API testing in Python

using the requests library

An open source workshop by …

Originally created by Bas Dijkstra - bas@ontestautomation.com - https://www.ontestautomation.com

What are we going to do?

_RESTful APIs

_requests

_Hands-on exercises

Preparation

_Install Python 3

_Install PyCharm (or any other IDE)

_Import project into IDE
  _https://github.com/basdijkstra/requests-workshop

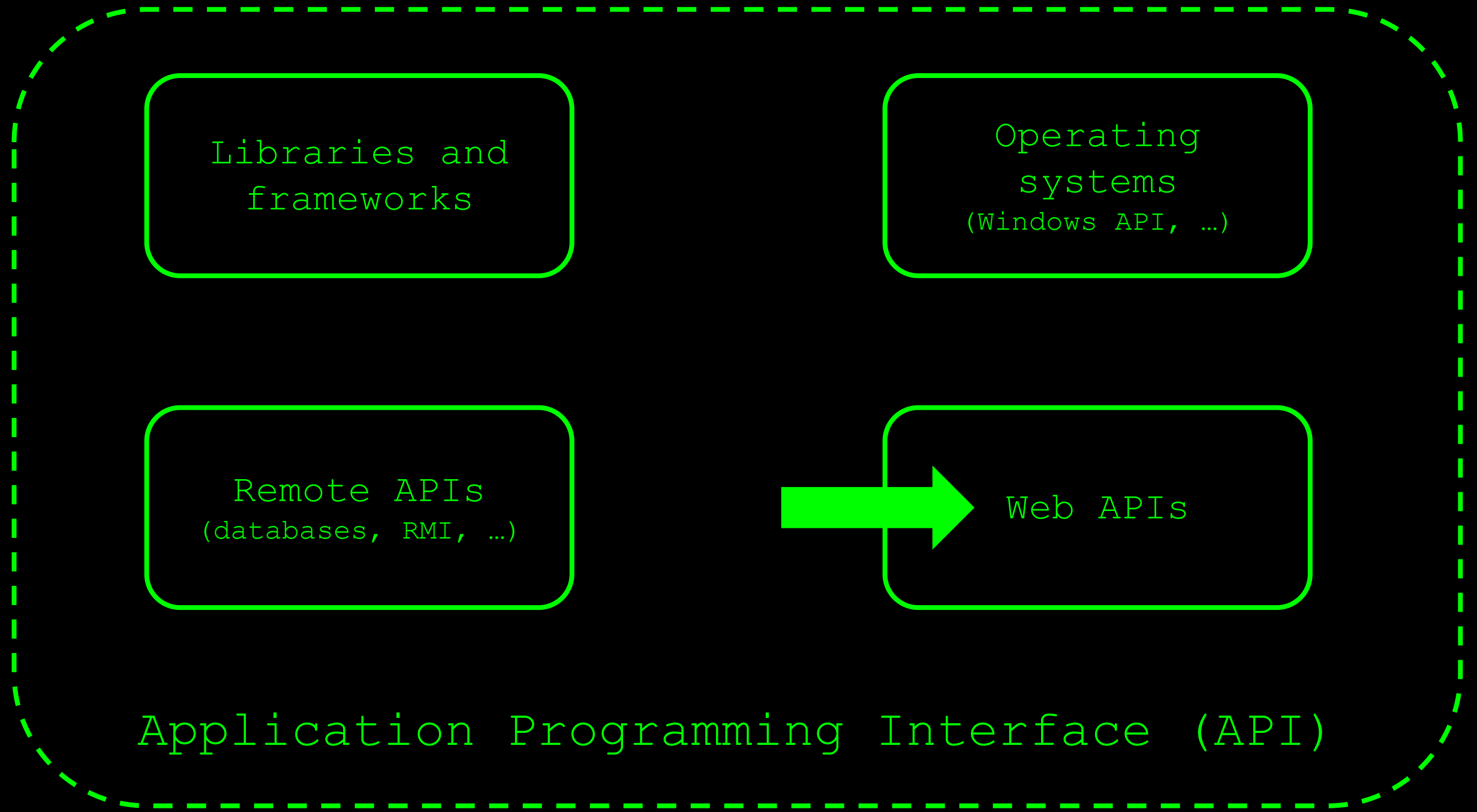
_Install dependencies, from project root:

  pip install -r requirements.txt

So, what is an API?

*"An **application programming interface (API)** is an interface or communication protocol between different parts of a computer program intended to simplify the implementation and maintenance of software"*

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

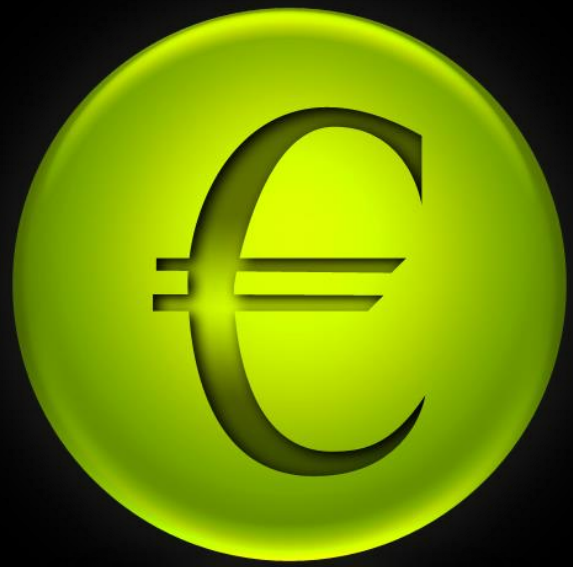

Libraries and frameworks
Operating systems
(Windows API, …)
Remote APIs
(databases, RMI, …)
Web APIs
Application Programming Interface (API)

From now on, I'll refer to these Web APIs simply as 'APIs'

Where are APIs used?

Mobile

Internet of Things



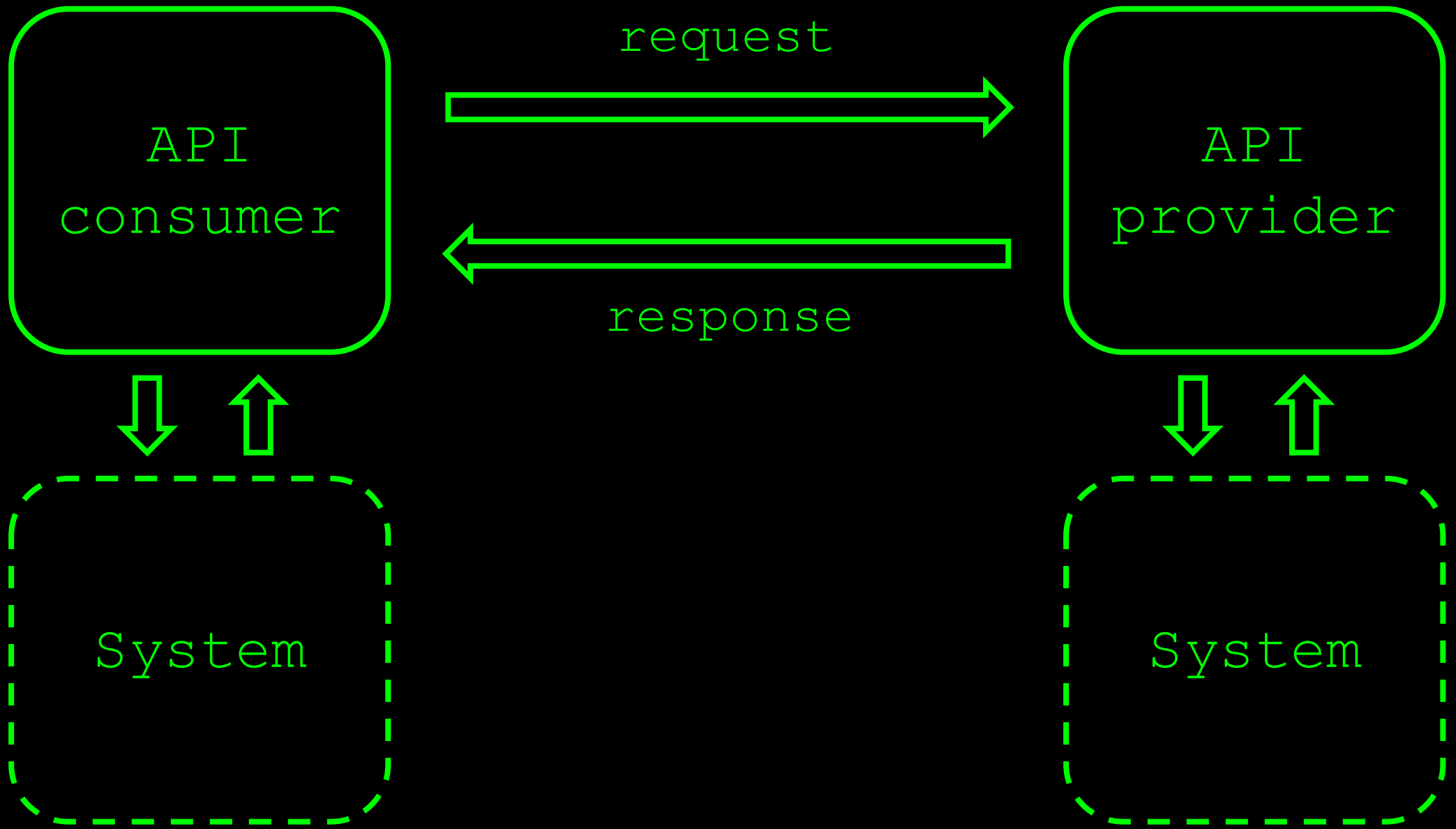
API economy

Where are APIs used?

Web applications

Microservices architectures

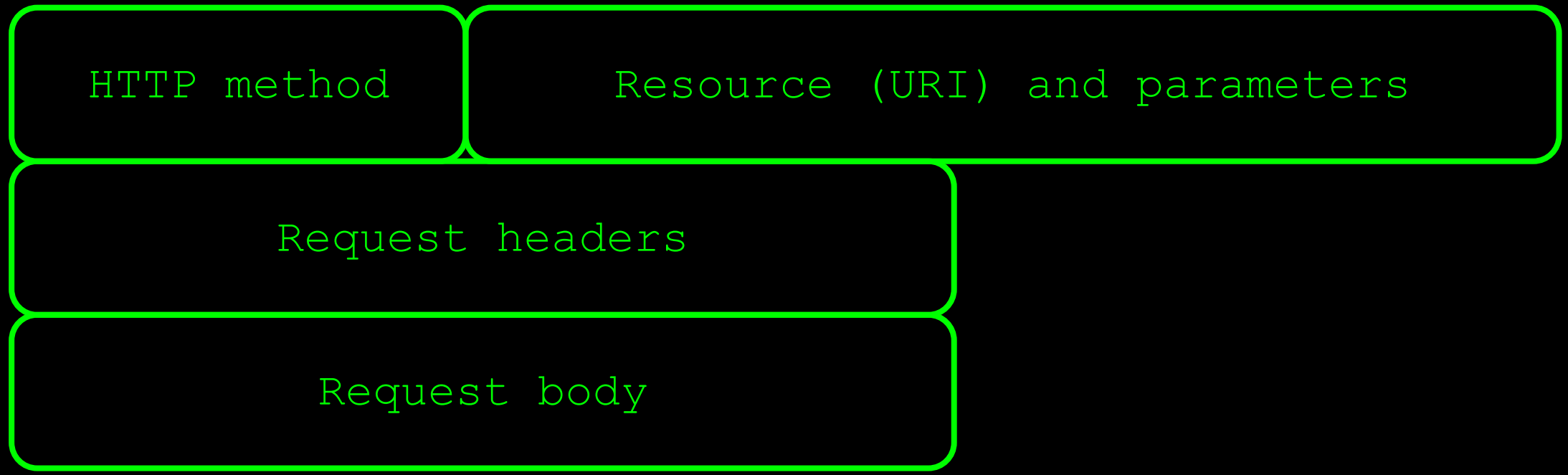
APIs are commonly used to exchange data between two parties

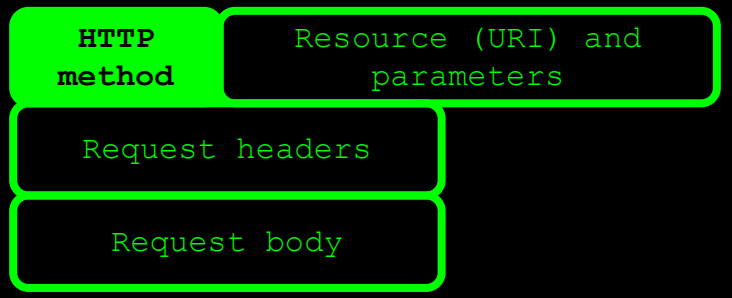

API
consumer
request
response
API
provider
System
System

SOAP and REST

	SOAP	**REST**
Protocol	HTTP, SMTP, …	HTTP
Message format	XML	XML, JSON, text, …
Specification	WSDL	WADL, RAML, Swagger, …
Standardized?	Yes	No

A REST API request





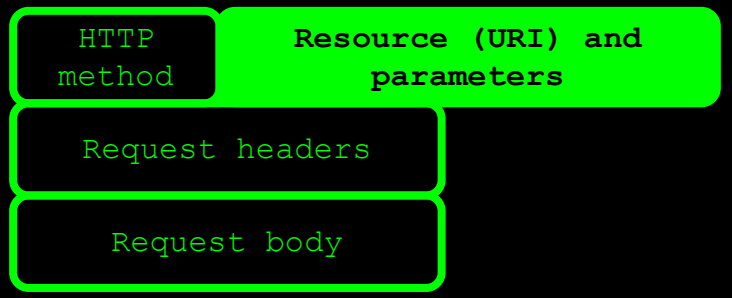
HTTP methods

_GET, POST, PUT, PATCH, DELETE, OPTIONS, …

_CRUD operations on data

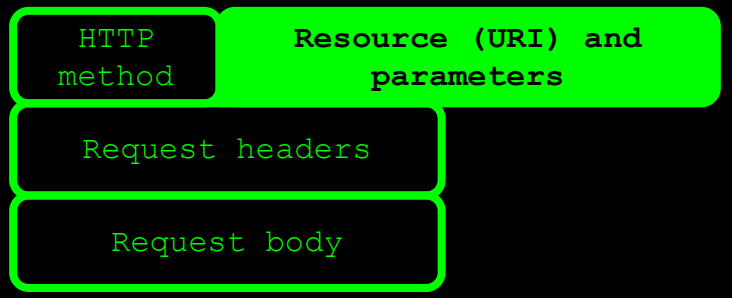
POST	Create
GET	Read
PUT / PATCH	Update
DELETE	Delete
…	…

_Conventions, not standards!



Resources and parameters

- Uniform Resource Identifier
- Uniquely identifies the resource to operate on
- Can contain parameters
  - Query parameters
  - Path parameters

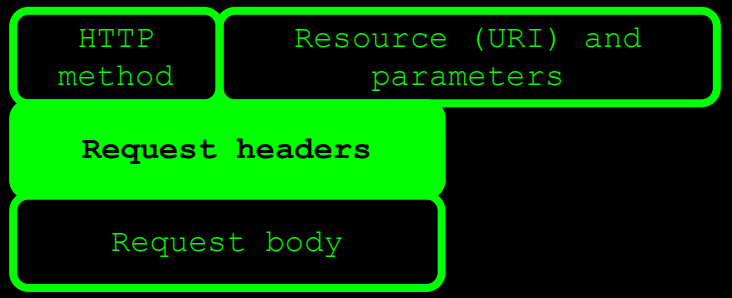


Resources and parameters

- Path parameters
  - http://api.zippopotam.us/us/90210
  - http://api.zippopotam.us/ca/B2A

- Query parameters
  - http://md5.jsontest.com/?text=testcaseOne
  - http://md5.jsontest.com/?text=testcaseTwo

- There is no official standard!

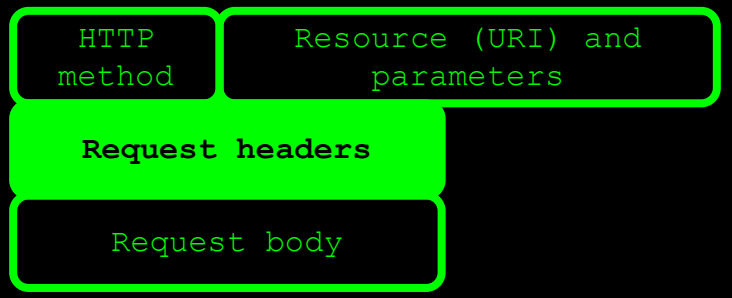


Request headers

- Key-value pairs

- Can contain metadata about the request body
  - Content-Type (what data format is the request body in?)
  - Accept (what data format would I like the response body to be in?)
  - …

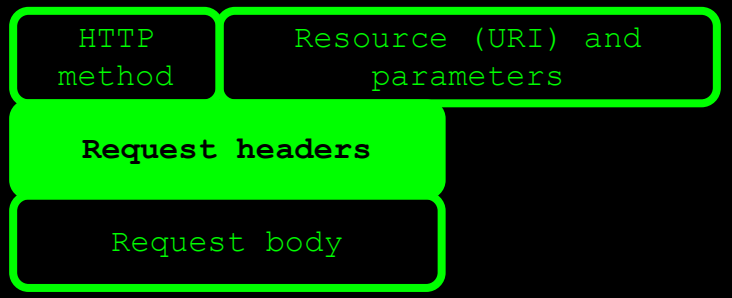
- Can contain session and authorization data
  - Cookies
  - Authorization tokens
  - …



Authorization: Basic

- Username and password sent with every request
- Base64 encoded (not really secure!)
- Ex: username = aladdin and password = opensesame

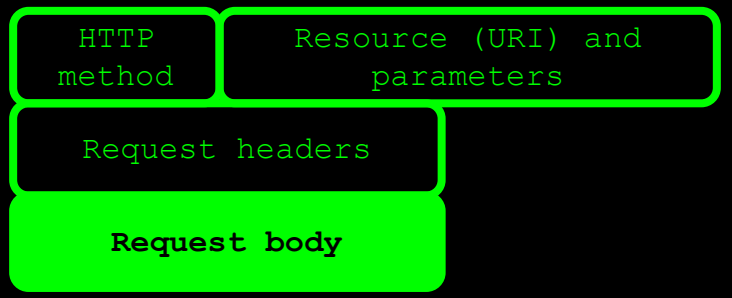
Authorization: Basic YWxhZGRpbjpvcGVuc2VzYW1l



Authorization: Bearer

- Token with limited validity is obtained first
- Token is then sent with all subsequent requests
- Most common mechanism is OAuth(2)
- JWT is a common token format

Authorization: Bearer RsT5OjbzRn430zqMLgV3Ia



Request body

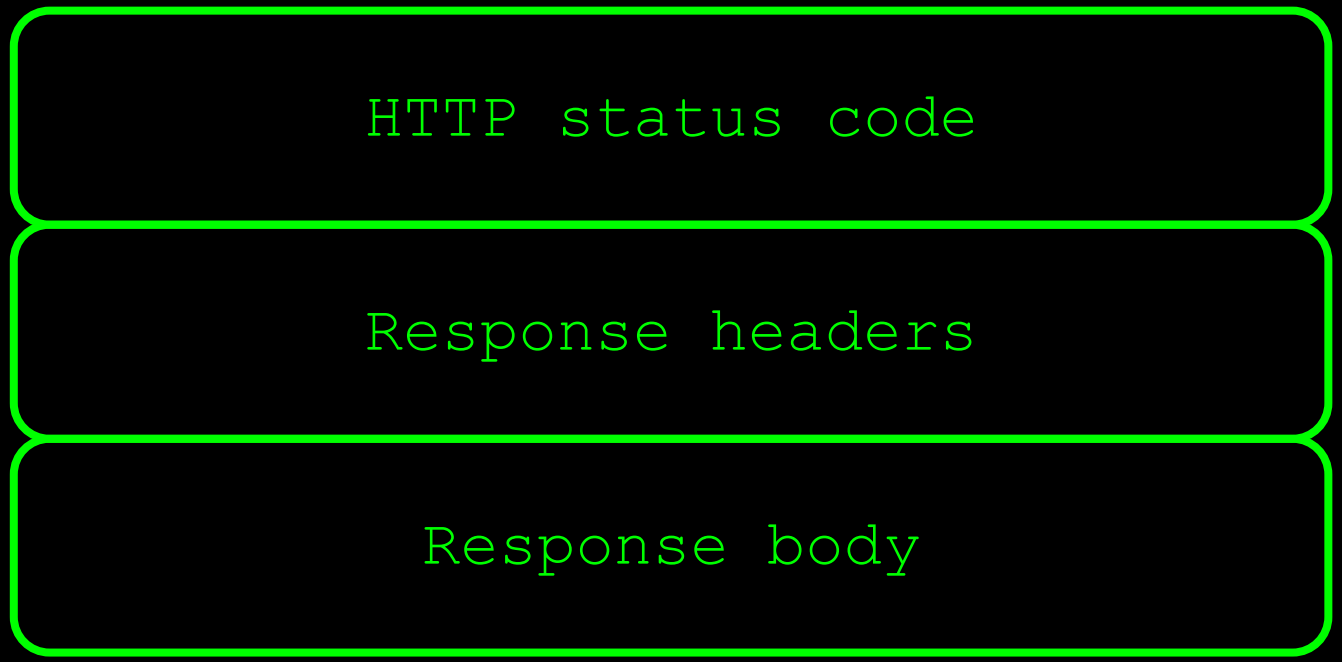
_Data to be sent to the provider

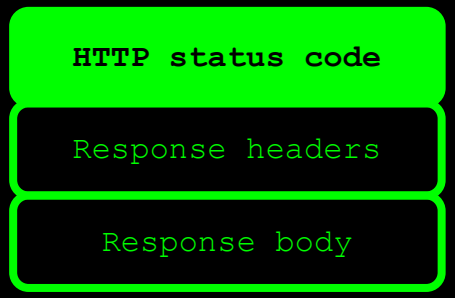
_REST does not prescribe a specific data format

_Most common:
  _JSON
  _XML
  _Plain text

_Other data formats can be sent using REST, too

A REST API response



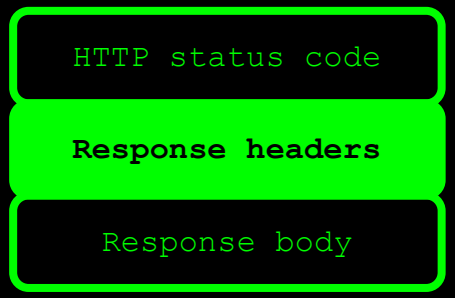


HTTP status code

_Indicates result of request processing by provider

_Five different categories

_1XX	Informational	100 Continue
_2XX	Success	200 OK
_3XX	Redirection	301 Moved Permanently
_4XX	Client errors	400 Bad Request
_5XX	Server errors	503 Service Unavailable

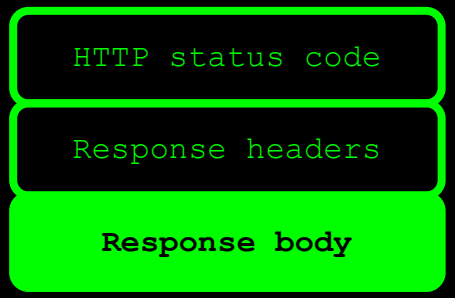


Response headers

- Key-value pairs

- Can contain metadata about the response body
  - Content-Type (what data format is the response body in?)
  - Content-Length (how many bytes in the response body?)

- Can contain provider-specific data
  - Caching-related headers
  - Information about the server type



Response body

_Data returned by the provider

_REST does not prescribe a specific data format

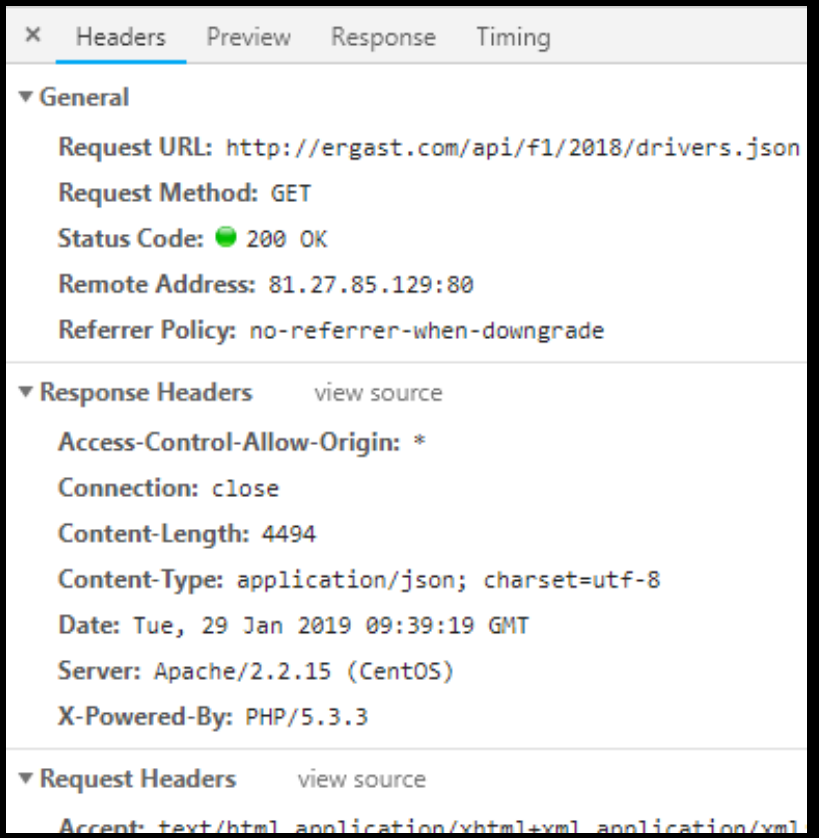
_Most common:
  _JSON
  _XML
  _Plain text

_Other data formats can be sent using REST, too

An example

_GET http://ergast.com/api/f1/2018/drivers.json


```
{
  - MRData: {
        xmlns: "http://ergast.com/mrd/1.4",
        series: "f1",
        url: "http://ergast.com/api/f1/2018/drivers.json",
        limit: "30",
        offset: "0",
        total: "20",
      - DriverTable: {
            season: "2018",
          - Drivers: [
              - {
                    driverId: "alonso",
                    permanentNumber: "14",
                    code: "ALO",
                    url: "http://en.wikipedia.org/wiki/Fernando_Alonso",
                    givenName: "Fernando",
                    familyName: "Alonso",
                    dateOfBirth: "1981-07-29",
                    nationality: "Spanish"
                },
              - {
                    driverId: "bottas",
                    permanentNumber: "77",
                    code: "BOT"
```

Why I ♥ testing at the API level

_Tests run much faster than UI-driven tests

_Tests are easier to stabilize than UI-driven tests

_Tests have a broader scope than unit tests

_Business logic is often exposed at the API level

Tools for testing RESTful web services

- Free / open source
  - Postman, SoapUI, REST Assured, requests, …
- Commercial
  - Parasoft SOAtest, SoapUI Pro, …
- Build your own (using HTTP libraries for your language of choice)

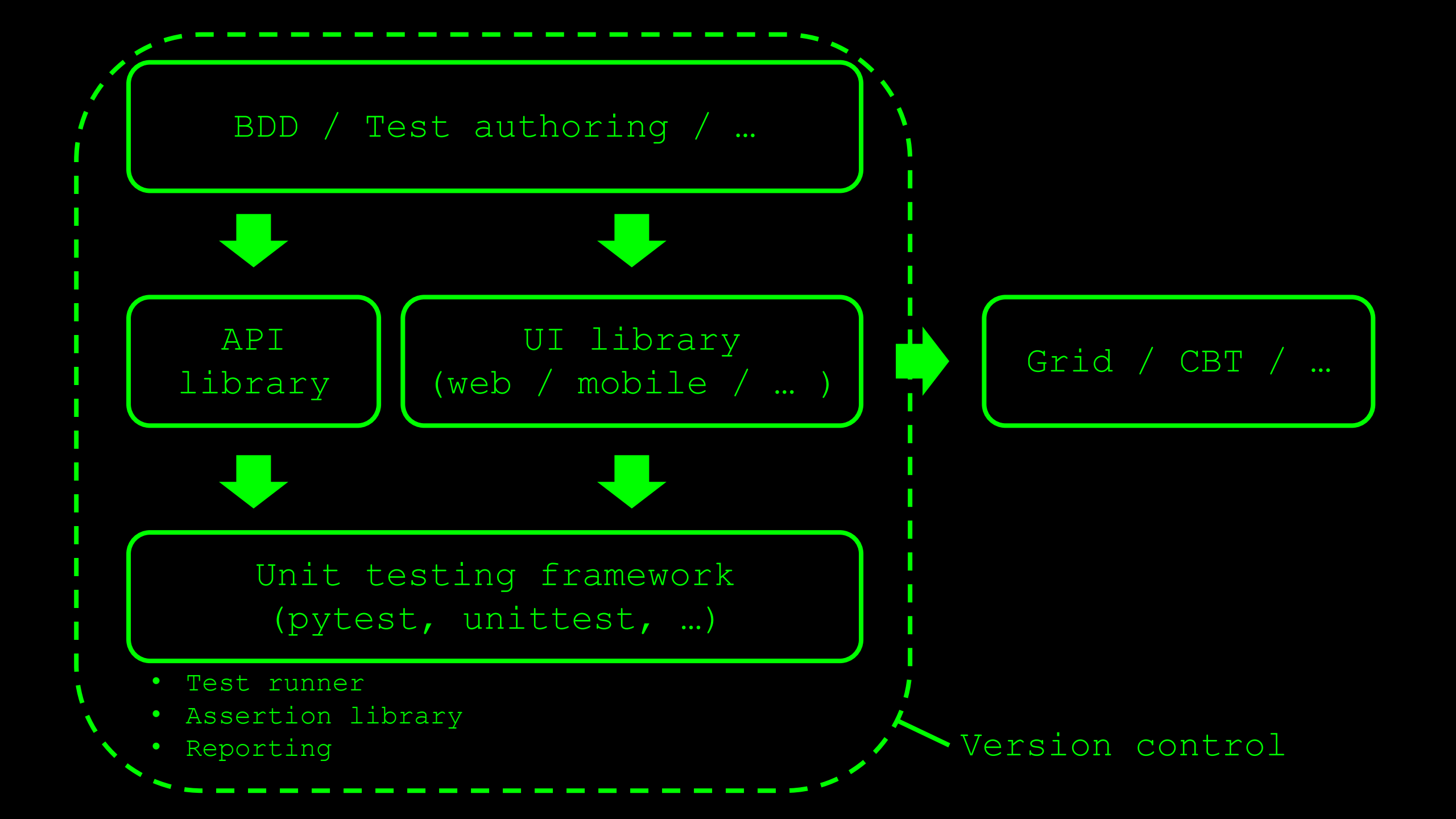
Python library for interacting with REST APIs

"Requests is an elegant and simple HTTP library for Python, built for human beings."

requests

pip install requests

https://requests.readthedocs.io/en/master/


BDD / Test authoring / …
API library
UI library (web / mobile / …)
Grid / CBT / …
Unit testing framework (pytest, unittest, …)
• Test runner
• Assertion library
• Reporting
Version control

In this workshop, we'll use requests with pytest

A few example tests

Checking response status code

```python
import requests


def test_get_user_with_id_1_check_status_code_equals_200():
    response = requests.get("https://jsonplaceholder.typicode.com/users/1")
    assert response.status_code == 200
```

Checking response headers

```
def test_get_user_with_id_1_check_content_type_equals_json():
    response = requests.get("https://jsonplaceholder.typicode.com/users/1")
    assert response.headers['Content-Type'] == "application/json; charset=utf-8"
```

Checking response encoding

```
def test_get_user_with_id_1_check_encoding_equals_utf8():
    response = requests.get("https://jsonplaceholder.typicode.com/users/1")
    assert response.encoding == "utf-8"
```

Checking a JSON body element

```python
def test_get_user_with_id_1_check_name_equals_leanne_graham():
    response = requests.get("https://jsonplaceholder.typicode.com/users/1")
    response_body = response.json()
    assert response_body["name"] == "Leanne Graham"
```


```
{
  "id": 1,
  "name": "Leanne Graham",
  "username": "Bret",
  "email": "Sincere@april.biz",
  "address": {
    "street": "Kulas Light",
    "suite": "Apt. 556",
    "city": "Gwenborough",
    "zipcode": "92998-3874",
    "geo": {
      "lat": "-37.3159",
      "lng": "81.1496"
    }
  },
  "phone": "1-770-736-8031 x56442",
  "website": "hildegard.org",
  "company": {
    "name": "Romaguera-Crona",
    "catchPhrase": "Multi-layered client-server neural-net",
    "bs": "harness real-time e-markets"
  }
}
```

Checking nested body elements

```python
def test_get_user_with_id_1_check_company_name_equals_romaguera_crona():
    response = requests.get("https://jsonplaceholder.typicode.com/users/1")
    response_body = response.json()
    assert response_body["company"]["name"] == "Romaguera-Crona"
```


```
{
  "id": 1,
  "name": "Leanne Graham",
  "username": "Bret",
  "email": "Sincere@april.biz",
  "address": {
    "street": "Kulas Light",
    "suite": "Apt. 556",
    "city": "Gwenborough",
    "zipcode": "92998-3874",
    "geo": {
      "lat": "-37.3159",
      "lng": "81.1496"
    }
  },
  "phone": "1-770-736-8031 x56442",
  "website": "hildegard.org",
  "company": {
    "name": "Romaguera-Crona",
    "catchPhrase": "Multi-layered client-server neural-net",
    "bs": "harness real-time e-markets"
  }
}
```

Checking the size of an array

```
def test_get_all_users_check_number_of_users_equals_10():
    response = requests.get("https://jsonplaceholder.typicode.com/users")
    response_body = response.json()
    assert len(response_body) == 10
```

Our API under test

_Zippopotam.us

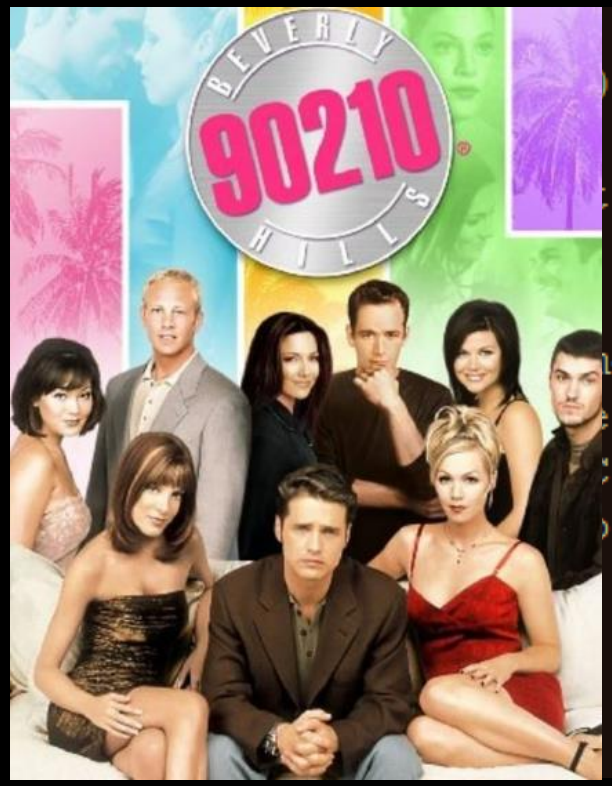
_Returns location data based on country and zip code

_http://api.zippopotam.us/

_RESTful API

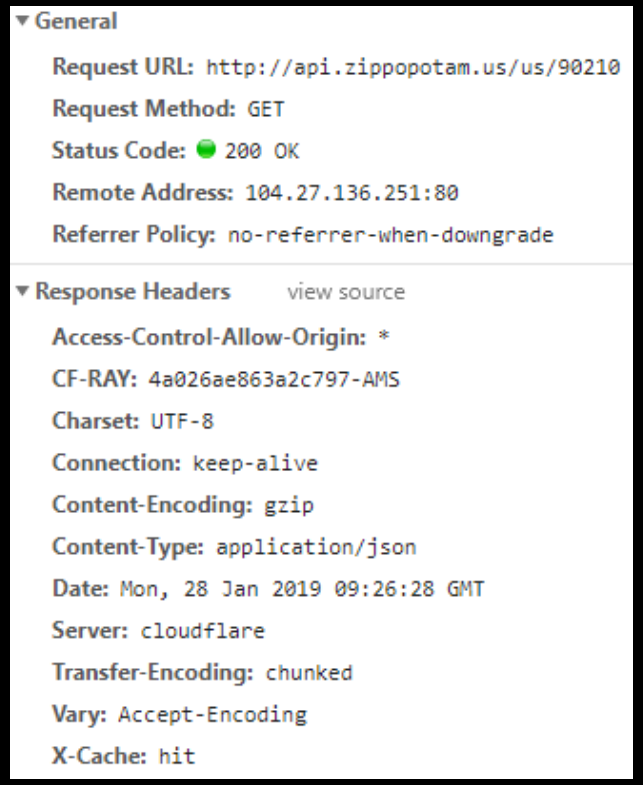
An example

_GET http://api.zippopotam.us/us/90210




```
",
States",
ion: "US",

e: "Beverly Hills",
: "-118.4065",
alifornia",
reviation: "CA",
"34.0901"
```

Now it's your turn!

_ exercises > exercises_01.py

_ run your answers (from the project root) using

pytest exercises\exercises_01.py

_ examples are in examples > examples_01.py

_ answers are in answers > answers_01.py

Exchange data between consumer and provider

GET to retrieve data from provider, POST to send data to provider, …

APIs are all about data

Business logic and calculations often exposed through APIs

Run the same test more than once…

… for different combinations of input and expected output values

Data driven testing

More efficient to do this at the API level…

… as compared to doing this at the UI level

http://chrismcmahonsblog.blogspot.com/2017/11/ui-test-heuristic-dont-repeat-your-paths.html

Parameters in RESTful APIs

_Path parameters
  _http://api.zippopotam.us/us/90210
  _http://api.zippopotam.us/ca/B2A

_Query parameters
  _http://md5.jsontest.com/?text=testcaseOne
  _http://md5.jsontest.com/?text=testcaseTwo

_There is no official standard!

Data driven API testing

```python
test_data_users = [
    (1, "Leanne Graham"),
    (2, "Ervin Howell"),
    (3, "Clementine Bauch")
]


@pytest.mark.parametrize("userid, expected_name", test_data_users)
def test_get_data_for_user_check_name(userid, expected_name):
    response = requests.get(f"https://jsonplaceholder.typicode.com/users/{userid}")
    response_body = response.json()
    assert response_body["name"] == expected_name
```

```
collected 3 items

examples_02.py ...                                                    [100%]

============================== 3 passed in 0.49s ===============================
```

Working with external data sources

Reading a .csv file

```
import csv
```

```
1,Leanne Graham
2,Ervin Howell
3,Clementine Bauch
```

```
def read_data_from_csv():
    test_data_users_from_csv = []
    with open("examples/test_data_users.csv", newline='') as csvfile:
        data = csv.reader(csvfile, delimiter=',')
        for row in data:
            test_data_users_from_csv.append(row)
    return test_data_users_from_csv
```

Using .csv data to drive tests

```
def read_data_from_csv():
    test_data_users_from_csv = []
    with open("examples/test_data_users.csv", newline='') as csvfile:
        data = csv.reader(csvfile, delimiter=',')
        for row in data:
            test_data_users_from_csv.append(row)
    return test_data_users_from_csv
```

```
@pytest.mark.parametrize("userid, expected_name", read_data_from_csv())
def test_get_location_data_check_place_name_with_data_from_csv(userid, expected_name):
    response = requests.get(f"https://jsonplaceholder.typicode.com/users/{userid}")
    response_body = response.json()
    assert response_body["name"] == expected_name
```

Now it's your turn!

_ exercises > exercises_02.py

_ run your answers from the project root using

pytest exercises\exercises_02.py

_ examples are in examples > examples_02.py

_ answers are in answers > answers_02.py

Creating a JSON request body

```
import uuid

unique_number = str(uuid.uuid4())  # e.g. 5b4832b4-da4c-48b2-8512-68fb49b69de1


def create_json_object():

    return {
        "users": [
            {
                "user": {
                    "id": unique_number,
                    "name": "John Smith",
                    "phone_1": "0612345678",
                    "phone_2": "0992345678"
                }
            }
        ]
    }
```

POSTing a JSON request body

```python
import uuid

unique_number = str(uuid.uuid4())  # e.g. 5b4832b4-da4c-48b2-8512-68fb49b69de1


def create_json_object():

    return {
        "users": [
            {
                "user": {
                    "id": unique_number,
                    "name": "John Smith",
                    "phone_1": "0612345678",
```

```python
def test_send_json_with_unique_number_check_status_code():
    response = requests.post("http://httpbin.org/post", json=create_json_object())
    print(response.request.body)
    assert response.status_code == 200
```

```
C:\Git\requests-workshop>pytest -s examples\examples_03.py
```

```
{"users": [{"user": {"id": "5d35ec81-fc4c-4288-9835-ebf2cd4d6160", "name": "John Smith", "phone_1": "0612345678", "phone_2": "0992345678"}}]}
```

Now it's your turn!

_ exercises > exercises_03.py

_ run your answers from the project root using

pytest exercises\exercises_03.py

_ examples are in examples > examples_03.py

_ you will need to Google some things yourself

_ answers are in answers > answers_03.py

Create XML request body using a docstring

```
def use_xml_string_block():

    return """
    <users>
        <user>
            <id>5b4832b4-da4c-48b2-8512-68fb
            <name>John Smith</name>
            <phone type="mobile">0612345678</phone>
            <phone type="landline">0992345678</phone>
        </user>
    </users>
    """
```

```
<users>
    <user>
        <id>5b4832b4-da4c-48b2-8512-68fb49b69de1</id>
        <name>John Smith</name>
        <phone type="mobile">0612345678</phone>
        <phone type="landline">0992345678</phone>
    </user>
</users>
```

```
def test_send_xml_using_xml_string_block():
    xml = use_xml_string_block()
    response = requests.post("http://httpbin.org/anything", data=xml)
    print(response.request.body)
    assert response.status_code == 200
```

Create XML request body using ElementTree

```python
import xml.etree.ElementTree as et


def create_xml_object():
    users = et.Element('users')
    user = et.SubElement(users, 'user')
    user_id = et.SubElement(user, 'id')
    user_id.text = unique_number
    name = et.SubElement(user, 'name')
    name.text = 'John Smith'
    phone1 = et.SubElement(user, 'phone')
    phone1.set('type', 'mobile')
    phone1.text = '0612345678'
    phone2 = et.SubElement(user, 'phone')
    phone2.set('type', 'landline')
    phone2.text = '0992345678'

    return users
```

```xml
<users>
    <user>
        <id>5b4832b4-da4c-48b2-8512-68fb49b69de1</id>
        <name>John Smith</name>
        <phone type="mobile">0612345678</phone>
        <phone type="landline">0992345678</phone>
    </user>
</users>
```

Send XML created using ElementTree

```python
import xml.etree.ElementTree as et


def create_xml_object():
    users = et.Element('users')
    user = et.SubElement(users, 'user')
    user_id = et.SubElement(user, 'id')
    user_id.text = unique_number
    name = et.SubElement(user, 'name')
    name.text = 'John Smith'
    phone1 = et.SubElement(user, 'phone')
    phone1.set('type', 'mobile')
    phone1.text = '0612345678'
    phone2 = et.SubElement(user, 'phone')
    phone
    phone

    retur
```

```python
def test_send_xml_using_element_tree():
    xml = create_xml_object()
    xml_as_string = et.tostring(xml)
    response = requests.post("http://httpbin.org/anything", data=xml_as_string)
    print(response.request.body)
    assert response.status_code == 200
```

```xml
<users>
    <user>
        <id>5b4832b4-da4c-48b2-8512-68fb49b69de1</id>
        <name>John Smith</name>
        <phone type="mobile">0612345678</phone>
        <phone type="landline">0992345678</phone>
    </user>
</users>
```

Now it's your turn!

_ exercises > exercises_04.py

_ run your answers from the project root using

pytest exercises\exercises_04.py

_ examples are in examples > examples_04.py

_ answers are in answers > answers_04.py

Checking response XML - root element

```
def test_check_root_of_xml_response():
    response = requests.get("http://parabank.parasoft.com/parabank/services/bank/customers/12212")
    response_body_as_xml = et.fromstring(response.content)
    xml_tree = et.ElementTree(response_body_as_xml)
    root = xml_tree.getroot()
    assert root.tag == "customer"
    assert root.text is None
```

```
<customer>
  <id>12212</id>
  <firstName>John</firstName>
  <lastName>Smith</lastName>
  <address>
    <street>1431 Main St</street>
    <city>Beverly Hills</city>
    <state>CA</state>
    <zipCode>90210</zipCode>
  </address>
  <phoneNumber>310-447-4121</phoneNumber>
  <ssn>622-11-9999</ssn>
</customer>
```

Checking response XML – find an element using *find()*

```
def test_check_specific_element_of_xml_response():
    response = requests.get("http://parabank.parasoft.com/parabank/services/bank/customers/12212")
    response_body_as_xml = et.fromstring(response.content)
    xml_tree = et.ElementTree(response_body_as_xml)
    first_name = xml_tree.find("firstName")
    assert first_name.text == "John"
    assert len(first_name.attrib) == 0
```

```
▼<customer>
  <id>12212</id>
  <firstName>John</firstName>
  <lastName>Smith</lastName>
 ▼<address>
    <street>1431 Main St</street>
    <city>Beverly Hills</city>
    <state>CA</state>
    <zipCode>90210</zipCode>
  </address>
  <phoneNumber>310-447-4121</phoneNumber>
  <ssn>622-11-9999</ssn>
</customer>
```

Checking response XML - find all elements using *findall()*

```python
# https://docs.python.org/3/library/xml.etree.elementtree.html#elementtree-xpath
def test_use_xpath_for_more_sophisticated_checks():
    response = requests.get("http://parabank.parasoft.com/parabank/services/bank/customers/12212")
    response_body_as_xml = et.fromstring(response.content)
    xml_tree = et.ElementTree(response_body_as_xml)
    address_children = xml_tree.findall(".//address/*")
    assert len(address_children) == 4
```

```xml
<customer>
  <id>12212</id>
  <firstName>John</firstName>
  <lastName>Smith</lastName>
  <address>
    <street>1431 Main St</street>
    <city>Beverly Hills</city>
    <state>CA</state>
    <zipCode>90210</zipCode>
  </address>
  <phoneNumber>310-447-4121</phoneNumber>
  <ssn>622-11-9999</ssn>
</customer>
```

Now it's your turn!

_ exercises > exercises_05.py

_ run your answers from the project root using

pytest exercises\exercises_05.py

_ examples are in examples > examples_05.py

_ you will need to Google some things yourself

_ answers are in answers > answers_05.py

API mocking


API consumer
Goal:
Testing how your API consumer handles faulty responses returned by an API provider
Needed:
A way to simulate the behaviour of the provider to create the responses we want
Solution:
Creating a mock API provider
Mock API provider
API provider

Utility library for mocking requests

Register mock responses for HTTP calls

responses

pip install responses

https://github.com/getsentry/responses

Returning a different HTTP status code

```python
@responses.activate
def test_get_user_with_id_1_mock_returns_404():

    responses.add(
        responses.GET,
        'https://jsonplaceholder.typicode.com/users/1',
        status=404
    )

    response = requests.get("https://jsonplaceholder.typicode.com/users/1")
    assert response.status_code == 404
```

Returning a specific response body

```python
@responses.activate
def test_get_user_with_id_1_mock_returns_404_and_error_message_in_body():

    responses.add(
        responses.GET,
        'https://jsonplaceholder.typicode.com/users/1',
        json={'error': 'No data exists for user with ID 1'},
        status=404
    )

    response = requests.get("https://jsonplaceholder.typicode.com/users/1")
    assert response.json()['error'] == 'No data exists for user with ID 1'
```

Unmatched requests return a ConnectionError

```python
@responses.activate
def test_unmatched_endpoint_raises_connectionerror():

    with pytest.raises(ConnectionError):
        requests.get('https://jsonplaceholder.typicode.com/users/99')
```

Raise an error on an HTTP request

```python
@responses.activate
def test_responses_can_raise_error_on_demand():

    responses.add(
        responses.GET,
        'https://jsonplaceholder.typicode.com/users/99',
        body=RuntimeError('A runtime error occurred')
    )

    with pytest.raises(RuntimeError) as re:
        requests.get('https://jsonplaceholder.typicode.com/users/99')
    assert str(re.value) == 'A runtime error occurred'
```

Create dynamic responses with callbacks

https://github.com/getsentry/responses#dynamic-responses

```
test_data = [1, 2, 3]

@pytest.mark.parametrize('userid', test_data)
@responses.activate
def test_using_a_callback_for_dynamic_responses(userid):

    def request_callback(request):
        request_url = request.url
        resp_body = {'value': generate_response_from(request_url)}
        return 200, {}, json.dumps(resp_body)

    responses.add_callback(
        responses.GET, f'https://jsonplaceholder.typicode.com/users/{userid}',
        callback=request_callback,
        content_type='application/json',
    )

    def generate_response_from(url):
        parsed_url = urlparse(url).path
        split_url = parsed_url.split('/')
        return f'You requested data for user {split_url[-1]}'

    response = requests.get(f'https://jsonplaceholder.typicode.com/users/{userid}')
    assert response.json()['value'] == f'You requested data for user {userid}'
```

Now it's your turn!

_ exercises > exercises_06.py

_ run your answers from the project root using

pytest exercises\exercises_06.py

_ examples are in examples > examples_06.py

_ answers are in answers > answers_06.py