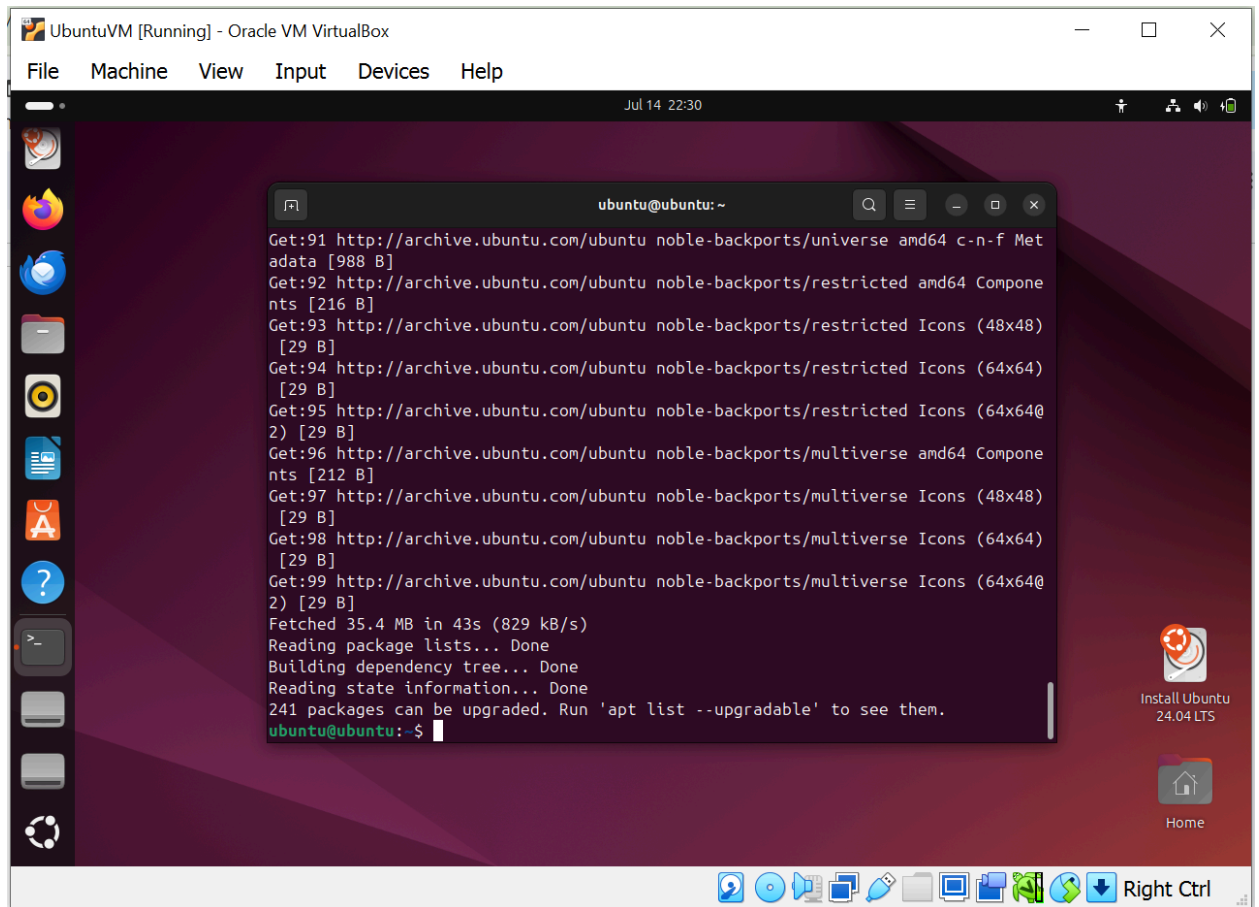
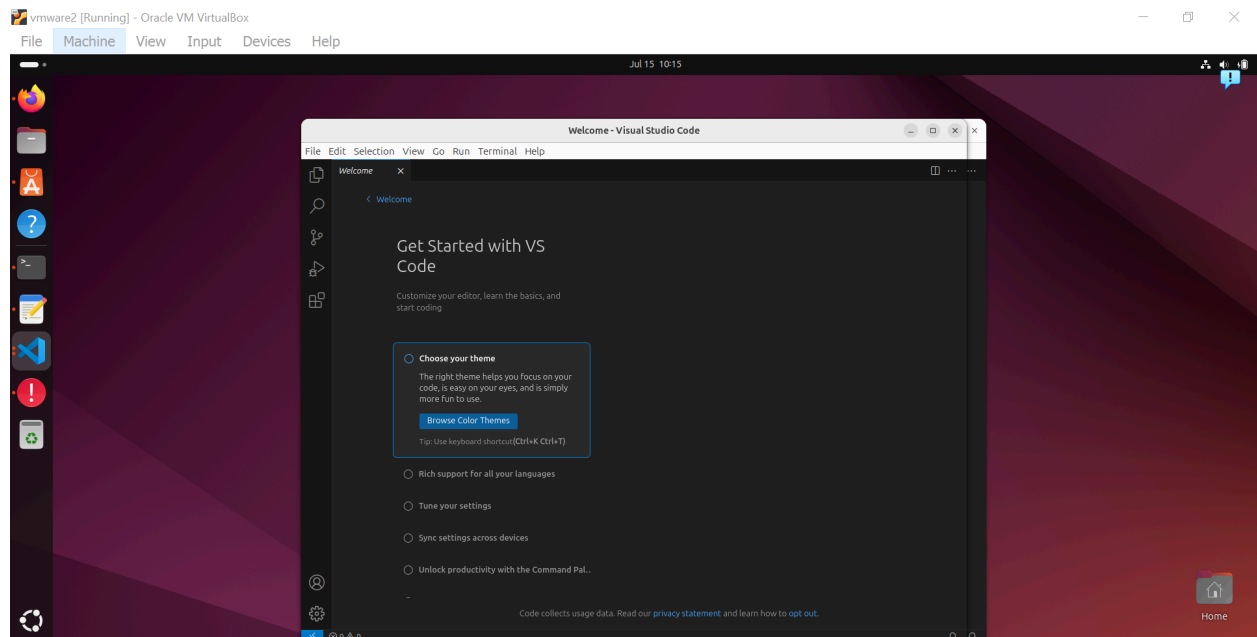


1. Host a Ubuntu Virtual Machine using Oracle VM Virtual Box.



2. Set up Visual Studio code on Ubuntu VM.



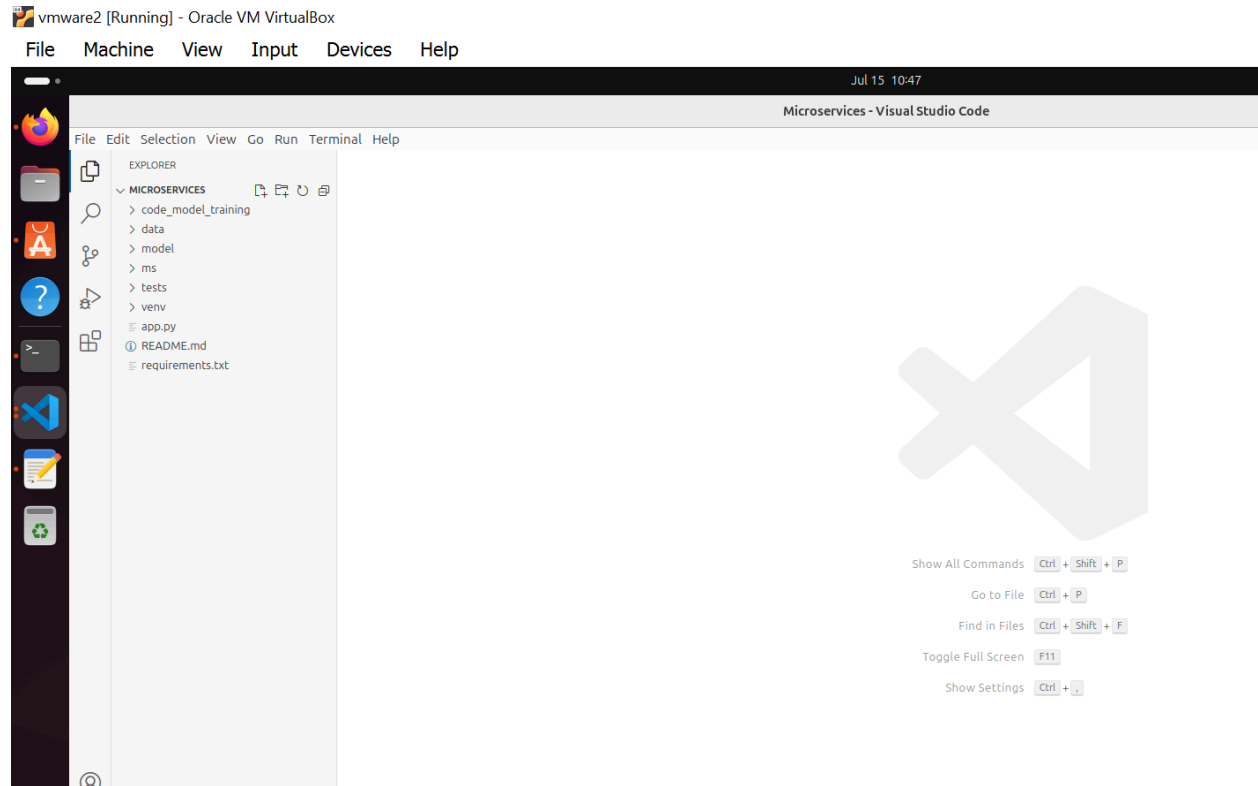
3. Set up Python

```
File Machine View Input Devices Help
Jul 15 10:36
root1@root1-VirtualBox: ~/Microservices

E: Package 'python-pip' has no installation candidate
root1@root1-VirtualBox: $ sudo apt install python3 python3-pip
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
python3 is already the newest version (3.12.3-0ubuntu1).
python3 set to manually installed.
The following additional packages will be installed:
  binutils binutils-common binutils-x86-64-linux-gnu build-essential bzip2
  dpkg-dev fakeroot g++ g++-13 g++-13-x86-64-linux-gnu g++-x86-64-linux-gnu
  gcc gcc-13 gcc-13-x86-64-linux-gnu gcc-x86-64-linux-gnu javascript-common
  libalgorithm-diff-perl libalgorithm-diff-xs-perl libalgorithm-merge-perl
  libasan8 libbinutils libcc1-0 libctf-nobfd0 libctf0 libdpkg-perl
  libexpat1-dev libfakeroot libfile-fcntllock-perl libgcc-13-dev libgprofng0
  libhwasan0 libitm1 libjs-jquery libjs-sphinxdoc libjs-underscore liblsan0
  libpython3-dev libpython3.12-dev libquadmath0 libsframe1 libstdc++-13-dev
  libtsan2 libubsan1 lto-disabled-list make python3-dev python3-setuptools
  python3-wheel python3.12-dev zlib1g-dev
Suggested packages:
  binutils-doc gprofng-gui bzip2-doc debian-keyring g++-multilib
  g++-13-multilib gcc-13-doc gcc-multilib autoconf automake libtool flex bison
  gcc-doc gcc-13-multilib gcc-13-locales gdb-x86-64-linux-gnu apache2
  | lighttpd | httpd git bzr libstdc++-13-doc make-doc python-setuptools-doc
The following NEW packages will be installed:
  binutils binutils-common binutils-x86-64-linux-gnu build-essential bzip2
  dpkg-dev fakeroot g++ g++-13 g++-13-x86-64-linux-gnu g++-x86-64-linux-gnu
  gcc gcc-13 gcc-13-x86-64-linux-gnu gcc-x86-64-linux-gnu javascript-common
  libalgorithm-diff-perl libalgorithm-diff-xs-perl libalgorithm-merge-perl
  libasan8 libbinutils libcc1-0 libctf-nobfd0 libctf0 libdpkg-perl
  libexpat1-dev libfakeroot libfile-fcntllock-perl libgcc-13-dev libgprofng0
  libhwasan0 libitm1 libjs-jquery libjs-sphinxdoc libjs-underscore liblsan0
  libpython3-dev libpython3.12-dev libquadmath0 libsframe1 libstdc++-13-dev
  libtsan2 libubsan1 lto-disabled-list make python3-dev python3-pip
  python3-setuptools python3-wheel python3.12-dev zlib1g-dev
0 upgraded, 51 newly installed, 0 to remove and 72 not upgraded.
Need to get 65.8 MB of archives.
After this operation, 252 MB of additional disk space will be used.
```

4. Clone this Github repository <https://github.com/Vikas098766/Microservices.git>

```
root1@root1-VirtualBox:~$ git clone https://github.com/Vikas098766/Microservices.git
Cloning into 'Microservices'...
remote: Enumerating objects: 95, done.
remote: Total 95 (delta 0), reused 0 (delta 0), pack-reused 95
Receiving objects: 100% (95/95), 96.20 KiB | 433.00 KiB/s, done.
Resolving deltas: 100% (28/28), done.
root1@root1-VirtualBox:~$ cd Microservices
```



5. Create a Virtual Environment.

```
Setting up python3-venv (3.12.3-0ubuntu1) ...  
root1@root1-VirtualBox:~/Microservices$ python3 -m venv venv  
root1@root1-VirtualBox:~/Microservices$ source venv/bin/activate  
(venv) root1@root1-VirtualBox:~/Microservices$
```

6. Install the dependencies from requirements.txt file.

```

(venv) root1@root1-VirtualBox:~/Microservices$ pip install -r requirements.txt
Collecting click==8.0.3 (from -r requirements.txt (line 1))
  Downloading click-8.0.3-py3-none-any.whl.metadata (3.2 kB)
Collecting cycler==0.11.0 (from -r requirements.txt (line 2))
  Downloading cycler-0.11.0-py3-none-any.whl.metadata (785 bytes)
Collecting Flask==2.0.2 (from -r requirements.txt (line 3))
  Downloading Flask-2.0.2-py3-none-any.whl.metadata (3.8 kB)
Collecting fonttools==4.28.5 (from -r requirements.txt (line 4))
  Downloading fonttools-4.28.5-py3-none-any.whl.metadata (118 kB)
  ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 119.0/119.0 kB 891.6 kB/s eta 0:00:00
Collecting gunicorn==20.1.0 (from -r requirements.txt (line 5))
  Downloading gunicorn-20.1.0-py3-none-any.whl.metadata (3.8 kB)
Collecting itsdangerous==2.0.1 (from -r requirements.txt (line 6))
  Downloading itsdangerous-2.0.1-py3-none-any.whl.metadata (2.9 kB)
Collecting Jinja2==3.0.3 (from -r requirements.txt (line 7))
  Downloading Jinja2-3.0.3-py3-none-any.whl.metadata (3.5 kB)
Collecting joblib==1.1.0 (from -r requirements.txt (line 8))
  Downloading joblib-1.1.0-py2.py3-none-any.whl.metadata (5.2 kB)
Collecting kiwisolver==1.3.2 (from -r requirements.txt (line 9))
  Downloading kiwisolver-1.3.2.tar.gz (54 kB)
  ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 54.6/54.6 kB 989.4 kB/s eta 0:00:00
Installing build dependencies ... done

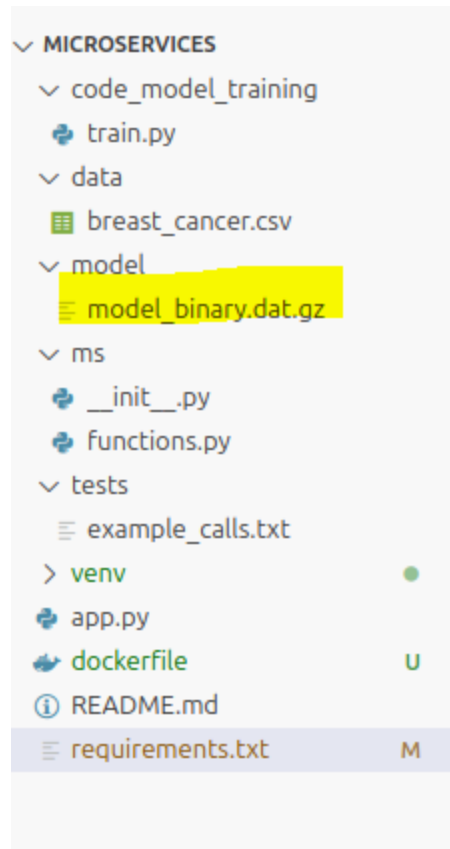
```

7. Train and save the model.

```

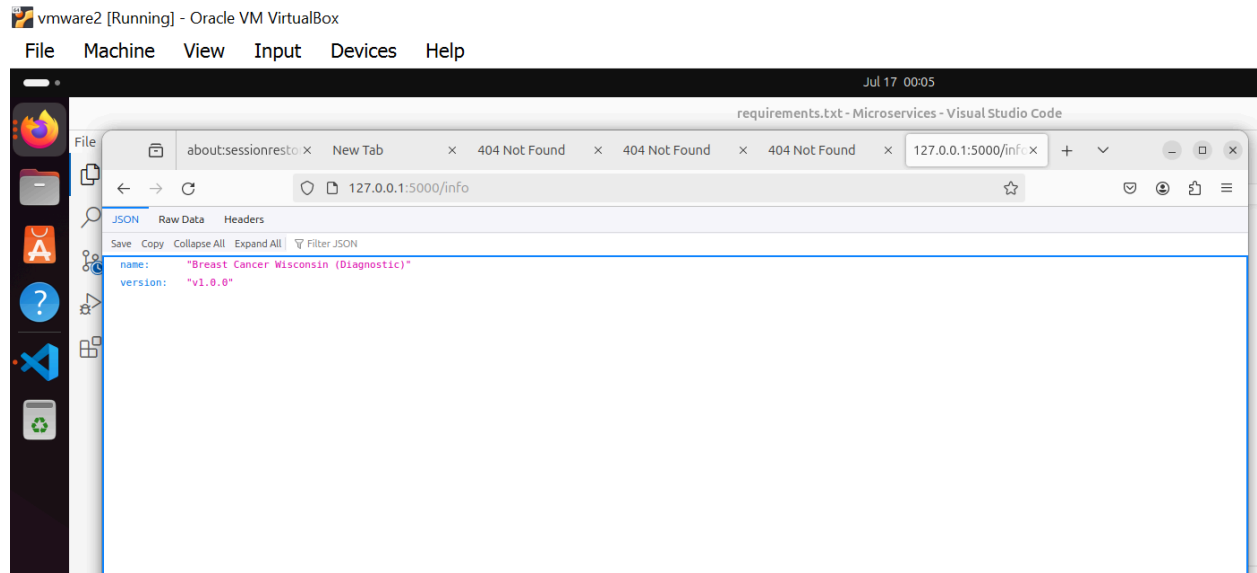
(venv) root1@root1-VirtualBox:~/Microservices$ python code_model_training/train.py
/home/root1/Microservices/code_model_training/train.py:23: FutureWarning: Downcasting behavior in 'replace' is deprecated and will be removed in a future version. To re-
tain the old behavior, explicitly call 'result.infer_objects(copy=False)'. To opt-in to the future behavior, set 'pd.set_option('future.no_silent_downcasting', True)'
  data['diagnosis'] = data['diagnosis'].replace(['B', 'M'], [0, 1]) # Encode y, B -> 0, M -> 1
Accuracy: 0.9736842105263158
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay object at 0x73b26f5ab1a0>
/home/root1/Microservices/code_model_training/train.py:54: UserWarning: FigureCanvasAgg is non-interactive, and thus cannot be shown
  plt.show()

```



8. Test the Flask web application.

```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
○ (venv) root1@root1-VirtualBox:~/Microservices$ python app.py
* Serving Flask app 'ms'
* Debug mode: off
WARNING: This is a development server. Do not use it in a production deployment. Use a production WSGI server instead.
* Running on all addresses (0.0.0.0)
* Running on http://127.0.0.1:5000
* Running on http://10.0.2.15:5000
Press CTRL+C to quit
```



9. Test the application and make predictions using the example calls available in the folder/tests.

```

requirements.txt M  example_calls.txt  dockerfile U
tests > example_calls.txt
1 # POST method predict
2 curl -d '{"radius_mean": 17.99, "texture_mean": 10.38, "perimeter_mean": 122.8, "area_mean": 1001.0, "smoothness_mean": 0.1184, "compactness_mean": 0.2776, "conca
3 | -H "Content-Type: application/json" \
4 | -X POST http://0.0.0.0:5000/predict
5
6 # GET method info
7 curl -X GET http://localhost:5000/info
8
9 # GET method health
10 curl -X GET http://localhost:5000/health

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
• (venv) root1@root1-VirtualBox:~/Microservices$ curl -d '{"radius_mean": 17.99, "texture_mean": 10.38, "perimeter_mean": 122.8, "area_mean": 1001.0, "smoothness_mean":
0.1184, "compactness_mean": 0.2776, "concavity_mean": 0.3001, "concave points mean": 0.1471, "symmetry_mean": 0.2419, "fractal dimension mean": 0.07871, "radius_se": 1.
xture se": 0.9053, "perimeter se": 8.589, "area se": 153.4, "smoothness se": 0.006399, "compactness se": 0.04904, "concavity se": 0.05373, "concave points se": 1.
0.01587, "symmetry se": 0.03003, "fractal dimension se": 0.006193, "radius worst": 25.38, "texture worst": 17.33, "perimeter worst": 184.6, "area worst": 2019.0, "smoot
hness worst": 0.1622, "compactness worst": 0.6656, "concavity worst": 0.7119, "concave points worst": 0.2654, "symmetry worst": 0.4601, "fractal_dimension_worst": 0.118
9}}' -H "Content-Type: application/json" -X POST http://0.0.0.0:5000/predict
{"label": "M", "prediction": 1, "status": 200}
• (venv) root1@root1-VirtualBox:~/Microservices$ curl -X GET http://localhost:5000/info
{"name": "Breast Cancer Wisconsin (Diagnostic)", "version": "v1.0.0"}
• (venv) root1@root1-VirtualBox:~/Microservices$ curl -X GET http://localhost:5000/health
ok (venv) root1@root1-VirtualBox:~/Microservices$

```

10. Create a docker image containing everything needed to run the application.

```
requirements.txt M example_calls.txt dockerfile U X
dockerfile
2 WORKDIR /app
3 COPY . /app
4 RUN pip install -r requirements.txt
5 EXPOSE 5000
6 ENV NAME World
7 CMD ["python", "app.py"]
```

```
vmware2 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Jul 17, 00:35
root1@root1-VirtualBox: ~/Microservices
root1@root1-VirtualBox: ~/Microservices
root1@root1-VirtualBox: ~/Microservices$ docker build -t predictive-service .
[+] Building 10.0s (3/8)
=> [internal] load build definition from dockerfile
=> => transferring dockerfile: 172B
=> [internal] load metadata for docker.io/library/python:3.9-slim
=> [internal] load .dockerignore
=> => transferring context: 2B
=> [1/4] FROM docker.io/library/python:3.9-slim@sha256:a6c12ec09f13df9d4b8b4e4d08678c1b21d89885be14b6c72b633bee2a520f4
=> => resolve docker.io/library/python:3.9-slim@sha256:a6c12ec09f13df9d4b8b4e4d08678c1b21d89885be14b6c72b633bee2a520f4
=> => sha256:a6c12ec09f13df9d4b8b4e4d08678c1b21d89885be14b6c72b633bee2a520f4 19.41kB / 10.41kB
=> => sha256:47191154eb9cc7a5479a793c37cfeac2be89fcaf0fed8c747e8dfb4b01a79a3 1.94kB / 1.94kB
=> => sha256:b9732a98c1caf64d4eeebb911ff8eb75bf12f671400a85302dd33b5de2d1cdc1 6.90kB / 6.90kB
=> => sha256:f11c1ada26e078479ccdd45312ea3b88476441b91be0ec898a7e07bf05badc 5.24MB / 29.13MB
=> => sha256:c1f67e5ba3d2a0d9c5f38c8c3f6c29ff3b6d6e0045b935c99e9ffc4182070fa1 3.51MB / 3.51MB
=> => sha256:9370038d11852cad5a70691e76b0ddc8e669018bc770cad15c23a3def629b874 4.19MB / 11.89MB
=> => sha256:174cb52e37e5d01d6ea95cdf8a0d25cc883946a96050ff4be1633a7f1712 0B / 231B
=> [internal] load build context
=> => transferring context: 7.74MB
```

11. Run the containerized application as a prediction service and test it locally by passing some example calls and get the prediction.

```
vmware2 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Jul 17, 00:52
root1@root1-VirtualBox: ~/Microservices
root1@root1-VirtualBox: ~/Microservices
root1@root1-VirtualBox: ~/Microservices$ docker build -t predictive-service .
=> [internal] load build definition from dockerfile
=> => transferring dockerfile: 172B
=> [internal] load metadata for docker.io/library/python:3.9-slim
=> [internal] load .dockerignore
=> => transferring context: 2B
=> [1/4] FROM docker.io/library/python:3.9-slim@sha256:a6c12ec09f13df9d4b8b4e4d08678c1b21d89885be14b6c72b633bee2a520f4
=> [internal] load build context
=> => transferring context: 1.35MB
=> [2/4] WORKDIR /app
=> [3/4] COPY . /app
=> [4/4] RUN pip install -r requirements.txt
=> exporting image
=> => exporting layers
=> => writing image sha256:4e319f86dc45351f852cf8382ed6a08c23de1c08f678ab5b0469e3f578d5f5ab
=> => naming to docker.io/library/predictive-service

1 warning found (use --debug to expand):
 - LegacyKeyValueFormat: "ENV key=value" should be used instead of legacy "ENV key value" format (line 6)
root1@root1-VirtualBox: ~/Microservices$ docker images
REPOSITORY TAG IMAGE ID CREATED SIZE
predictive-service latest 4e319f86dc45 2 minutes ago 1.1GB
hello-world latest d2c94e258dc3 14 months ago 13.3kB
root1@root1-VirtualBox: ~/Microservices$ docker run -p 5000:5000 predictive-service
docker: Error response from daemon: driver failed programing external connectivity on endpoint amazing_villant (bf4587accfccb2855474eb216b6e4ae9b85ab4b387fe63953c50f2ace51425): fail
ed to bind port 0.0.0.0:5000/tcp: Error starting userland proxy: listen tcp 0.0.0.0:5000: bind: address already in use.
root1@root1-VirtualBox: ~/Microservices$ docker run -p 5000:5000 predictive-service
* Serving Flask app 'ms'
* Debug mode: off
WARNING: This is a development server. Do not use it in a production deployment. Use a production WSGI server instead.
* Running on all addresses (0.0.0.0)
* Running on http://127.0.0.1:5000
* Running on http://172.17.0.2:5000
Press CTRL+C to quit
172.17.0.1 - - [16/Jul/2024 19:22:40] "GET /info HTTP/1.1" 200 -
```