CS571- Week 10 Homework 1: Machine Learning on Kubernetes

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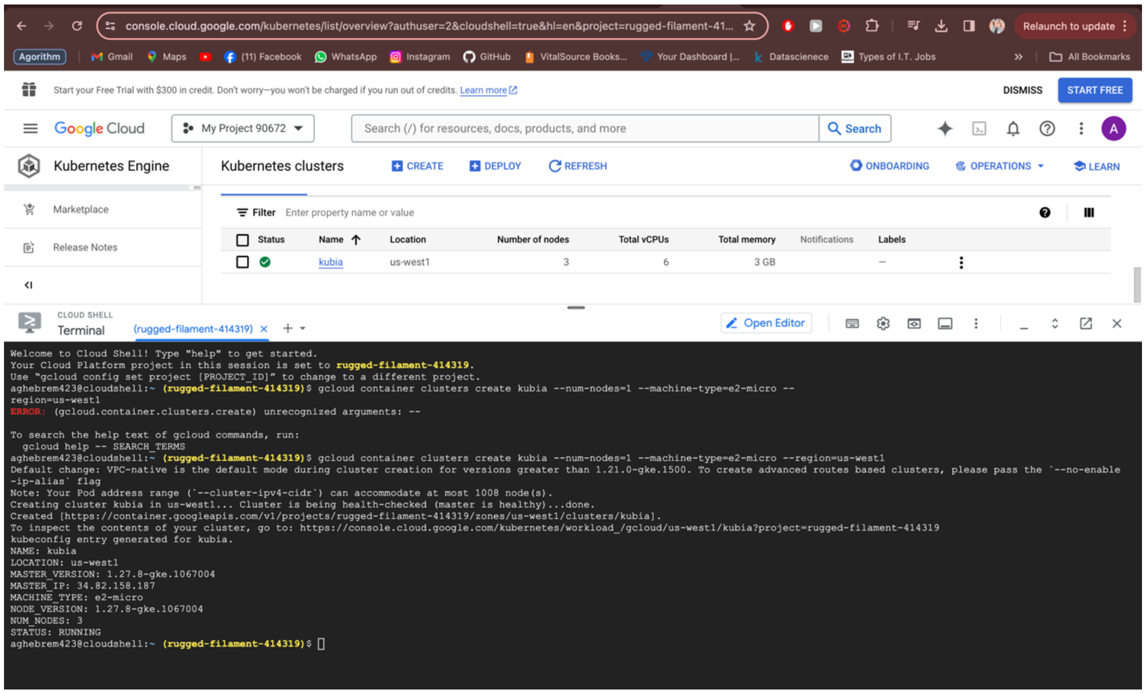
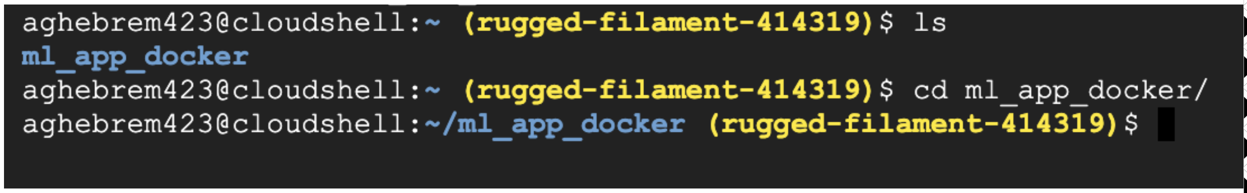
1. **Set up a functional Kubernetes cluster even if the cluster has only one node.**


console.cloud.google.com/kubernetes/list/overview?authuser=2&cloudshell=true&hl=en&project=rugged-filament-41...
Relaunch to update
Start your Free Trial with $300 in credit. Don't worry—you won't be charged if you run out of credits. Learn more
DISMISS
START FREE
Google Cloud
My Project 90672
Search (/) for resources, docs, products, and more
Search
Kubernetes Engine
Kubernetes clusters
CREATE
DEPLOY
REFRESH
ONBOARDING
OPERATIONS
LEARN
Marketplace
Release Notes
Filter Enter property name or value
CLOUD SHELL
Terminal
(rugged-filament-414319)
Open Editor

Status	Name	Location	Number of nodes	Total vCPUs	Total memory	Notifications	Labels
✓	kubia	us-west1	3	6	3 GB		–

```
Welcome to Cloud Shell! Type "help" to get started.
Your Cloud Platform project in this session is set to rugged-filament-414319.
Use “gcloud config set project [PROJECT_ID]” to change to a different project.
aghebrem423@cloudshell:~ (rugged-filament-414319)$ gcloud container clusters create kubia --num-nodes=1 --machine-type=e2-micro --
region=us-west1
ERROR: (gcloud.container.clusters.create) unrecognized arguments: --

To search the help text of gcloud commands, run:
  gcloud help -- SEARCH_TERMS
aghebrem423@cloudshell:~ (rugged-filament-414319)$ gcloud container clusters create kubia --num-nodes=1 --machine-type=e2-micro --region=us-west1
Default change: VPC-native is the default mode during cluster creation for versions greater than 1.21.0-gke.1500. To create advanced routes based clusters, please pass the `--no-enable
-ip-alias` flag
Note: Your Pod address range (`--cluster-ipv4-cidr`) can accommodate at most 1008 node(s).
Creating cluster kubia in us-west1... Cluster is being health-checked (master is healthy)...done.
Created [https://container.googleapis.com/v1/projects/rugged-filament-414319/zones/us-west1/clusters/kubia].
To inspect the contents of your cluster, go to: https://console.cloud.google.com/kubernetes/workload_/gcloud/us-west1/kubia?project=rugged-filament-414319
kubeconfig entry generated for kubia.
NAME: kubia
LOCATION: us-west1
MASTER_VERSION: 1.27.8-gke.1067004
MASTER_IP: 34.82.158.187
MACHINE_TYPE: e2-micro
NODE_VERSION: 1.27.8-gke.1067004
NUM_NODES: 3
STATUS: RUNNING
aghebrem423@cloudshell:~ (rugged-filament-414319)$
```

2. **Create a ml_app_docker directory using mkdir**

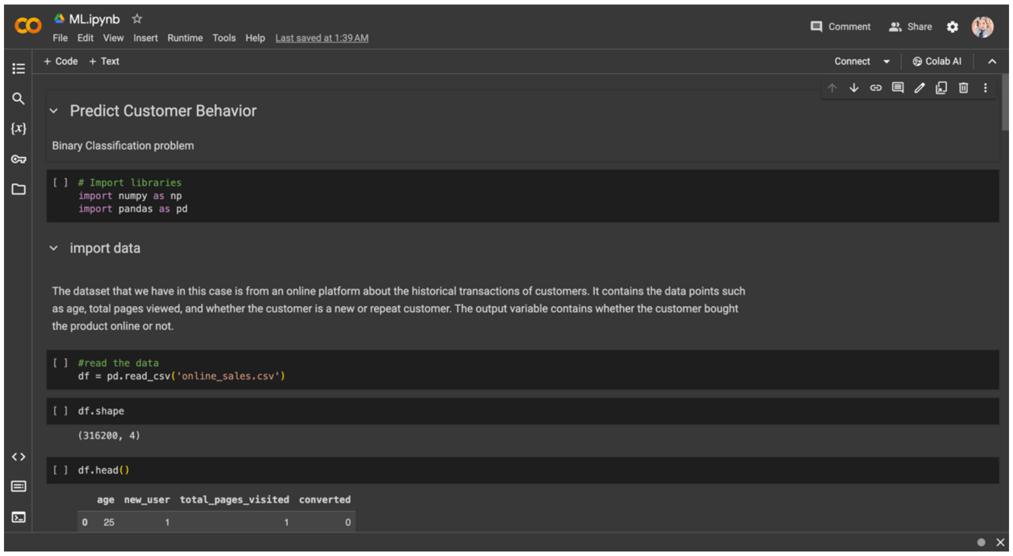


```
aghebrem423@cloudshell:~ (rugged-filament-414319)$ ls
ml_app_docker
aghebrem423@cloudshell:~ (rugged-filament-414319)$ cd ml_app_docker/
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$
```

3. **In google Collab - Machine Learning - Python (ML.ipynb, logreg.pkl)**

   Step 1: Training the Machine Learning Model (source)

   Step 2: Exporting the Trained Model (source)


ML.ipynb
File Edit View Insert Runtime Tools Help Last saved at 1:39 AM
Comment Share
+ Code + Text
Connect
Colab AI

Predict Customer Behavior

Binary Classification problem

```
[ ] # Import libraries
    import numpy as np
    import pandas as pd
```

import data

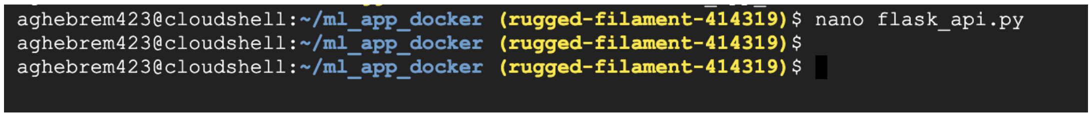
The dataset that we have in this case is from an online platform about the historical transactions of customers. It contains the data points such as age, total pages viewed, and whether the customer is a new or repeat customer. The output variable contains whether the customer bought the product online or not.

```
[ ] #read the data
    df = pd.read_csv('online_sales.csv')
```

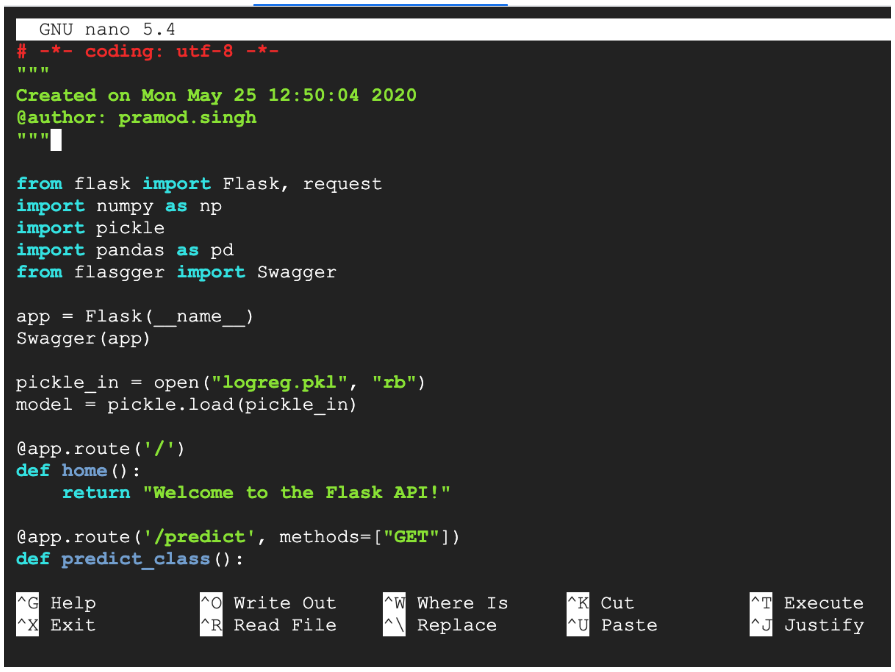
```
[ ] df.shape

    (316200, 4)
```

```
[ ] df.head()

       age  new_user  total_pages_visited  converted
    0   25         1                    1          0
```

4. **Unser Interface - Python (Flask / Swagger) - Creating a Flask App Including UI file flask_api.py.**

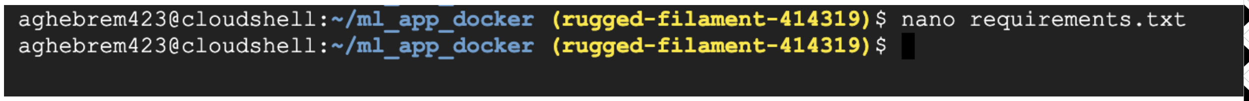


```
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$ nano flask_api.py
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$
```

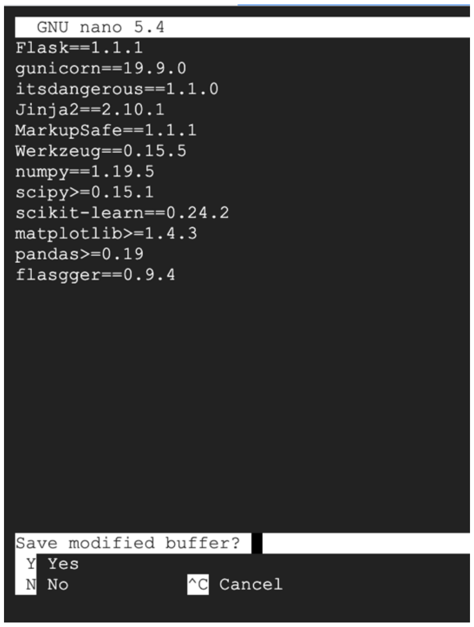


```
  GNU nano 5.4
# -*- coding: utf-8 -*-
"""
Created on Mon May 25 12:50:04 2020
@author: pramod.singh
"""

from flask import Flask, request
import numpy as np
import pickle
import pandas as pd
from flasgger import Swagger

app = Flask(__name__)
Swagger(app)

pickle_in = open("logreg.pkl", "rb")
model = pickle.load(pickle_in)

@app.route('/')
def home():
    return "Welcome to the Flask API!"

@app.route('/predict', methods=["GET"])
def predict_class():

^G Help          ^O Write Out     ^W Where Is      ^K Cut           ^T Execute
^X Exit          ^R Read File     ^\ Replace       ^U Paste         ^J Justify
```

5. **Create the requirments.txt file.**

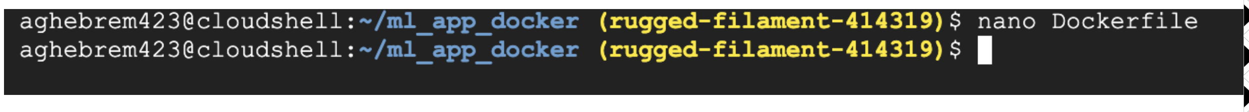


```
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$ nano requirements.txt
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$
```

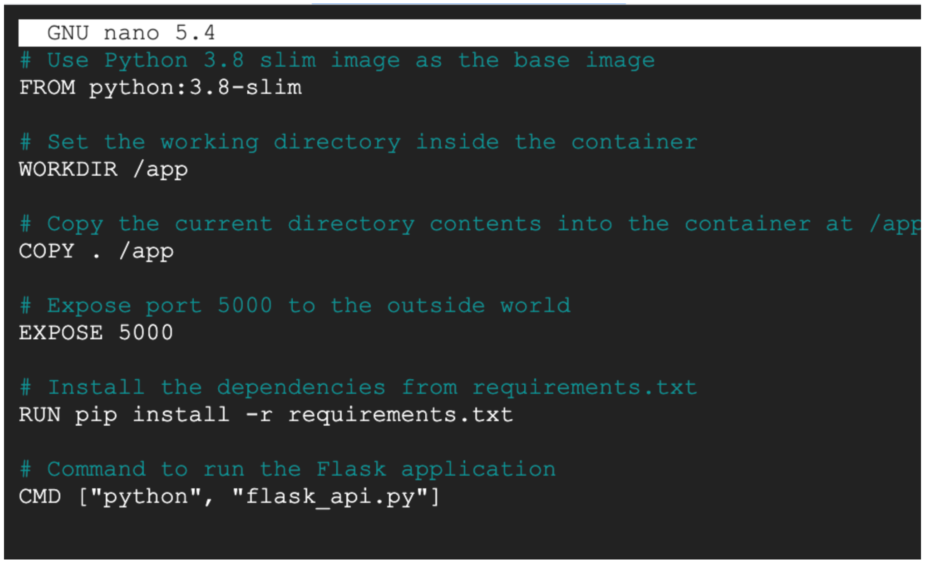


```
  GNU nano 5.4
Flask==1.1.1
gunicorn==19.9.0
itsdangerous==1.1.0
Jinja2==2.10.1
MarkupSafe==1.1.1
Werkzeug==0.15.5
numpy==1.19.5
scipy>=0.15.1
scikit-learn==0.24.2
matplotlib>=1.4.3
pandas>=0.19
flasgger==0.9.4








Save modified buffer?
 Y Yes
 N No           ^C Cancel
```

6. **Create the Dockerfile.**

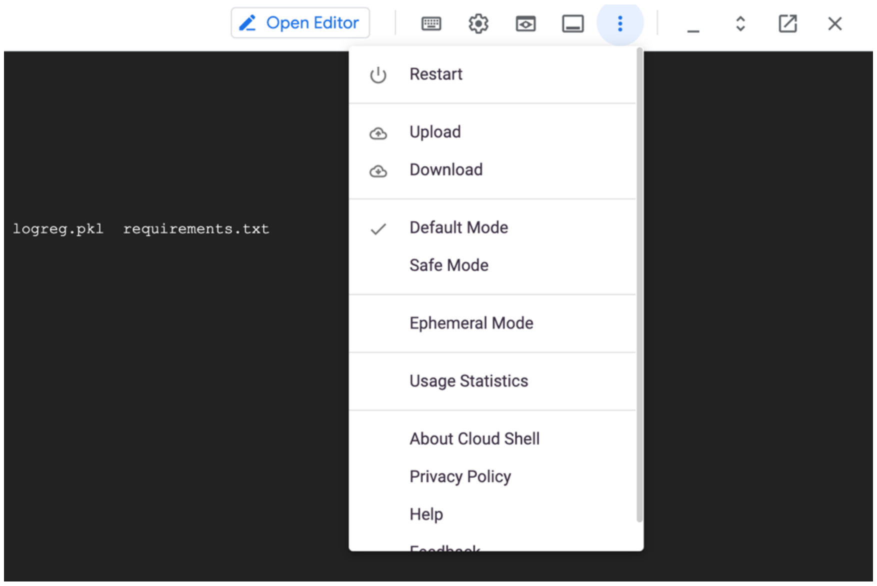


```
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$ nano Dockerfile
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$
```

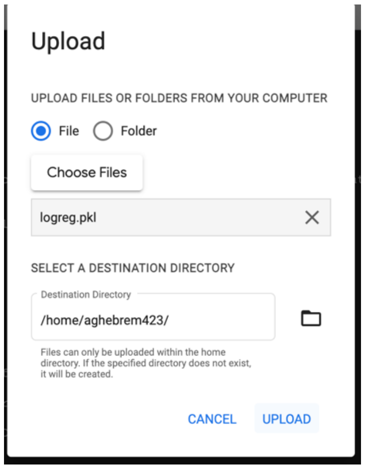


```
  GNU nano 5.4
# Use Python 3.8 slim image as the base image
FROM python:3.8-slim

# Set the working directory inside the container
WORKDIR /app

# Copy the current directory contents into the container at /app
COPY . /app

# Expose port 5000 to the outside world
EXPOSE 5000

# Install the dependencies from requirements.txt
RUN pip install -r requirements.txt

# Command to run the Flask application
CMD ["python", "flask_api.py"]
```

7. **Going to the right of the file upload logreg.pkl pickle file we get from ML.ipynb model from your local machine as it should exist I the same directory.**



```
logreg.pkl  requirements.txt
```


Upload
UPLOAD FILES OR FOLDERS FROM YOUR COMPUTER
File
Folder
Choose Files
SELECT A DESTINATION DIRECTORY
CANCEL
UPLOAD

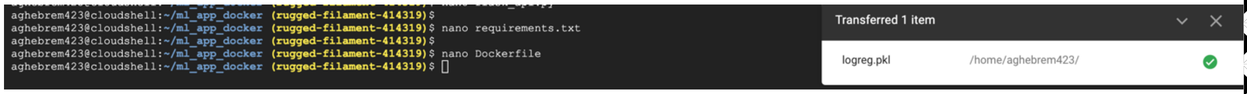
[✓ File] Folder

logreg.pkl

Destination Directory: /home/aghebrem423/

Files can only be uploaded within the home directory. If the specified directory does not exist, it will be created.

- **Will see this message showing that it is uploaded successfully.**

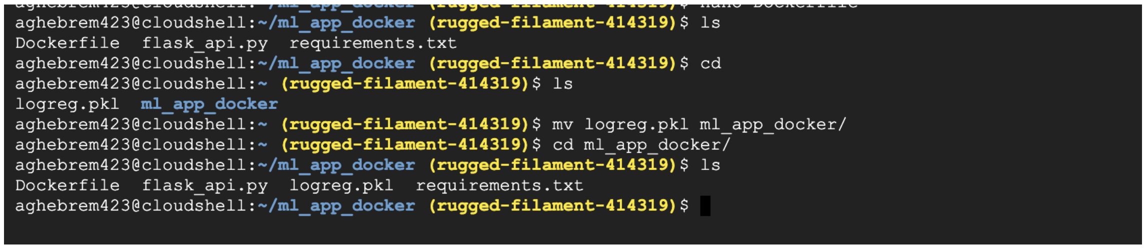


```
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$ nano requirements.txt
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$ nano Dockerfile
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$
```

Transferred 1 item

logreg.pkl /home/aghebrem423/ ✓

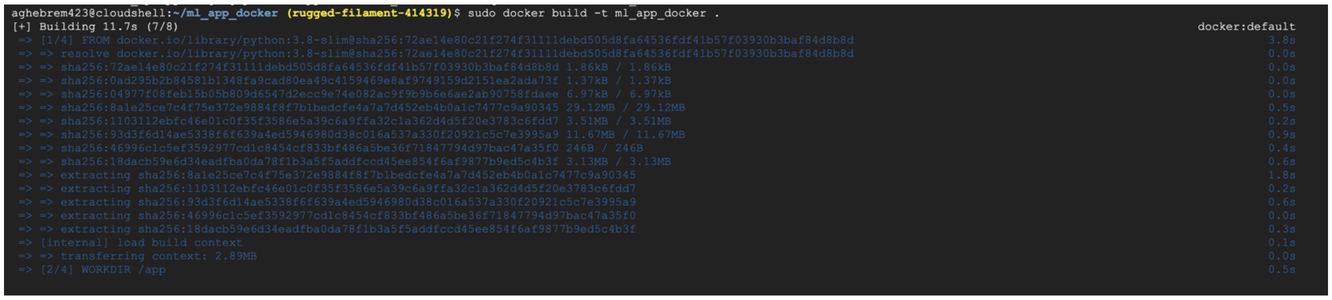
8. **Check if it is in the ml_app_docker directory, if not move it as shown.**



```
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$ ls
Dockerfile  flask_api.py  requirements.txt
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$ cd
aghebrem423@cloudshell:~ (rugged-filament-414319)$ ls
logreg.pkl  ml_app_docker
aghebrem423@cloudshell:~ (rugged-filament-414319)$ mv logreg.pkl ml_app_docker/
aghebrem423@cloudshell:~ (rugged-filament-414319)$ cd ml_app_docker/
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$ ls
Dockerfile  flask_api.py  logreg.pkl  requirements.txt
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$
```

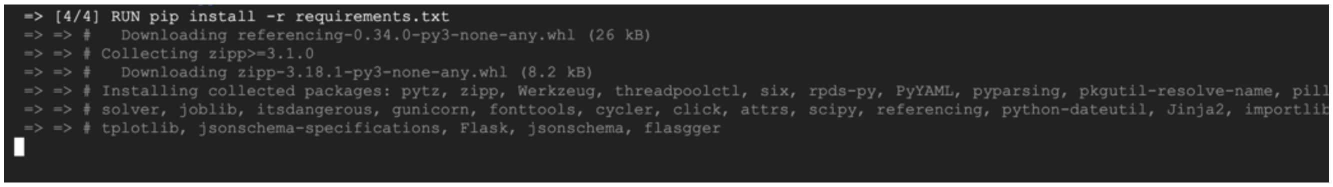
9. **Build the docker image, In this step of the process, we build the Docker custom image from the Dockerfile created in the previous step and run the container.**

sudo docker build -t ml_app_docker .



```
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$ sudo docker build -t ml_app_docker .
[+] Building 11.7s (7/8)                                                                                              docker:default
 => [1/4] FROM docker.io/library/python:3.8-slim@sha256:72ae14e80c21f274f31111debd505d8fa64536fdf41b57f03930b3baf84d8b8d           3.8s
 => => resolve docker.io/library/python:3.8-slim@sha256:72ae14e80c21f274f31111debd505d8fa64536fdf41b57f03930b3baf84d8b8d           0.0s
 => => sha256:72ae14e80c21f274f31111debd505d8fa64536fdf41b57f03930b3baf84d8b8d 1.86kB / 1.86kB                                     0.0s
 => => sha256:0ad295b2b84581b1348fa9cad80ea49c4159469e8af9749159d2151ea2ada73f 1.37kB / 1.37kB                                     0.0s
 => => sha256:04977f08feb15b05b809d6547d2ecc9e74e082ac9f9b9b6e6ae2ab90758fdaee 6.97kB / 6.97kB                                     0.0s
 => => sha256:8a1e25ce7c4f75e372e9884f8f7b1bedcfe4a7a7d452eb4b0a1c7477c9a90345 29.12MB / 29.12MB                                   0.5s
 => => sha256:1103112ebfc46e01c0f35f3586e5a39c6a9ffa32c1a362d4d5f20e3783c6fdd7 3.51MB / 3.51MB                                     0.2s
 => => sha256:93d3f6d14ae5338f6f639a4ed5946980d38c016a537a330f20921c5c7e3995a9 11.67MB / 11.67MB                                   0.9s
 => => sha256:46996c1c5ef3592977cd1c8454cf833bf486a5be36f71847794d97bac47a35f0 246B / 246B                                         0.4s
 => => sha256:18dacb59e6d34eadfba0da78f1b3a5f5addfccd45ee854f6af9877b9ed5c4b3f 3.13MB / 3.13MB                                     0.6s
 => => extracting sha256:8a1e25ce7c4f75e372e9884f8f7b1bedcfe4a7a7d452eb4b0a1c7477c9a90345                                          1.8s
 => => extracting sha256:1103112ebfc46e01c0f35f3586e5a39c6a9ffa32c1a362d4d5f20e3783c6fdd7                                          0.2s
 => => extracting sha256:93d3f6d14ae5338f6f639a4ed5946980d38c016a537a330f20921c5c7e3995a9                                          0.6s
 => => extracting sha256:46996c1c5ef3592977cd1c8454cf833bf486a5be36f71847794d97bac47a35f0                                          0.0s
 => => extracting sha256:18dacb59e6d34eadfba0da78f1b3a5f5addfccd45ee854f6af9877b9ed5c4b3f                                          0.3s
 => [internal] load build context                                                                                                  0.1s
 => => transferring context: 2.89MB                                                                                                0.0s
 => [2/4] WORKDIR /app                                                                                                             0.5s
```

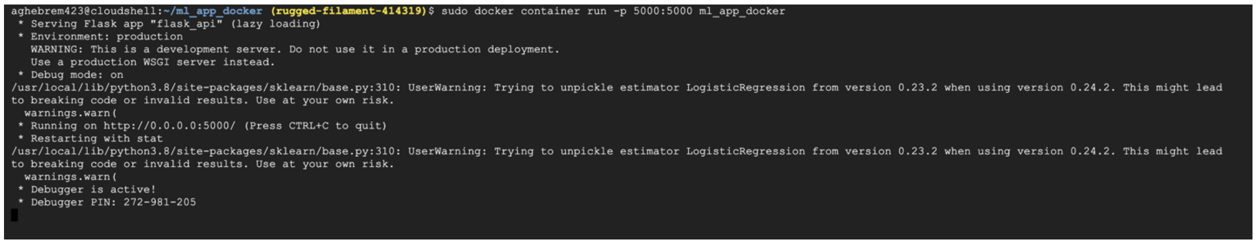
The requirements.txt file contains all the dependencies and libraries.



```
 => [4/4] RUN pip install -r requirements.txt
 => => #   Downloading referencing-0.34.0-py3-none-any.whl (26 kB)
 => => # Collecting zipp>=3.1.0
 => => #   Downloading zipp-3.18.1-py3-none-any.whl (8.2 kB)
 => => # Installing collected packages: pytz, zipp, Werkzeug, threadpoolctl, six, rpds-py, PyYAML, pyparsing, pkgutil-resolve-name, pill
 => => # solver, joblib, itsdangerous, gunicorn, fonttools, cycler, click, attrs, scipy, referencing, python-dateutil, Jinja2, importlib
 => => # tplotlib, jsonschema-specifications, Flask, jsonschema, flasgger
```

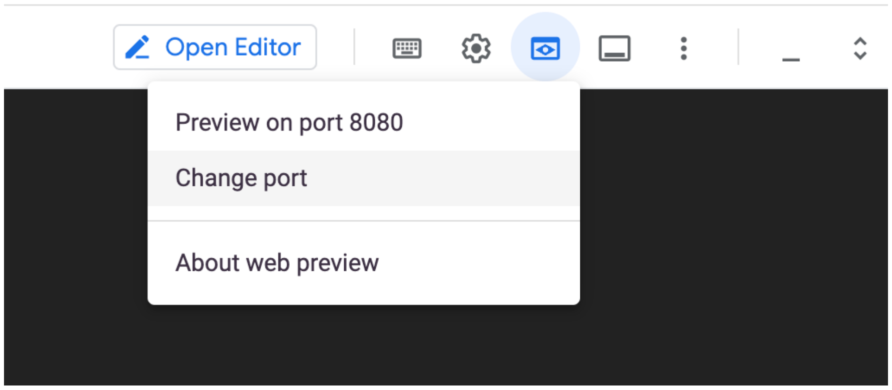
10. **Run the docker image, The key thing to remember here is to do the explicit port mapping to route the requests from the host to the Docker port.**

sudo docker container run -p 5000:5000 ml_app_docker

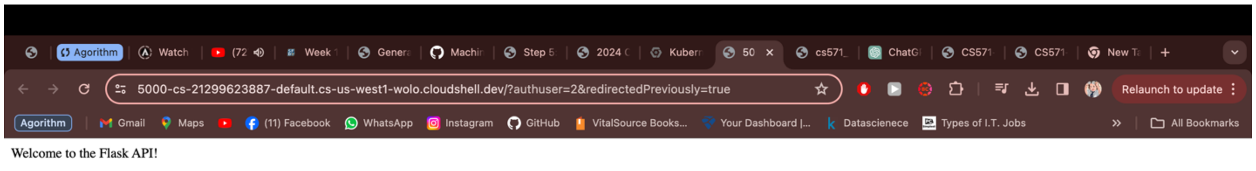


```
aghebrem423@cloudshell:~/ml_app_docker (rugged-filament-414319)$ sudo docker container run -p 5000:5000 ml_app_docker
 * Serving Flask app "flask_api" (lazy loading)
 * Environment: production
   WARNING: This is a development server. Do not use it in a production deployment.
   Use a production WSGI server instead.
 * Debug mode: on
/usr/local/lib/python3.8/site-packages/sklearn/base.py:310: UserWarning: Trying to unpickle estimator LogisticRegression from version 0.23.2 when using version 0.24.2. This might lead
to breaking code or invalid results. Use at your own risk.
  warnings.warn(
 * Running on http://0.0.0.0:5000/ (Press CTRL+C to quit)
 * Restarting with stat
/usr/local/lib/python3.8/site-packages/sklearn/base.py:310: UserWarning: Trying to unpickle estimator LogisticRegression from version 0.23.2 when using version 0.24.2. This might lead
to breaking code or invalid results. Use at your own risk.
  warnings.warn(
 * Debugger is active!
 * Debugger PIN: 272-981-205
```

11. **On the upper right of cloud shell change the port to 5000 and see the preview.**

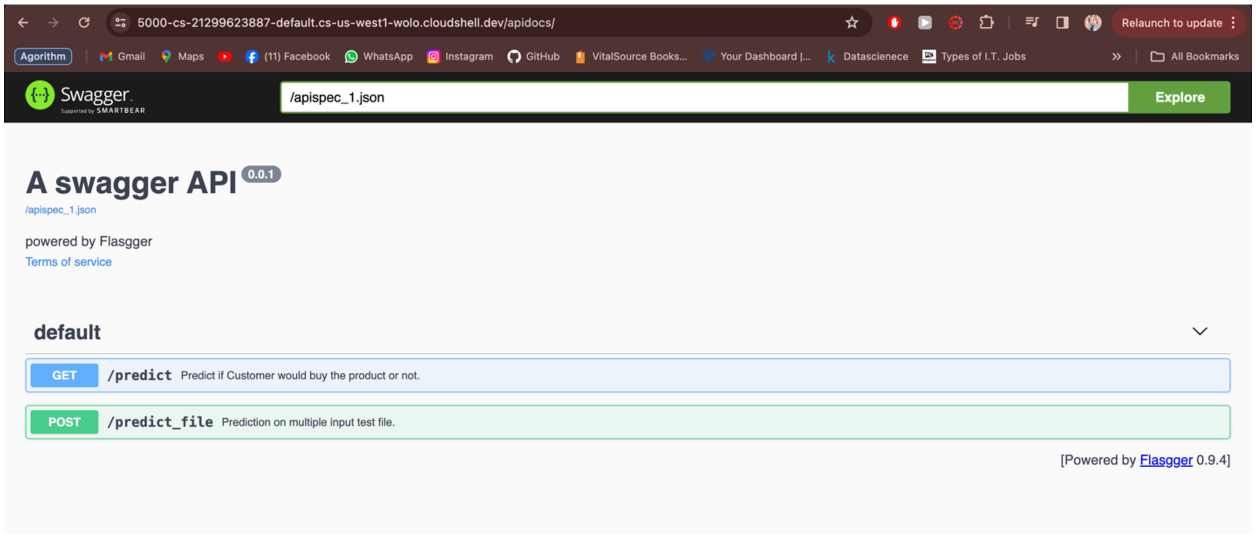


12. Now you are directed to the web preview.


5000-cs-21299623887-default.cs-us-west1-wolo.cloudshell.dev/?authuser=2&redirectedPreviously=true
Relaunch to update

Welcome to the Flask API!

13. To go to the swagger UI after dev/ , add apidocs/


5000-cs-21299623887-default.cs-us-west1-wolo.cloudshell.dev/apidocs/
Swagger
/apispec_1.json
Explore

A swagger API 0.0.1

/apispec_1.json

powered by Flasgger

Terms of service

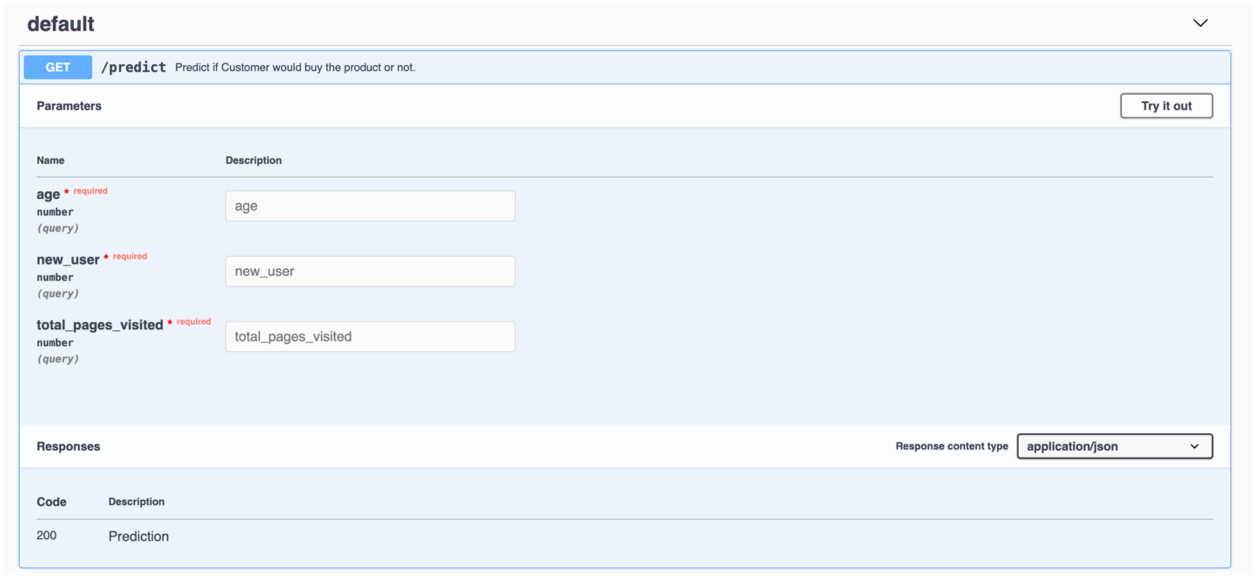
default

GET /predict Predict if Customer would buy the product or not.

POST /predict_file Prediction on multiple input test file.

[Powered by Flasgger 0.9.4]

14. Once we click the Get tab, we can see the options to provide input parameters on which the prediction needs to be made. The top-right corner contains a "Try it out" tab that allows us to fill in the values for the input parameters.



default

GET /predict Predict if Customer would buy the product or not.

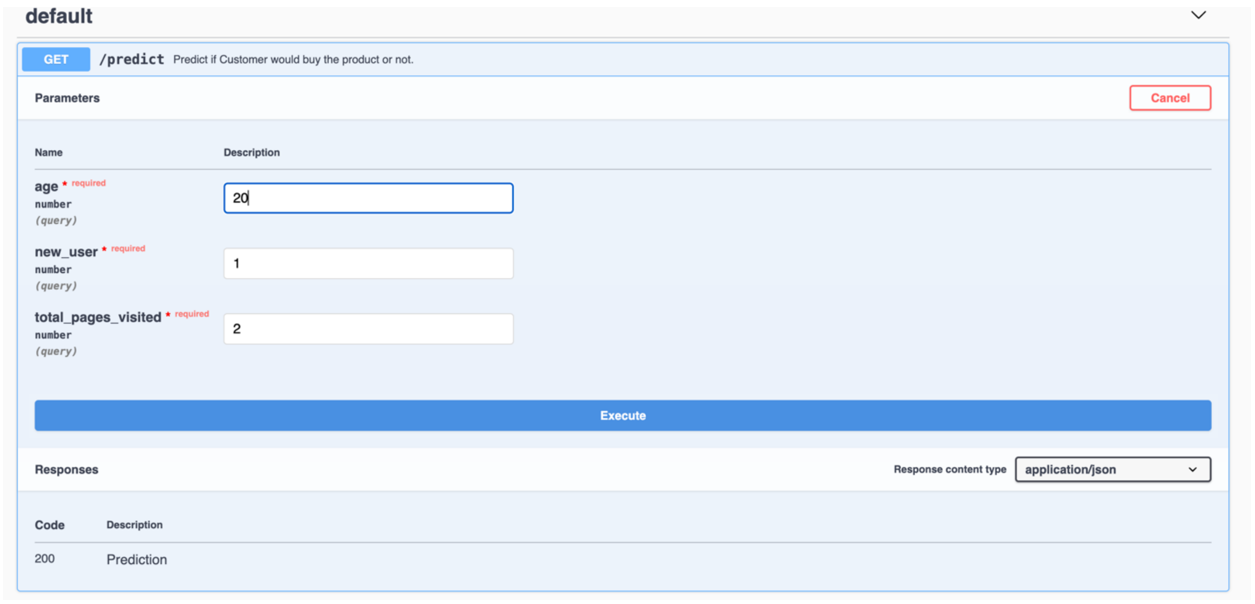
Parameters

Name	Description
age * required number (query)	age
new_user * required number (query)	new_user
total_pages_visited * required number (query)	total_pages_visited

Responses

Code	Description
200	Prediction

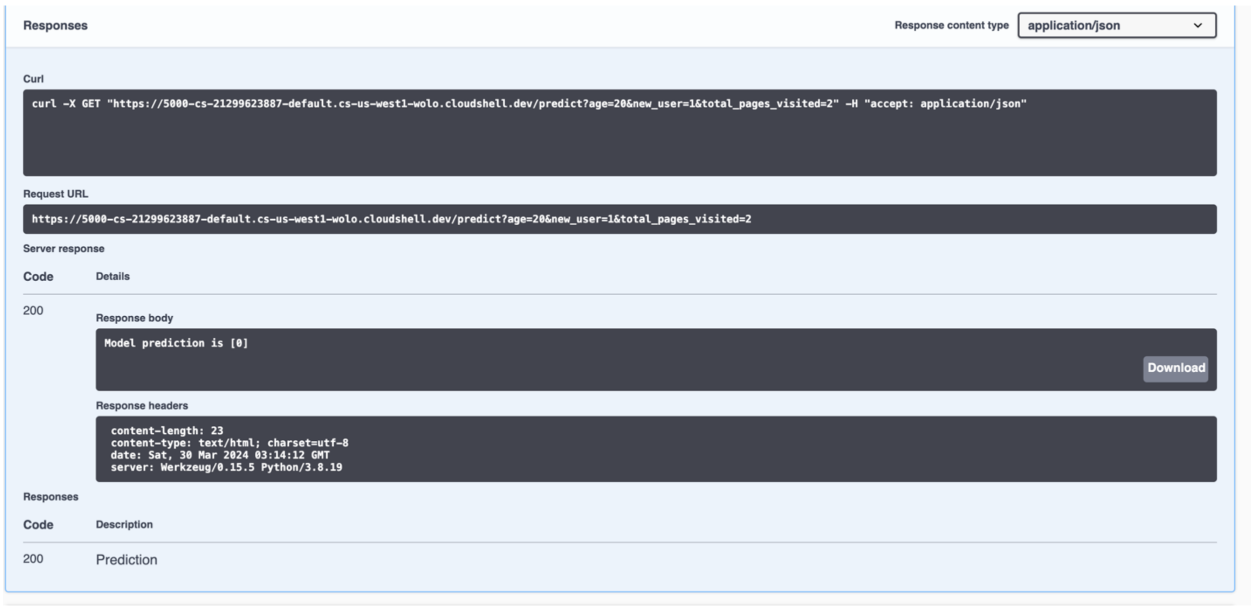
15. **We can fill in the values for all three parameters for a test customer, and click the Execute tab.**
    Upon the execution call, the request goes to the app, and predictions are made by the model.
    The result of the model prediction is displayed in the Prediction section of the page.



Name	Description
age * required number (query)	20
new_user * required number (query)	1
total_pages_visited * required number (query)	2

Code	Description
200	Prediction

When we hit execute the response/model prediction we will get is as follows.



Curl

```
curl -X GET "https://5000-cs-21299623887-default.cs-us-west1-wolo.cloudshell.dev/predict?age=20&new_user=1&total_pages_visited=2" -H "accept: application/json"
```

Request URL

```
https://5000-cs-21299623887-default.cs-us-west1-wolo.cloudshell.dev/predict?age=20&new_user=1&total_pages_visited=2
```

Server response

Code: 200

Response body

```
Model prediction is [0]
```

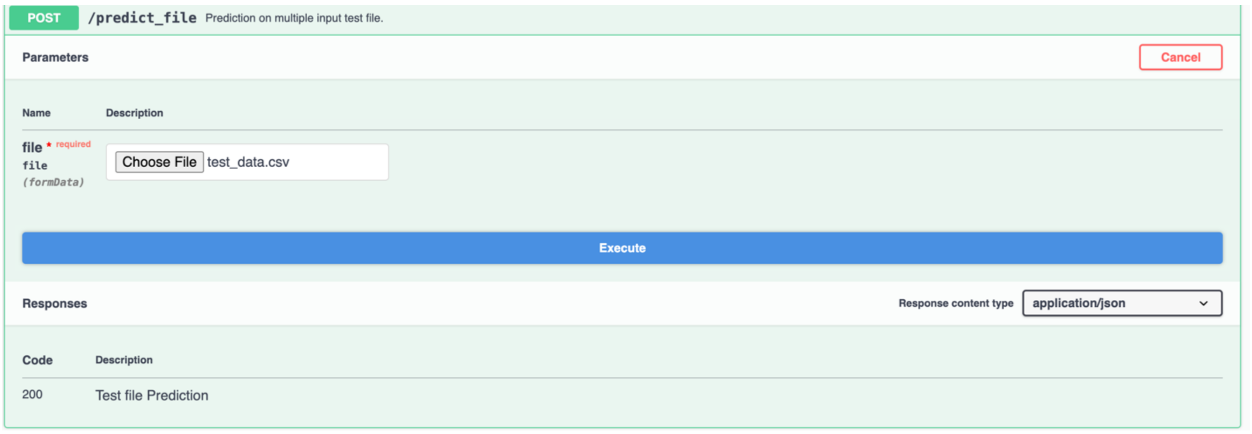
Response headers

```
content-length: 23
content-type: text/html; charset=utf-8
date: Sat, 30 Mar 2024 03:14:12 GMT
server: Werkzeug/0.15.5 Python/3.8.19
```

Responses

Code	Description
200	Prediction

16. **The next prediction that can be done is for a group of customers (test data) via a post request.**
We need to upload the test data file containing the same parameters in a similar order.
The model would make the prediction, and the results would be displayed upon execute.



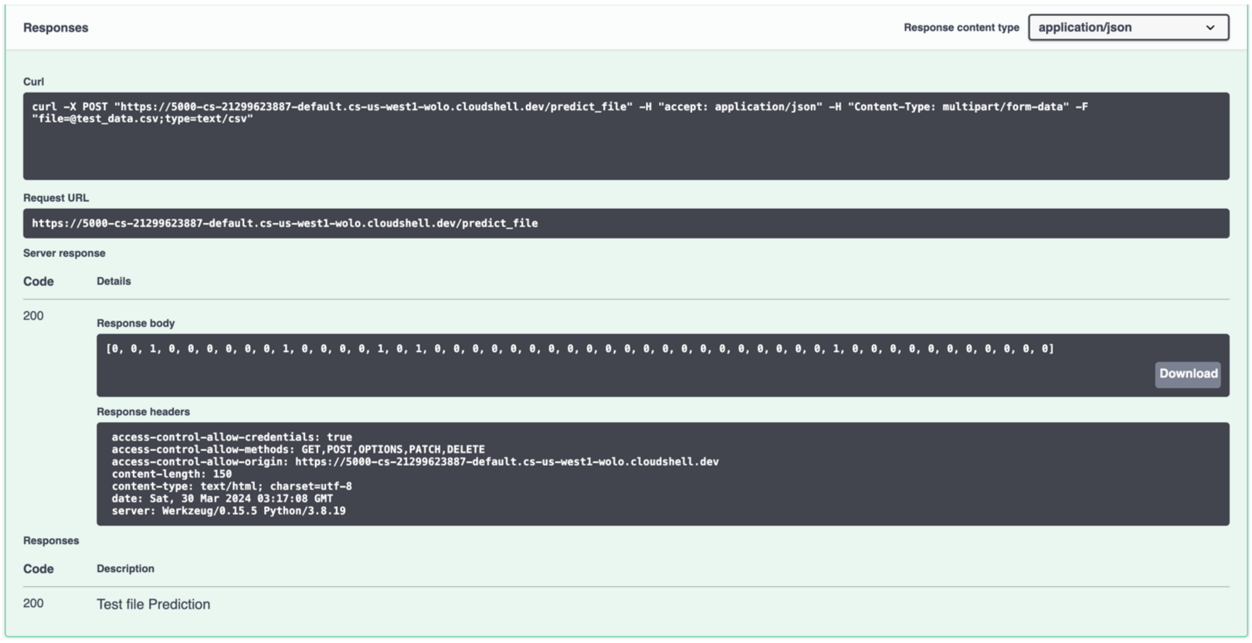
POST `/predict_file` Prediction on multiple input test file.

Parameters

Name	Description
file * required file (formData)	Choose File test_data.csv

Responses — Response content type: application/json

Code	Description
200	Test file Prediction



Responses — Response content type: application/json

Curl

```
curl -X POST "https://5000-cs-21299623887-default.cs-us-west1-wolo.cloudshell.dev/predict_file" -H "accept: application/json" -H "Content-Type: multipart/form-data" -F
"file=@test_data.csv;type=text/csv"
```

Request URL

```
https://5000-cs-21299623887-default.cs-us-west1-wolo.cloudshell.dev/predict_file
```

Server response

Code: 200

Response body

```
[0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
```

Response headers

```
access-control-allow-credentials: true
access-control-allow-methods: GET,POST,OPTIONS,PATCH,DELETE
access-control-allow-origin: https://5000-cs-21299623887-default.cs-us-west1-wolo.cloudshell.dev
content-length: 150
content-type: text/html; charset=utf-8
date: Sat, 30 Mar 2024 03:17:08 GMT
server: Werkzeug/0.15.5 Python/3.8.19
```

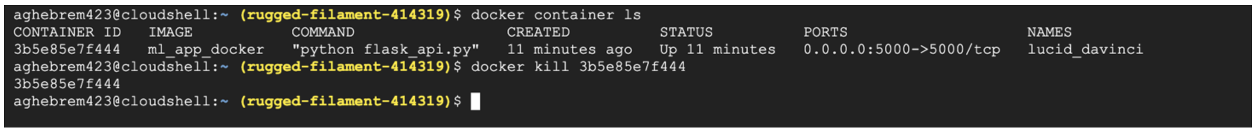
Responses

Code	Description
200	Test file Prediction

17. **The last step left after running the application is to stop the running container. This can be done using the docker stop or kill command on the running container.**
    We can see the list of running containers using the docker ps command and can select the running container ID to stop it.

docker ps

docker kill <Container_ID>



```
aghebrem423@cloudshell:~ (rugged-filament-414319)$ docker container ls
CONTAINER ID   IMAGE           COMMAND                  CREATED          STATUS          PORTS                    NAMES
3b5e85e7f444   ml_app_docker   "python flask_api.py"   11 minutes ago   Up 11 minutes   0.0.0.0:5000->5000/tcp   lucid_davinci
aghebrem423@cloudshell:~ (rugged-filament-414319)$ docker kill 3b5e85e7f444
3b5e85e7f444
aghebrem423@cloudshell:~ (rugged-filament-414319)$ 
```