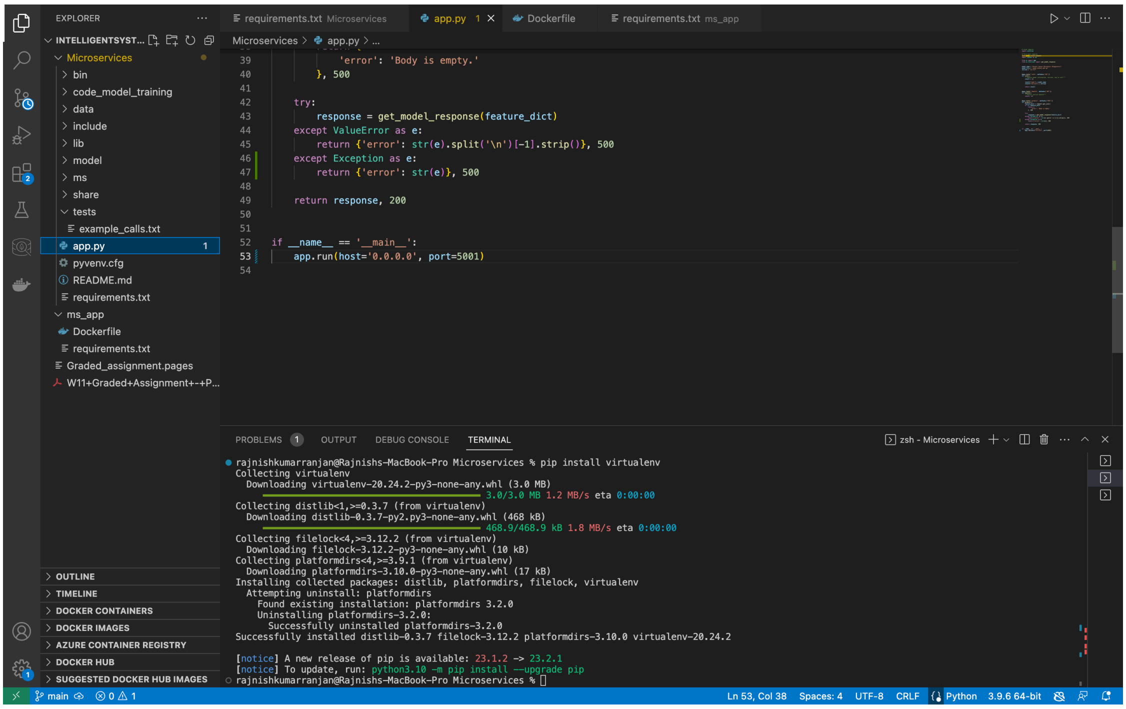
Project Summary

Links - [Github Link](), [Docker Images]()

- **Created virtual environment in VS code locally**
  - Trained the model
  - Tested using curl command

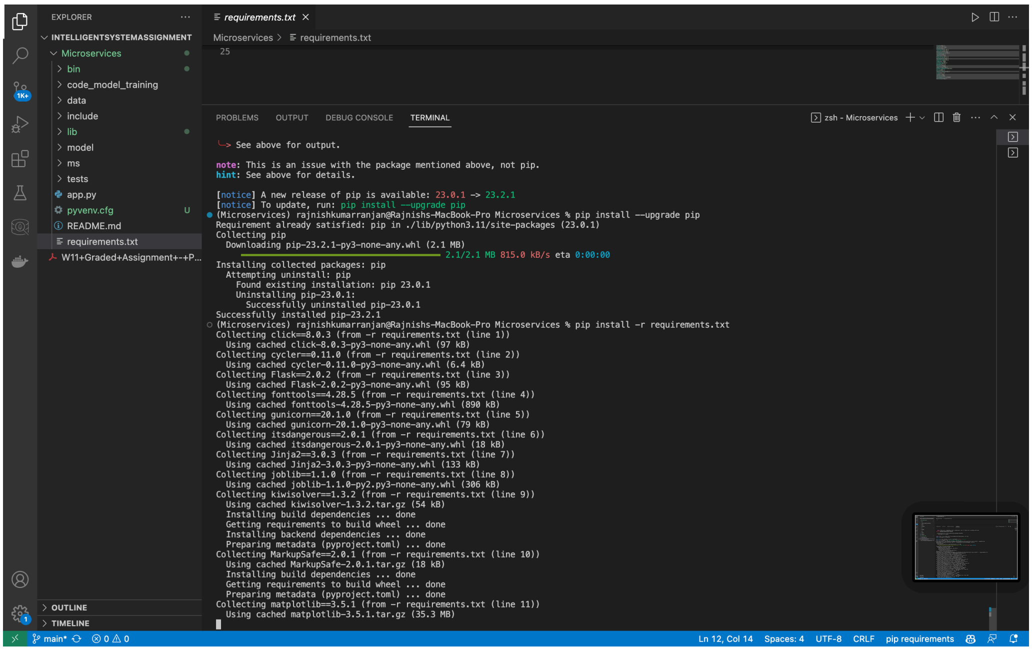
- **Docker images and containers**
  - Image1 - ms_app
    - Contains API to predict breast cancer, to get method info and health
    - Pushed it on docker hub as - rajnish06/breast_cancer_predict_api
  - Image2 - front_app
    - Contains html template to render form and prediction result. Where form takes input from user and displays the result
    - Pushed it on docker hub as - rajnish06/breast_cancer_predict_web
  - Creating a network for communication among containers
    - Used [docker network inspect <network_name>] for pointing to IPAddress of another container



```
            'error': 'Body is empty.'
        }, 500

    try:
        response = get_model_response(feature_dict)
    except ValueError as e:
        return {'error': str(e).split('\n')[-1].strip()}, 500
    except Exception as e:
        return {'error': str(e)}, 500

    return response, 200


if __name__ == '__main__':
    app.run(host='0.0.0.0', port=5001)
```

```
rajnishkumarranjan@Rajnishs-MacBook-Pro Microservices % pip install virtualenv
Collecting virtualenv
  Downloading virtualenv-20.24.2-py3-none-any.whl (3.0 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 3.0/3.0 MB 1.2 MB/s eta 0:00:00
Collecting distlib<1,>=0.3.7 (from virtualenv)
  Downloading distlib-0.3.7-py2.py3-none-any.whl (468 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 468.9/468.9 kB 1.8 MB/s eta 0:00:00
Collecting filelock<4,>=3.12.2 (from virtualenv)
  Downloading filelock-3.12.2-py3-none-any.whl (10 kB)
Collecting platformdirs<4,>=3.9.1 (from virtualenv)
  Downloading platformdirs-3.10.0-py3-none-any.whl (17 kB)
Installing collected packages: distlib, platformdirs, filelock, virtualenv
  Attempting uninstall: platformdirs
    Found existing installation: platformdirs 3.2.0
    Uninstalling platformdirs-3.2.0:
      Successfully uninstalled platformdirs-3.2.0
Successfully installed distlib-0.3.7 filelock-3.12.2 platformdirs-3.10.0 virtualenv-20.24.2

[notice] A new release of pip is available: 23.1.2 -> 23.2.1
[notice] To update, run: python3.10 -m pip install --upgrade pip
rajnishkumarranjan@Rajnishs-MacBook-Pro Microservices % 
```

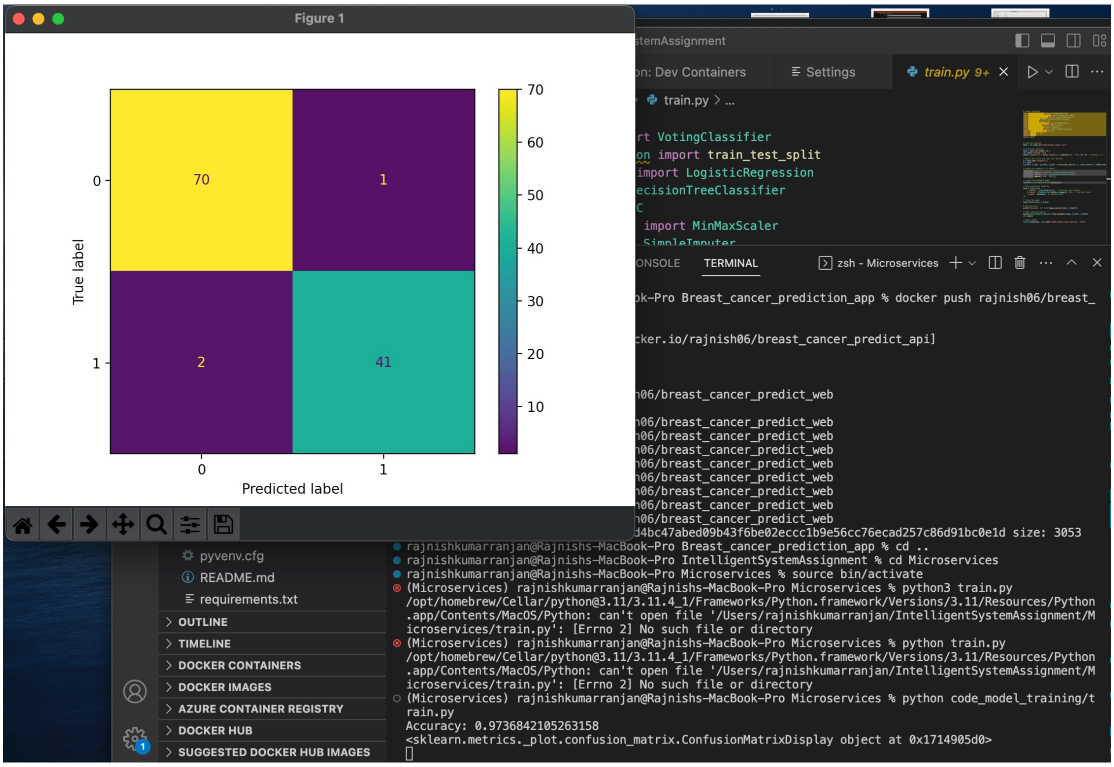
Installing requirements



```
╰─> See above for output.

note: This is an issue with the package mentioned above, not pip.
hint: See above for details.

[notice] A new release of pip is available: 23.0.1 -> 23.2.1
[notice] To update, run: pip install --upgrade pip
(Microservices) rajnishkumarranjan@Rajnishs-MacBook-Pro Microservices % pip install --upgrade pip
Requirement already satisfied: pip in ./lib/python3.11/site-packages (23.0.1)
Collecting pip
  Downloading pip-23.2.1-py3-none-any.whl (2.1 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 2.1/2.1 MB 815.0 kB/s eta 0:00:00
Installing collected packages: pip
  Attempting uninstall: pip
    Found existing installation: pip 23.0.1
    Uninstalling pip-23.0.1:
      Successfully uninstalled pip-23.0.1
Successfully installed pip-23.2.1
(Microservices) rajnishkumarranjan@Rajnishs-MacBook-Pro Microservices % pip install -r requirements.txt
Collecting click==8.0.3 (from -r requirements.txt (line 1))
  Using cached click-8.0.3-py3-none-any.whl (97 kB)
Collecting cycler==0.11.0 (from -r requirements.txt (line 2))
  Using cached cycler-0.11.0-py3-none-any.whl (6.4 kB)
Collecting Flask==2.0.2 (from -r requirements.txt (line 3))
  Using cached Flask-2.0.2-py3-none-any.whl (95 kB)
Collecting fonttools==4.28.5 (from -r requirements.txt (line 4))
  Using cached fonttools-4.28.5-py3-none-any.whl (890 kB)
Collecting gunicorn==20.1.0 (from -r requirements.txt (line 5))
  Using cached gunicorn-20.1.0-py3-none-any.whl (79 kB)
Collecting itsdangerous==2.0.1 (from -r requirements.txt (line 6))
  Using cached itsdangerous-2.0.1-py3-none-any.whl (18 kB)
Collecting Jinja2==3.0.3 (from -r requirements.txt (line 7))
  Using cached Jinja2-3.0.3-py3-none-any.whl (133 kB)
Collecting joblib==1.1.0 (from -r requirements.txt (line 8))
  Using cached joblib-1.1.0-py2.py3-none-any.whl (306 kB)
Collecting kiwisolver==1.3.2 (from -r requirements.txt (line 9))
  Using cached kiwisolver-1.3.2.tar.gz (54 kB)
  Installing build dependencies ... done
  Getting requirements to build wheel ... done
  Installing backend dependencies ... done
  Preparing metadata (pyproject.toml) ... done
Collecting MarkupSafe==2.0.1 (from -r requirements.txt (line 10))
  Using cached MarkupSafe-2.0.1.tar.gz (18 kB)
  Installing build dependencies ... done
  Getting requirements to build wheel ... done
  Preparing metadata (pyproject.toml) ... done
Collecting matplotlib==3.5.1 (from -r requirements.txt (line 11))
  Using cached matplotlib-3.5.1.tar.gz (35.3 MB)
```

Creating a virtual environment

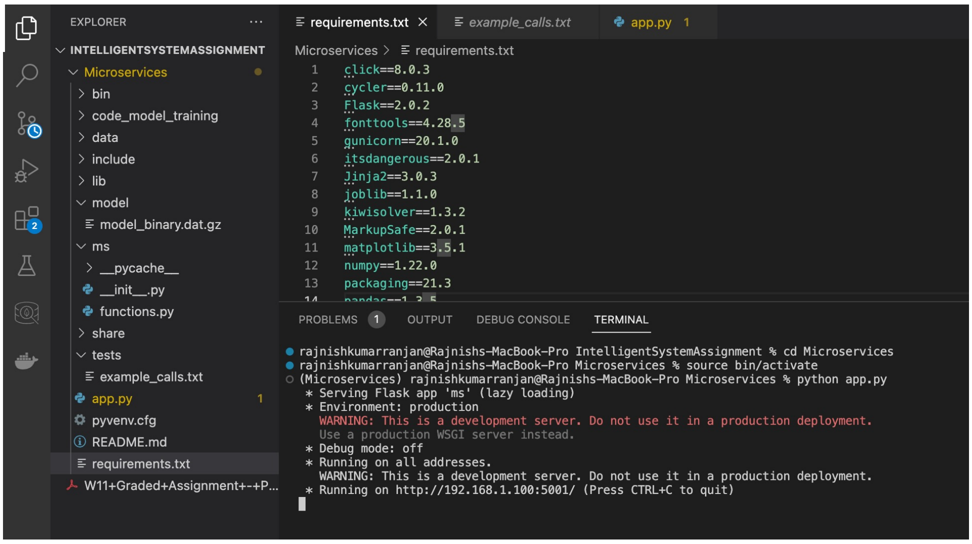
Training the Model



```
rt VotingClassifier
on import train_test_split
import LogisticRegression
ecisionTreeClassifier
C
 import MinMaxScaler
 SimpleImputer
```

```
ok-Pro Breast_cancer_prediction_app % docker push rajnish06/breast_

cker.io/rajnish06/breast_cancer_predict_api]


h06/breast_cancer_predict_web

h06/breast_cancer_predict_web
h06/breast_cancer_predict_web
h06/breast_cancer_predict_web
h06/breast_cancer_predict_web
h06/breast_cancer_predict_web
h06/breast_cancer_predict_web
h06/breast_cancer_predict_web
h06/breast_cancer_predict_web
d4bc47abed09b43f6be02eccc1b9e56cc76ecad257c86d91bc0e1d size: 3053
rajnishkumarranjan@Rajnishs-MacBook-Pro Breast_cancer_prediction_app % cd ..
rajnishkumarranjan@Rajnishs-MacBook-Pro IntelligentSystemAssignment % cd Microservices
rajnishkumarranjan@Rajnishs-MacBook-Pro Microservices % source bin/activate
(Microservices) rajnishkumarranjan@Rajnishs-MacBook-Pro Microservices % python3 train.py
/opt/homebrew/Cellar/python@3.11/3.11.4_1/Frameworks/Python.framework/Versions/3.11/Resources/Python
.app/Contents/MacOS/Python: can't open file '/Users/rajnishkumarranjan/IntelligentSystemAssignment/M
icroservices/train.py': [Errno 2] No such file or directory
(Microservices) rajnishkumarranjan@Rajnishs-MacBook-Pro Microservices % python train.py
/opt/homebrew/Cellar/python@3.11/3.11.4_1/Frameworks/Python.framework/Versions/3.11/Resources/Python
.app/Contents/MacOS/Python: can't open file '/Users/rajnishkumarranjan/IntelligentSystemAssignment/M
icroservices/train.py': [Errno 2] No such file or directory
(Microservices) rajnishkumarranjan@Rajnishs-MacBook-Pro Microservices % python code_model_training/t
rain.py
Accuracy: 0.9736842105263158
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay object at 0x1714905d0>
```

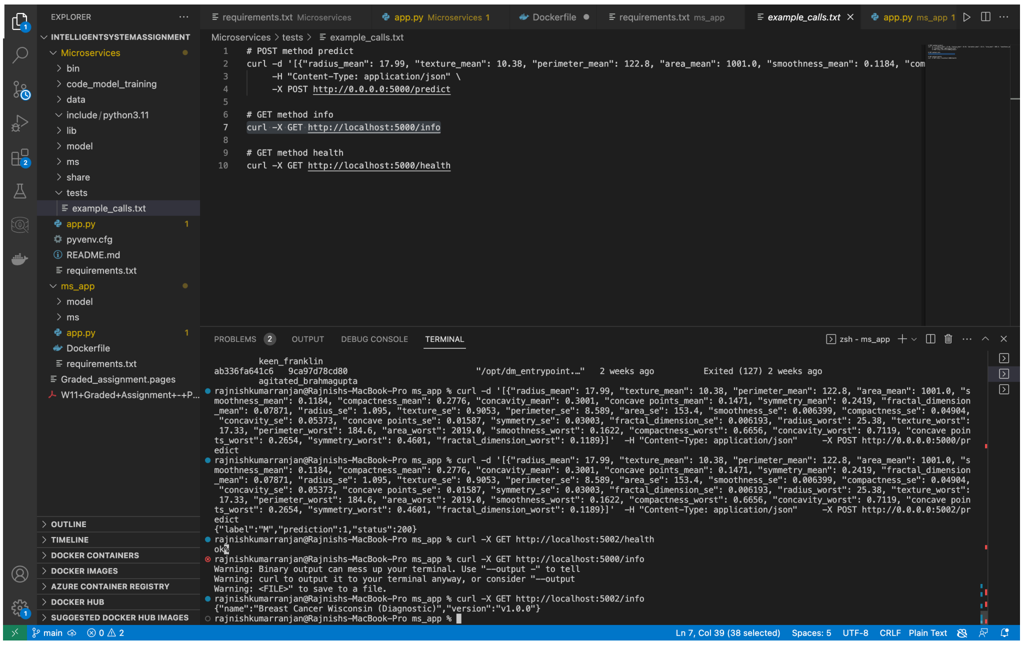
Running and Testing the App in Virtual Env



```
click==8.0.3
cycler==0.11.0
Flask==2.0.2
fonttools==4.28.5
gunicorn==20.1.0
itsdangerous==2.0.1
Jinja2==3.0.3
joblib==1.1.0
kiwisolver==1.3.2
MarkupSafe==2.0.1
matplotlib==3.5.1
numpy==1.22.0
packaging==21.3
pandas==1.3.5
```

```
rajnishkumarranjan@Rajnishs-MacBook-Pro IntelligentSystemAssignment % cd Microservices
rajnishkumarranjan@Rajnishs-MacBook-Pro Microservices % source bin/activate
(Microservices) rajnishkumarranjan@Rajnishs-MacBook-Pro Microservices % python app.py
 * Serving Flask app 'ms' (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: off
 * Running on all addresses.
   WARNING: This is a development server. Do not use it in a production deployment.
 * Running on http://192.168.1.100:5001/ (Press CTRL+C to quit)
```

Testing all 3 APIs provided

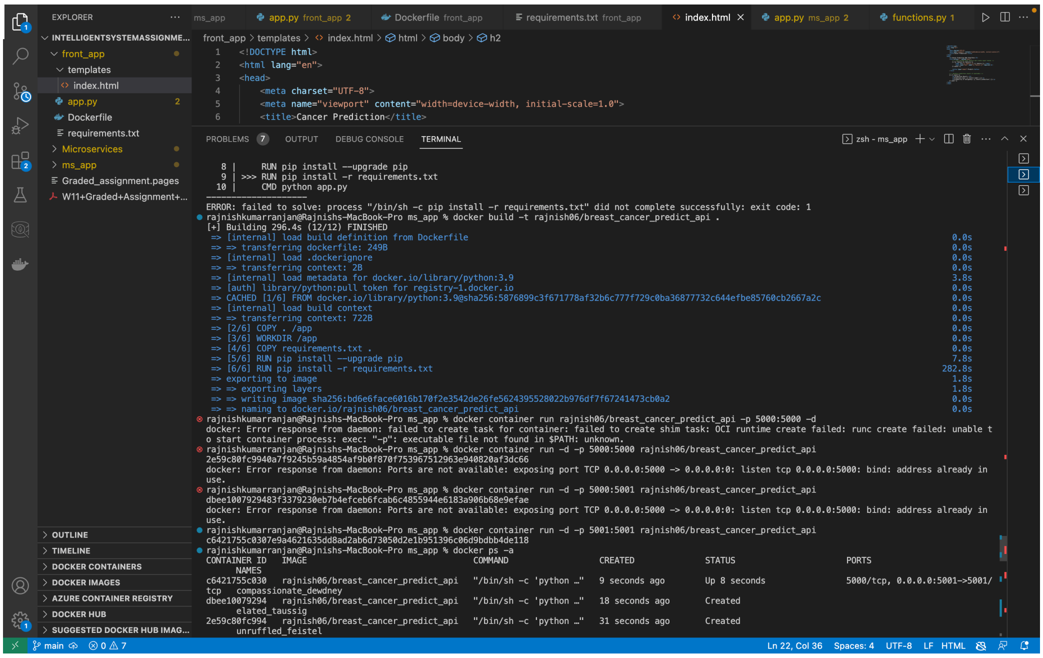


```
# POST method predict
curl -d '[{"radius_mean": 17.99, "texture_mean": 10.38, "perimeter_mean": 122.8, "area_mean": 1001.0, "smoothness_mean": 0.1184, "com
    -H "Content-Type: application/json" \
    -X POST http://0.0.0.0:5000/predict

# GET method info
curl -X GET http://localhost:5000/info

# GET method health
curl -X GET http://localhost:5000/health
```

```
         keen_franklin
ab336fa641c6   9ca97d78cd80                     "/opt/dm_entrypoint.…"   2 weeks ago          Exited (127) 2 weeks ago
         agitated_brahmagupta
rajnishkumarranjan@Rajnishs-MacBook-Pro ms_app % curl -d '[{"radius_mean": 17.99, "texture_mean": 10.38, "perimeter_mean": 122.8, "area_mean": 1001.0, "s
moothness_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": 1.095, "texture_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": 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, "smoothness_worst": 0.1622, "compactness_worst": 0.6656, "concavity_worst": 0.7119, "concave poin
ts_worst": 0.2654, "symmetry_worst": 0.4601, "fractal_dimension_worst": 0.1189}]'  -H "Content-Type: application/json"     -X POST http://0.0.0.0:5000/pr
edict
rajnishkumarranjan@Rajnishs-MacBook-Pro ms_app % curl -d '[{"radius_mean": 17.99, "texture_mean": 10.38, "perimeter_mean": 122.8, "area_mean": 1001.0, "s
moothness_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": 1.095, "texture_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": 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, "smoothness_worst": 0.1622, "compactness_worst": 0.6656, "concavity_worst": 0.7119, "concave poin
ts_worst": 0.2654, "symmetry_worst": 0.4601, "fractal_dimension_worst": 0.1189}]'  -H "Content-Type: application/json"     -X POST http://0.0.0.0:5002/pr
edict
{"label":"M","prediction":1,"status":200}
rajnishkumarranjan@Rajnishs-MacBook-Pro ms_app % curl -X GET http://localhost:5002/health
ok%
rajnishkumarranjan@Rajnishs-MacBook-Pro ms_app % curl -X GET http://localhost:5000/info
Warning: Binary output can mess up your terminal. Use "--output -" to tell
Warning: curl to output it to your terminal anyway, or consider "--output
Warning: <FILE>" to save to a file.
rajnishkumarranjan@Rajnishs-MacBook-Pro ms_app % curl -X GET http://localhost:5002/info
{"name":"Breast Cancer Wisconsin (Diagnostic)","version":"v1.0.0"}
rajnishkumarranjan@Rajnishs-MacBook-Pro ms_app %
```

Creating Docker Images and Testing Them

Please find the code for API app here on here on Github.
 - It’s container deploys API to predict breast cancer using post method

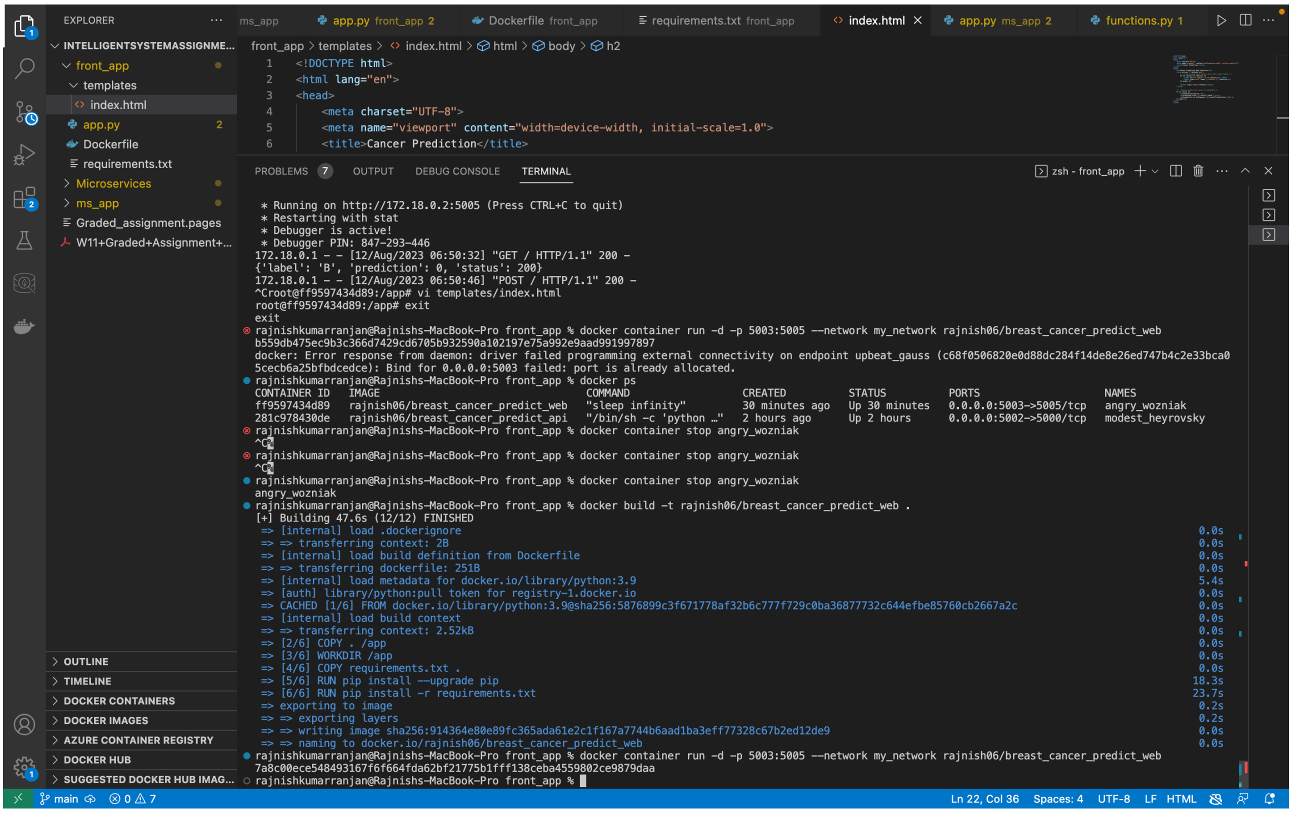


```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Cancer Prediction</title>
```

```
   8 |     RUN pip install --upgrade pip
   9 | >>> RUN pip install -r requirements.txt
  10 |     CMD python app.py
--------------------
ERROR: failed to solve: process "/bin/sh -c pip install -r requirements.txt" did not complete successfully: exit code: 1
rajnishkumarranjan@Rajnishs-MacBook-Pro ms_app % docker build -t rajnish06/breast_cancer_predict_api .
[+] Building 296.4s (12/12) FINISHED
 => [internal] load build definition from Dockerfile                                                                  0.0s
 => => transferring dockerfile: 249B                                                                                  0.0s
 => [internal] load .dockerignore                                                                                     0.0s
 => => transferring context: 2B                                                                                       0.0s
 => [internal] load metadata for docker.io/library/python:3.9                                                         3.8s
 => [auth] library/python:pull token for registry-1.docker.io                                                         0.0s
 => CACHED [1/6] FROM docker.io/library/python:3.9@sha256:5876899c3f671778af32b6c777f729c0ba36877732c644efbe85760cb2667a2c  0.0s
 => [internal] load build context                                                                                     0.0s
 => => transferring context: 722B                                                                                     0.0s
 => [2/6] COPY . /app                                                                                                 0.0s
 => [3/6] WORKDIR /app                                                                                                0.0s
 => [4/6] COPY requirements.txt .                                                                                     0.0s
 => [5/6] RUN pip install --upgrade pip                                                                               7.8s
 => [6/6] RUN pip install -r requirements.txt                                                                       282.8s
 => exporting to image                                                                                                1.8s
 => => exporting layers                                                                                               1.8s
 => => writing image sha256:bd6e6face6016b170f2e3542de26fe5624395528022b976df7f67241473cb0a2                          0.0s
 => => naming to docker.io/rajnish06/breast_cancer_predict_api                                                        0.0s
rajnishkumarranjan@Rajnishs-MacBook-Pro ms_app % docker container run rajnish06/breast_cancer_predict_api -p 5000:5000 -d
docker: Error response from daemon: failed to create task for container: failed to create shim task: OCI runtime create failed: runc create failed: unable t
o start container process: exec: "-p": executable file not found in $PATH: unknown.
rajnishkumarranjan@Rajnishs-MacBook-Pro ms_app % docker container run -d -p 5000:5000 rajnish06/breast_cancer_predict_api
2e59c80fc9940a7f9245b59a4854af9b0f870f753967512963e940820af3dc66
docker: Error response from daemon: Ports are not available: exposing port TCP 0.0.0.0:5000 -> 0.0.0.0:0: listen tcp 0.0.0.0:5000: bind: address already in
use.
rajnishkumarranjan@Rajnishs-MacBook-Pro ms_app % docker container run -d -p 5000:5001 rajnish06/breast_cancer_predict_api
dbee1007929483f3379230eb7b4efceb6fcab6c4855944e6183a906b68e9efae
docker: Error response from daemon: Ports are not available: exposing port TCP 0.0.0.0:5000 -> 0.0.0.0:0: listen tcp 0.0.0.0:5000: bind: address already in
use.
rajnishkumarranjan@Rajnishs-MacBook-Pro ms_app % docker container run -d -p 5001:5001 rajnish06/breast_cancer_predict_api
c6421755c0307e9a4621635dd8ad2ab6d73050d2e1b951396c06d9bdbb4de118
rajnishkumarranjan@Rajnishs-MacBook-Pro ms_app % docker ps -a
CONTAINER ID   IMAGE                                COMMAND                  CREATED          STATUS                    PORTS
      NAMES
c6421755c030   rajnish06/breast_cancer_predict_api   "/bin/sh -c 'python …"   9 seconds ago    Up 8 seconds              5000/tcp, 0.0.0.0:5001->5001/
tcp   compassionate_dewdney
dbee10079294   rajnish06/breast_cancer_predict_api   "/bin/sh -c 'python …"   18 seconds ago   Created
      elated_taussig
2e59c80fc994   rajnish06/breast_cancer_predict_api   "/bin/sh -c 'python …"   31 seconds ago   Created
      unruffled_feistel
```

Please find the code related to web app image here on Github.

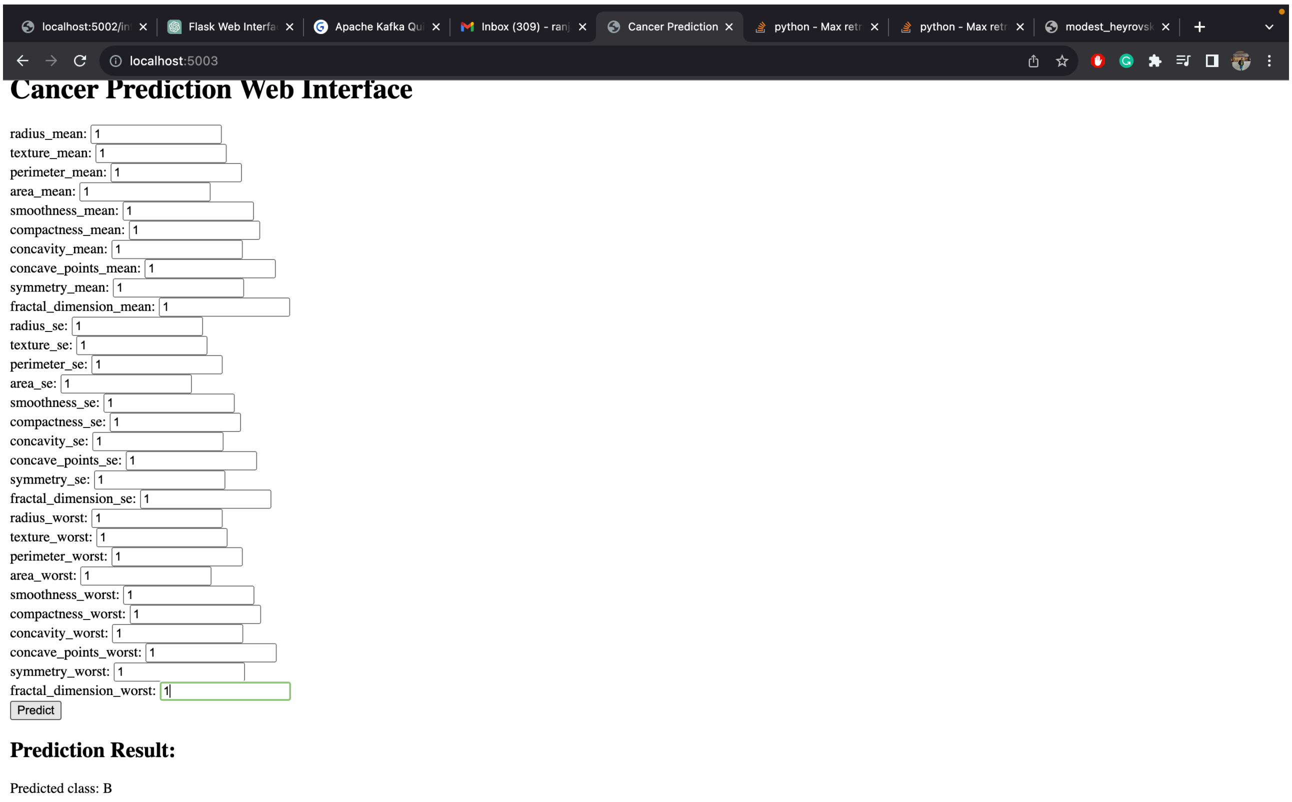
 - It’s container creates a form web UI, when filled and upon clicking on predict, it shows the prediction



```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Cancer Prediction</title>
```

```
 * Running on http://172.18.0.2:5005 (Press CTRL+C to quit)
 * Restarting with stat
 * Debugger is active!
 * Debugger PIN: 847-293-446
172.18.0.1 - - [12/Aug/2023 06:50:32] "GET / HTTP/1.1" 200 -
{'label': 'B', 'prediction': 0, 'status': 200}
172.18.0.1 - - [12/Aug/2023 06:50:46] "POST / HTTP/1.1" 200 -
^Croot@ff9597434d89:/app# vi templates/index.html
root@ff9597434d89:/app# exit
exit
rajnishkumarranjan@Rajnishs-MacBook-Pro front_app % docker container run -d -p 5003:5005 --network my_network rajnish06/breast_cancer_predict_web
b559db475ec9b3c366d7429cd6705b932590a102197e75a992e9aad991997897
docker: Error response from daemon: driver failed programming external connectivity on endpoint upbeat_gauss (c68f0506820e0d88dc284f14de8e26ed747b4c2e33bca0
5cecb6a25bfbdcedce): Bind for 0.0.0.0:5003 failed: port is already allocated.
rajnishkumarranjan@Rajnishs-MacBook-Pro front_app % docker ps
CONTAINER ID   IMAGE                                COMMAND                  CREATED          STATUS          PORTS                    NAMES
ff9597434d89   rajnish06/breast_cancer_predict_web   "sleep infinity"         30 minutes ago   Up 30 minutes   0.0.0.0:5003->5005/tcp   angry_wozniak
281c978430de   rajnish06/breast_cancer_predict_api   "/bin/sh -c 'python …"   2 hours ago      Up 2 hours      0.0.0.0:5002->5000/tcp   modest_heyrovsky
rajnishkumarranjan@Rajnishs-MacBook-Pro front_app % docker container stop angry_wozniak
^C%
rajnishkumarranjan@Rajnishs-MacBook-Pro front_app % docker container stop angry_wozniak
^C%
rajnishkumarranjan@Rajnishs-MacBook-Pro front_app % docker container stop angry_wozniak
angry_wozniak
rajnishkumarranjan@Rajnishs-MacBook-Pro front_app % docker build -t rajnish06/breast_cancer_predict_web .
[+] Building 47.6s (12/12) FINISHED
 => [internal] load .dockerignore                                                                                     0.0s
 => => transferring context: 2B                                                                                       0.0s
 => [internal] load build definition from Dockerfile                                                                  0.0s
 => => transferring dockerfile: 251B                                                                                  0.0s
 => [internal] load metadata for docker.io/library/python:3.9                                                         5.4s
 => [auth] library/python:pull token for registry-1.docker.io                                                         0.0s
 => CACHED [1/6] FROM docker.io/library/python:3.9@sha256:5876899c3f671778af32b6c777f729c0ba36877732c644efbe85760cb2667a2c  0.0s
 => [internal] load build context                                                                                     0.0s
 => => transferring context: 2.52kB                                                                                   0.0s
 => [2/6] COPY . /app                                                                                                 0.0s
 => [3/6] WORKDIR /app                                                                                                0.0s
 => [4/6] COPY requirements.txt .                                                                                     0.0s
 => [5/6] RUN pip install --upgrade pip                                                                              18.3s
 => [6/6] RUN pip install -r requirements.txt                                                                        23.7s
 => exporting to image                                                                                                0.2s
 => => exporting layers                                                                                               0.2s
 => => writing image sha256:914364e80e89fc365ada61e2c1f167a7744b6aad1ba3eff77328c67b2ed12de9                          0.0s
 => => naming to docker.io/rajnish06/breast_cancer_predict_web                                                        0.0s
rajnishkumarranjan@Rajnishs-MacBook-Pro front_app % docker container run -d -p 5003:5005 --network my_network rajnish06/breast_cancer_predict_web
7a8c00ece548493167f6f664fda62bf21775b1fff138ceba4559802ce9879daa
rajnishkumarranjan@Rajnishs-MacBook-Pro front_app %
```

Web UI illustration



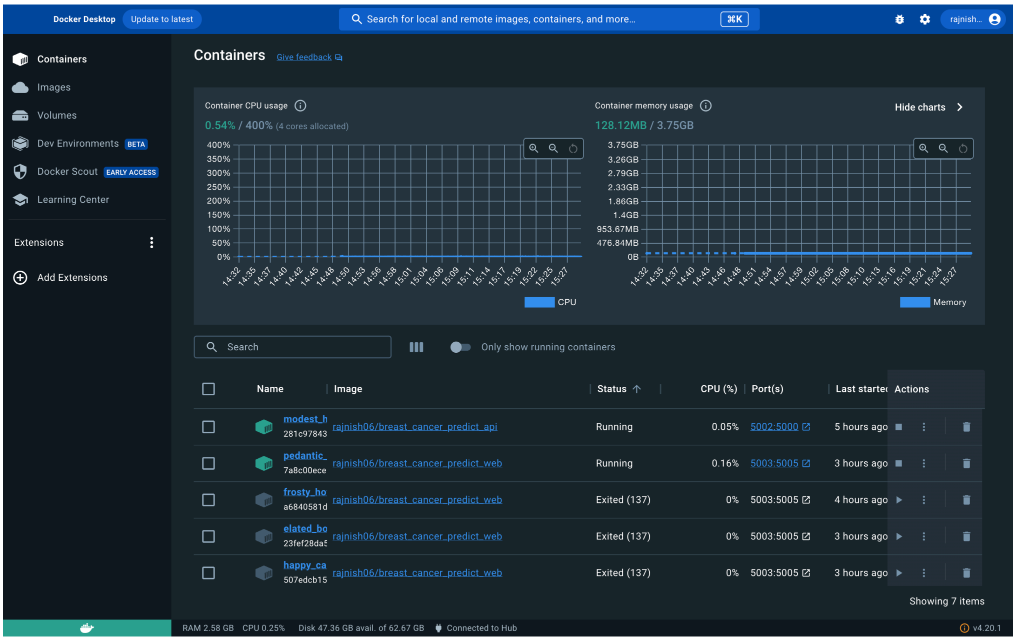
Cancer Prediction Web Interface

radius_mean: 1
texture_mean: 1
perimeter_mean: 1
area_mean: 1
smoothness_mean: 1
compactness_mean: 1
concavity_mean: 1
concave_points_mean: 1
symmetry_mean: 1
fractal_dimension_mean: 1
radius_se: 1
texture_se: 1
perimeter_se: 1
area_se: 1
smoothness_se: 1
compactness_se: 1
concavity_se: 1
concave_points_se: 1
symmetry_se: 1
fractal_dimension_se: 1
radius_worst: 1
texture_worst: 1
perimeter_worst: 1
area_worst: 1
smoothness_worst: 1
compactness_worst: 1
concavity_worst: 1
concave_points_worst: 1
symmetry_worst: 1
fractal_dimension_worst: 1

Predict

Prediction Result:

Predicted class: B



Containers

☐	Name	Image	Status	CPU (%)	Port(s)	Last startec	Actions
☐	modest_h 281c97843	rajnish06/breast_cancer_predict_api	Running	0.05%	5002:5000	5 hours ago	■ ⋮
☐	pedantic_ 7a8c00ece	rajnish06/breast_cancer_predict_web	Running	0.16%	5003:5005	3 hours ago	■ ⋮
☐	frosty_ho a6840581d	rajnish06/breast_cancer_predict_web	Exited (137)	0%	5003:5005	4 hours ago	▶ ⋮
☐	elated_bo 23fef28da5	rajnish06/breast_cancer_predict_web	Exited (137)	0%	5003:5005	3 hours ago	▶ ⋮
☐	happy_ca 507edcb15	rajnish06/breast_cancer_predict_web	Exited (137)	0%	5003:5005	3 hours ago	▶ ⋮

Showing 7 items

RAM 2.58 GB CPU 0.25% Disk 47.36 GB avail. of 62.67 GB Connected to Hub v4.20.1