Programmable Web Project

Exercise 1

Introduction to Web Development

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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.

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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.

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WEB FRAMEWORKS

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Web Frameworks

- Help us to focus in the ”**Business Logic”** of applications
  - Hides HTTP protocol
  - Serialization + parsing of resources representation
  - Security
  - Authentication and authorization

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Flask

- Flask is a micro web development framework for Python
  - Simple but extensible core
    - Hooks and signals
  - Support for ORM, Validation, Open authentication through extensions
  - Permits the creation of web applications with no configuration or setup.
    - A complete application may run in one python module.

```
from flask import Flask
app = Flask(__name__)
@app.route("/hello/<name>")
def index(name):
    return “Hello {}“.format(name), 200
```

```
>> flask.run()
```

Flask

`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.
`.remote_addr`	The ip address of the incoming request
`.json`	Parses the incoming JSON request into python dictionary. This is None if the data is not correctly well-formed, is not JSON, or does not have the Content-Type: application/json

DATABASES AND ORM

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Relational Database

- A database:
  - is a data structure
  - stores organized information.
  - can be easily accessed, managed and updated.

- Relational database:
  - data is organized in tables
  - tables are related among each other.

- The structure of a database (tables, fields, relationships...) is called the **database schema**.

Basic Vocabulary in RBD (I)

- Data is stored in tables (or relations)
  - A table is formed by:
    - rows (or records, or tuples)
    - columns (or attributes)
- **Relational Model** implies each row in a table must be unique
- **Primary Keys (PK)** guarantee that Uniqueness:
  - Fields defined as PK are set to be unique and identify each row.
  - Each table can have one PK
- **Foreign Key:** referential constraint between two tables
  - For each record in the **child** table there must be a unique record that matches the key in the **parent** table

Example 1: PK for *users*

id	firstname	lastname	mobile	residence	nickname
1	Jane	Thomas	334455	New York	lucy
2	John	Smith	223355	London	smith

- Possible candidate keys:
- i) id
- ii) (lastname + firstname)
- iii) nickname
- iv) (id, nickname)
- v)(residence + mobile).

Example 2: FK

messages Table

id	title	body	user_id
1	aaa	abc	2

[Child table]

users Table

id	firstname	lastname	nickname
1	Jane	Thomas	lucy
2	John	Smith	smith

[Parent table]

```
Foreign Key (user_id) REFERENCES users.id
```

For each row in *messages* table, it must exist a row in *users* table where

messages.user_id = users.id

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Types of relations
One-to-many

many-to-one:
many (pets) to
one (person)

one-to-many:
one (person) to
many (pets)

PET			
id	name	species	owner
1	wanwan	doge	1
2	nyanyan	neko	1

PERSON		
id	name	job
1	winnie	the pooh
2	eeyore	donkey

values in this column
are limited to values
in person.id

Types of relations
One-to-one

one-to-one:
one (image) to
one (fileinfo)

IMAGE			
id	handle	alt	file
1	doge	this dog	1
2	neko	this cat	2

FILEINFO		
id	filename	size
1	dog.png	4096
2	cat.png	2048

values in this column are limited to values in fileinfo.id and are unique

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Types of relations Many-to-Many

ENROLLMENT

class_id	student_id
1	1
1	2

these columns form the PK together; each pair of values is unique

values in this column are limited to values in class.id

values in this column are limited to values in student.id

CLASS

id	name	code
1	internet 101	1337
2	donkeys 101	4451

many-to-many: many (classes) to many (students)

STUDENT

id	name	major
1	winnie	gastronomy
2	eeyore	apathy

Basic Vocabulary in RDB (ii)

- Foreign key **ON DELETE** and **ON UPDATE** clauses are used to configure actions that take place when
  - deleting rows from the parent table
  - modifying the parent key values of existing rows
- E.g. in an *SQLite* database:
  - **SET NULL**: when a parent key is deleted or modified, the child key columns of all rows in the child table that mapped to the parent key are set to contain SQL NULL values.
  - **CASCADE**: A "CASCADE" action propagates the delete or update operation on the parent key to each dependent child key

SQLite

- Lightweight database implementation that support SQL
  - Database is stored in one file
- Only supports five **data types**:
  - null, integer, real, text and blob
  - Type affinity
- **ALTER:** SQLite allows just a subset for ALTER TABLE
  - You can rename a table or add a new column to an existing table (with no constraints).
  - You cannot add or remove constraints after creating the table
- **GRANT and REVOKE** are not supported:
  - SQLite databases are files
  - Thus, file access permission should be used instead
- **PRAGMA command**: SQL extension specific to SQLite
  - PRAGMA FK
- **Foreing Keys** support implicitly
  - you need to execute **PRAGMA foreign_keys = ON** always before any statement or transaction.

ORM with SQLAlchemy

- **Object relational mapping**
- Abstraction layer of a database using models
  - Properties -> database attributes
  - Methods -> SQL operations

- Initialization

```
app = Flask(__name__)
app.config["SQLALCHEMY_DATABASE_URI"] = "sqlite:///test.db"
app.config["SQLALCHEMY_TRACK_MODIFICATIONS"] = False
db = SQLAlchemy(app)
```

- Model generation

```
class Measurement(db.Model):
    id = db.Column(db.Integer, primary_key=True)
    sensor = db.Column(db.String(20), nullable=False)
    value = db.Column(db.Float, nullable=False)
    time = db.Column(db.DateTime, nullable=False)
```

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ORM with SQLAlchemy

- Schema generation

```
db.create_all()
```

- Add objects

```
db.session.add(meas)
db.session.commit()
```

- Retrieving objects

```
measurements = Measurement.query.all()
meas = Measurement.query.first()
measurements = measurement.query.filter_by(sensor="d").all()
meas2 = measurement.query.filter(Measurement.value>100).first()
```

- Removing and modifying objects

```
db.session.delete(meas2)
meas.sensor = ‘donkeysensor1’
db.session.commit()
```

ORM with SQLAlchemy

- One-to-many relations: sensor has multiple measurements

```
class Sensor(db.Model):
    id = db.Column(db.Integer, primary_key=True)
    name = db.Column(db.String(32), nullable=False, unique=True)
    model = db.Column(db.String(128), nullable=False)
    measurements = db.relationship("Measurement", back_populates="sensor")

class Measurement(db.Model):
    id = db.Column(db.Integer, primary_key=True)
    sensor_id = db.Column(db.Integer, db.ForeignKey("sensor.id", 
                                                       onDelete="CASCADE"))
    value = db.Column(db.Float, nullable=False)
    sensor = db.relationship("Sensor", back_populates="measurements")
```

- DELETE on CASCADE must be also informed to SQLAlchemy

```
 measurements = db.relationship("Measurement", cascade="all, delete-orphan
", back_populates="sensor")
```

ORM with SQLAlchemy

- One-to-one relation: each location can hold only one sensor

```
class Location(db.Model):
    id = db.Column(db.Integer, primary_key=True)
    latitude = db.Column(db.Float, nullable=True)
    longitude = db.Column(db.Float, nullable=True)
    altitude = db.Column(db.Float, nullable=True)
    description=db.Column(db.String(256), nullable=True)
    sensor = db.relationship("Sensor", back_populates="location", uselist=
False)

class Sensor(db.Model):
    id = db.Column(db.Integer, primary_key=True)
    name = db.Column(db.String(32), nullable=False, unique=True)
    model = db.Column(db.String(128), nullable=False)
    location_id = db.Column(db.Integer, db.ForeignKey("location.id"), on_d
elete="SET NULL“, unique=True)
    location = db.relationship("Location", back_populates="sensor")
```

ORM with SQLAlchemy

- Many-to-Many relation: one sensor may be in multiple deployments and one deployment has multiple sensors

```
class Deployment(db.Model):
          id = db.Column(db.Integer, primary_key=True)
          start = db.Column(db.DateTime, nullable=False)
          end = db.Column(db.DateTime, nullable=False)
          name = db.Column(db.String(128), nullable=False)
          sensors = db.relationship("Sensor", secondary=deployments, back_populates="deploym
ents")


class Sensor(db.Model):
    id = db.Column(db.Integer, primary_key=True)
    name = db.Column(db.String(32), nullable=False, unique=True)
    model = db.Column(db.String(128), nullable=False)
    location_id = db.Column(db.Integer, db.ForeignKey("location.id"), on_delete="SET NULL",
unique=True)
    deployments = db.relationship("Deployment", secondary=deployments, back_populates="senso
rs")



deployments = db.Table("deployments",
          db.Column("deployment_id", db.Integer, db.ForeignKey("deployment.id"), primary_key
=True),
          db.Column("sensor_id", db.Integer, db.ForeignKey("sensor.id"), primary_key=True))
```

TESTING

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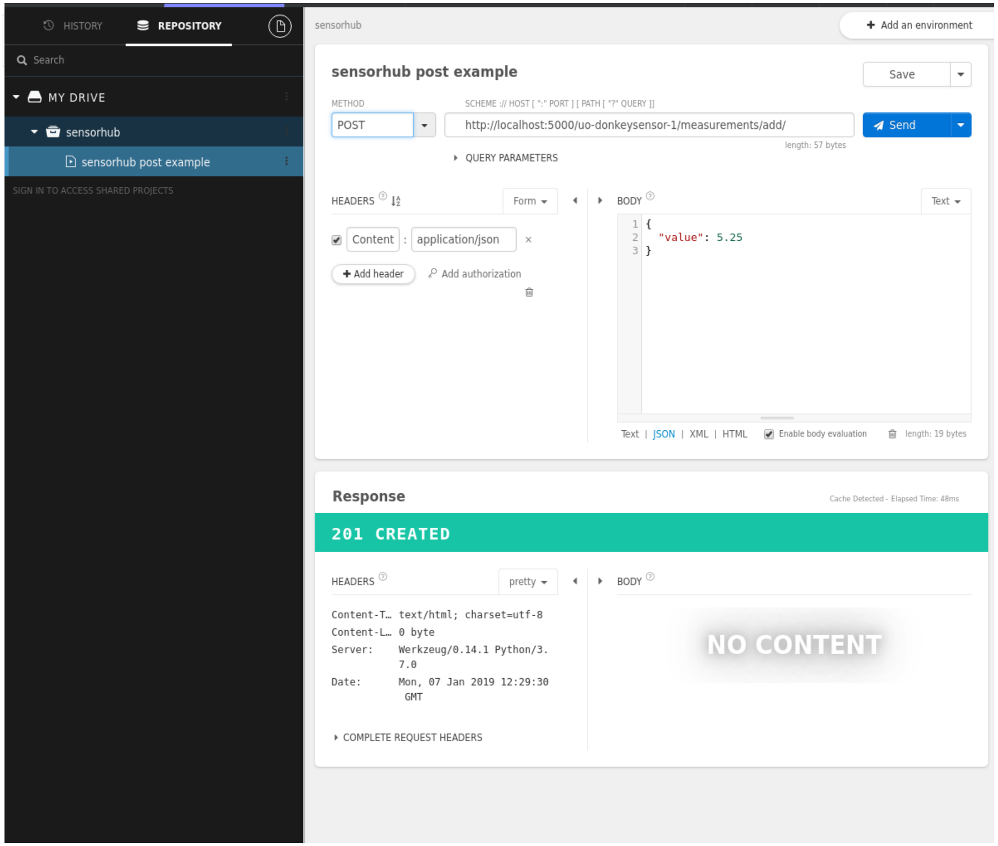
Talend API



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Unit Testing

- Unit testing is a process for which small pieces of codes are tested isolating them from the rest of the code.

- **Purpose:** ensure that individual components of the program behave as they are expected to.

- **What to test in databases:**
  - Instances can be created, retrieved, modified and deleted
  - foreign key relationships are created correctly
  - foreign key relationships works as expected (integrity, ondelete, oncascade)
  - Uniqueness, nullability and restrictions works

Testing with pytest

```
import pytest

@pytest.fixture
def my_fixture():
    # do preparations here; eg. Create and populate the database
    yield db
    # teardown: clean the database and resources

def test_something(my_fixture):
    # do some testing
    # you can use the database object defined in my fixture
```

```
assert db_measurement.sensor == db_sensor
```

```
with pytest.raises(IntegrityError):
        db_handle.session.commit()
```

```
>> pytest test.py
```

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Environmental Variables

DEBUGGING MODE

- In Linux:

```
export FLASK_ENV=development
```

- In Windows command prompt:

```
set FLASK_ENV=development
```

- You can also use environment variables to run your app from a Python file that is not named app.py:

```
export FLASK_APP=sensorhub.py
```

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