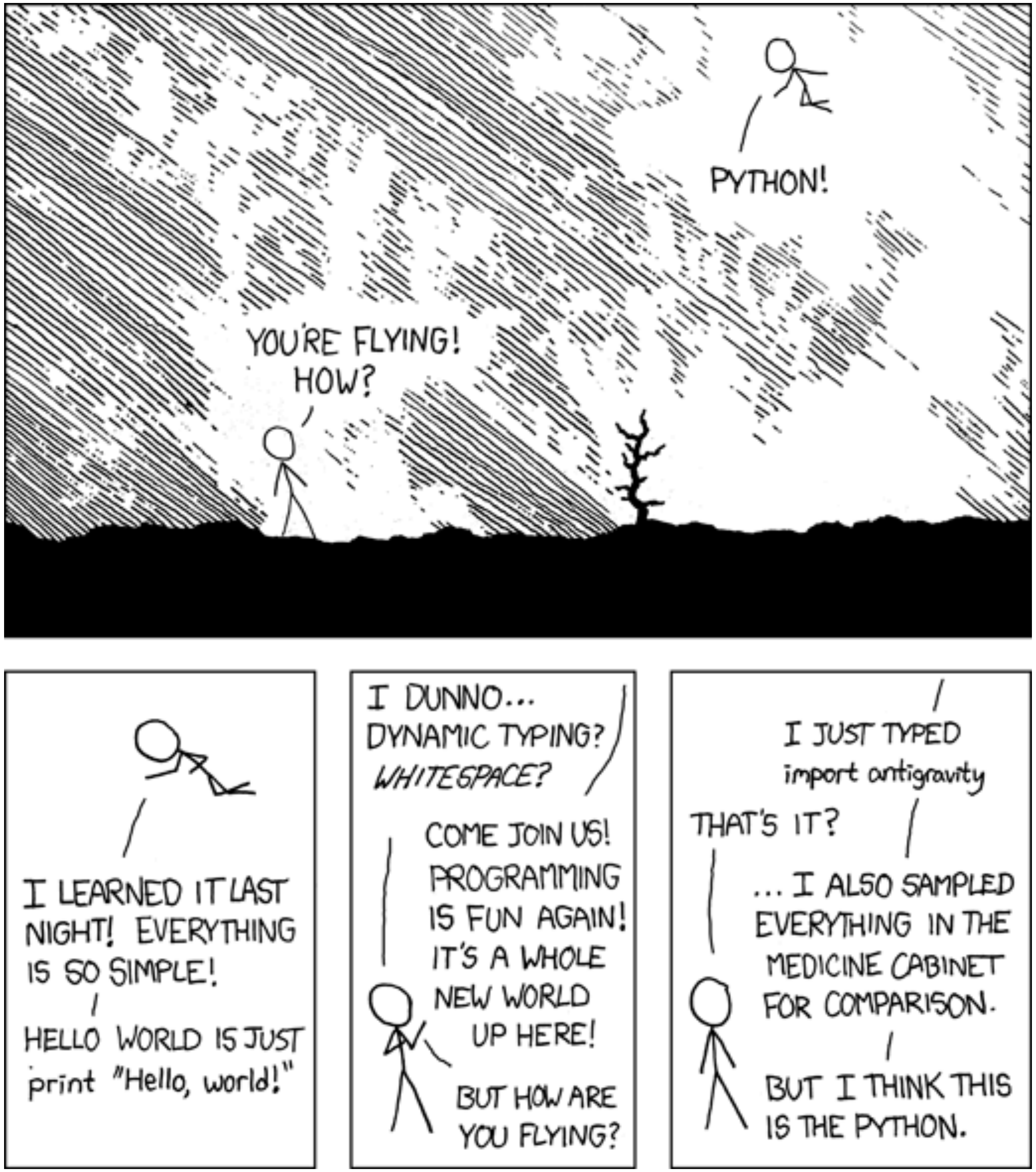
- Authorization
- Content-Type
- Cookie
- Host
- Referer
- User-Agent

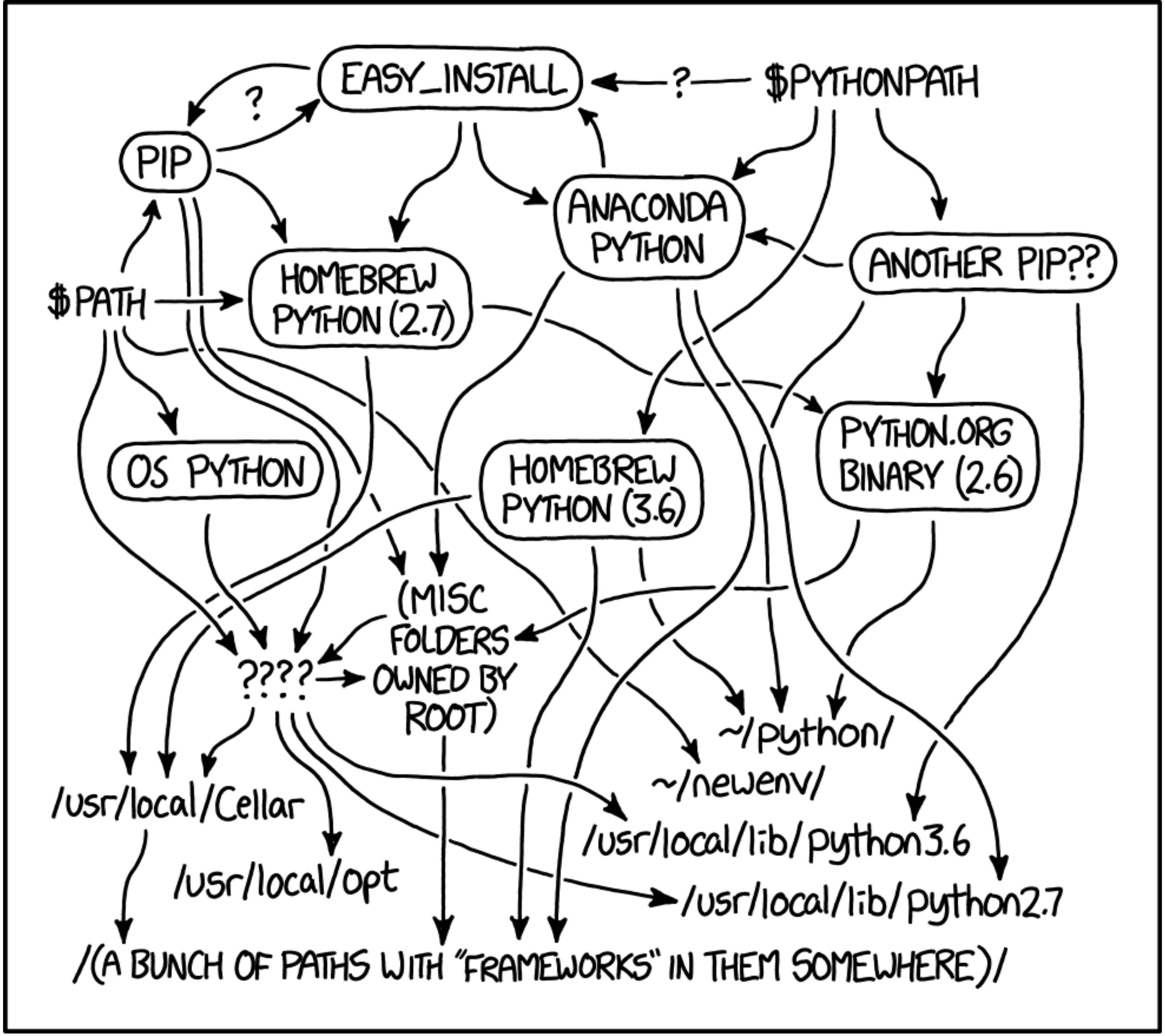
Response

- Location
- Server
- Set-Cookie

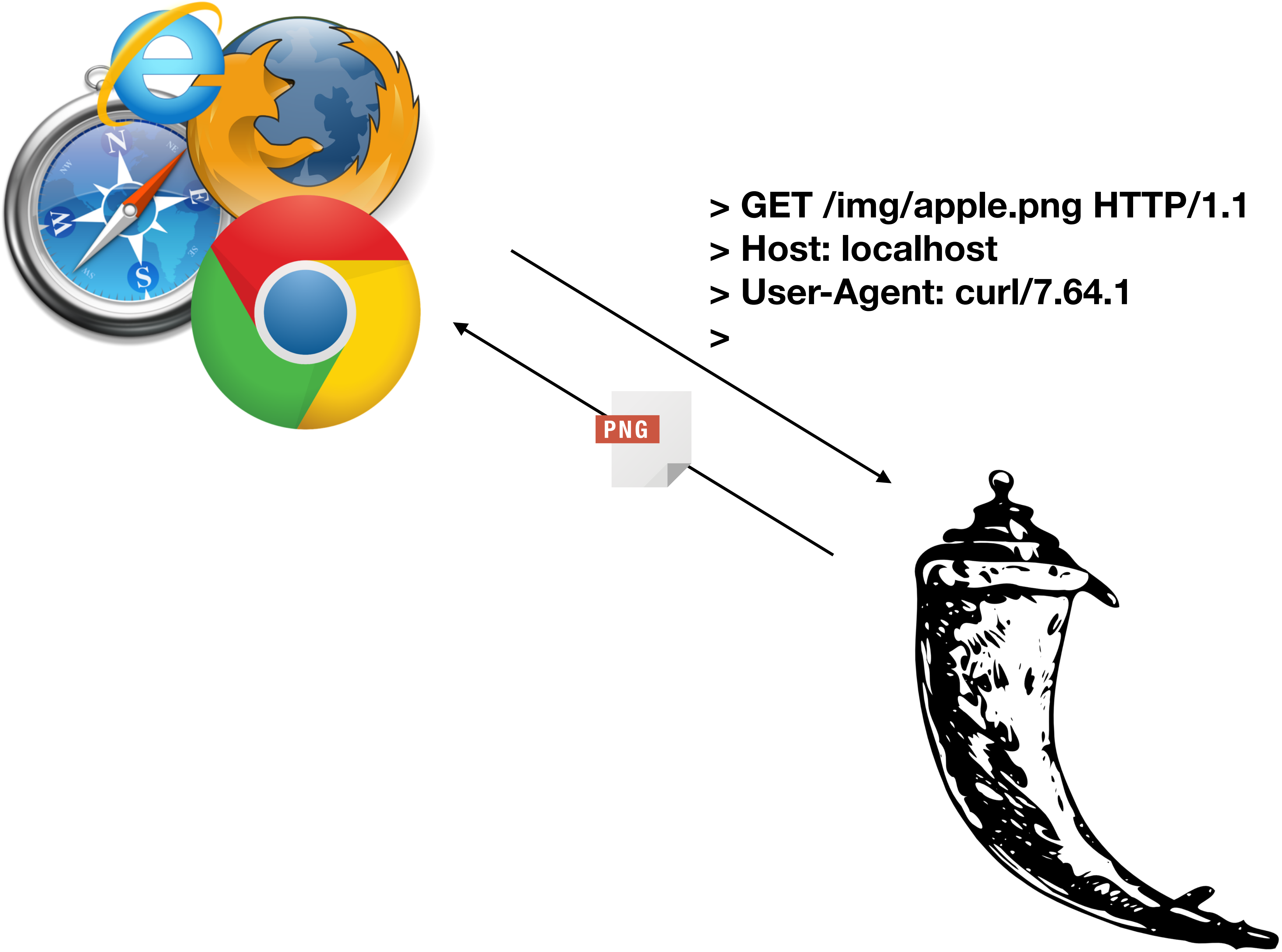
Demo

Python Flask

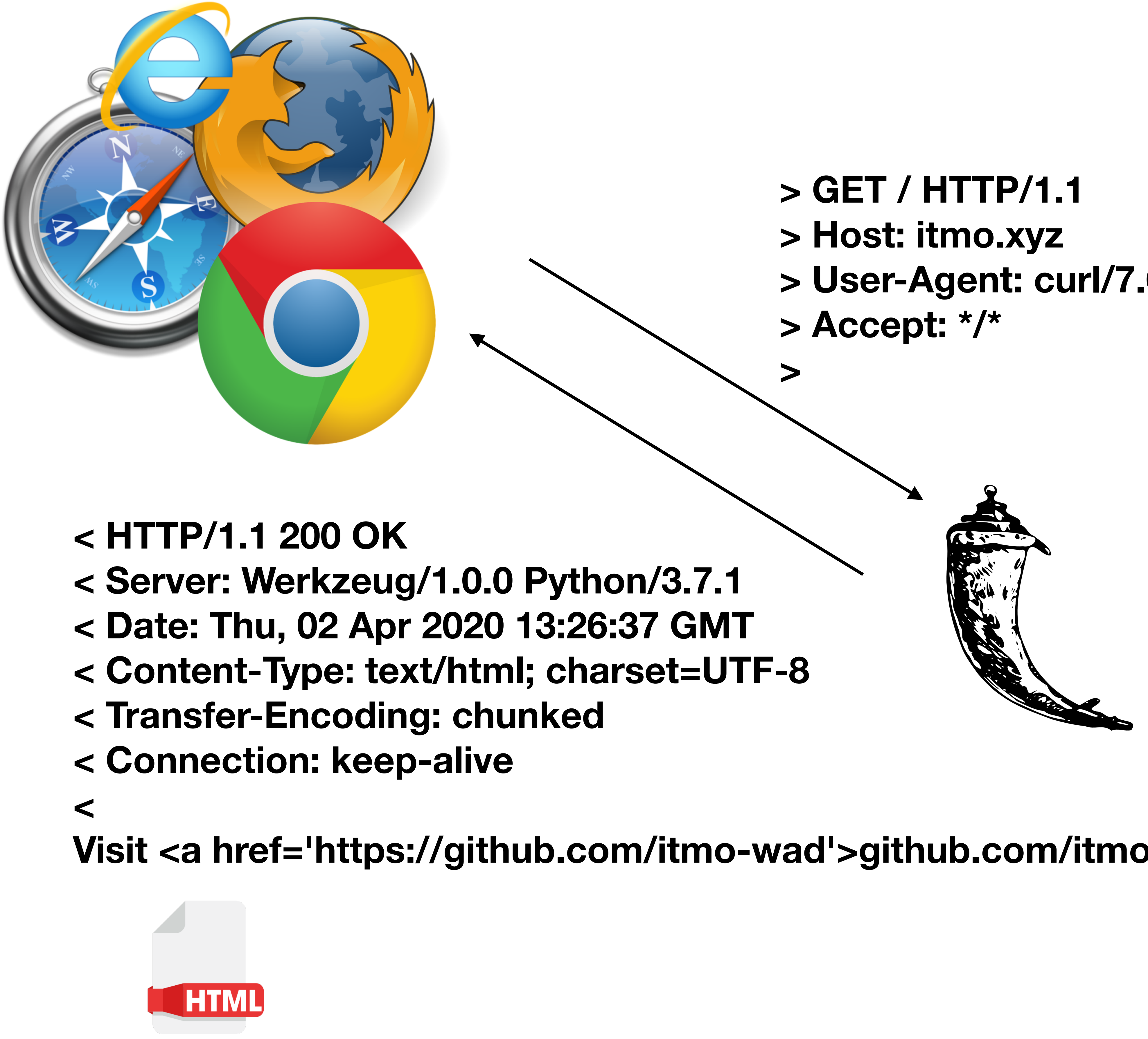

PYTHON!
YOU'RE FLYING! HOW?
I LEARNED IT LAST NIGHT! EVERYTHING IS SO SIMPLE!
HELLO WORLD IS JUST print "Hello, world!"
I DUNNO... DYNAMIC TYPING? WHITESPACE?
COME JOIN US! PROGRAMMING IS FUN AGAIN! IT'S A WHOLE NEW WORLD UP HERE!
BUT HOW ARE YOU FLYING?
I JUST TYPED import antigravity
THAT'S IT?
... I ALSO SAMPLED EVERYTHING IN THE MEDICINE CABINET FOR COMPARISON.
BUT I THINK THIS IS THE PYTHON.



MY PYTHON ENVIRONMENT HAS BECOME SO DEGRADED THAT MY LAPTOP HAS BEEN DECLARED A SUPERFUND SITE.



```
> GET /img/apple.png HTTP/1.1
> Host: localhost
> User-Agent: curl/7.64.1
>
```

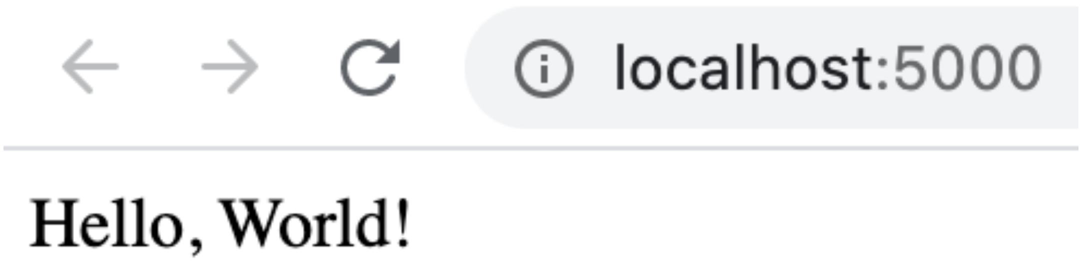


```
> GET / HTTP/1.1
> Host: itmo.xyz
> User-Agent: curl/7.64.1
> Accept: */*
>
```

```
< HTTP/1.1 200 OK
< Server: Werkzeug/1.0.0 Python/3.7.1
< Date: Thu, 02 Apr 2020 13:26:37 GMT
< Content-Type: text/html; charset=UTF-8
< Transfer-Encoding: chunked
< Connection: keep-alive
<
Visit <a href='https://github.com/itmo-wad'>github.com/itmo-wad</a>
```

Sample

```python
from flask import Flask
app = Flask(__name__)

@app.route('/')
def hello_world():
    return 'Hello, World!'


app.run(host="localhost", port=5000)
```

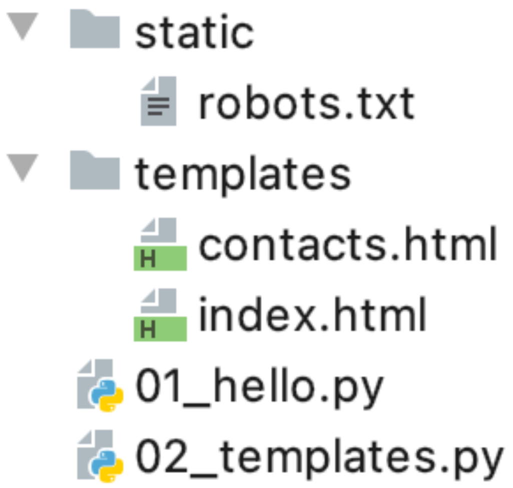


localhost:5000

Hello, World!

Templates

```python
from flask import Flask, render_template

app = Flask(__name__)


@app.route('/')
def index():
    return render_template("index.html")


@app.route('/contacts')
def contacts():
    return render_template("contacts.html")


app.run(host="localhost", port=5000, debug=True)
```



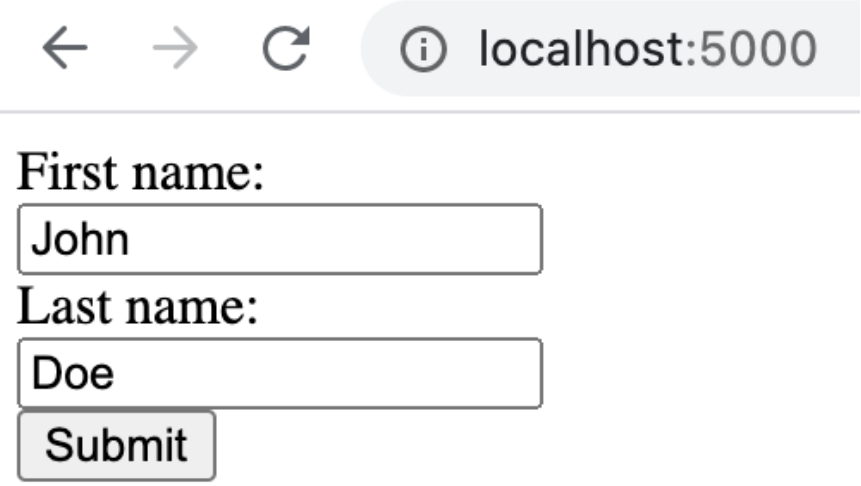
```
▼ static
      robots.txt
▼ templates
      contacts.html
      index.html
  01_hello.py
  02_templates.py
```

http://localhost:5000/

http://localhost:5000/contacts

Forms

```
<form action="/" method="POST">
  First name:<br>
  <input type="text" name="fname" value="John"><br>
  Last name:<br>
  <input type="text" name="lname" value="Doe"><br>

  <input type="submit" value="Submit">
</form>
```



First name:

John

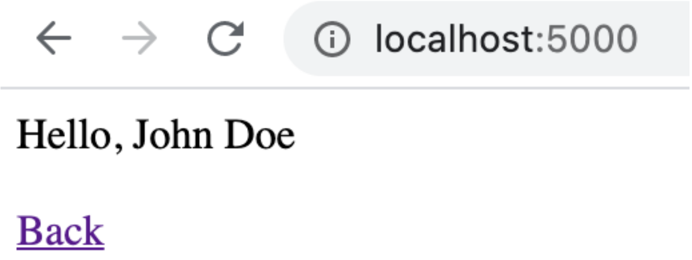
Last name:

Doe

Forms

```
from flask import Flask, render_template, request

app = Flask(__name__)


@app.route('/', methods=["GET", "POST"])
def index():
    if request.method == "GET":
        return render_template("form.html")
    else:
        lname = request.form.get("lname")
        fname = request.form.get("fname")
        return render_template("cabinet.html", lname=lname, fname=fname)


app.run(host="localhost", port=5000, debug=True)
```

```
Hello, {{ fname }} {{ lname }}

<br><br><a href="/">Back</a>
```



Hello, John Doe

Back

IDE

- Notepad/vim
- PyCharm community edition: https://www.jetbrains.com/pycharm/download/

Install packages

- PIP — https://www.w3schools.com/python/python_pip.asp

```
pip install flask
```

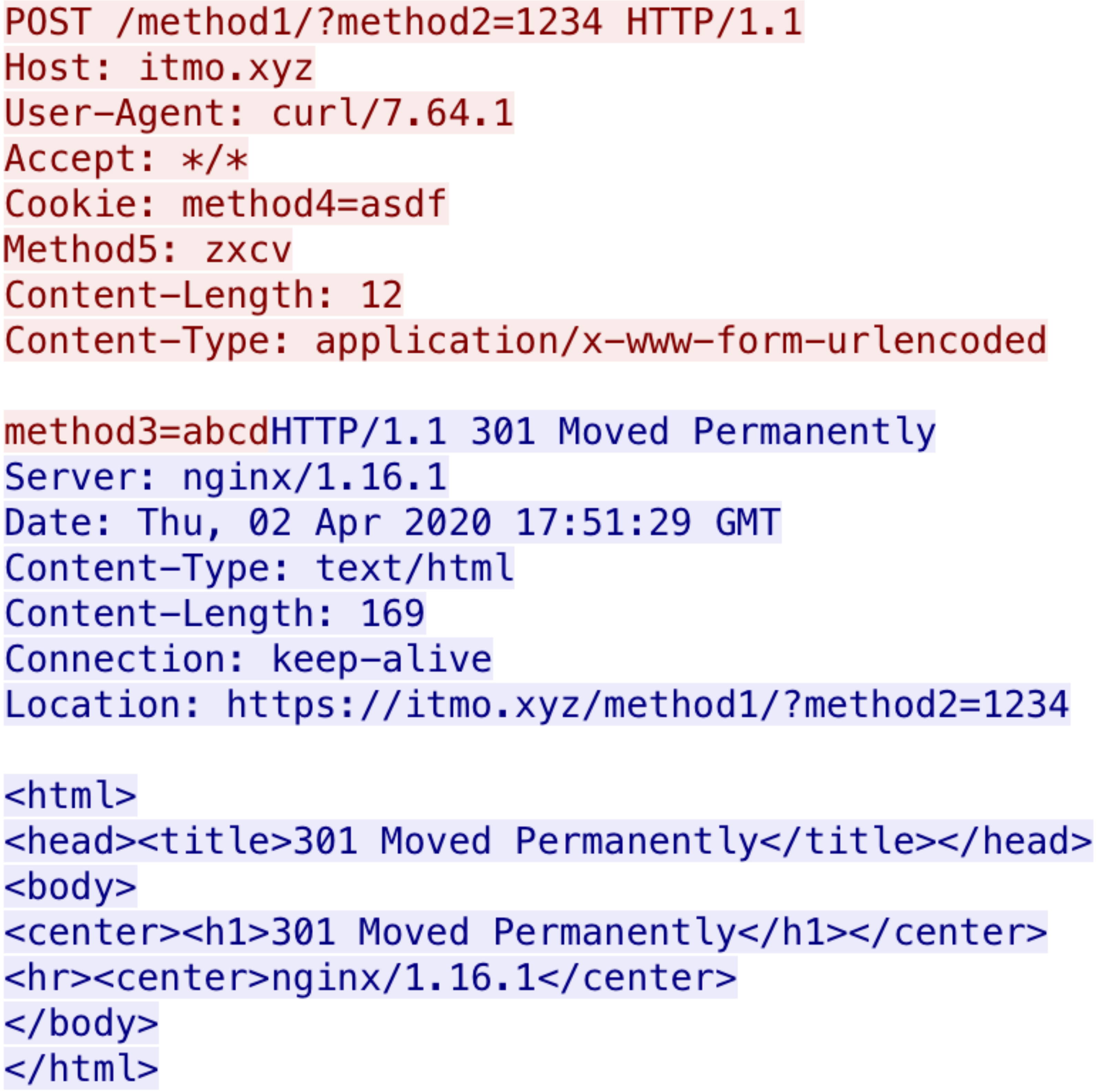
Literature 📚

- Documentation: https://flask.palletsprojects.com/en/1.1.x/
- Step-by-step tutorial: https://blog.miguelgrinberg.com/post/the-flask-mega-tutorial-part-i-hello-world
- Python simple tutorial: https://pythontutor.ru/
- HTML Forms: https://www.w3schools.com/html/html_forms.asp

Practice time

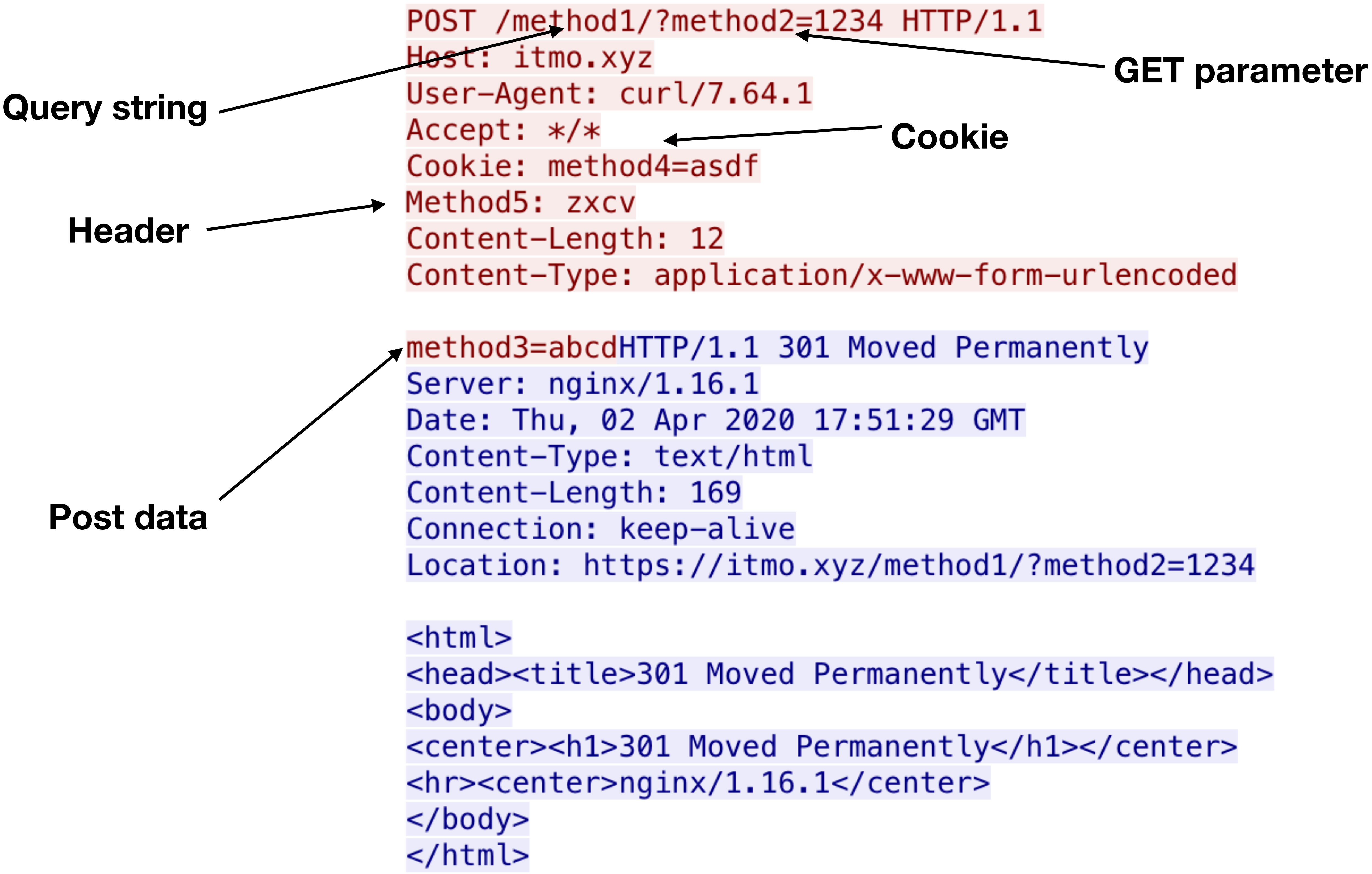
HTTP data transfer

Input data



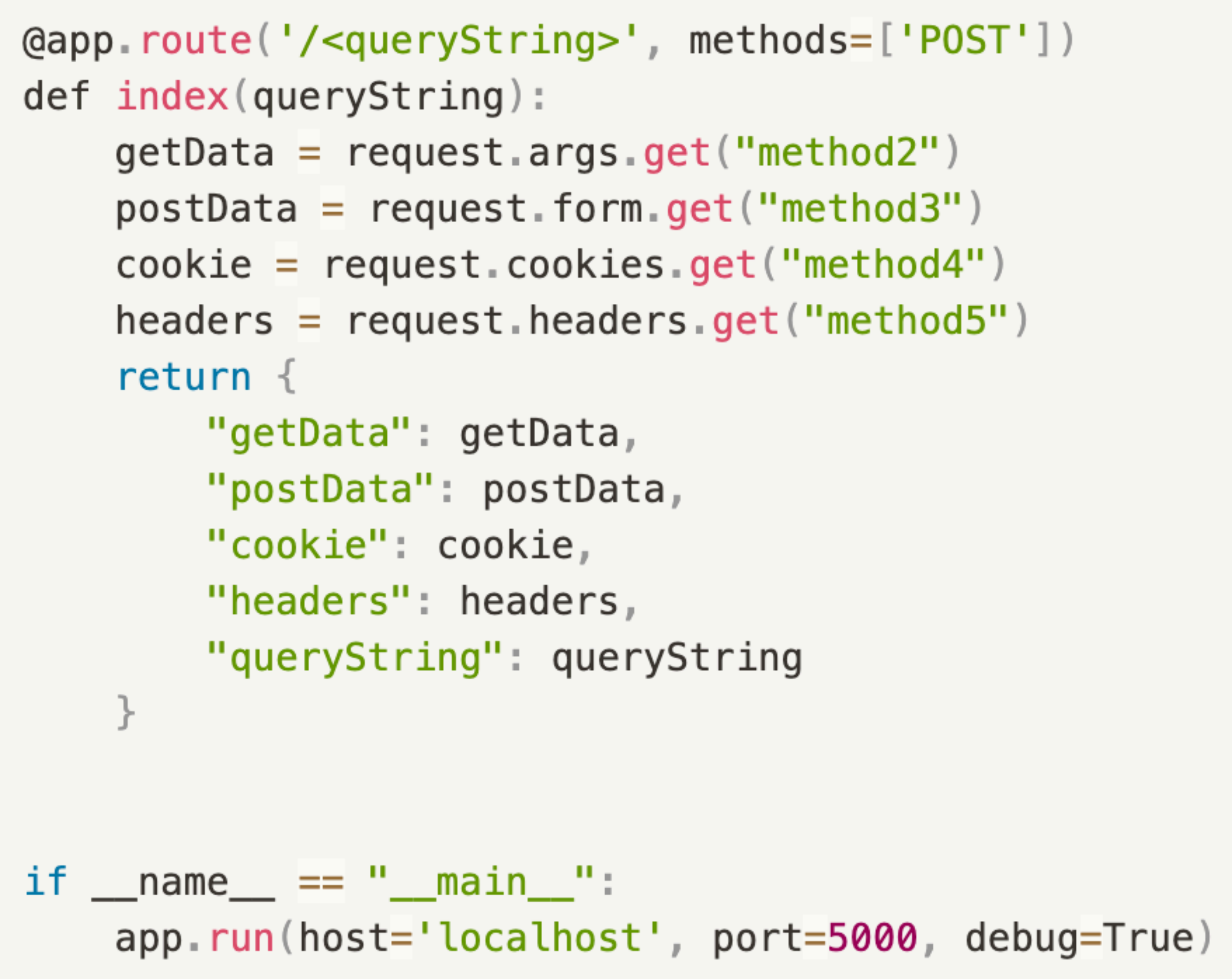
```
POST /method1/?method2=1234 HTTP/1.1
Host: itmo.xyz
User-Agent: curl/7.64.1
Accept: */*
Cookie: method4=asdf
Method5: zxcv
Content-Length: 12
Content-Type: application/x-www-form-urlencoded

method3=abcdHTTP/1.1 301 Moved Permanently
Server: nginx/1.16.1
Date: Thu, 02 Apr 2020 17:51:29 GMT
Content-Type: text/html
Content-Length: 169
Connection: keep-alive
Location: https://itmo.xyz/method1/?method2=1234

<html>
<head><title>301 Moved Permanently</title></head>
<body>
<center><h1>301 Moved Permanently</h1></center>
<hr><center>nginx/1.16.1</center>
</body>
</html>
```

Input data



```
POST /method1/?method2=1234 HTTP/1.1
Host: itmo.xyz
User-Agent: curl/7.64.1
Accept: */*
Cookie: method4=asdf
Method5: zxcv
Content-Length: 12
Content-Type: application/x-www-form-urlencoded

method3=abcdHTTP/1.1 301 Moved Permanently
Server: nginx/1.16.1
Date: Thu, 02 Apr 2020 17:51:29 GMT
Content-Type: text/html
Content-Length: 169
Connection: keep-alive
Location: https://itmo.xyz/method1/?method2=1234

<html>
<head><title>301 Moved Permanently</title></head>
<body>
<center><h1>301 Moved Permanently</h1></center>
<hr><center>nginx/1.16.1</center>
</body>
</html>
```

Get data in Flask



```
@app.route('/<queryString>', methods=['POST'])
def index(queryString):
    getData = request.args.get("method2")
    postData = request.form.get("method3")
    cookie = request.cookies.get("method4")
    headers = request.headers.get("method5")
    return {
        "getData": getData,
        "postData": postData,
        "cookie": cookie,
        "headers": headers,
        "queryString": queryString
    }


if __name__ == "__main__":
    app.run(host='localhost', port=5000, debug=True)
```

```
curl -X POST -H "Cookie: method4=444" -H "method5: 555" --data
"method3=333" http://localhost:5000/111?method2=222
```

Practice guide

- Make an App which will host your previous homework with Flask on http://localhost:5000/
  - Images on http://localhost:5000/static/…
  - HTML on http://localhost:5000/
  - Styles on http://localhost:5000/static/styles.css
- (optional) Add page that will change subset of images according to the GET parameter

Practice guide

- Make an App which will host your previous homework with Flask on http://localhost:5000/
  - Images on http://localhost:5000/static/…
  - HTML on http://localhost:5000/
  - Styles on http://localhost:5000/static/styles.css
- (optional) Add page that will return images according to the ARG parameter
  - http://localhost:5000/get/1 — image1.png
  - http://localhost:5000/get/2 — image2.png

Demo

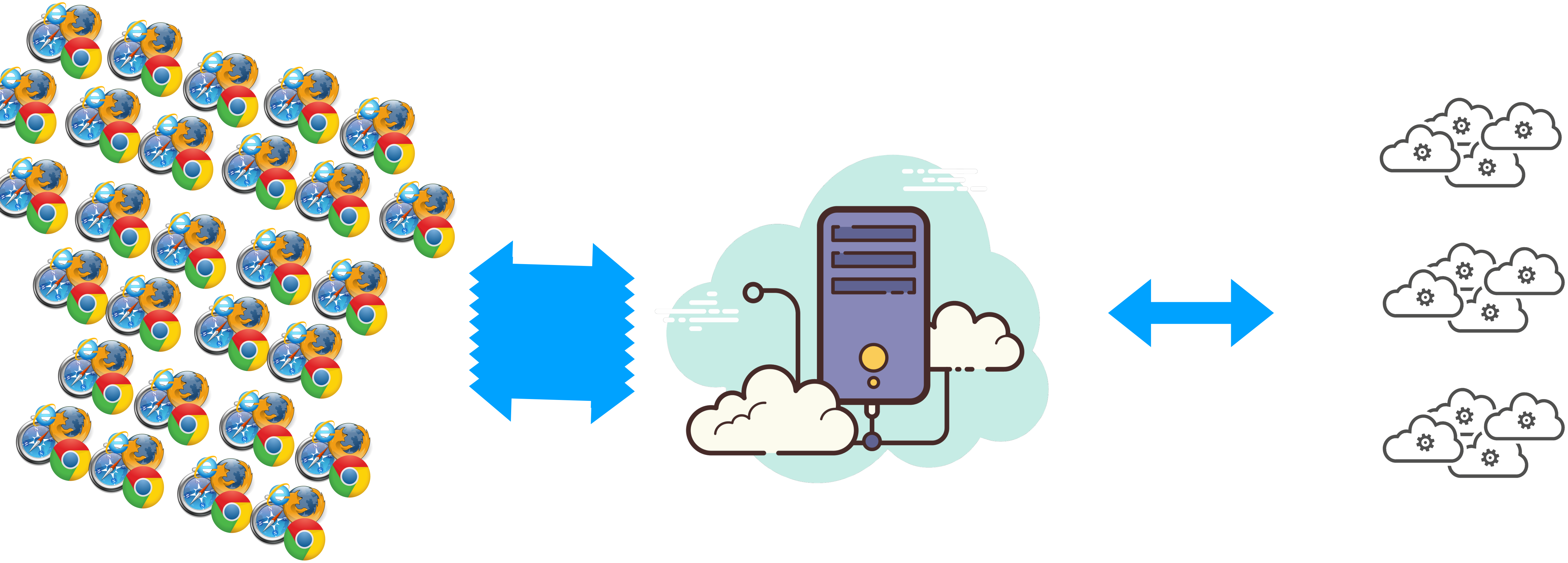
Literature 📚

- GET and POST: https://www.w3schools.com/tags/ref_httpmethods.asp
- Cookie: https://developer.mozilla.org/en-US/docs/Web/HTTP/Cookies
- URL Encode: https://www.w3schools.com/tags/ref_urlencode.ASP
- POST Encode: https://developer.mozilla.org/en-US/docs/Web/HTTP/Methods/POST

Practice time

Flask parallelism

Parallel requests

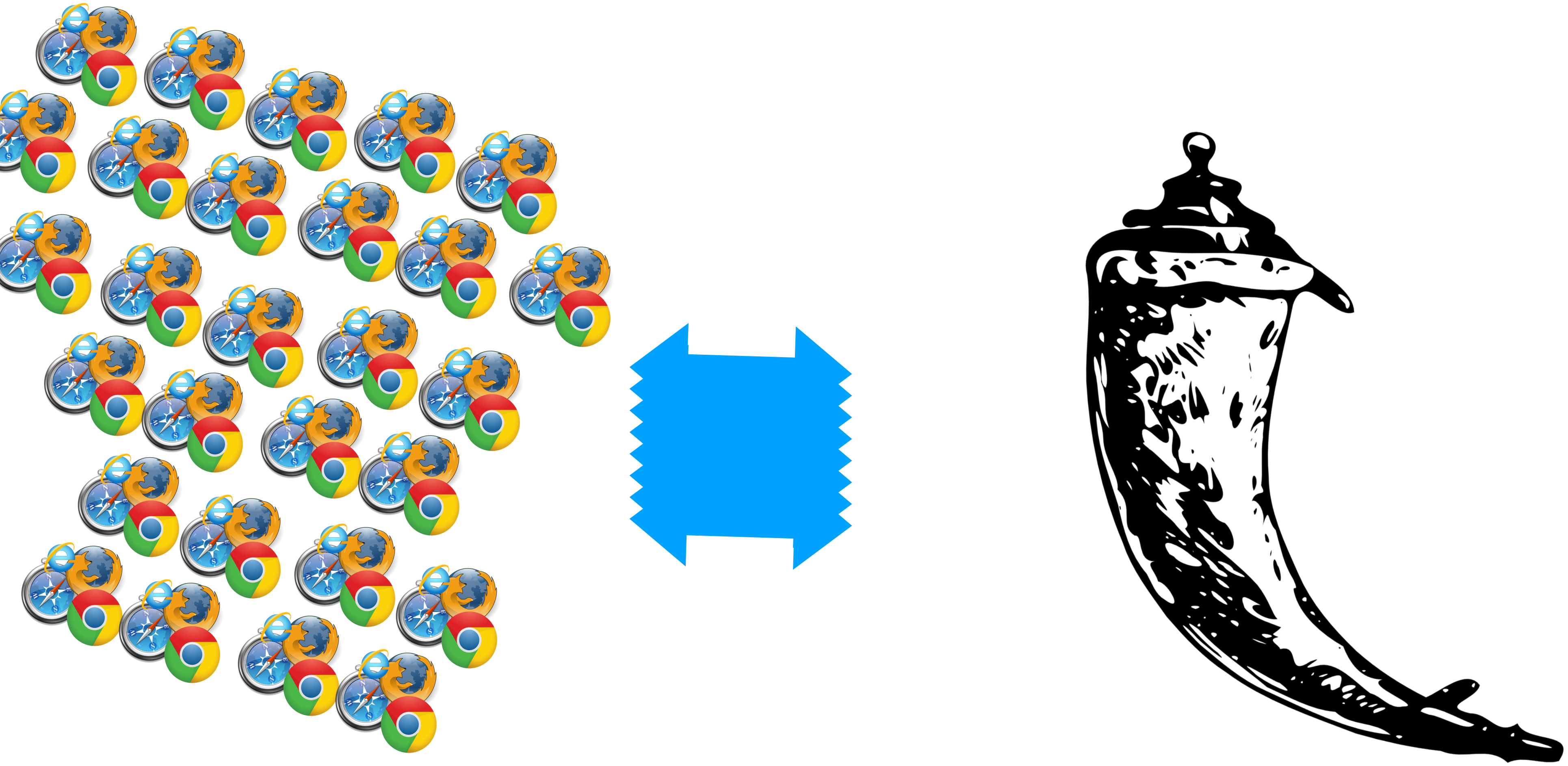


Users

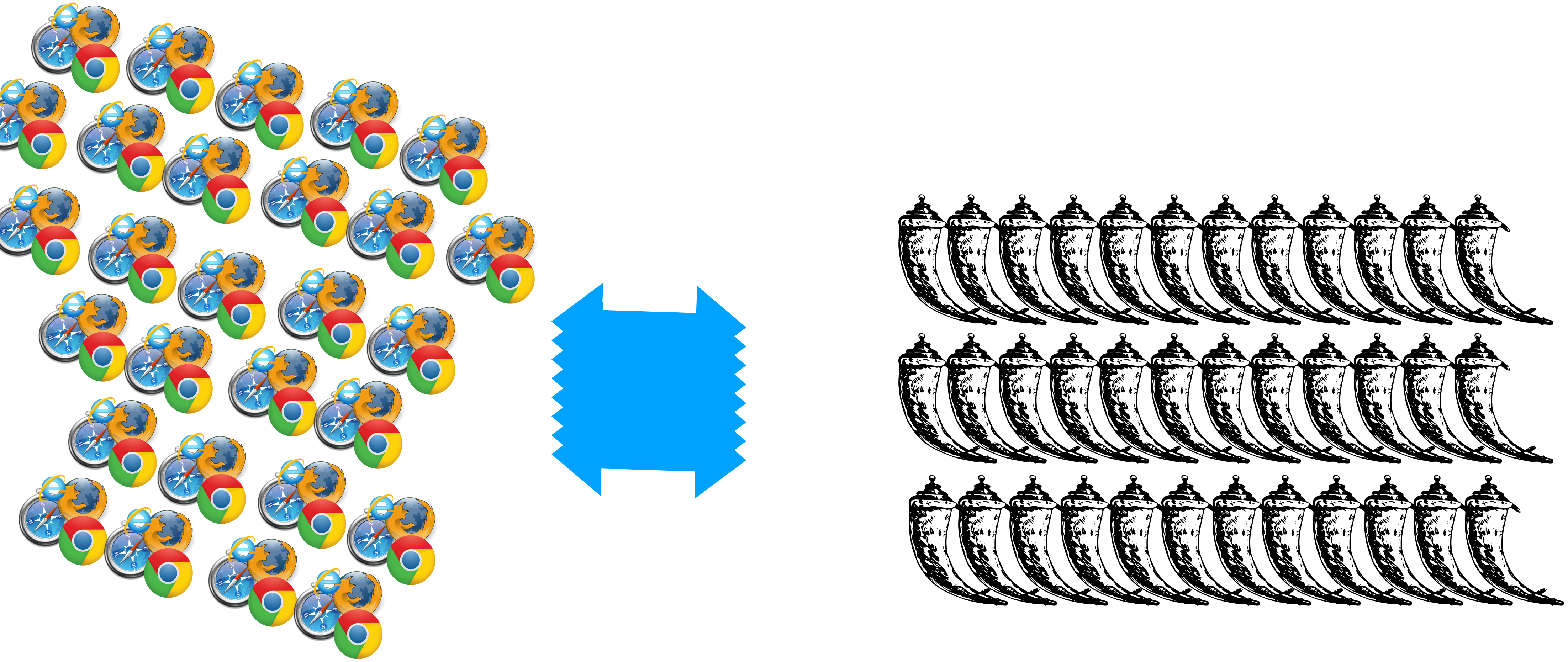
Single server

App copies

Flask



Flask



🚀 threaded=**True**

Literature 📚

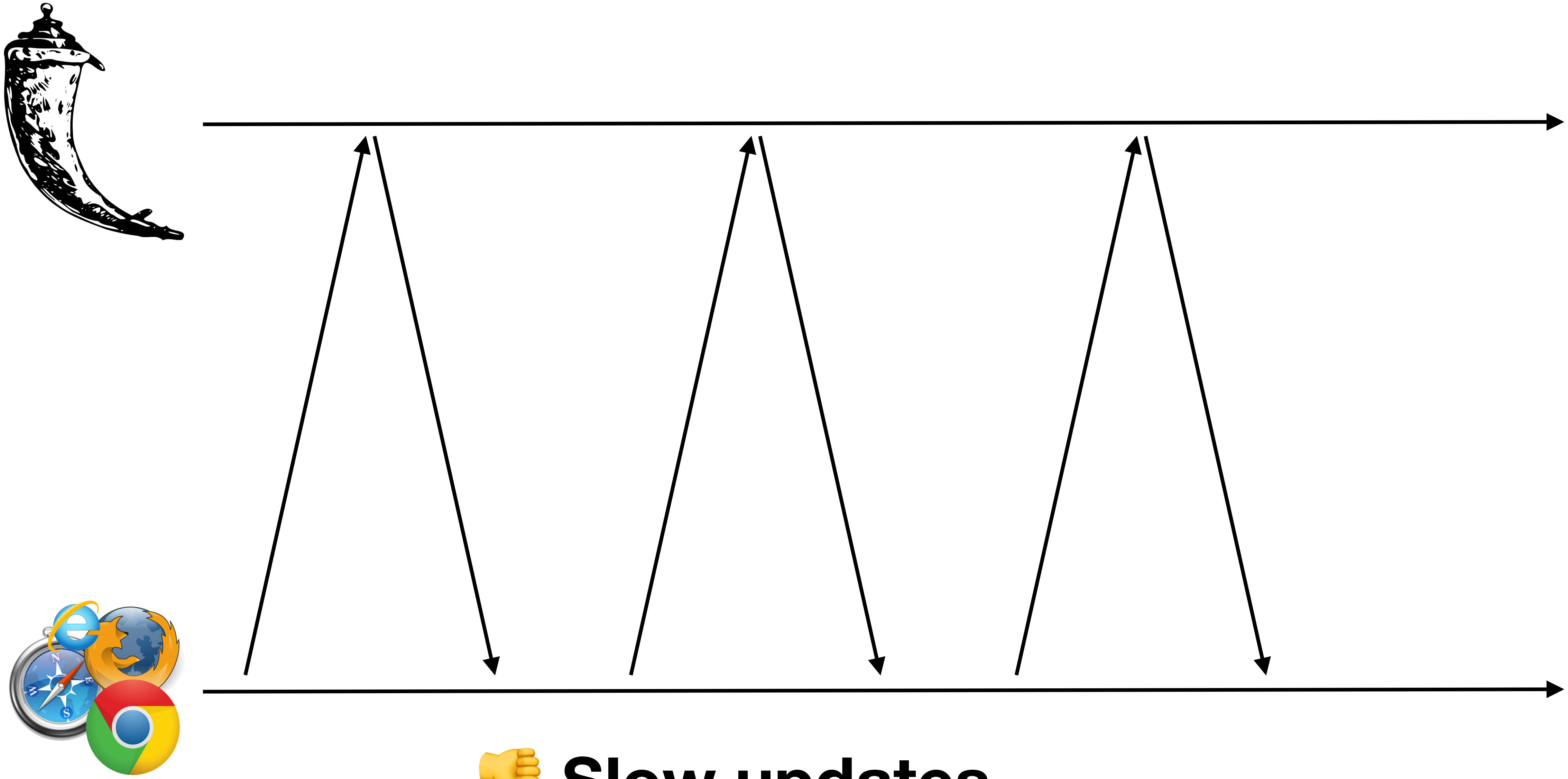
- Python Multithreading and Multiprocessing Tutorial: https://www.toptal.com/python/beginners-guide-to-concurrency-and-parallelism-in-python

Demo

Pub/Sub

Short polling, Long polling, WebSocket

Short polling

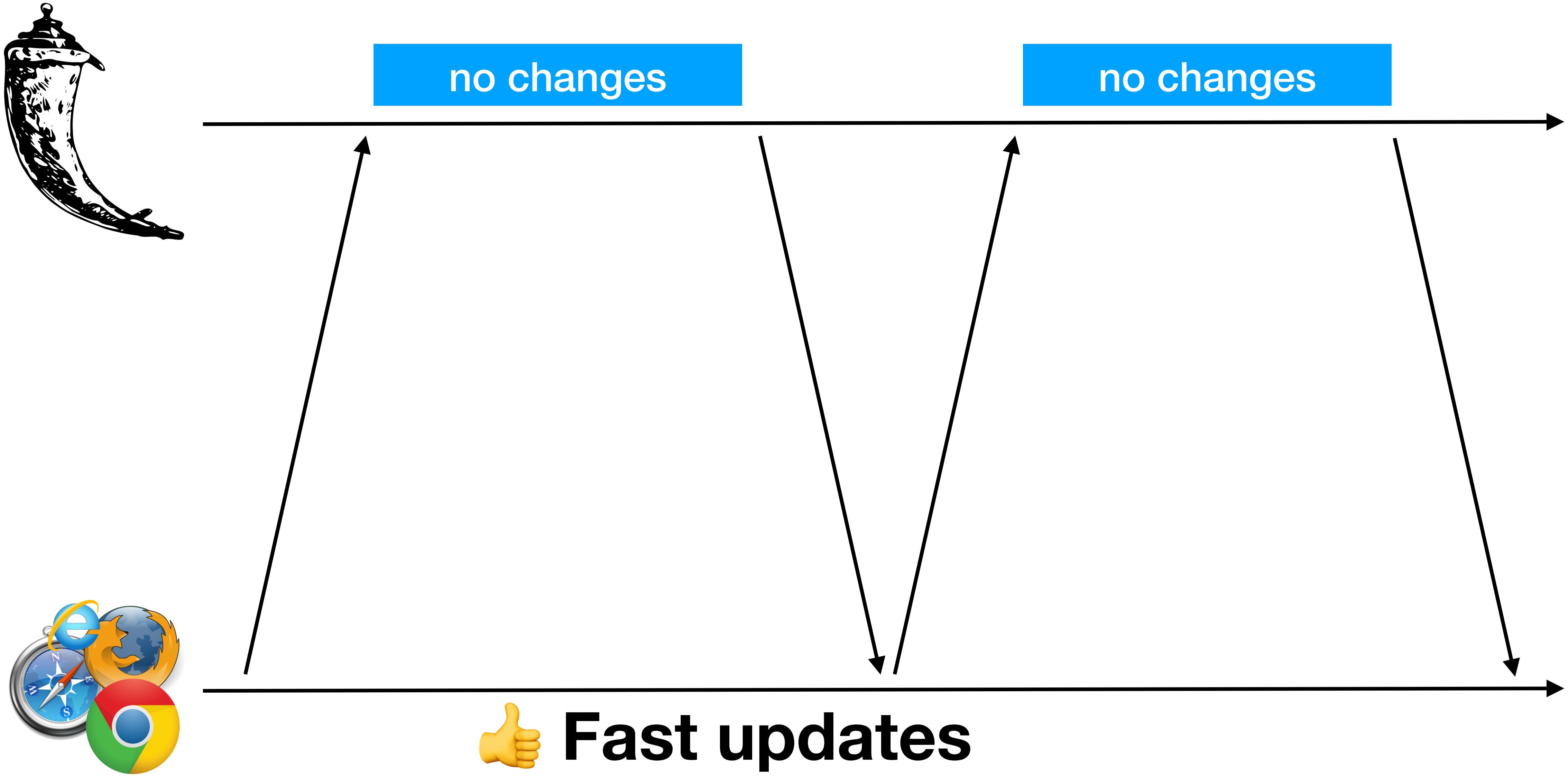


👎 **Slow updates**

👎 **Resource intensive**

👍 **Simple**

Long polling



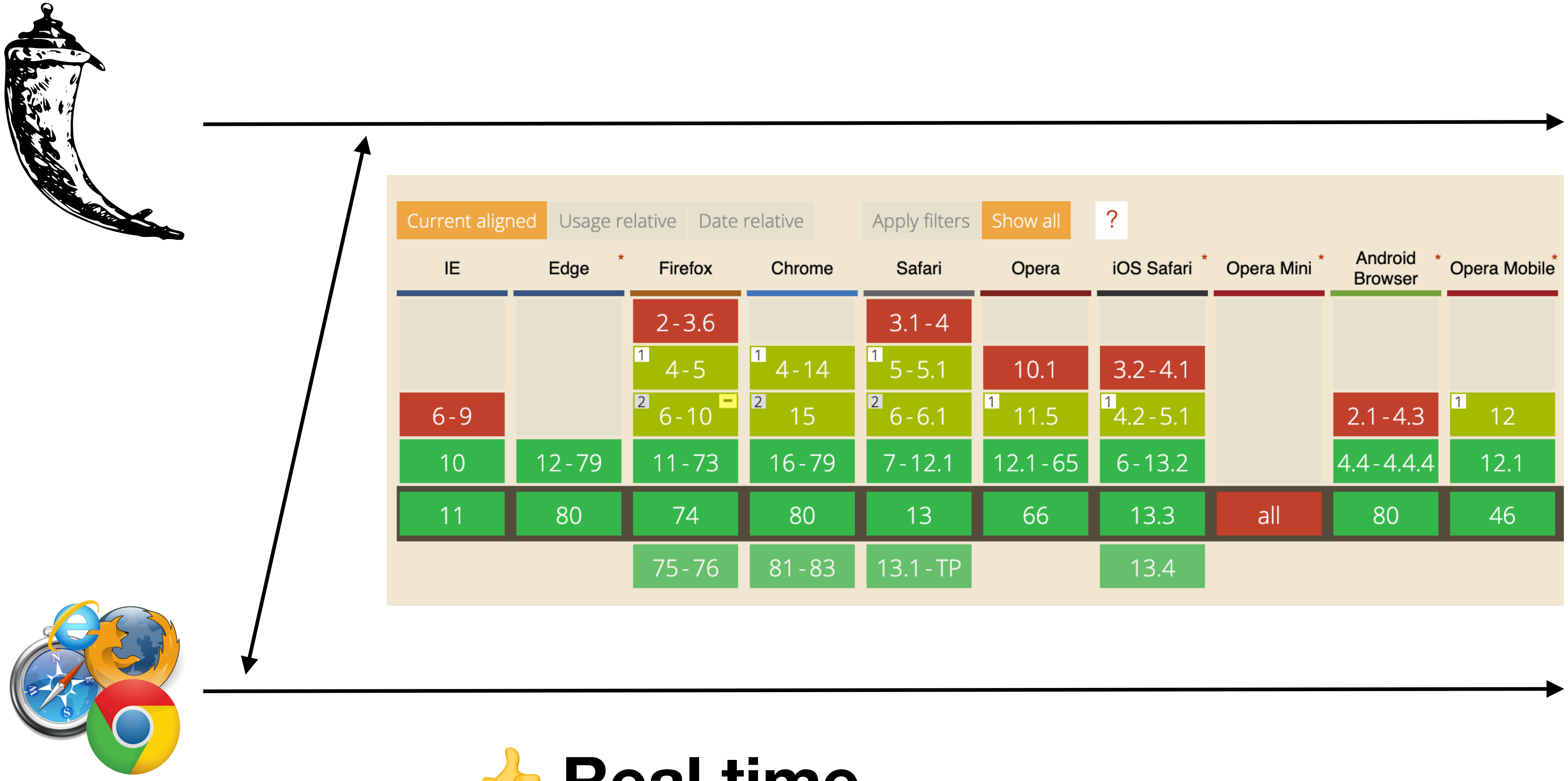
👍 **Fast updates**

👍 **Less resource intensive**

👎 **Kludge**

👎 **Takes 1 worker**

Web Sockets



IE	Edge *	Firefox	Chrome	Safari	Opera	iOS Safari *	Opera Mini *	Android Browser *	Opera Mobile *
		2-3.6		3.1-4					
		[1] 4-5	[1] 4-14	[1] 5-5.1	10.1	3.2-4.1			
6-9		[2] 6-10 −	[2] 15	[2] 6-6.1	[1] 11.5	[1] 4.2-5.1		2.1-4.3	[1] 12
10	12-79	11-73	16-79	7-12.1	12.1-65	6-13.2		4.4-4.4.4	12.1
11	80	74	80	13	66	13.3	all	80	46
		75-76	81-83	13.1-TP		13.4			

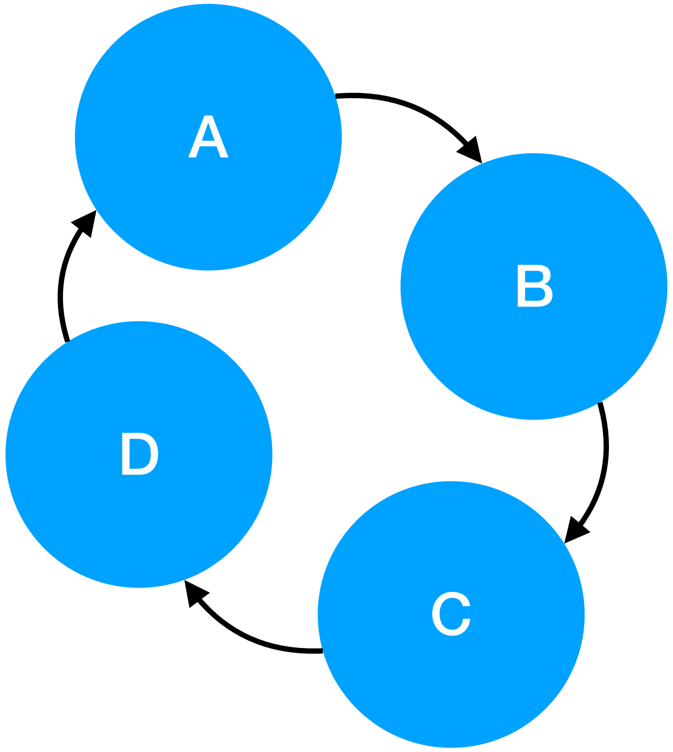
- 👍 **Real time**
- 👍 **Bidirectional**
- 👍 **Efficient**

Literature 📚

- https://javascript.info/websocket
- https://javascript.info/long-polling
- https://github.com/heroku-python/flask-sockets
- https://www.ably.io/blog/websockets-vs-long-polling/

Demo

Brainstorming



Make google docs template

Each person makes a copy

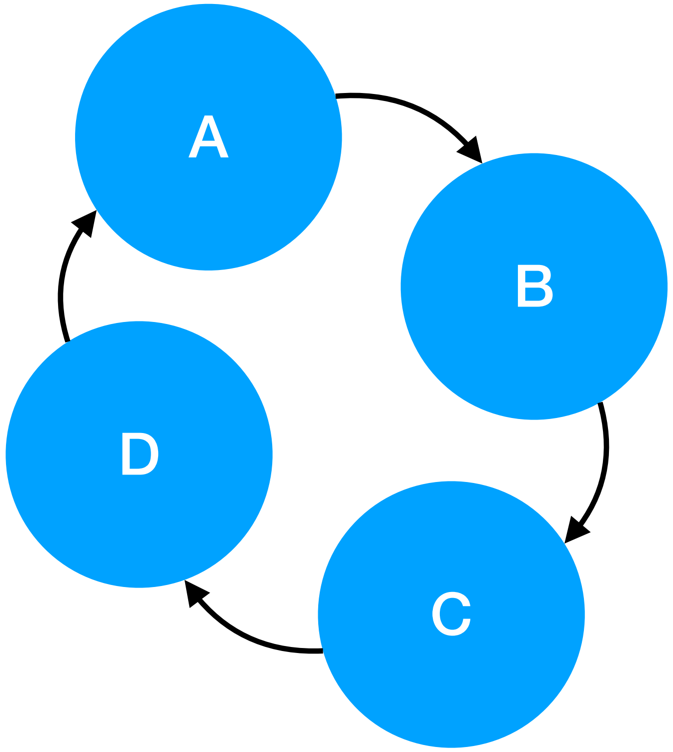
Write ideas in your doc for 10 minutes

Share link with edit access to the next person (A->B, B->C, ...)

Add ideas to the new doc, append new details for the ideas

After 10 minutes share second document to C and take third from A ...

Brainstorming



After 10 + 10 * 3 = 40 minutes

Take all 4 documents and merge ideas

Now read carefully

And discuss in the voice chat

Best ideas worth realization

Homework #2

- Create web application, which can host your image gallery:
  - Listen on `localhost:5000`
  - Render HTML document on `http://localhost:5000/`
  - Show static images on `http://localhost:5000/img/<image_name>`
  - Your external **CSS** and **JS** files should be returned on `http://localhost:5000/static/<js/css filename>`

advanced

Homework #2

- Create a web application, which emulates a chat with a human
  - Web page with messages log
  - Input for writing a new message
  - Button for sending message to the server
  - Robot should answer on a message according to the predefined set of rules

How to deploy homework

- Create personal repository **in the organisation itmo-wad** (*ex: hw2-your-name*)
- Push homework sources
- Write documentation in README.md file
- Ask any questions in Telegram chat

Deadline ☠️

- Soft — 16.04 at 15:00 (get 100% of points)
- Hard — 19.04 at 15:00 (get 80% of points)

Literature 📚

- Python Flask big tutorial:
  - https://blog.miguelgrinberg.com/post/the-flask-mega-tutorial-part-i-hello-world
  - https://blog.miguelgrinberg.com/post/the-flask-mega-tutorial-part-ii-templates
- HTML forms: https://www.w3schools.com/html/html_forms.asp
- Markdown: https://guides.github.com/features/mastering-markdown/

Practice time