Unit 9

Codio – Developing an API for Distributed Environments

Q1: run the API.py code. Take a screenshot of the terminal output. What command did you use to compile and run the code?

```
codio@change-forest:~/workspace$ ll
total 3272
drwxr-xr-x 1 codio codio      436 Oct 19 19:24  ./
drwxr-xr-x 1 codio codio      106 Sep  5 22:32  ../
-rw-r--r-- 1 codio codio     1908 Oct 19 19:24  api.py
-rw-r--r-- 1 codio codio      246 Sep 30  2020  .codio
-rw-r--r-- 1 codio codio        0 Sep 30  2020  .codio-jupyter
-rw-r--r-- 1 codio codio     6576 Sep 28 00:09  CommandLine.ipynb
-rw-r--r-- 1 codio codio       72 Sep 30  2020 'Empty Notebook.ipynb'
-rw-r--r-- 1 codio codio     3806 Oct 19 16:17  File_Encryption_RSA.ipynb
-rw-r--r-- 1 codio codio     4874 Oct 19 19:22  Flask_API.ipynb
-rw-r--r-- 1 codio codio       46 Sep 30  2020  .gitignore
drwxr-xr-x 1 codio codio       68 Sep  5 22:32  img/
drwxr-xr-x 1 codio codio      386 Oct 19 19:23  .ipynb_checkpoints/
-rw-r--r-- 1 codio codio    37695 Oct 19 19:24  .nbgrader.log
-rw-r--r-- 1 codio codio      944 Sep 30  2020  README.md
-rw-r--r-- 1 codio codio     1249 Sep 30  2020  .settings
-rw-r--r-- 1 codio codio  3254884 Sep  6 00:31  Towers_of_Hanoi.ipynb
-rw-r--r-- 1 codio codio     1507 Sep  6 01:35 'UK Postcodes.ipynb'
-rw-r--r-- 1 codio codio       72 Oct 19 19:23  Untitled.ipynb
codio@change-forest:~/workspace$ python api.py
Traceback (most recent call last):
  File "api.py", line 1, in <module>
    from flask import Flask
ImportError: No module named flask
codio@change-forest:~/workspace$ 
```

To compile and run the code, I issued the command "`python api.py`". This command then attempted to parse the code from top to bottom and produced an error regarding failure to locate the **flask** modules.

To resolve this compilation error, I issued the command "`pip install flask`" and also "`pip install flask-restful`" to obtain the necessary Python packages. However, this resulted in a failure on the virtual environment development box due to insufficient permissions:

```
codio@change-forest:~/workspace$ pip install flask
Collecting flask
  Downloading https://files.pythonhosted.org/packages/8f/b6/b4fdcb6d01ee20f9cfe81dcf9d3cd6c2f874b996f186f1c0b898c4a59c04/Fl
ask-2.0.2-py3-none-any.whl (95kB)
    |                          | 102kB 3.9MB/s
Collecting Jinja2>=3.0 (from flask)
  Downloading https://files.pythonhosted.org/packages/94/42/d8bca8e99789bcc35dfa9b03acaa8b518720d6e060163745bc2bf2ead842/Ji
nja2-3.0.2-py3-none-any.whl (133kB)
    |                          | 143kB 9.1MB/s
Collecting click>=7.1.2 (from flask)
  Downloading https://files.pythonhosted.org/packages/48/58/c8aa6a8e62cc75f39fee1092c45d6b6ba684122697d7ce7d53f64f98a129/cl
ick-8.0.3-py3-none-any.whl (97kB)
    |                          | 102kB 41.0MB/s
Collecting Werkzeug>=2.0 (from flask)
  Downloading https://files.pythonhosted.org/packages/1e/73/51137805d1b8d97367a8a77cae4a792af14bb7ce58fbd071af294c740cf0/We
rkzeug-2.0.2-py3-none-any.whl (288kB)
    |                          | 296kB 47.3MB/s
Collecting itsdangerous>=2.0 (from flask)
  Downloading https://files.pythonhosted.org/packages/9c/96/26f935afba9cd6140216da5add223a0c465b99d0f112b68a4ca426441019/it
sdangerous-2.0.1-py3-none-any.whl
Collecting MarkupSafe>=2.0 (from Jinja2>=3.0->flask)
  Downloading https://files.pythonhosted.org/packages/08/dc/a5ed54fcc61f75343663ee702cbf69831dcec9b1a952ae21cf3d1fbc56ba/Ma
rkupSafe-2.0.1-cp36-cp36m-manylinux2010_x86_64.whl
Collecting importlib-metadata; python_version < "3.8" (from click>=7.1.2->flask)
  Downloading https://files.pythonhosted.org/packages/71/c2/cb1855f0b2a0ae9ccc9b69f150a7aebd4a8d815bd951e74621c4154c52a8/im
portlib_metadata-4.8.1-py3-none-any.whl
Collecting dataclasses; python_version < "3.7" (from Werkzeug>=2.0->flask)
  Downloading https://files.pythonhosted.org/packages/fe/ca/75fac5856ab5cfa51bbbcefa250182e50441074fdc3f803f6e76451fab43/da
taclasses-0.8-py3-none-any.whl
Collecting typing-extensions>=3.6.4; python_version < "3.8" (from importlib-metadata; python_version < "3.8"->click>=7.1.2-
>flask)
  Downloading https://files.pythonhosted.org/packages/74/60/18783336cc7fcdd95dae91d73477830aa53f5d3181ae4fe20491d7fc3199/ty
ping_extensions-3.10.0.2-py3-none-any.whl
Collecting zipp>=0.5 (from importlib-metadata; python_version < "3.8"->click>=7.1.2->flask)
  Downloading https://files.pythonhosted.org/packages/bd/df/d4a4974a3e3957fd1c1fa3082366d7fff6e428ddb55f074bf64876f8e8ad/zi
pp-3.6.0-py3-none-any.whl
Installing collected packages: MarkupSafe, Jinja2, typing-extensions, zipp, importlib-metadata, click, dataclasses, Werkzeu
g, itsdangerous, flask
  Found existing installation: MarkupSafe 1.1.1
    Uninstalling MarkupSafe-1.1.1:
ERROR: Could not install packages due to an EnvironmentError: [Errno 13] Permission denied: 'INSTALLER'
Consider using the `--user` option or check the permissions.

WARNING: You are using pip version 19.1.1, however version 21.3 is available.
You should consider upgrading via the 'pip install --upgrade pip' command.
codio@change-forest:~/workspace$
```

I then reissued the command using "`pip install flask -user`" to install packages without any root privileges or the need to run the **sudo** command.

Figure 1 Installing flask-restful module

Figure 2 Installing flask module

With the required packages installed, I then reissued the command "`python api.py`".

Figure 3 Python v2.7 failed to launch API.py

This command failed. So, I reissued the command using the command "`python --version`" to note that the version used is "2.7.17".

Next, I attempted to run the command "`python3 api.py`" and success!

Figure 4 Python 3.6 launches API.py

Q2: run the following command at the terminal prompt: "`w3m` http://127.0.0.1:5000/user/Ann". What happens when this command is run, and why?

The command failed to execute because of a missing package "w3m". To correct for this missing package, one must ensure that the apt list is up to date:

Welcome to Ubuntu 18.04.4 LTS (GNU/Linux 5.4.0-1035-aws x86_64)

```
 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

 *
 * Welcome to the Codio Terminal!
 *
 * https://docs.codio.com/project/ide/boxes/#overview
 *
 * Your Codio Box domain is: change-forest.codio.io
 *
Last login: Tue Oct 19 19:49:59 2021 from 192.168.10.156
codio@change-forest:~/workspace$ node --version
-bash: node: command not found
codio@change-forest:~/workspace$ w3m
-bash: w3m: command not found
codio@change-forest:~/workspace$ sudo apt update
Hit:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu bionic InRelease
Get:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu bionic-updates InRelease [88.7 kB]
Get:3 http://security.ubuntu.com/ubuntu bionic-security InRelease [88.7 kB]
Get:4 http://us-east-1.ec2.archive.ubuntu.com/ubuntu bionic-updates/main amd64 Packages [2,267 kB]
Get:5 http://security.ubuntu.com/ubuntu bionic-security/main amd64 Packages [1,910 kB]
Get:6 http://us-east-1.ec2.archive.ubuntu.com/ubuntu bionic-updates/main Translation-en [440 kB]
Get:7 http://us-east-1.ec2.archive.ubuntu.com/ubuntu bionic-updates/restricted amd64 Packages [508 kB]
Get:8 http://us-east-1.ec2.archive.ubuntu.com/ubuntu bionic-updates/restricted Translation-en [69.0 kB]
Get:9 http://us-east-1.ec2.archive.ubuntu.com/ubuntu bionic-updates/universe amd64 Packages [1,758 kB]
Get:10 http://us-east-1.ec2.archive.ubuntu.com/ubuntu bionic-updates/universe Translation-en [378 kB]
Get:11 http://us-east-1.ec2.archive.ubuntu.com/ubuntu bionic-updates/multiverse amd64 Packages [27.3 kB]
Get:12 http://us-east-1.ec2.archive.ubuntu.com/ubuntu bionic-updates/multiverse Translation-en [6,808 B]
Get:13 http://security.ubuntu.com/ubuntu bionic-security/main Translation-en [346 kB]
Get:14 http://security.ubuntu.com/ubuntu bionic-security/restricted amd64 Packages [474 kB]
Get:15 http://security.ubuntu.com/ubuntu bionic-security/restricted Translation-en [64.0 kB]
Get:16 http://security.ubuntu.com/ubuntu bionic-security/universe amd64 Packages [1,142 kB]
Get:17 http://security.ubuntu.com/ubuntu bionic-security/universe Translation-en [262 kB]
Get:18 http://security.ubuntu.com/ubuntu bionic-security/multiverse amd64 Packages [20.9 kB]
Get:19 http://security.ubuntu.com/ubuntu bionic-security/multiverse Translation-en [4,732 B]
Fetched 9,855 kB in 3s (3,575 kB/s)
Reading package lists... Done
Building dependency tree
Reading state information... Done
145 packages can be upgraded. Run 'apt list --upgradable' to see them.
codio@change-forest:~/workspace$
```

Figure 5 Updating apt list

Next, it is necessary to install the w3m package:

```
codio@change-forest:~/workspace$ sudo apt install w3m
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  libgclc2
Suggested packages:
  cmigemo dict dict-wn dictd libsixel-bin man-db mpv w3m-el w3m-img xdg-utils xsel
The following NEW packages will be installed:
  libgclc2 w3m
0 upgraded, 2 newly installed, 0 to remove and 145 not upgraded.
Need to get 1,006 kB of archives.
After this operation, 2,939 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://us-east-1.ec2.archive.ubuntu.com/ubuntu bionic/main amd64 libgclc2 amd64 1:7.4.2-8ubuntu1 [81.8 kB]
Get:2 http://us-east-1.ec2.archive.ubuntu.com/ubuntu bionic/main amd64 w3m amd64 0.5.3-36build1 [924 kB]
Fetched 1,006 kB in 1s (1,826 kB/s)
Selecting previously unselected package libgclc2:amd64.
(Reading database ... 33784 files and directories currently installed.)
Preparing to unpack .../libgclc2_1%3a7.4.2-8ubuntu1_amd64.deb ...
Unpacking libgclc2:amd64 (1:7.4.2-8ubuntu1) ...
Selecting previously unselected package w3m.
Preparing to unpack .../w3m_0.5.3-36build1_amd64.deb ...
Unpacking w3m (0.5.3-36build1) ...
Setting up libgclc2:amd64 (1:7.4.2-8ubuntu1) ...
Setting up w3m (0.5.3-36build1) ...
Processing triggers for libc-bin (2.27-3ubuntu1) ...
Processing triggers for mime-support (3.60ubuntu1) ...
codio@change-forest:~/workspace$
```

Figure 6 Installing 23m package

Now with the required package installed, it's time to run "`python3 api.py`". This starts up a new instance of the flask web server which we can now connect to at port 5000.

After executing the command "`w3m http://127.0.0.1:5000/user/Ann`", the user is presented with a screen:
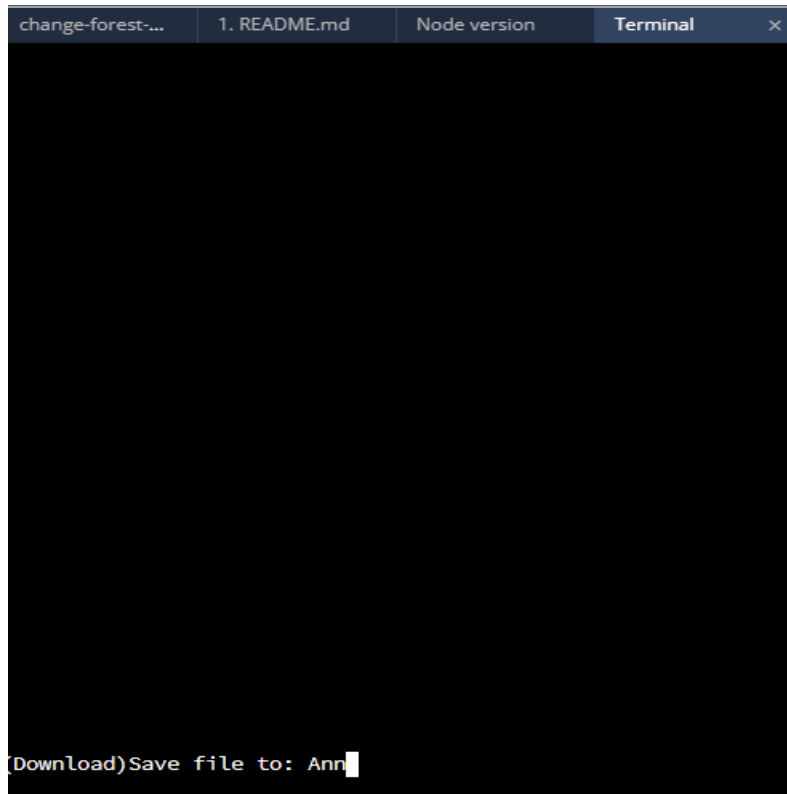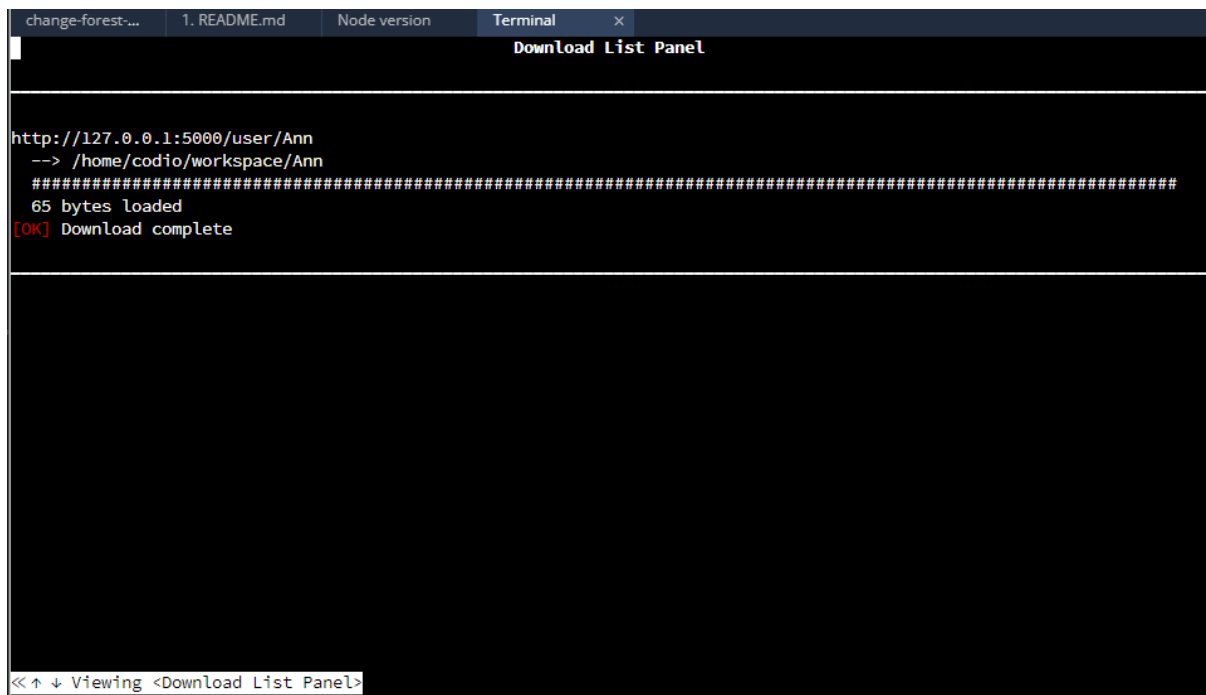
And corresponding, on the flask web server, we can observe that a user has connected to the specified endpoint:

Figure 7 User connected to flask web server

The user is then presented with an interactive screen where they can use the arrow keys to navigate around the text-based screen.

The w3m command is an open-source text-based web browser which runs within a terminal window. Since it is a text-based browser, all requests received from a server, are processed as local files. In the request above, the result of calling into `http://127.0.0.1:5000/user/Ann` is stored in a local file called "Ann".

To look at the response data received from the REST endpoint, we simply open the content of the "Ann" file on disk:

```
codio@change-forest:~/workspace$ ll
total 3276
drwxr-xr-x 1 codio codio     442 Oct 19 19:54  ./
drwxr-xr-x 1 codio codio     144 Oct 19 19:53  ../
-rw-rw-r-- 1 codio codio      65 Oct 19 20:01  Ann
-rw-r--r-- 1 codio codio    1908 Oct 19 19:24  api.py
-rw-r--r-- 1 codio codio     246 Sep 30  2020  .codio
-rw-r--r-- 1 codio codio       0 Sep 30  2020  .codio-jupyter
-rw-r--r-- 1 codio codio    6576 Sep 28 00:09  CommandLine.ipynb
-rw-r--r-- 1 codio codio      72 Sep 30  2020  'Empty Notebook.ipynb'
-rw-r--r-- 1 codio codio    3806 Oct 19 16:17  File_Encryption_RSA.ipynb
-rw-r--r-- 1 codio codio    4874 Oct 19 19:22  Flask_API.ipynb
-rw-r--r-- 1 codio codio      46 Sep 30  2020  .gitignore
drwxr-xr-x 1 codio codio      68 Sep  5 22:32  img/
drwxr-xr-x 1 codio codio     386 Oct 19 19:23  .ipynb_checkpoints/
-rw-r--r-- 1 codio codio   39225 Oct 19 19:49  .nbgrader.log
-rw-r--r-- 1 codio codio     944 Sep 30  2020  README.md
-rw-r--r-- 1 codio codio    1249 Sep 30  2020  .settings
-rw-r--r-- 1 codio codio 3254884 Sep  6 00:31  Towers_of_Hanoi.ipynb
-rw-r--r-- 1 codio codio    1507 Sep  6 01:35  'UK Postcodes.ipynb'
-rw-r--r-- 1 codio codio      72 Oct 19 19:23  Untitled.ipynb
codio@change-forest:~/workspace$ cat Ann
{
    "name": "Ann",
    "age": 32,
    "occupation": "Doctor"
}
codio@change-forest:~/workspace$ 
```

Figure 8 REST response in JSON format

Here we can see that the response from the specified webserver is a JSON object containing the properties "name", "age" and "occupation".

Q3: run the following command at the terminal prompt: "w3m http://127.0.0.1:5000/user/Adam". What happens when this command is run, and why?

Figure 9 Execute command to load resource at "/Adam"

When we "cat" into the output of the request to the resource specified by "/user/Adam", the result is:

This error message implies that the specified resource was not found at the address specified. More specifically, consulting the API.py code file, we can see that the following users would be located:

```
users = [
    {
        "name": "James",
        "age": 30,
        "occupation": "Network Engineer"
    },
    {
        "name": "Ann",
        "age": 32,
        "occupation": "Doctor"
    },
    {
        "name": "Jason",
        "age": 22,
        "occupation": "Web Developer"
    }
```

```
]
```

Given that the `GET` request looks as follows:

```python
def get(self, name):
    for user in users:
        if(name == user["name"]):
            return user, 200
    return "User not found", 404
```

It is understandable that a user like "Adam" could not be found.

Create a new user (POST)

However, the API does expose a `POST` method which we can leverage to create new users.

So, we achieve that by defining a file with the data needed for the POST call:

1. Create data file with `POST` arguments

```
Vim NewUser

age=509&occupation=Beekeeper

:w

:q
```

2. Call w3m with `POST` data

```
W3m -post NewUser http://127.0.0.1:5000/user/Adam
```

3. Inspect the result of the call (it should be an HTTP 201 status code)

Figure 10 POST call using w3m succeeded

Update an existing user (PUT)

Although the API does expose a PUT operation, the documentation for w3m
(http://w3m.sourceforge.net/MANUAL) indicates that it only supports the HTTP verbs
GET and POST. Therefore, one would have to use other tools such as Postman or
Insomnia to action these verbs.

Removing a user (DELETE)

Although the API does expose a DELETE operation, the documentation for w3m
(http://w3m.sourceforge.net/MANUAL) indicates that it only supports the HTTP verbs
GET and POST. Therefore, one would have to use other tools such as Postman or
Insomnia to action these verbs.

Q4: what capability is achieved by the flask library?

The flask library acts like a mini web server that exposes one or more REST-based endpoints over a given network address and port. It supports both standard HTTP connections and HTTPS connections when using a command like

```
app.run(ssl_context='adhoc', debug=True)
```

According to (https://www.fullstackpython.com/flask.html), the flask web framework is considered a better alternative to the Django framework because flask is more "explicit" and "easy to get started with as a beginner" due to the lack of excessive boilerplate code to start a web server.

Flask uses the Wekzeug Web Server Gateway Interface (WSGI) toolkit to act as an interface between web servers and web applications. While jinja2 is used as a web template engine (https://pythonbasics.org/what-is-flask-python/)