SI 506 Lecture 18

Goals

1. Understand the basics of the HTTP request/response communication cycle.
2. Learn about JSON and how to leverage the Python `json` module.
3. Write utility functions that leverage the requests and json libraries in order to retrieve SWAPI resources, decode/encode JSON documents and write a JSON document to a file.
4. Challenges

Vocabulary

- **API**: Application Programming Interface that species a set of permitted interactions between systems.
- **HTTP**: The Hypertext Transport Protocol is an application layer protocol designed to facilitate the distributed transmission of hypermedia. Web data communications largely depends on HTTP.
- **JSON**: Javascript Object Notation, a lightweight data interchange format.
- **Querystring**: That part of a Uniform Resouce Locator (URL) that assigns values to specified parameters.
- **Resource**: A named object (e.g., document, image, service, collection of objects) that is both addressable and accessible via an API.
- **URI**: Uniform Resource Identifier that identifies unambiguously a particular resource.
- **URL**: Uniform Resource Locator is a type of URI that specifies the *location* of a resource on a network and provides the means to retrieve it.
- **URN**: Uniform Resource Name is a type of URI that provides a unique identifier for a resource but does not specify its location on a network.

Previous

- **Argument**. A value passed to a function or method that corresponds to a parameter defined for the function or method.
- **Boolean**. A type (`bool`) or an expression that evaluates to either `True` or `False`.
- **Built-in Function**. A function defined by the Standard Library that is always available for use.
- **Caller**. The initiator of a function call.
- **Conditional Statement**. A statement that determines a computer program's *control flow* or the order in which particular computations are to be executed.
- **Deep copying**. For a given mutable object (e.g., `list`) constructs a new compound object and recursively *copies* into it objects found in the original.
- **Dictionary**. An associative array or a map, wherein each specified value is associated with or mapped to a defined key that is used to access the value.
- **Expression**. An accumulation of values, operators, and/or function calls that return a value. `len(< some_list >)` is considered an expression.
- **f-string**. Formatted string literal prefixed with `f` or `F`.
- **File Object**. An object that provides a file-oriented application programming interface (API) to a either a text file, binary file (e.g., image file), or a buffered binary file. File objects include read and write methods for interacting with a file stored locally or remotely.

- **Flow of execution**. The order in which statements in a program are executed. Also referred to as *control flow*.
- **Function**. A defined block of code that performs (ideally) a single task. Functions only run when they are explicitly called. A function can be defined with one or more *parameters* that allow it to accept *arguments* from the caller in order to perform a computation. A function can also be designed to return a computed value. Functions are considered "first-class" objects in the Python eco-system.
- **Immutable**. Object state cannot be modified following creation. Strings are immutable.
- **Iterable**. An object capable of returning its members one at a time. Both strings and lists are examples of an iterable.
- **Iteration**. Repetition of a computational procedure in order to generate a possible sequence of outcomes. Iterating over a `list` using a `for` loop is an example of iteration.
- **Method**. A function defined by and bound to an object. For example the `str` type is provisioned with a number of methods including `str.strip()`.
- **Mutable**. Object state can be modified following creation. Lists are mutable.
- **Nested Loop**. A `for` or `while` loop located within the code block of another loop.
- **Operator**. A symbol for performing operations on values and variables. The assignment operator (`=`) and arithmetic operators (`+`, `-`, `*`, `/`, `**`, `%`, `//`).
- **Parameter**. A named entity in a function or method definition that specifies an argument that the function or method accepts.
- **Scope**. The part of a script or program in which a variable and the object to which it is assigned is visible and accessible.
- **Sequence**. An ordered set such as `str`, `list`, or `tuple`, the members of which (e.g., characters, elements, items) can be accessed.
- **Shallow copying**. For a given mutable object (e.g., `list`) constructs a new compound object but inserts *references* (rather than copies) into it of objects found in the original. The `list.copy()` returns a shallow copy of the original list.
- **Slice**. A subset of a sequence. A slice is created using the subscript notation `[]` with colons separating numbers when several are given, such as in `variable_name[1:3:5]`. The bracket notation uses slice objects internally.
- **Statement**. An instruction that the Python Interpreter can execute. For example, assigning a variable to a value such as `name = 'arwhyte'` is considered a statement.
- **Truth Value**. In Python any object can be tested for its truth value using an `if` or `while` condition or when it is used as an operand in a Boolean operation.
- **Tuple**. An ordered sequence that cannot be modified once it is created.
- **Tuple packing**. Assigning items to a tuple.
- **Tuple unpacking**. Assigning tuple items to an equal number of variables in a single assignment. A `list` can also be unpacked.

1.0 HTTP Request/Response cycle

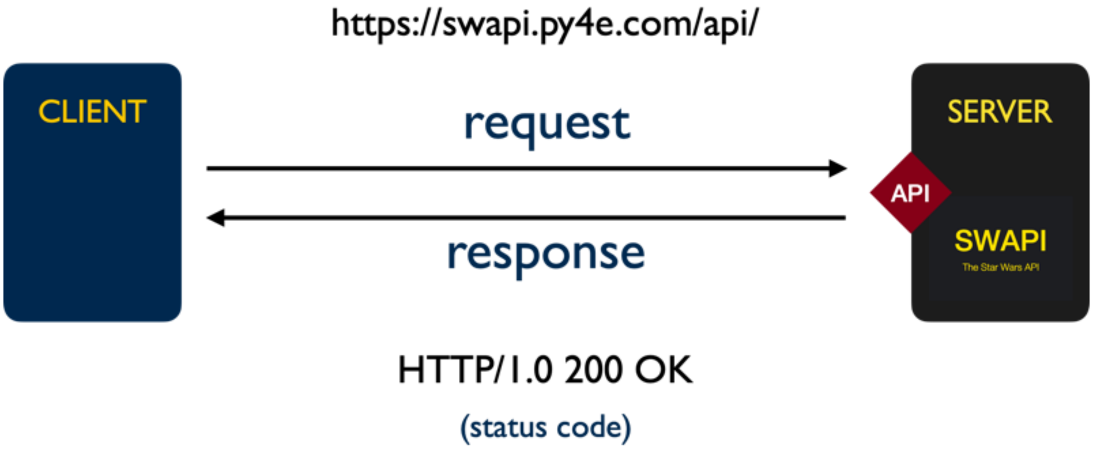
The `swapi_test.py` script utilizes the `requests` module to send a message (known as a *request*) to a remote server. The message is sent over HTTP (Hypertext Transfer Protocol), an application layer protocol that supports data exchange between clients and servers. The server replies with a message (known as a *response*). If the client is authorized to access the requested data (known as a *resource*) identified by the provided Uniform Resource Identifier (in our case a URL) the response will contain a representation of the resource, usually in the form of a JSON document.

HTTP and its extension HTTPS (Hypertext Transfer Protocol Secure) rely on lower level transport layer protocols such as the Transmission Control Protocol (TCP) or the User Datagram Protocol (UDP) to transmit packets of data between a client and a server. TCP privileges reliable message delivery over speed and requires the server to acknowledge the receipt of data and permit retransmission. UDP privileges speed over reliability and offers no guarantee of message delivery. Exchanging messages with SWAPI leverages HTTPS over TCP and the still lower-level Internet Protocol (IP).

An HTTP request consists of an HTTP verb (e.g., `GET`), a resource identifier (e.g., `https://swapi.py4e.com/api/people/10/`), the protocol version (`HTTP/1.1`) and optional headers and an optional body (itself a resource). An HTTP response consists of the protocol version, status code (e.g., `200`), status message (e.g., `OK`), headers, and an optional body (the requested resource).

The HTTP request methods utilized most frequently include `GET`, `PUT`, `POST`, and `DELETE`. Other HTTP methods include `CONNECT`, `HEAD`, `OPTIONS`, `PATCH` and `TRACE`.

💡 For SI 506 you need only concern yourself with the `GET` method.



The Python requests package abstracts away much of the complexity associated with creating an HTTP request. In the case of `swapi_test.py` we need only pass a URL to the `request` library's `get()` function to initiate a valid HTTP `GET` request. The `get()` function's return value is an instance of `request.Response`, an object which contains the JSON-encoded representation of the requested resource. We can access the `response.text` property to return the JSON documents as a string. Better yet, we can call the `response.json()` method in order to decode the JSON document into a dictionary.

2.0 JSON

SWAPI responds to a resource request with a message encoded as a JSON (JavaScript Object Notation) document. JSON is a lightweight data interchange format for exchanging information between systems.

JSON consists of two basic data structures and several value types:

2.1 JSON data structures

1. An *unordered* set of key-value pairs known as an *object* and denoted by curly braces (`{}`).
2. An *ordered* list of values known as an *array* and denoted by square brackets (`[]`).

2.2 JSON value types

1. string
2. number
3. boolean
4. array `[]`
5. object `{}`
6. null

2.3 JSON example

```json
{
  "url": "https://swapi.co/api/people/10/",
  "name": "Obi-Wan Kenobi",
  "height": 182,
  "mass": 77.5,
  "hair_color": ["auburn", "white"],
  "eye_color": "blue-gray",
  "birth_year": "57BBY",
  "homeworld": {
    "url": "https://swapi.co/api/planets/20/",
    "name": "Stewjon",
    "climate": "temperate",
    "population": null
  },
  "is_jedi": true
}
```

3.0 json module

Like the `csv` module the Python standard libary's `json` module provides enhanced functionality for working with JSON files. JSON is a lightweight data interchange format for exchanging information between systems.

To use the `json` module you must import it in your Python file:

```python
import json
```

There are four `json` module functions; two of which are of particular interest to us:

1. **`json.load()`** -- *deserializes* (decodes) a text or binary file that contains a JSON document to a `dict` or `list`.
2. `json.loads()` -- *deserializes* (decodes) a string, bytes, or bytearry containing a JSON document to a `dict` or `list`.
3. **`json.dump()`** -- *serializes* (encodes) an object as a JSON formatted stream to be stored in a file.
4. `json.dumps()` -- *serializes* (encodes) an object to a JSON formatted string.

Since you will also be working with JSON documents between now and the end of the semester implmenting a function that can read a JSON document as well one that can write a JSON document to a file will prove useful.

3.1 Reading JSON files (`json_load()`)

The function `read_json()` reads a JSON document per the provided filepath, calls the json module's `json.load()` function in order to *decode* the file data as a `dict` or a `list` (of dictionaries), and returns the decoded data to the caller.

```
def read_json(filepath, encoding='utf-8'):
    """Reads a JSON document, decodes the file content, and returns a list
or
    dictionary if provided with a valid filepath.

    Parameters:
        filepath (str): path to file
        encoding (str): name of encoding used to decode the file

    Returns:
        dict/list: dict or list representations of the decoded JSON
document
    """

    with open(filepath, 'r', encoding=encoding) as file_obj:
        return json.load(file_obj)
```

3.2 Writing to a JSON file (`json_dump()`)

The function `write_json()` accepts a dictionary or a list of dictionaries, calls the json module's `json.dump()` function in order to *encode* the passed in data as JSON, and writes the encoded data to the target file.

```
def write_json(filepath, data, encoding='utf-8', ensure_ascii=False,
indent=2):
    """Serializes object as JSON. Writes content to the provided filepath.

    Parameters:
        filepath (str): the path to the file
        data (dict)/(list): the data to be encoded as JSON and written to
the file
        encoding (str): name of encoding used to encode the file
        ensure_ascii (str): if False non-ASCII characters are printed as
is; otherwise
                            non-ASCII characters are escaped.
        indent (int): number of "pretty printed" indention spaces applied
to encoded JSON

    Returns:
        None
    """

    with open(filepath, 'w', encoding=encoding) as file_obj:
        json.dump(data, file_obj, ensure_ascii=ensure_ascii,
indent=indent)
```

4.0 Challenges

4.1 Challenge 01

Task: Retrieve a SWAPI representation of Chewbacca and supplement representation with homeland and species data.

1. In `main` call the function `get_swapi_resource` passing the search string "chewbacca" and retrieve a response that contains a representation of the Wookiee Chewbacca (a.k.a Chewie). Assign the return value to a variable named response.

   ❗ The JSON response that is decoded into a dictionary is structured as follows:

   ```
   {
     'count': 1,
     'next': None,
     'previous': None,
     'results': [
       {< Chewbacca >}
     ]
   }
   ```

2. Access the Chewbacca dictionary and assign it to variable named `chewie`.

3. Call the function `write_json` and write `chewie` to a file named `chewie.json`.

4. Access the `homeworld` URL in `chewie` and retrieve the Wookiee's home plant by calling `get_swapi_resource` and passing the URL to it as an argument (no search string required). Assign the return value to `chewie['homeworld']`.

5. Access the `species` URL in `chewie` and retrieve the Wookiee's species by calling `get_swapi_resource` and passing the URL to it as an argument (no search string required). Assign the return value to `chewie['species']`.

   ❗ note that the value of `chewie['species']` is a `list`.

6. Call the function `write_json` and write `chewie` to a file named `chewie_enriched.json`.

4.2 Challenge 02

Task: Implement the function `drop_data`. Refer to the Docstring for more information. Utilize the `drop_keys` tuple to thin SWAPI entities of unneeded key-value pairs.

1. After implementing the function return to `main`. Call `get_swapi_resource` and retrieve a dictionary representation of a **T-65 X-wing** starfighter. Assign the return value to a variable named `x_wing`.

   💡 employ the search string "t-65 x-wing" rather than "x-wing" as there are two models of X-wing starfighters available for retrieval.

2. Call the function `drop_data` passing to it as arguments `x_wing` and `drop_keys`. Assign the return value to `x_wing`.

3. Call the function `write_json` and write `x_wing` to a file named `x_wing.json`.

4.3 Challenge 03

Task: Combine the T-65 X-wing data sourced from Wookieepedia and contained in the file `wookieepedia_starships.csv` with the SWAPI `x_wing` dictionary.

1. Call `read_csv_to_dicts` and retrieve the Starfighter data sourced from Wookieepedia. Assign the list of dictionaries to the variable named `wookiee_starships`.

2. Access the T-65 Starfighter dictionary in `wookiee_starships` and assign to a variable named `woookiee_x_wing`.

3. Update `x_wing` with `wookiee_x_wing`.

   💡 Visit w3school's "Python Dictionary Methods" page; there is a handy `dict` method available to accomplish this task.

4. call the function `write_json` and write `x_wing` to a file named `x_wing_enriched.json`.

4.4 Challenge 04

Task: Replace the `x_wing` pilot URLs with dictionary representations of each pilot. When adding the pilot dictionaries to `x_wing` remove unneeded key-value pairs.

💡 leverage the `range` object to solve this challenge.

1. Utilize a `for` loop to update the `x_wing pilots` list. For each pilot call `get_swapi_resource` to retrieve the pilot. Drop unneeded key-value pairs and assign the return value to `pilot`.

   1. Then retrieve the pilot's home planet, drop unneeded key-value pairs and assign the return value to the pilot's `homeworld` key.

   2. Also retrieve the pilot's species—*if species data exists*— drop unneeded key-value pairs and assign the return value to the pilot's `species` key.

   3. Finally, assign the `pilot` to the appropriate `x_wing['pilots']` list element.

2. After updating `x_wing` call the function `write_json` and write `x_wing` to a file named `x_wing_pilots.json`.

4.5 Challenge 05

Task: Drop the `x_wing` `pilots` key-value pair. Retrieve Luke Skywalker and the astromech droid R2-D2 from SWAPI. Add `homeworld` and `species` dictionaries. Drop all unneeded key-value pairs for person, droid, home planet and species. Assign Luke and R2-D2 as the `x_wing` crew members.

1. Drop the `x_wing` `pilots` key-value pair. Pass **a single item tuple** to `drop_data` to accomplish the task.

2. Retrieve a SWAPI representation of Luke Skywalker. Drop unneeded key-value pairs. Assign the return value to a variable named `luke`.

3. Retrieve Luke's home planet and species. Drop unneeded key-value pairs for each. Assign to the `homeworld` and `species` keys in `luke`.

4. Retrieve a SWAPI representation of R2-D2. Repeat the same steps performed for Luke, i.e., drop unneeded key-value pairs, retreive `homeworld` and `species` data. Assign the return value to a variable named `r2`.

5. Create a dictionary with two key-value pairs: `pilot` and `astromech_droid`. Assign `luke` and `r2` as values and assign to `luke` using the new key `crew_members`.

6. Call the function `write_json` and write `x_wing` to a file named `x_wing_crew.json`.