CS501- Week 10 Homework 1: Machine Learning on Kubernetes

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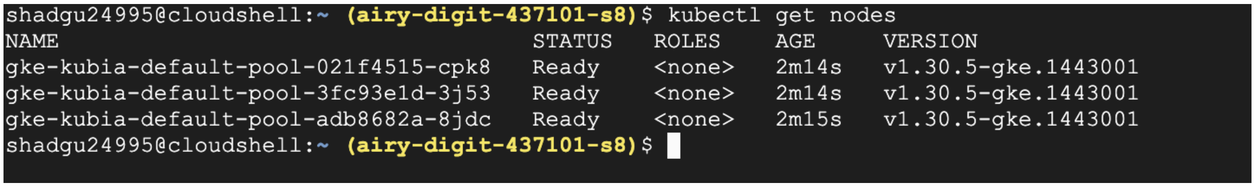
https://hc.labnet.sfbu.edu/~henry/sfbu/course/cloud_computing/genai/slide/exercise_kubernetes. html

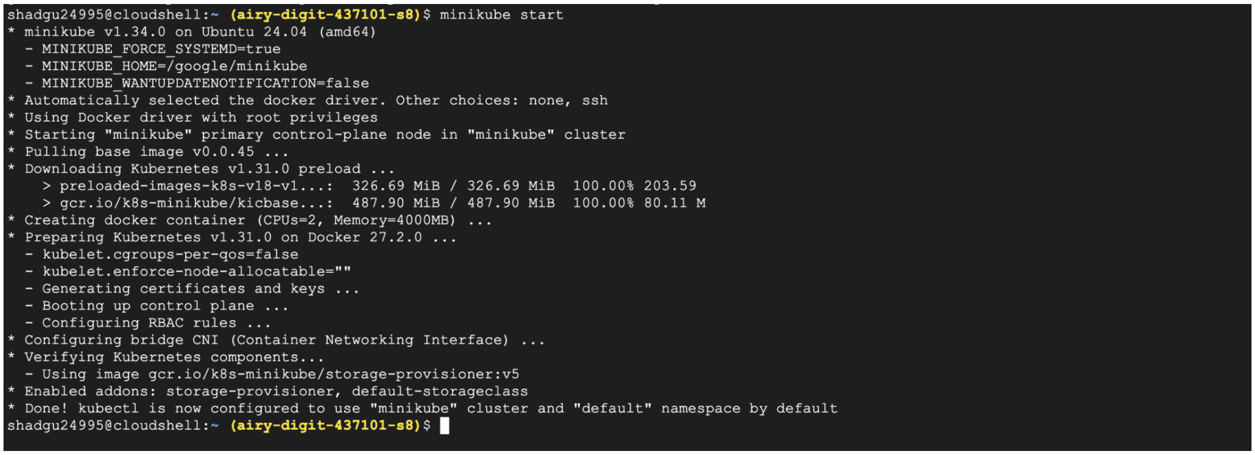
Q2 ===> Machine Learning on Kubernetes Machine Learning on Kubernetes

Creating and uploading necessary files in GCP- Cloud Shell Terminal



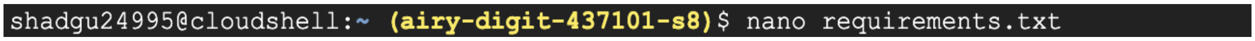
```
shadgu24995@cloudshell:~ (airy-digit-437101-s8)$ kubectl get nodes
NAME                                       STATUS   ROLES    AGE    VERSION
gke-kubia-default-pool-021f4515-cpk8   Ready    <none>   2m14s   v1.30.5-gke.1443001
gke-kubia-default-pool-3fc93e1d-3j53   Ready    <none>   2m14s   v1.30.5-gke.1443001
gke-kubia-default-pool-adb8682a-8jdc   Ready    <none>   2m15s   v1.30.5-gke.1443001
shadgu24995@cloudshell:~ (airy-digit-437101-s8)$
```

1. Start minikube in Google Cloud Platform



```
shadgu24995@cloudshell:~ (airy-digit-437101-s8)$ minikube start
* minikube v1.34.0 on Ubuntu 24.04 (amd64)
  - MINIKUBE_FORCE_SYSTEMD=true
  - MINIKUBE_HOME=/google/minikube
  - MINIKUBE_WANTUPDATENOTIFICATION=false
* Automatically selected the docker driver. Other choices: none, ssh
* Using Docker driver with root privileges
* Starting "minikube" primary control-plane node in "minikube" cluster
* Pulling base image v0.0.45 ...
* Downloading Kubernetes v1.31.0 preload ...
    > preloaded-images-k8s-v18-v1...:  326.69 MiB / 326.69 MiB  100.00% 203.59
    > gcr.io/k8s-minikube/kicbase...:  487.90 MiB / 487.90 MiB  100.00% 80.11 M
* Creating docker container (CPUs=2, Memory=4000MB) ...
* Preparing Kubernetes v1.31.0 on Docker 27.2.0 ...
  - kubelet.cgroups-per-qos=false
  - kubelet.enforce-node-allocatable=""
  - Generating certificates and keys ...
  - Booting up control plane ...
  - Configuring RBAC rules ...
* Configuring bridge CNI (Container Networking Interface) ...
* Verifying Kubernetes components...
  - Using image gcr.io/k8s-minikube/storage-provisioner:v5
* Enabled addons: storage-provisioner, default-storageclass
* Done! kubectl is now configured to use "minikube" cluster and "default" namespace by default
shadgu24995@cloudshell:~ (airy-digit-437101-s8)$
```

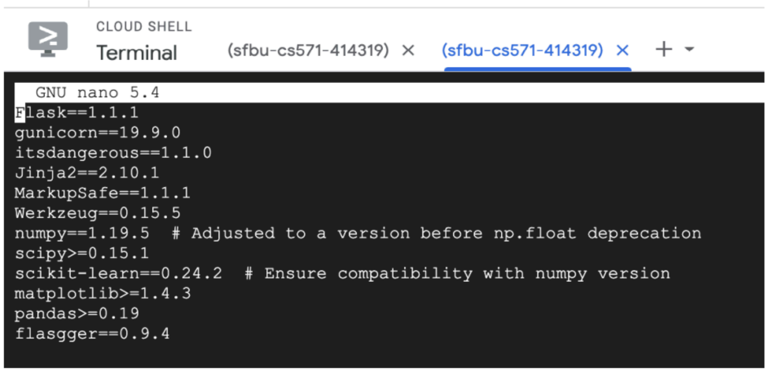
2. Create requirements.txt file using the following command - nano requirements.txt



```
shadgu24995@cloudshell:~ (airy-digit-437101-s8)$ nano requirements.txt
```

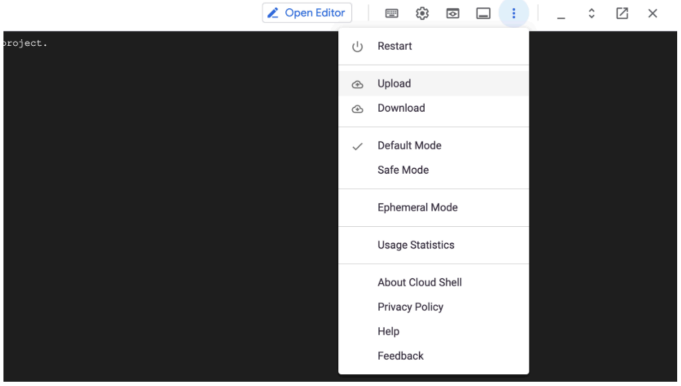
Then enter the following contents

```
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  # Adjusted to a version before np.float deprecation
scipy>=0.15.1
scikit-learn==0.24.2  # Ensure compatibility with numpy version
matplotlib>=1.4.3
pandas>=0.19
flasgger==0.9.4
```



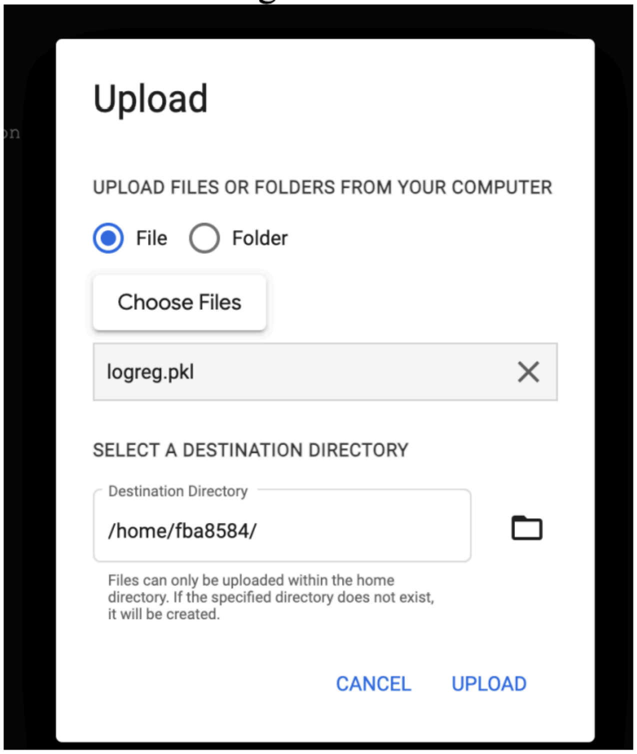
```
  GNU nano 5.4
Flask==1.1.1
gunicorn==19.9.0
itsdangerous==1.1.0
Jinja2==2.10.1
MarkupSafe==1.1.1
Werkzeug==0.15.5
numpy==1.19.5  # Adjusted to a version before np.float deprecation
scipy>=0.15.1
scikit-learn==0.24.2  # Ensure compatibility with numpy version
matplotlib>=1.4.3
pandas>=0.19
flasgger==0.9.4
```

Upload logreg.pkl file by clicking the three dots in the top-right part of the Cloud Shell Terminal and then choose upload



```
roject.
```

Then upload the logreg.pkl file as following



Upload

UPLOAD FILES OR FOLDERS FROM YOUR COMPUTER

● File ○ Folder

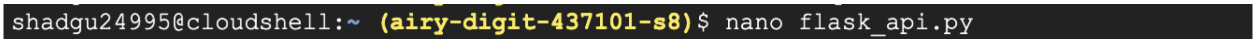
logreg.pkl

SELECT A DESTINATION DIRECTORY

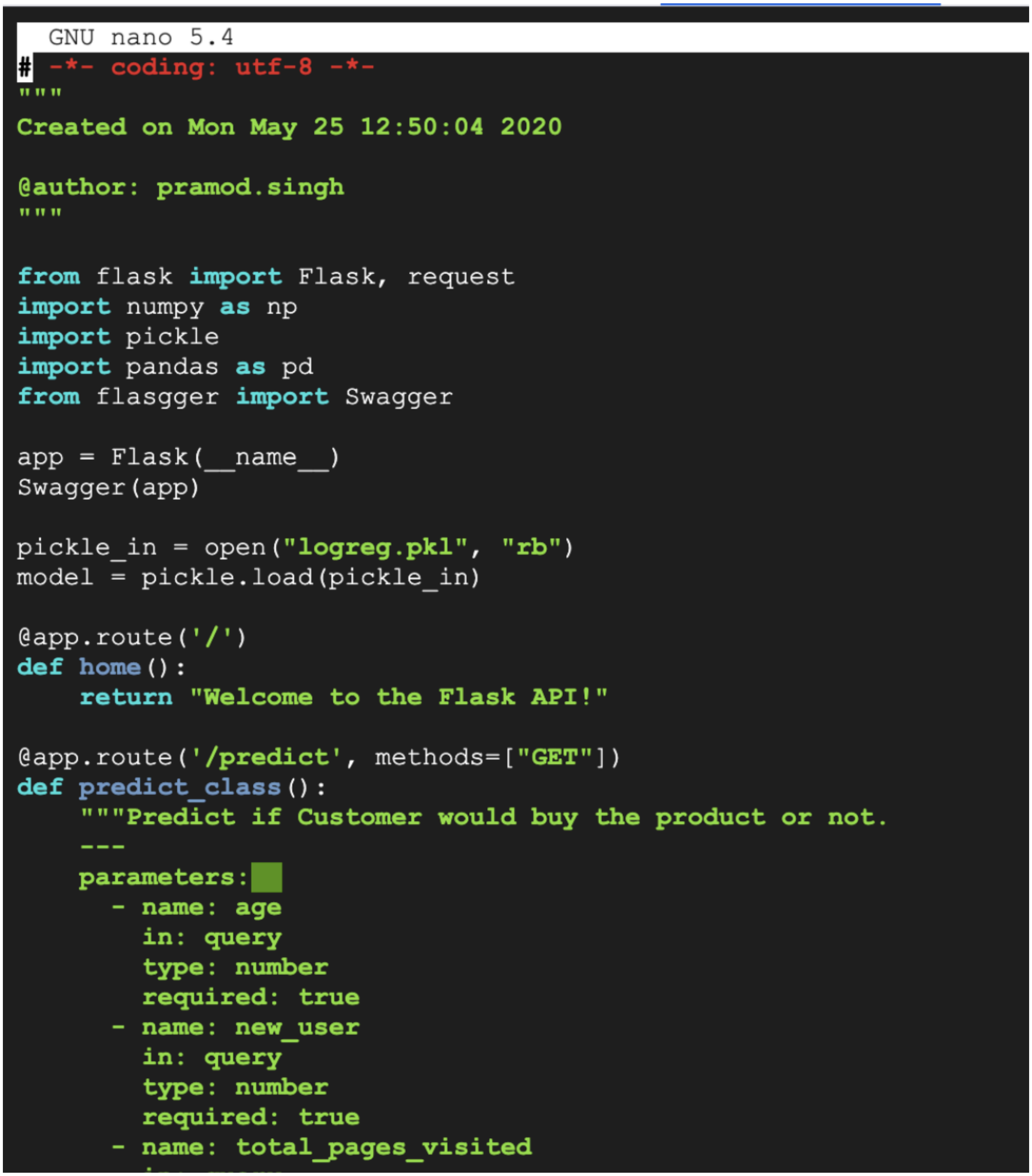
Destination Directory: /home/fba8584/

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

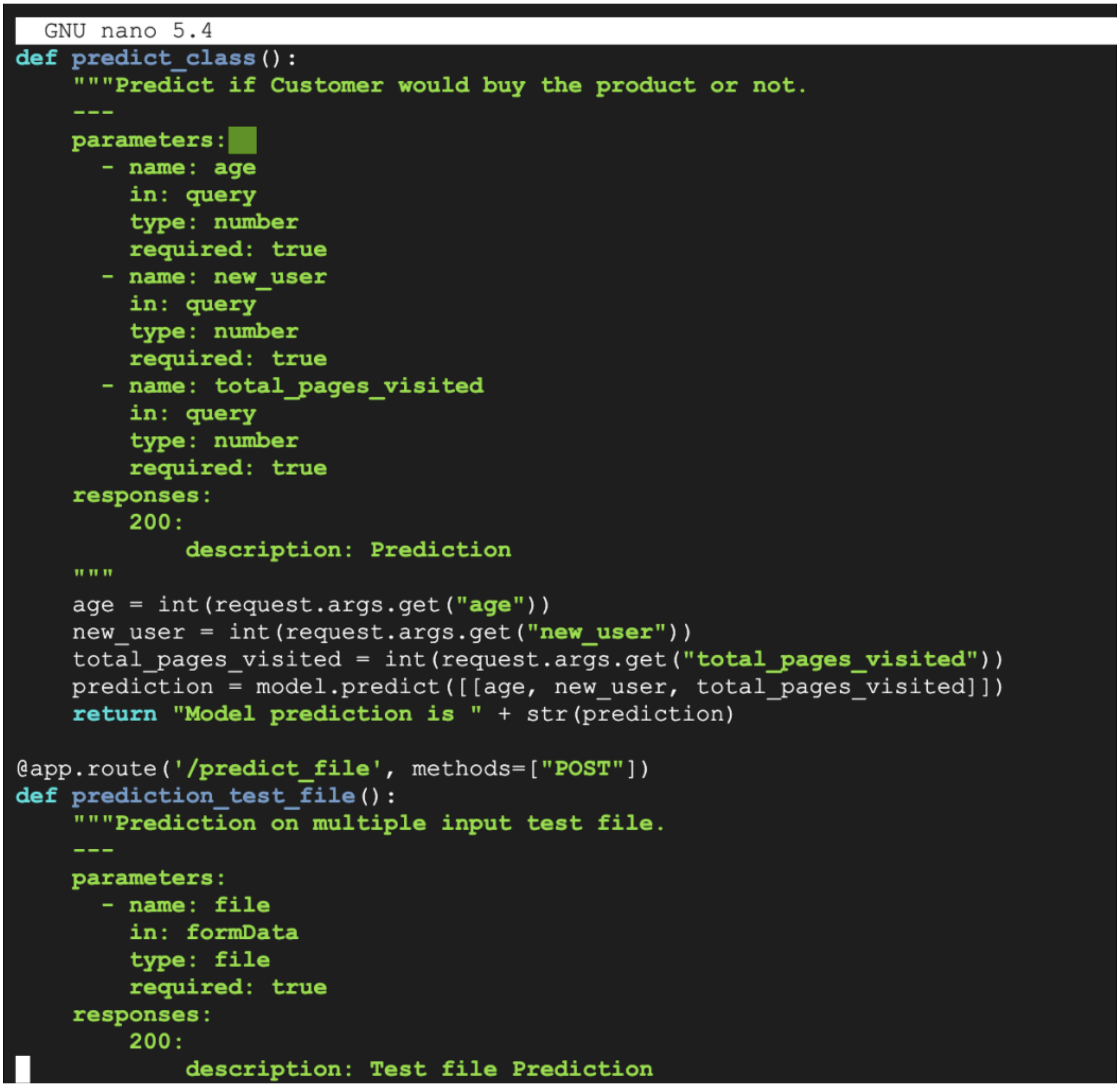
4. Create flask_api.py file using the command
   - *nano flask_api.py*



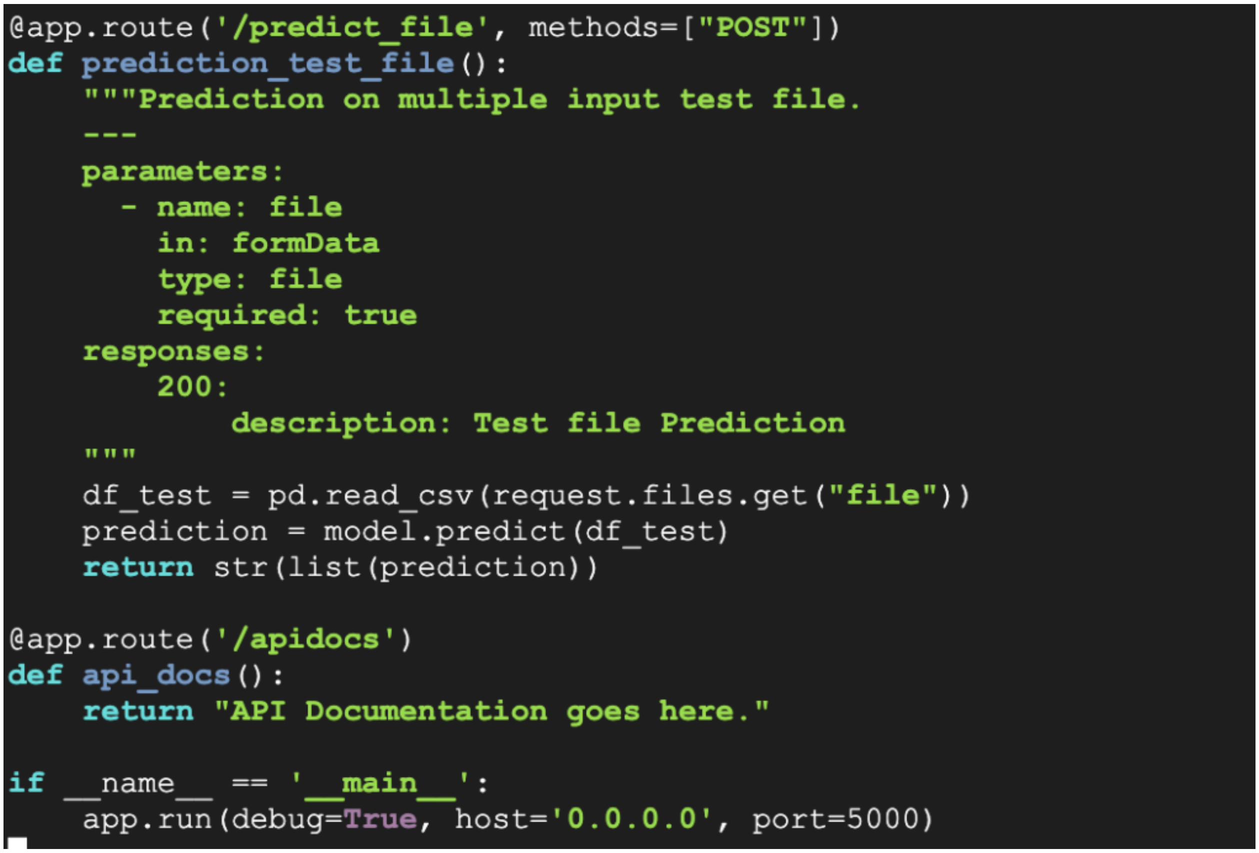
```
shadgu24995@cloudshell:~ (airy-digit-437101-s8)$ nano flask_api.py
```



```
  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():
    """Predict if Customer would buy the product or not.
    ---
    parameters:
      - name: age
        in: query
        type: number
        required: true
      - name: new_user
        in: query
        type: number
        required: true
      - name: total_pages_visited
```

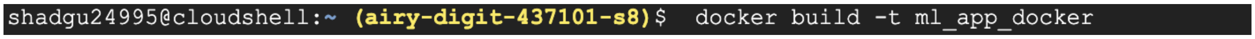


```
def predict_class():
    """Predict if Customer would buy the product or not.
    ---
    parameters:
      - name: age
        in: query
        type: number
        required: true
      - name: new_user
        in: query
        type: number
        required: true
      - name: total_pages_visited
        in: query
        type: number
        required: true
    responses:
        200:
            description: Prediction
    """
    age = int(request.args.get("age"))
    new_user = int(request.args.get("new_user"))
    total_pages_visited = int(request.args.get("total_pages_visited"))
    prediction = model.predict([[age, new_user, total_pages_visited]])
    return "Model prediction is " + str(prediction)

@app.route('/predict_file', methods=["POST"])
def prediction_test_file():
    """Prediction on multiple input test file.
    ---
    parameters:
      - name: file
        in: formData
        type: file
        required: true
    responses:
        200:
            description: Test file Prediction
```



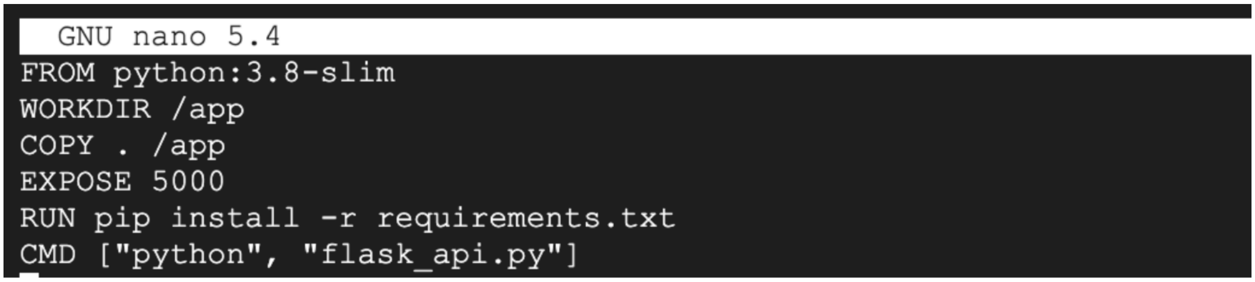
```
@app.route('/predict_file', methods=["POST"])
def prediction_test_file():
    """Prediction on multiple input test file.
    ---
    parameters:
      - name: file
        in: formData
        type: file
        required: true
    responses:
        200:
            description: Test file Prediction
    """
    df_test = pd.read_csv(request.files.get("file"))
    prediction = model.predict(df_test)
    return str(list(prediction))

@app.route('/apidocs')
def api_docs():
    return "API Documentation goes here."

if __name__ == '__main__':
    app.run(debug=True, host='0.0.0.0', port=5000)
```

Step 4: Dockerfile 1. Create Dockerfile using command - nano Dockerfile



```
shadgu24995@cloudshell:~ (airy-digit-437101-s8)$  docker build -t ml_app_docker
```

Then enter the following content FROM python:3.8-slim WORKDIR /app COPY . /app EXPOSE 5000 RUN pip install -r requirements.txt CMD ["python", "flask_api.py"]

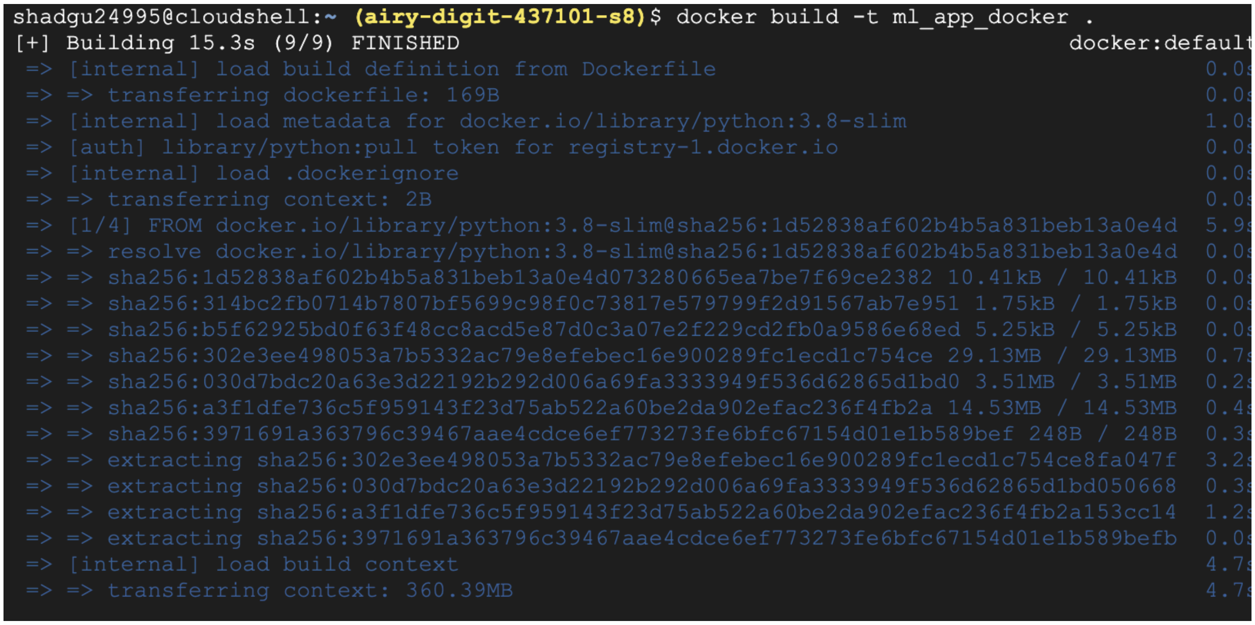


```
  GNU nano 5.4
FROM python:3.8-slim
WORKDIR /app
COPY . /app
EXPOSE 5000
RUN pip install -r requirements.txt
CMD ["python", "flask_api.py"]
```

1. 'FROM python:3.8-slim'
 • This line sets the base image for the Docker image you are creating. It tells Docker to start with the 'python:3.8- slim' image, which is an official Python image with Python 3.8 installed on it. The 'slim' version is a smaller version of the image that has fewer packages pre-installed, making the image size smaller.
2. 'WORKDIR /app' • This instruction sets the working directory within the Docker container to */app*. All subsequent commands will be executed in this directory within the container.

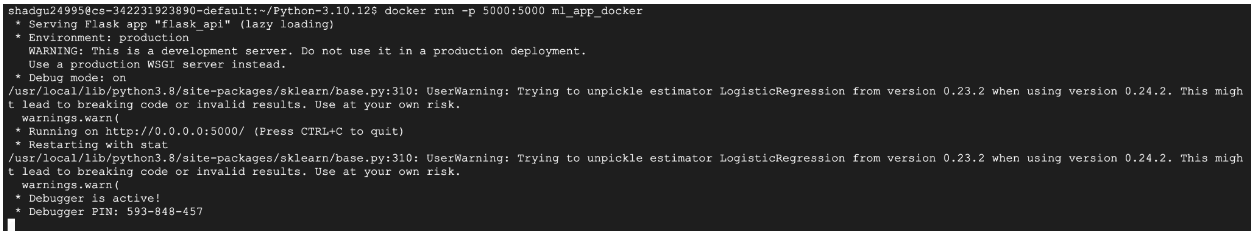
3. 'COPY . /app' • This line copies everything from the current directory (on the host machine where you're running the Docker build command, indicated by the first**) into the */app directory inside the Docker image (the second ' /app*).
4. 'EXPOSE 5000' • The 'EXPOSE' instruction informs Docker that the container listens on the specified network port at runtime. In this case, it tells Docker that the container will listen on port 5000. It's worth noting that this does not actually publish the port—it serves as documentation and is used by the 'docker run -p' command to map the container port to a port on the Docker host.
5. 'RUN pip install -r requirements.txt* • This command tells Docker to run pip install' inside the container, which will install the Python dependencies listed in the requirements.tt file. These dependencies are necessary for the Flask application to run correctly.
6. CMD ["python", "flask_api.py"]' • This is the command that will be executed by default when the Docker container starts. In this case, it's telling Docker to run 'flask_api.py using Python. This is the Flask application you want to run inside the container.

Step 5: Running the Docker Container 1. To build the docker image use the command - sudo docker build -t ml_app_docker .



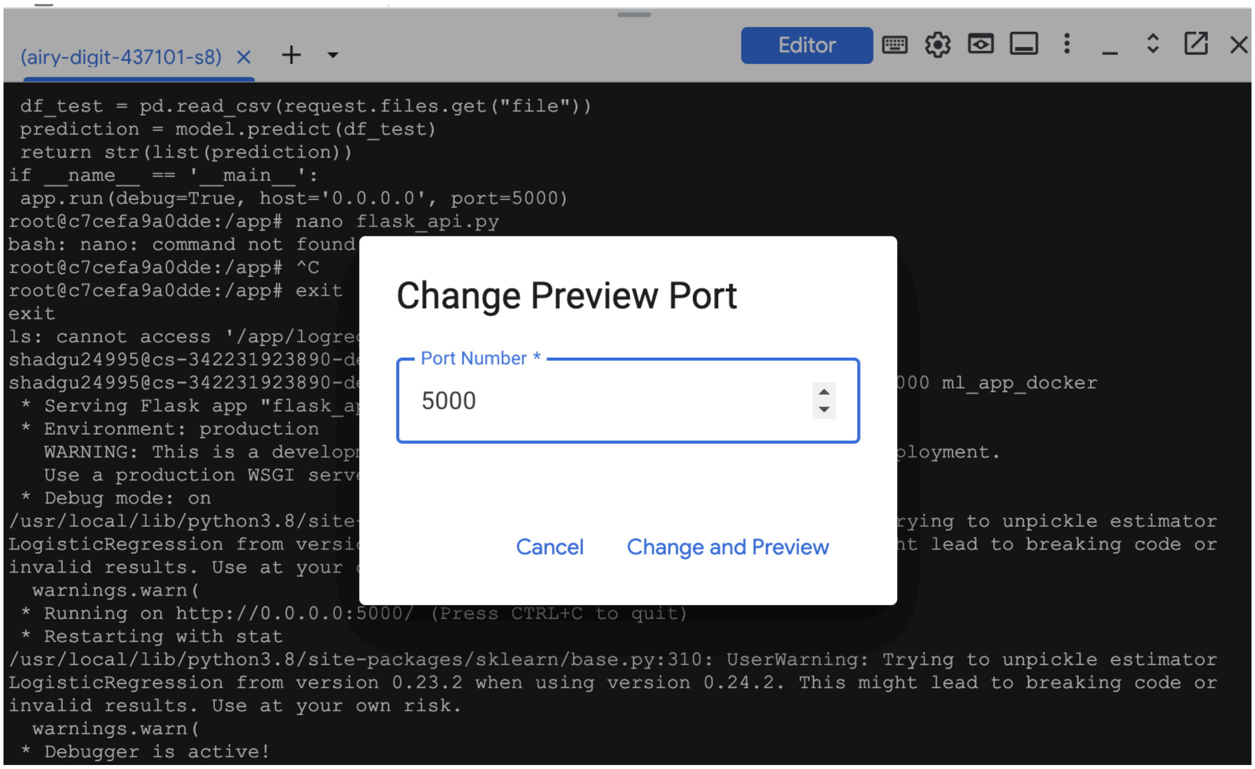
```
shadgu24995@cloudshell:~ (airy-digit-437101-s8)$ docker build -t ml_app_docker .
[+] Building 15.3s (9/9) FINISHED                                              docker:default
 => [internal] load build definition from Dockerfile                                     0.0s
 => => transferring dockerfile: 169B                                                     0.0s
 => [internal] load metadata for docker.io/library/python:3.8-slim                       1.0s
 => [auth] library/python:pull token for registry-1.docker.io                            0.0s
 => [internal] load .dockerignore                                                        0.0s
 => => transferring context: 2B                                                          0.0s
 => [1/4] FROM docker.io/library/python:3.8-slim@sha256:1d52838af602b4b5a831beb13a0e4d  5.9s
 => => resolve docker.io/library/python:3.8-slim@sha256:1d52838af602b4b5a831beb13a0e4d  0.0s
 => => sha256:1d52838af602b4b5a831beb13a0e4d073280665ea7be7f69ce2382 10.41kB / 10.41kB  0.0s
 => => sha256:314bc2fb0714b7807bf5699c98f0c73817e579799f2d91567ab7e951 1.75kB / 1.75kB  0.0s
 => => sha256:b5f62925bd0f63f48cc8acd5e87d0c3a07e2f229cd2fb0a9586e68ed 5.25kB / 5.25kB  0.0s
 => => sha256:302e3ee498053a7b5332ac79e8efebec16e900289fc1ecd1c754ce 29.13MB / 29.13MB  0.7s
 => => sha256:030d7bdc20a63e3d22192b292d006a69fa3333949f536d62865d1bd0 3.51MB / 3.51MB  0.2s
 => => sha256:a3f1dfe736c5f959143f23d75ab522a60be2da902efac236f4fb2a 14.53MB / 14.53MB  0.4s
 => => sha256:3971691a363796c39467aae4cdce6ef773273fe6bfc67154d01e1b589bef 248B / 248B  0.3s
 => => extracting sha256:302e3ee498053a7b5332ac79e8efebec16e900289fc1ecd1c754ce8fa047f  3.2s
 => => extracting sha256:030d7bdc20a63e3d22192b292d006a69fa3333949f536d62865d1bd050668  0.3s
 => => extracting sha256:a3f1dfe736c5f959143f23d75ab522a60be2da902efac236f4fb2a153cc14  1.2s
 => => extracting sha256:3971691a363796c39467aae4cdce6ef773273fe6bfc67154d01e1b589befb  0.0s
 => [internal] load build context                                                        4.7s
 => => transferring context: 360.39MB                                                    4.7s
```

2. This command runs a Docker container from the ml_app_docker image: - docker container run -p 5000:5000 ml_app_docker



```
shadgu24995@cs-342231923890-default:~/Python-3.10.12$ docker 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 migh
t 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 migh
t lead to breaking code or invalid results. Use at your own risk.
  warnings.warn(
 * Debugger is active!
 * Debugger PIN: 593-848-457
```

3. In the right-upper side of the terminal click the eye shaped button and then click Preview on port 5000. Change port if it is not 5000 by default.



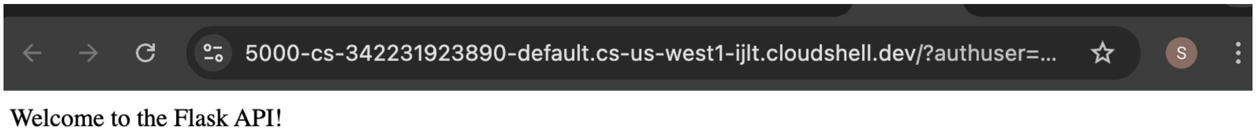
```
 df_test = pd.read_csv(request.files.get("file"))
 prediction = model.predict(df_test)
 return str(list(prediction))
if __name__ == '__main__':
 app.run(debug=True, host='0.0.0.0', port=5000)
root@c7cefa9a0dde:/app# nano flask_api.py
bash: nano: command not found
root@c7cefa9a0dde:/app# ^C
root@c7cefa9a0dde:/app# exit
exit
ls: cannot access '/app/logre
shadgu24995@cs-342231923890-d
shadgu24995@cs-342231923890-d                                   000 ml_app_docker
 * Serving Flask app "flask_a
 * Environment: production
   WARNING: This is a develop                                   ployment.
   Use a production WSGI serv
 * Debug mode: on
/usr/local/lib/python3.8/site                                   rying to unpickle estimator
LogisticRegression from versi                                   ht lead to breaking code or
invalid results. Use at your
  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!
```

Change Preview Port

Port Number *: 5000

Cancel   Change and Preview

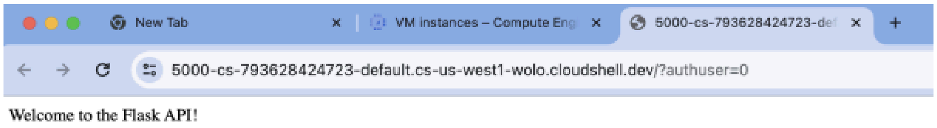
4. You will see this using the web preview.



5000-cs-342231923890-default.cs-us-west1-ijlt.cloudshell.dev/?authuser=...

Welcome to the Flask API!

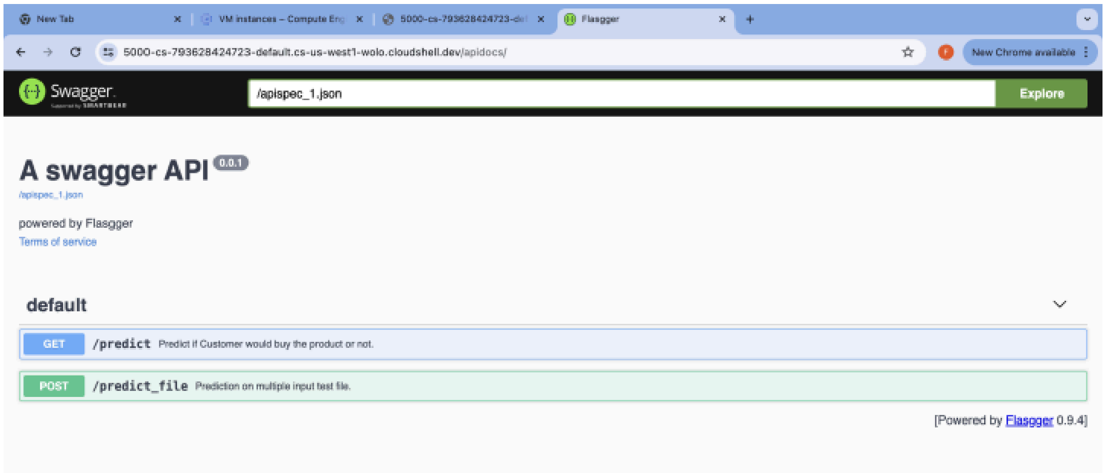
4. You will see this using the web preview.



5000-cs-793628424723-default.cs-us-west1-wolo.cloudshell.dev/?authuser=0

Welcome to the Flask API!

5. Add /apidocs/ at the end of the link to access the running ml- app as following
   - There are two tabs GET and POST.



New Tab
VM instances – Compute Eng
5000-cs-793628424723-def
Flasgger
5000-cs-793628424723-default.cs-us-west1-wolo.cloudshell.dev/apidocs/
New Chrome available
Swagger
/apispec_1.json
Explore

A swagger API 0.0.1

/apispec_1.json

powered by Flasgger

Terms of service

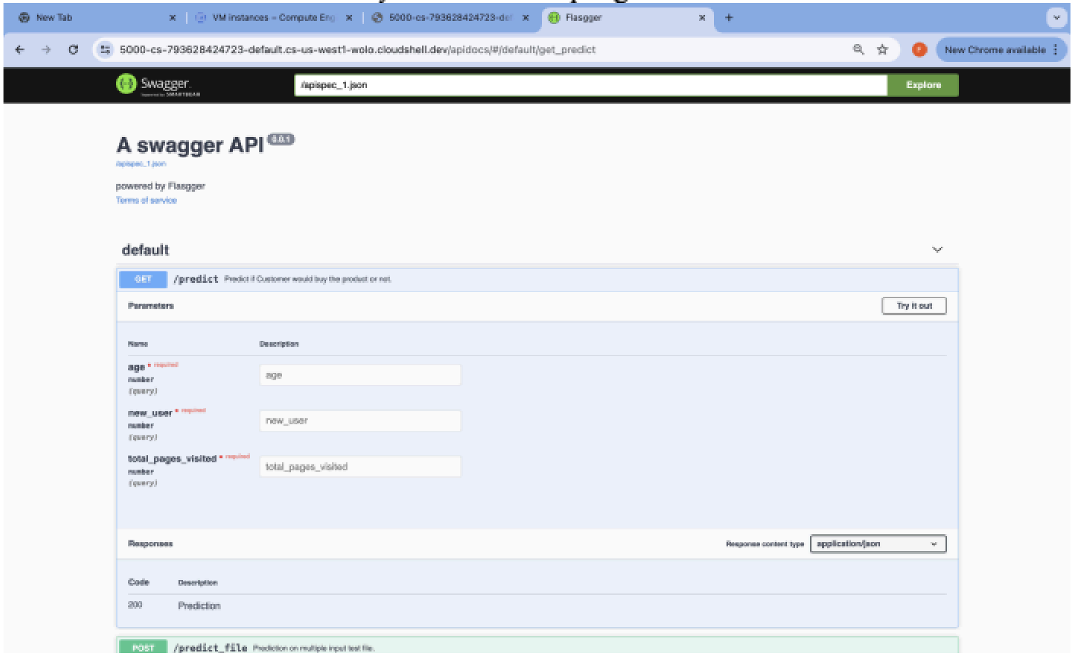
default

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]

6. Click *GET* and then click *Try it out* in the top-right corner of the GET box.



New Tab
VM instances – Compute Eng
5000-cs-793628424723-def
Flasgger
5000-cs-793628424723-default.cs-us-west1-wolo.cloudshell.dev/apidocs/#/default/get_predict
New Chrome available
Swagger
/apispec_1.json
Explore
Try it out

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.

Parameters

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

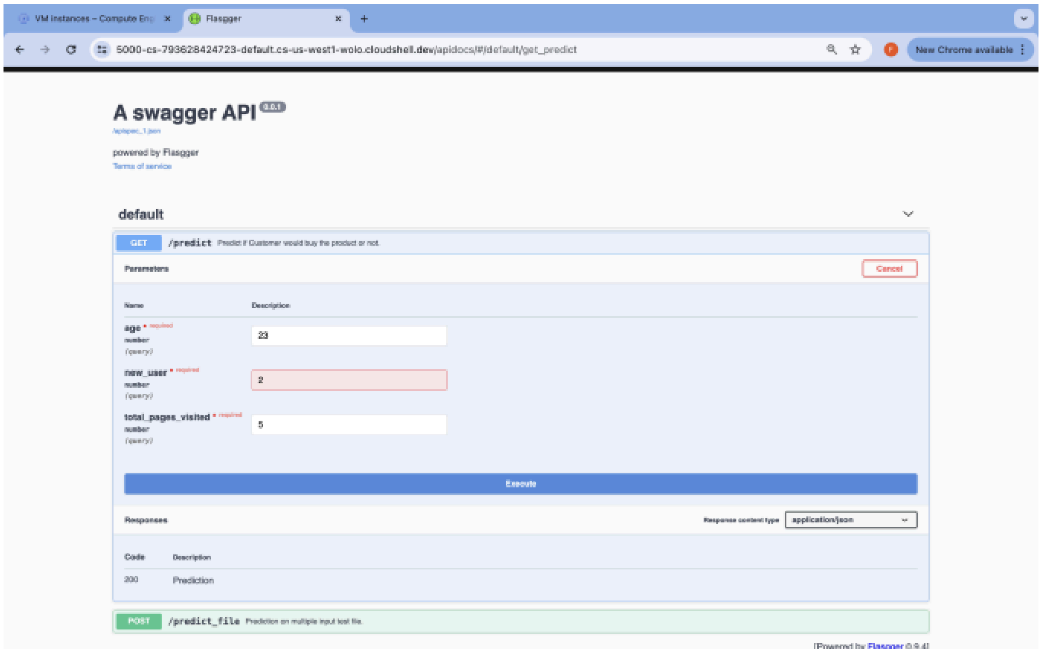
Responses

Response content type: application/json

Code	Description
200	Prediction

POST /predict_file Prediction on multiple input test file.

7. Fill values for the input parameters and then click Execute.



5000-cs-793628424723-default.cs-us-west1-wolo.cloudshell.dev/apidocs/#/default/get_predict

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.

Parameters

Name	Description
age * required number (query)	23
new_user * required number (query)	2
total_pages_visited * required number (query)	5

Responses

Response content type: application/json

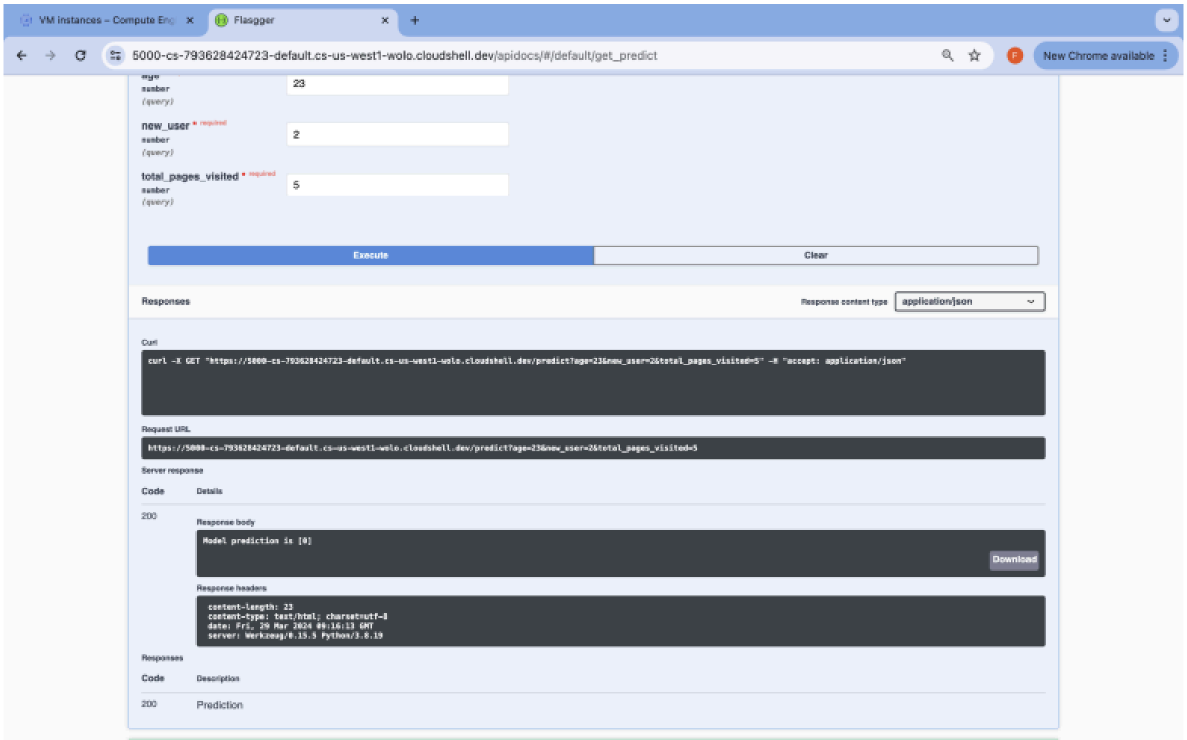
Code	Description
200	Prediction

POST /predict_file Prediction on multiple input test file.

[Powered by Flasgger 0.9.4]

8. 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 as following


VM instances – Compute Eng
Flasgger
5000-cs-793628424723-default.cs-us-west1-wolo.cloudshell.dev/apidocs/#/default/get_predict
New Chrome available

age
number
(query)
23

new_user * required
number
(query)
2

total_pages_visited * required
number
(query)
5

Responses

Response content type: application/json

Curl

```
curl -X GET "https://5000-cs-793628424723-default.cs-us-west1-wolo.cloudshell.dev/predict?age=23&new_user=2&total_pages_visited=5" -H "accept: application/json"
```

Request URL

```
https://5000-cs-793628424723-default.cs-us-west1-wolo.cloudshell.dev/predict?age=23&new_user=2&total_pages_visited=5
```

Server response

Code Details

200

Response body

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

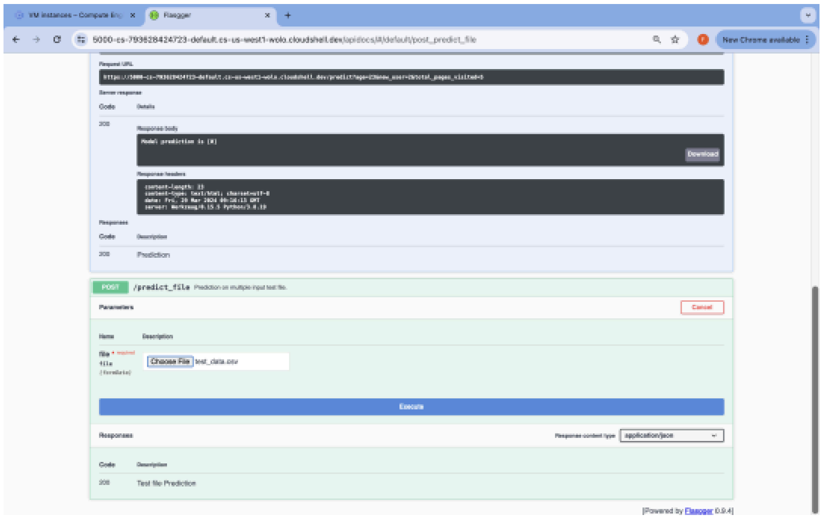
Response headers

```
content-length: 23
content-type: text/html; charset=utf-8
date: Fri, 29 Mar 2024 09:16:13 GMT
server: Werkzeug/0.15.5 Python/3.8.19
```

Responses

Code	Description
200	Prediction

9. The next prediction that can be done is for a group of customers (test data) via a post request.


VM instances – Compute Eng
Flasgger
5000-cs-793628424723-default.cs-us-west1-wolo.cloudshell.dev/apidocs/#/default/post_predict_file
New Chrome available

Request URL

```
https://5000-cs-793628424723-default.cs-us-west1-wolo.cloudshell.dev/predict?age=23&new_user=2&total_pages_visited=5
```

Server response

Code Details

200

Response body

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

Response headers

```
content-length: 23
content-type: text/html; charset=utf-8
date: Fri, 29 Mar 2024 09:16:13 GMT
server: Werkzeug/0.15.5 Python/3.8.19
```

Responses

Code	Description
200	Prediction

POST /predict_file Prediction on multiple input test file.

Parameters

Name Description

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

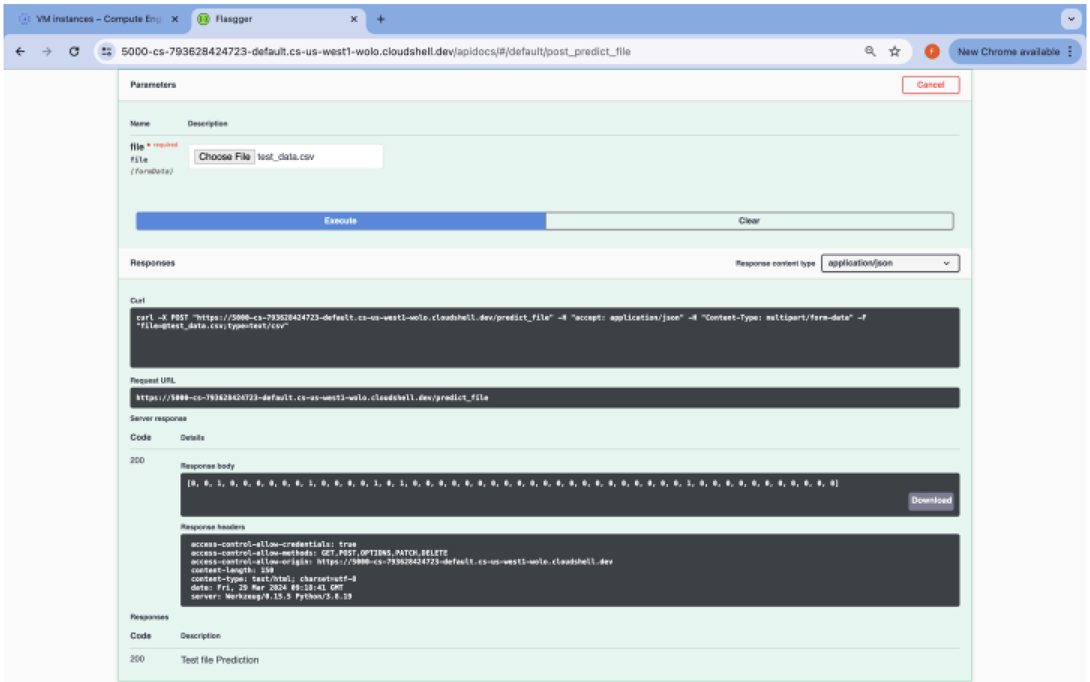
Responses

Response content type: application/json

Code	Description
200	Test file Prediction

[Powered by Flasgger 0.9.4]

10. 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 as following.



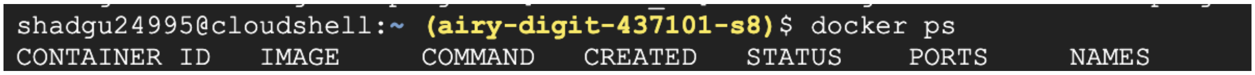
```
curl -X POST "https://5000-cs-793628424723-default.cs-us-west1-wolo.cloudshell.dev/predict_file" -H "accept: application/json" -H "Content-Type: multipart/form-data" -F "file=@test_data.csv;type=text/csv"
```

```
https://5000-cs-793628424723-default.cs-us-west1-wolo.cloudshell.dev/predict_file
```

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

```
access-control-allow-credentials: true
access-control-allow-methods: GET,POST,OPTIONS,PATCH,DELETE
access-control-allow-origin: https://5000-cs-793628424723-default.cs-us-west1-wolo.cloudshell.dev
content-length: 150
content-type: text/html; charset=utf-8
date: Fri, 29 Mar 2024 09:18:41 GMT
server: Werkzeug/0.15.5 Python/3.8.19
```

Step 6: Stopping/killing the running container 1. Use docker ps to list running Docker containers



```
shadgu24995@cloudshell:~ (airy-digit-437101-s8)$ docker ps
CONTAINER ID   IMAGE     COMMAND   CREATED   STATUS    PORTS     NAMES
```

Updating Portfolio- GitHub link

https://github.com/Ghanitu/CloudComputing.git