Programmable Web Project

Exercise 3

Implementing REST APIs in Python

Learning outcomes (I)

- ~~Students understand what a Web API is and learn different Web API architectures.~~
- ~~Students understand the concept of hypermedia and how it can be used to build Web APIs.~~
- **Students are able to design and implement a Web API following REST architectural style principles using existing web frameworks.**

Learning outcomes (II)

- **Students are able to write ~~unit~~ and functional tests to inspect their APIS.**
- ~~Students are able to document their Web APIs using adequate software tools.~~
- Students are able to implement simple software applications that make use of the APIs.

FLASK-RESTFUL

Flask-REST

- Library that applies the ROA principles to Flask framework
  - http://flask-restful.readthedocs.org/en/latest/index.html

- Main characteristics
  - Substitutes *view function calls* with *object calls*
    - Implementing classes which extends **`flask.rest.restful.Resource`**
    - Its main functionality encapsulated in the **`flask.rest.restful.Api`**

Flask REST framework

- Skeleton

```
class Message (Resource):

 #DELETE
   def delete(self,*uritemplatevariables):
       pass
  #GET
   def get(self,*uritemplatevariables):
       pass
  #PUT
   def put (self,*uritemplatevariables):
       pass
  #POST
    def post(self,*uritemplatevariables):
       pass
```

Methods:

Each one maps to one HTTP method

Flask REST routing(I)

- We need to create an `Api` object which will enclose all Flask-Restful functionality

```
from flask import Flask
from flask_restful import Api
app = Flask(__name__)
api = Api(app)
```

- All new endpoints registered using the `Api.add_resource` method:

```
api.add_resource(Message, '/forum/api/message/<messageid>')
```

Name of the Resource class

URL path (including path variables)

Flask REST routing (II)

- The method receives extra arguments if the associated uri template contains template variables

```
api.add_resource(Message,
                 '/forum/api/message/<messageid>/)
```

```
class Message (Resource):
    def get(self, message_id):
            pass
```

Flask REST routing (III)

- **Reverse routing:**
  - Mechanism to get dynamically the url associated to a resource.
  - **HATEOAS!!! ->** Never hardcode the URLs in the response!!!

```
resource_url= api.url_for(resource_class,
                          **urltemplatevariables)
```

- **Example:**
  - Resource **Message**; url = **`/forum/api/messages/<msg-id>`**
  - If we want to get the URL associated to a **`Message`** with id **`msg-1`**

```
api.url_for(Message, messageid = 'msg-1')
```

  - Generates the url: **`/forum/api/messages/msg-1`**

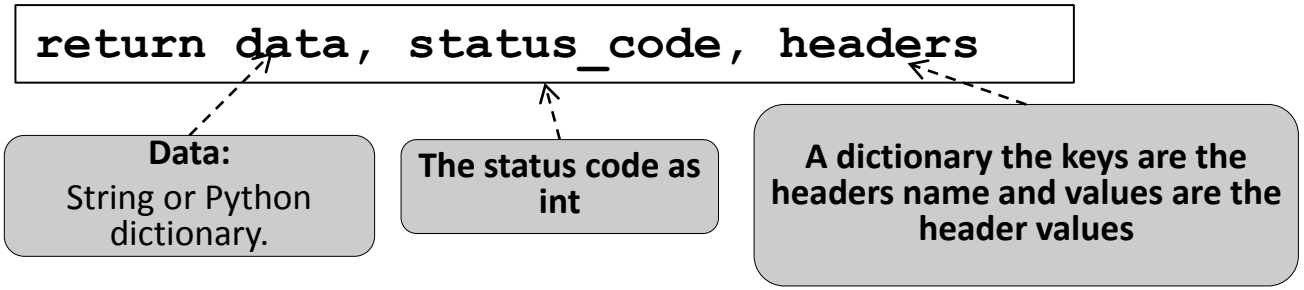
Flask-REST framework.
Request object

`flask.request` is a globally accessible variable which contains HTTP request information.

ATTRIBUTE / METHOD	DESCRIPTION
`.data`	A string containing the request boty
`.args`	A dictionary with the URL query parameters
`.headers`	A dictionary with HTTP request headers.
`.json`	Parses the incoming JSON request into python dictionary.

Flask-REST framework. Response object

- Each one of the HTTP methods return a tuple that is transformed into a response object.



- You can return also use the **`Response`** object:

```
return Response (data=None, status=None,
                 headers=None, mimetype=None)
```

- Flask tries to serialize response in right format (**Accept header**).
  - Does not support hypermedia type => use **`json.dumps()`**

Hooks

- Execute code before or after a request is processed
  - E.g. Useful to configure database connections.
  - Implemented as decorator:

```
@app.before_first_request
```

```
@app.before_request
```

```
@app.after_request
```

`@app.teardown_request`. After a request is processed or exception occurred.

Contexts

- When Flask receives a request, it needs to make a few objects available to the view function.
  - Flask use context: temporally makes objects globally accessible

Variable name	Context	Description
`current_app`	Application context	The application instance for the active application.
`g`	Application context	An object that the application can use for temporary storage during the handling of a request. This variable is reset with each request.
`request`	Request context	The request object, which encapsulates the contents of a HTTP request sent by the client.
`session`	Request context	The user session, a dictionary that the application can use to store values that are "remembered" between requests.

Source: Flask Web Development. Miguel Grinberg. O'Reilly

Flask-Restul framework cycle (I)

1. **Fill the request object with the HTTP request data**:
   - Store the headers in `request.headers`
   - Stores the query parameters of the URL in `request.args`
   - Stores the data in `request.stream` or `request.data` (a string)
   - The request body is accessible using the `json` if the HTTP header Content-Type is application/json
2. **Consults the routing mechanism to determine the Resource class which must handle the request.**

Flask-Restulf framework cycle (II)

3. **Execute pre request hooks**

4. **Calls the view method with the same name of the HTTP method.**
   - The method receives keyword arguments with the values of URI template variables.

5. **The application access the request data and process it**
   - The app accesses the database and extracts/modify necessary information.
   - The app generates a python dictionary to store the response data.

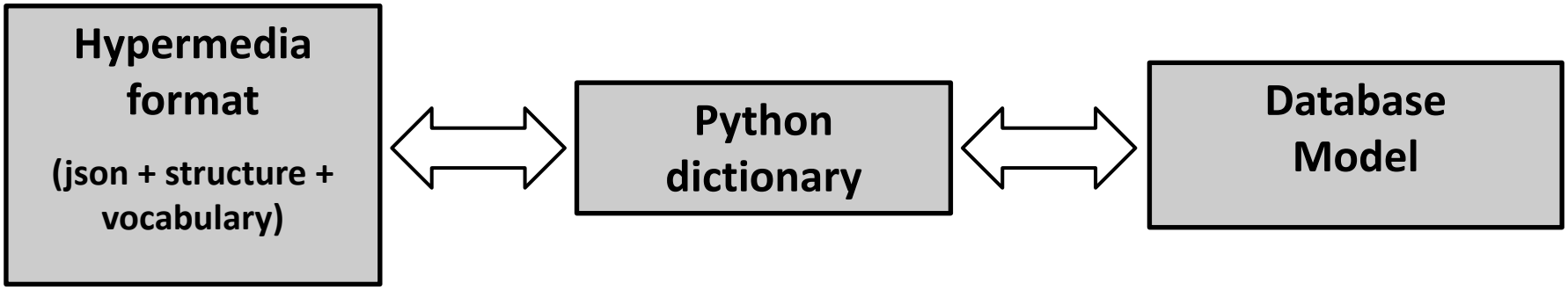
Flask-Restulf framework cycle (II)

6. **The app method returns the dictionary containing the data, the status code and the a dictionary with the response headers**
   - Flask will serialize this dictionary using the adequate resource representation depending on the MIME type contained in the Accept header.
7. **Execute post request hooks**
8. **The HTTP response is returned to the client**

HYPERMEDIA

Generating hypermedia

- If you find a parser / serializer library for your hypermedia format use it.
  - Working with strings is **insane**!!!!!!!!!!



- Otherwise, implement it (e.g):
  - `MasonBuilder(dict)` -> Extend dictionary class to support structure and Mason vocabulary
  - `InventoryBuilder(MasonBuilder)` -> API Resource specific subclass -> Uses application semantics

Schemas

- Mason uses JSON Schema schemas to define the structure of the HTTP requests of **PUT** and **POST** methods.
  - Define the schema as dictionary

```
def sensor_schema():
        schema = {
            "type": "object",
            "required": ["name", "model"]
        }
        props = schema["properties"] = {}
        props["name"] = {
            "description": "Sensor's unique name",
            "type": "string"
        }
        props["model"] = {
            "description": "Name of the sensor's model",
            "type": "string"
        }
        return schema
```

  - Use **`jsonschema.validate`** to check if the received requests is valid

Returning Profiles and Link relations

- The profile and link relation documenation should be accessible by the REST clients.
  1. If the documentation is stored in your server
     - Store the files in a folder named `static`
     - Use the `flask.send_from_directory`

```
from flask import send_from_directory

app = Flask(__name__, static_folder="static")

@app.route("/profiles/<resource>/")
def send_profile_html(resource):
    return send_from_directory(app.static_folder, "{}.html".format(resource))
```

  2. If the documentation is stored in external server
     - Use the `flask.redirect`

```
from flask import redirect

@app.route("/profiles/<resource>/")
def send_profile_html(resource):
    return redirect(completeurltotheprofile)
```

TESTING

Functional testing in Flask (I)

- Flask provides an HTTP test client

```
from app import app, db

client = app.test_client()

#Sending HTTP requests
resp = client.get(url)
resp = client.put(url, data="string_data", headers={})
resp = client.post(url, data="string_data", headers={})
resp = client.delete(url)

#Accessing the response
body = resp.data
status = resp.status_code
header = resp.headers #Dictionary of headers
```

Functional testing in Flask (II)

- Use pytest

```
# based on http://flask.pocoo.org/docs/1.0/testing/
@pytest.fixture
def client():
    db_fd, db_fname = tempfile.mkstemp()
    app.config["SQLALCHEMY_DATABASE_URI"] = "sqlite:///" + db_fname
    app.config["TESTING"] = True

    db.create_all()
    _populate_db()

    yield app.test_client()

    db.session.remove()
    os.close(db_fd)
    os.unlink(db_fname)
```

- Use test cases as you did for the database
  - Remember that the Flask HTTP client is passed as argument to the test!!!

```
def test_post_valid_request(self, client):
        valid = _get_sensor_json()
        resp = client.post(self.RESOURCE_URL, json=valid)
        assert resp.status_code == 201
```

Functional testing in Flask (II)

What to test?

- Resources are created, modified and removed correctly
- Structure of the responses are correct
- Headers and status code are correct
- Your API response correctly to incorrect Request(wrong url, wrong format, wrong headers...)
- In hypermedia, check that the controls are correct

Coverage

- Use coverage plugin to check how many lines of your code has been testing.
- Aim for high coverage (>95%)

Unit testing

- To access the request, session attributes or url_for function you must be inside the request context.
- Two ways of working with the request context while performing unit-testing
  - with **`test_client`**:

```
with resources.app.test_client() as client:
            resp = client.get(url)
            links = resp.data['links']
            self.assertEquals(links[0]['href'], api.url_for(Messages))
```

  - with **`test_request_context`**

```
with resources.app.test_request_context(self.url):
            request.data = mydata
            app.preprocess_request()
              ....
            resp = Response(...)
            resp = app.process_response
```

  - Much more info at http://flask.pocoo.org/docs/testing/?highlight=test_request_context

PROJECT LAYOUT

Suggested layout

- In the exercise everything in one single file, BUT ...
- Recommended structure for your project:

```
/your/project/root/
├── MANIFEST.in
├── README.md
├── setup.py
├── sensorhub
│   ├── __init__.py
│   ├── api.py
│   ├── models.py
│   ├── utils.py
│   ├── resources/
│   │   ├── __init__.py
│   │   ├── deployment.py
│   │   ├── location.py
│   │   ├── measurement.py
│   │   └── sensor.py
│   └── static/
│       └── schema/
└── tests
    ├── api_test.py
    ├── db_test.py
    └── utils.py
```

- **Other recommendations:**
  - Application factory: separate development, production, testing
  - Configuration to `config.py`
  - Use blueprints to separate different APIs / different APIs functionalities:
    - e.g. Admin vs User
  - Make your project installable
  - Use command line interface for administrative tasks: e.g. create / populate the database.

SEE THE FLASK API PROJECT LAYOUT IN LOVELACE