In-class Assignment 2

Instructor: Qasim Ali

Develop and Deploy a Machine Learning Application using Docker

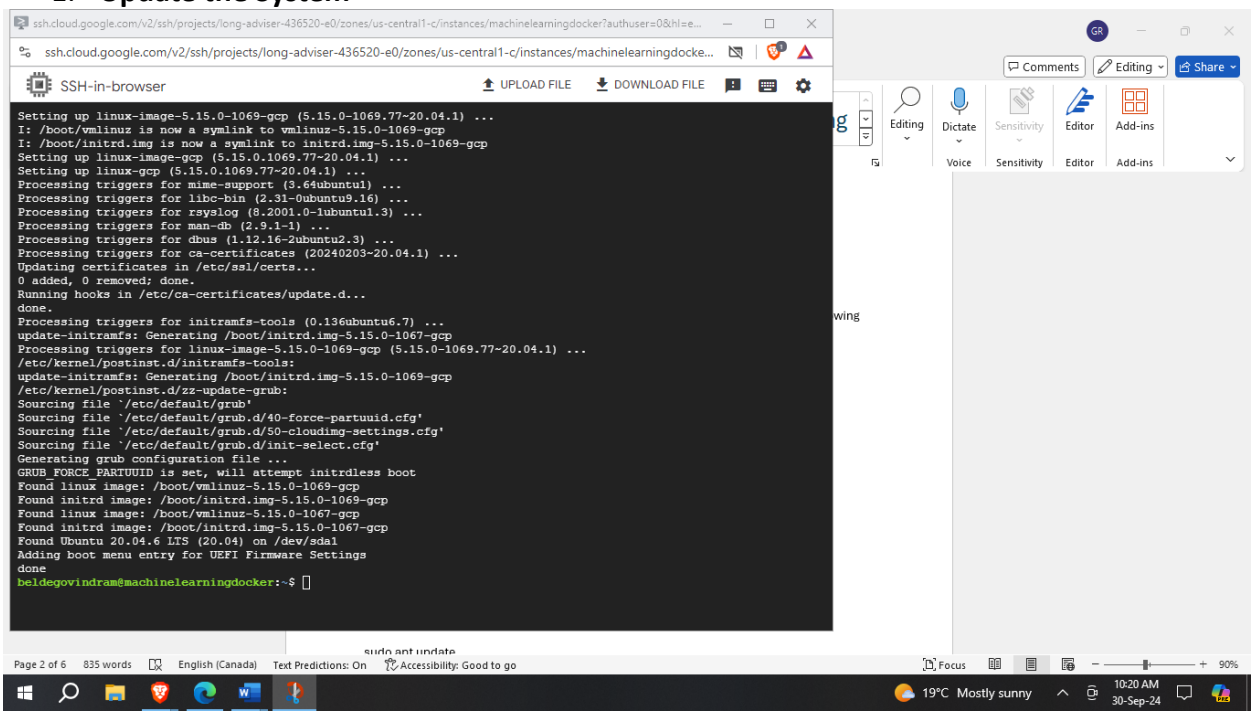
Group C

Govind Ram Gupta Belde

Assignment Steps

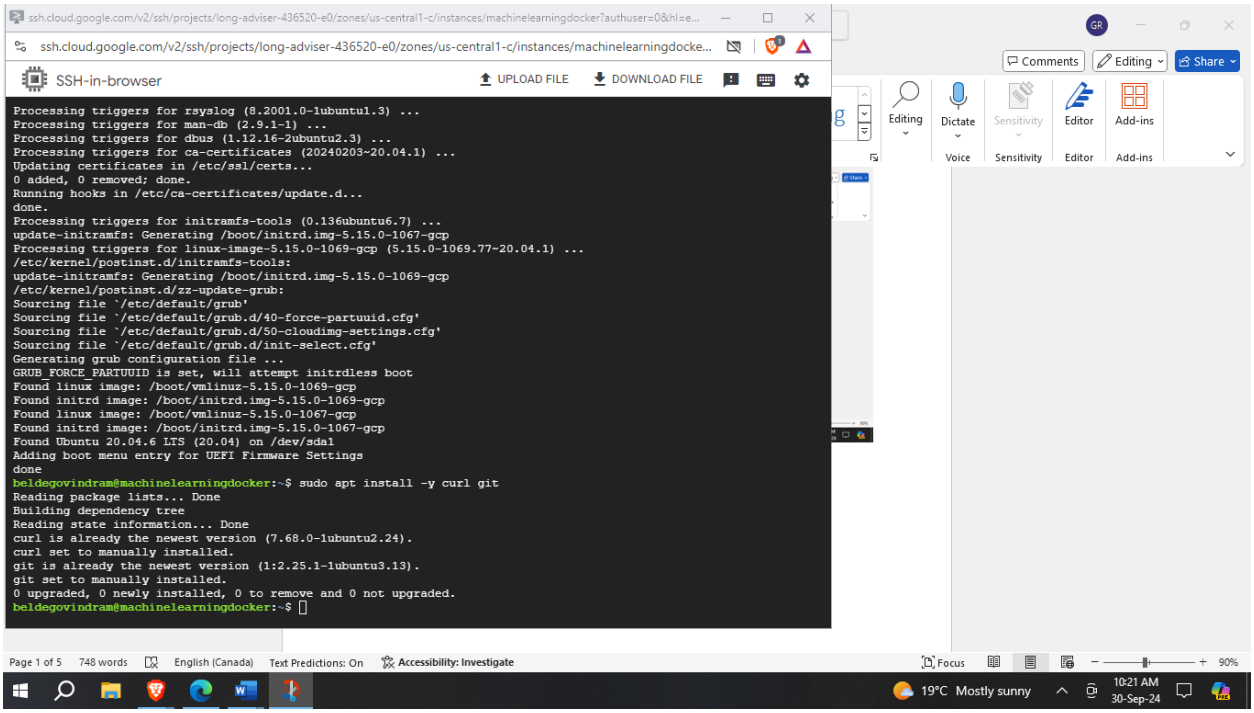
Step 1: Set Up the VM

1. **Update the System**



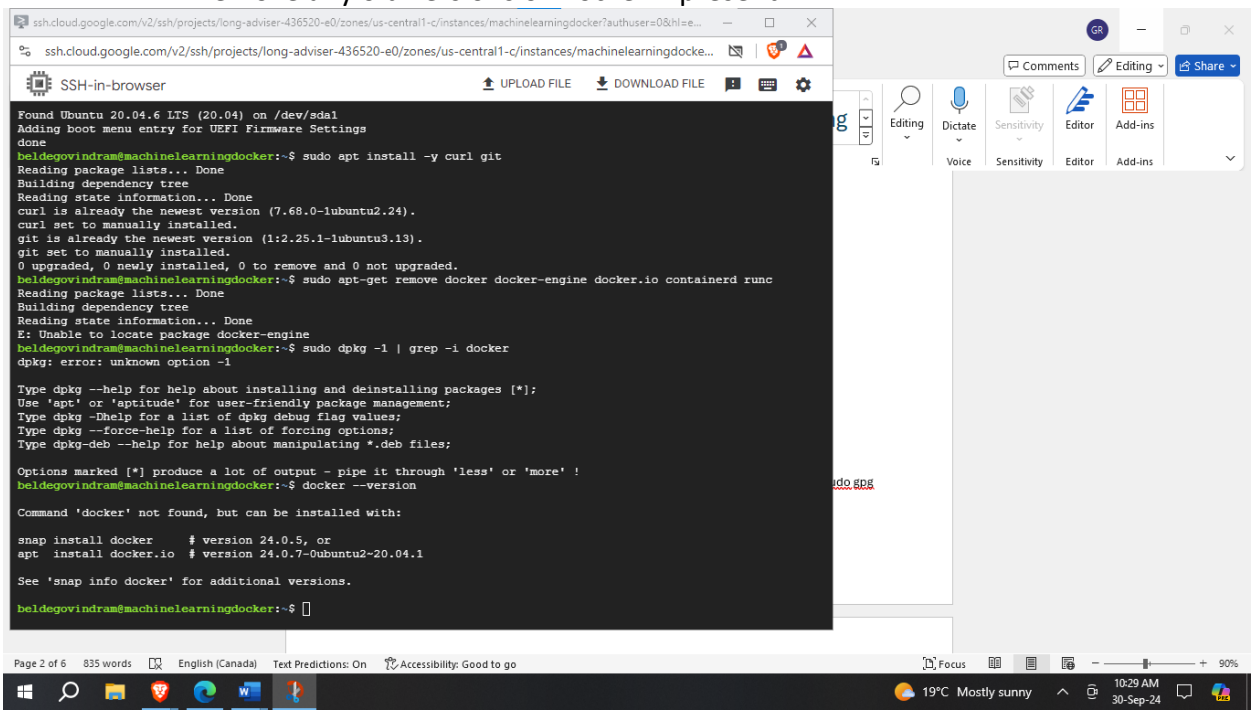
2. **Install Necessary Packages**
   - Install curl and git:

sudo apt install -y curl git



Step 2: Install Docker

1. **Remove Old Versions**
   - Remove any old versions of Docker if present:

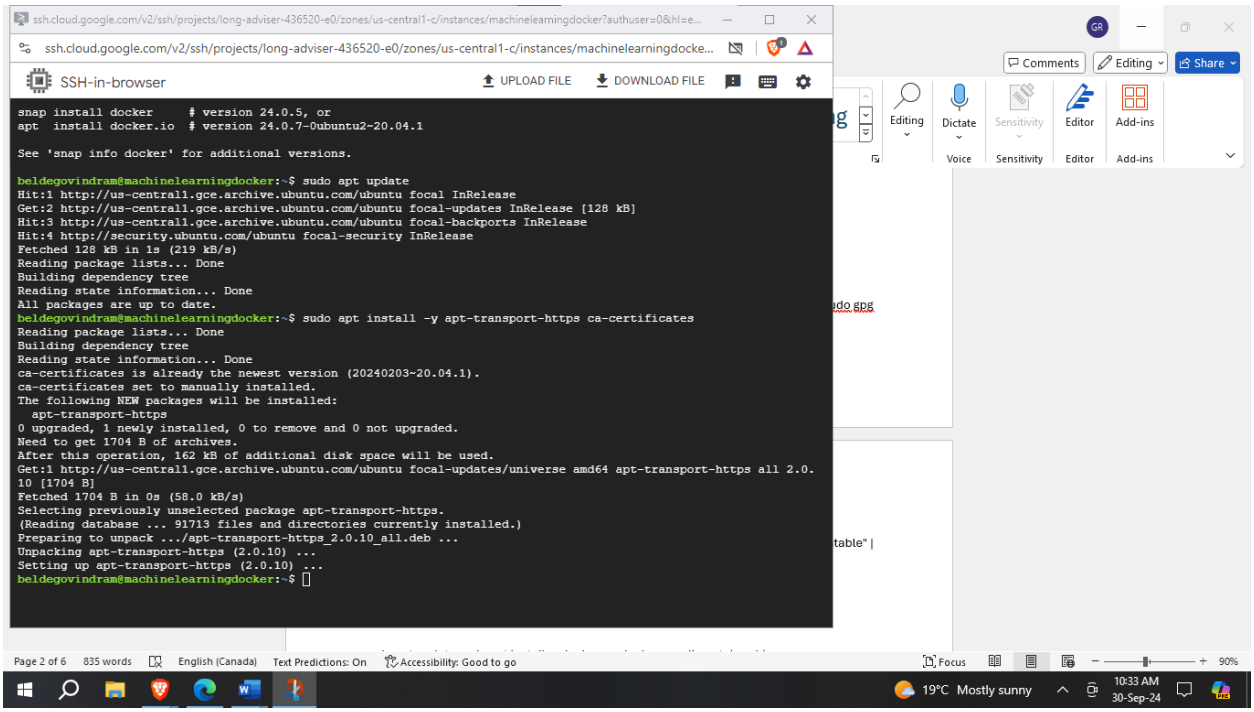


There are no versions of docker installed so we proceed.

2. **Set Up the Docker Repository**
    - Run the following commands to set up the Docker repository:

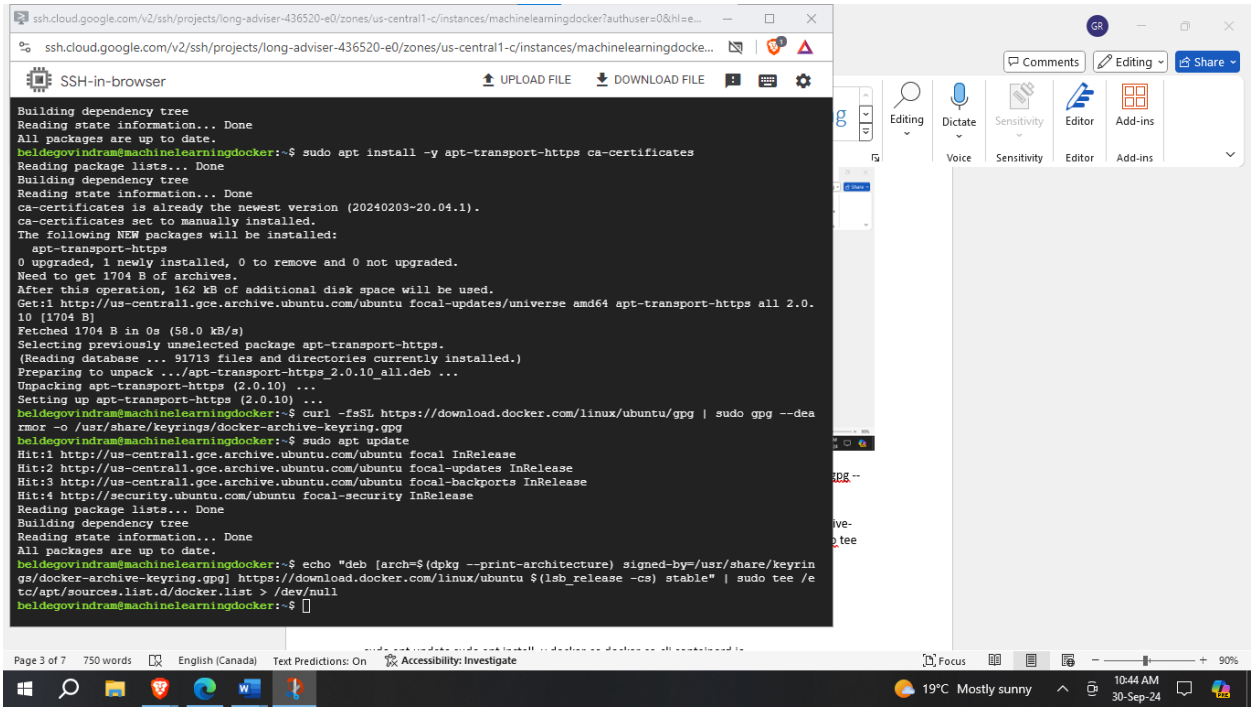
sudo apt update

sudo apt install -y apt-transport-https ca-certificates



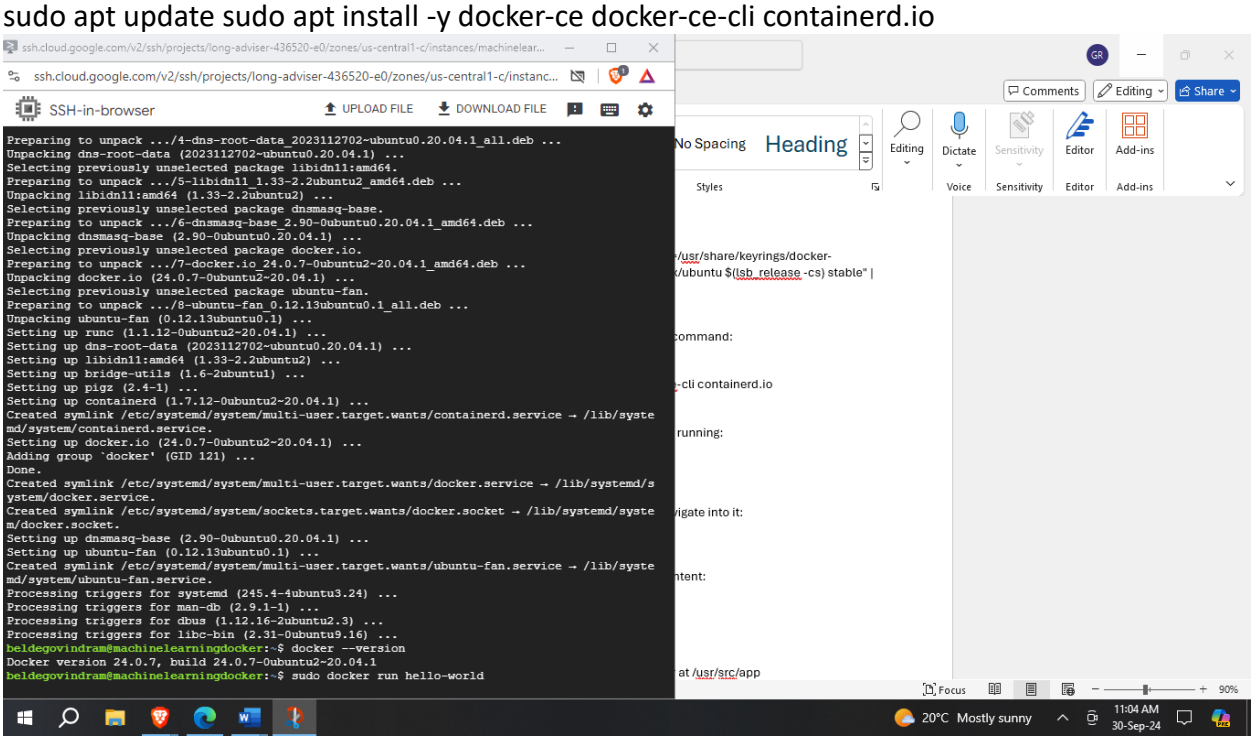
curl gnupg lsb-release curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo gpg --dearmor -o /usr/share/keyrings/docker-archive-keyring.gpg

echo "deb [arch=$(dpkg --print-architecture) signed-by=/usr/share/keyrings/docker-archive-keyring.gpg] https://download.docker.com/linux/ubuntu $(lsb_release -cs) stable" | sudo tee /etc/apt/sources.list.d/docker.list > /dev/null



3. **Install Docker Engine**
    - Install Docker Engine using the following command:

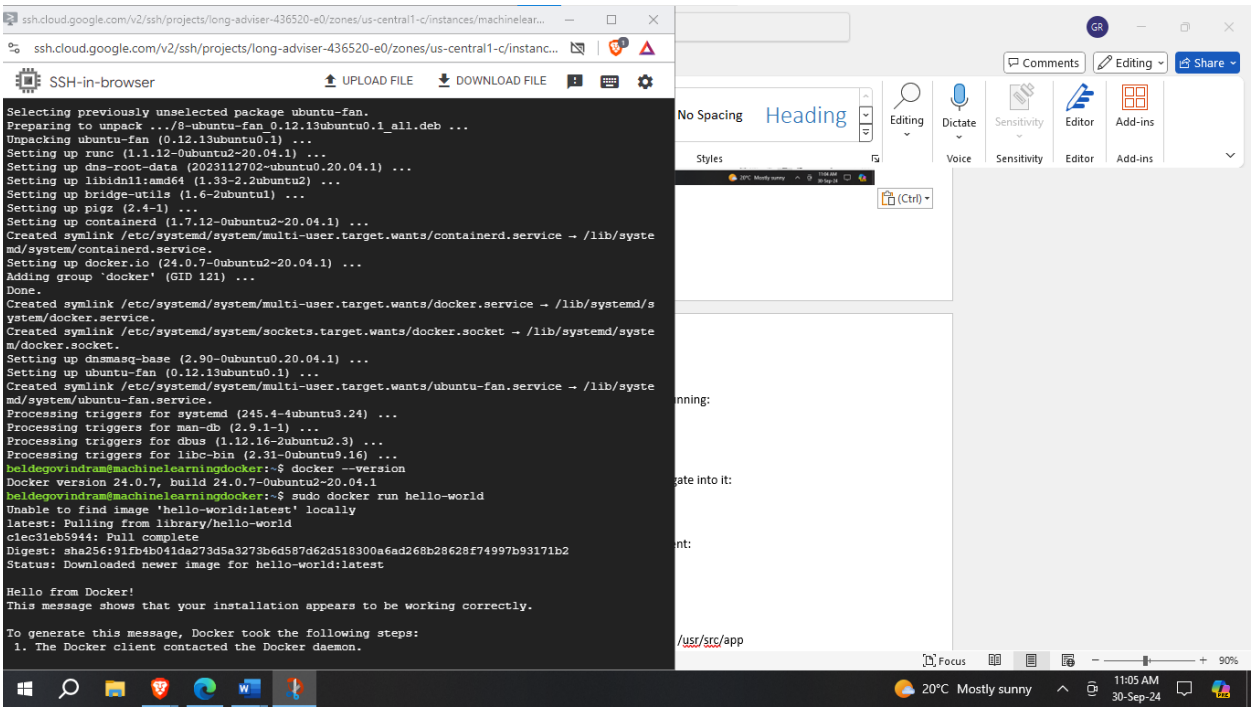
sudo apt update sudo apt install -y docker-ce docker-ce-cli containerd.io



4. **Verify Docker Installation**

- Verify that Docker is installed correctly by running:

sudo docker run hello-world

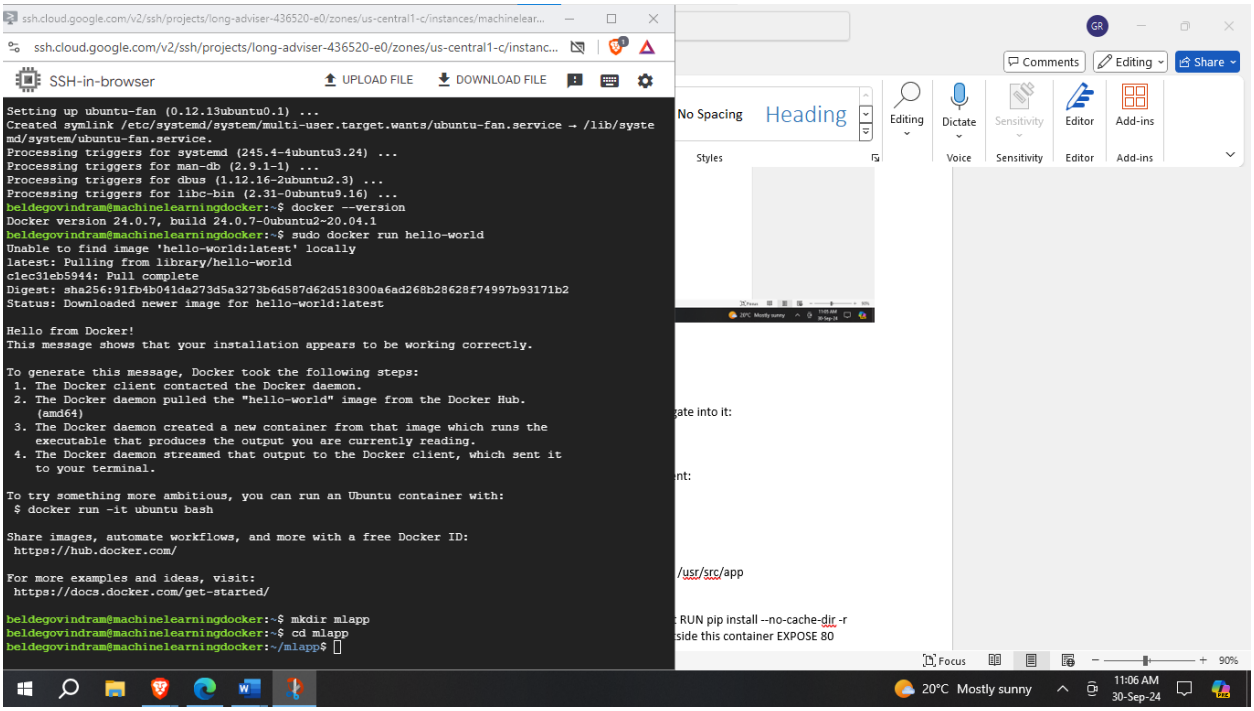


WE can see that docker is installed correctly.

Step 3: Create a Dockerfile for the ML Application

1. **Create Project Directory**
    - Create a directory for your project and navigate into it:

mkdir ml-app cd ml-app



2. **Create a Dockerfile**
   - Create a **Dockerfile** with the following content:

Use an official Python runtime as a parent image
FROM python:3.9-slim
Set the working directory
WORKDIR /usr/src/app
Copy the current directory contents into the container at /usr/src/app
*****YOU NEED TO WRITE COMMAND HERE*****

Install any needed packages specified in requirements.txt RUN pip install --no-cache-dir -r requirements.txt # Make port 80 available to the world outside this container EXPOSE 80

Run app.py when the container launches CMD ["python", "app.py"]

ssh.cloud.google.com/v2/ssh/projects/long-adviser-436520-e0/zones/us-central1-c/instances/machinelear...

SSH-in-browser UPLOAD FILE DOWNLOAD FILE

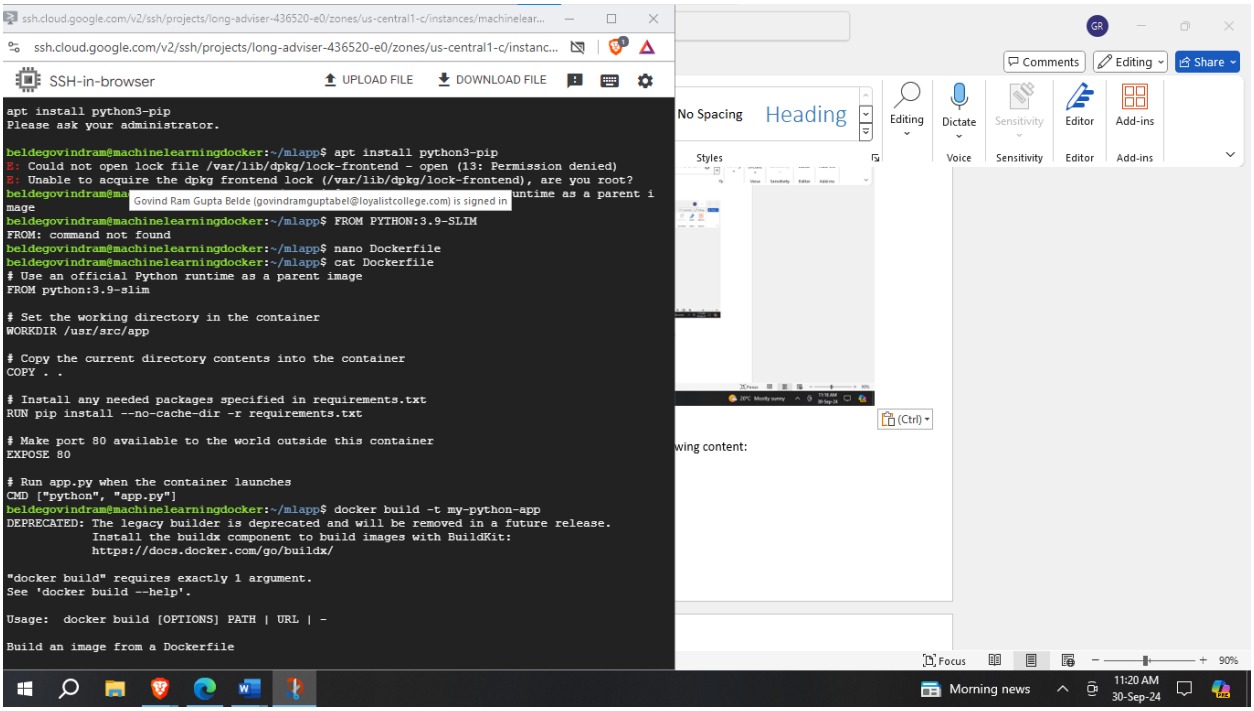
```
  GNU nano 4.8                    Dockerfile                    Modified
# Use an official Python runtime as a parent image
FROM python:3.9-slim

# Set the working directory in the container
WORKDIR /usr/src/app

# Copy the current directory contents into the container
COPY . .

# Install any needed packages specified in requirements.txt
RUN pip install --no-cache-dir -r requirements.txt

# Make port 80 available to the world outside this container
EXPOSE 80

# Run app.py when the container launches
CMD ["python", "app.py"]
[]

^G Get Help   ^O Write Out   ^W Where Is   ^K Cut Text   ^J Justify   ^C Cur Pos
^X Exit       ^R Read File   ^\ Replace    ^U Paste Text ^T To Spell   ^_ Go To Line
```

ssh.cloud.google.com/v2/ssh/projects/long-adviser-436520-e0/zones/us-central1-c/instances/machinelear...

SSH-in-browser UPLOAD FILE DOWNLOAD FILE

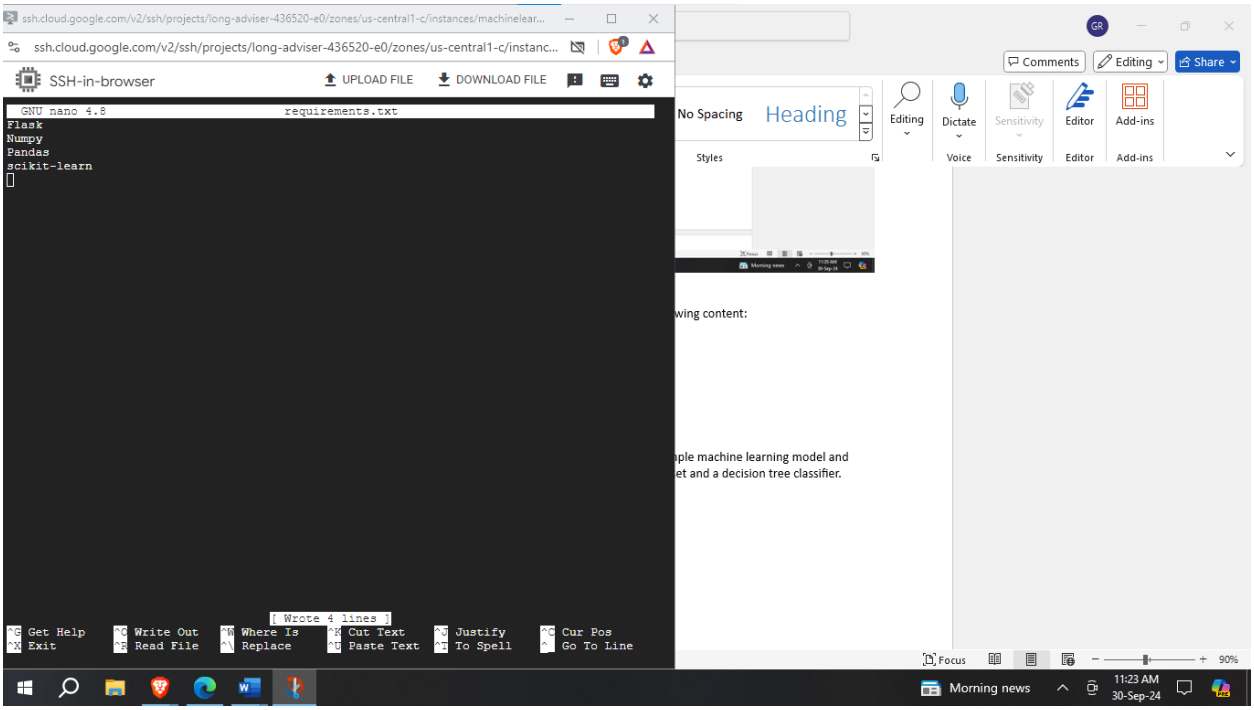
```
beldegovindram@machinelearningdocker:~$ mkdir mlapp
beldegovindram@machinelearningdocker:~$ cd mlapp
beldegovindram@machinelearningdocker:~/mlapp$ FROM python:3.9-slim
FROM: command not found
beldegovindram@machinelearningdocker:~/mlapp$ touch Dockerfile
beldegovindram@machinelearningdocker:~/mlapp$ pip freeze ? requirements.txt

Command 'pip' not found, but can be installed with:

apt install python3-pip
Please ask your administrator.

beldegovindram@machinelearningdocker:~/mlapp$ apt install python3-pip
E: Could not open lock file /var/lib/dpkg/lock-frontend - open (13: Permission denied)
E: Unable to acquire the dpkg frontend lock (/var/lib/dpkg/lock-frontend), are you root?
beldegovindram@machinelearningdocker:~/mlapp$ #use an official python runtime as a parent i
mage
beldegovindram@machinelearningdocker:~/mlapp$ FROM PYTHON:3.9-SLIM
FROM: command not found
beldegovindram@machinelearningdocker:~/mlapp$ nano Dockerfile
beldegovindram@machinelearningdocker:~/mlapp$ cat Dockerfile
# Use an official Python runtime as a parent image
FROM python:3.9-slim

# Set the working directory in the container
WORKDIR /usr/src/app

# Copy the current directory contents into the container
COPY . .

# Install any needed packages specified in requirements.txt
RUN pip install --no-cache-dir -r requirements.txt

# Make port 80 available to the world outside this container
EXPOSE 80

# Run app.py when the container launches
CMD ["python", "app.py"]
beldegovindram@machinelearningdocker:~/mlapp$ []
```

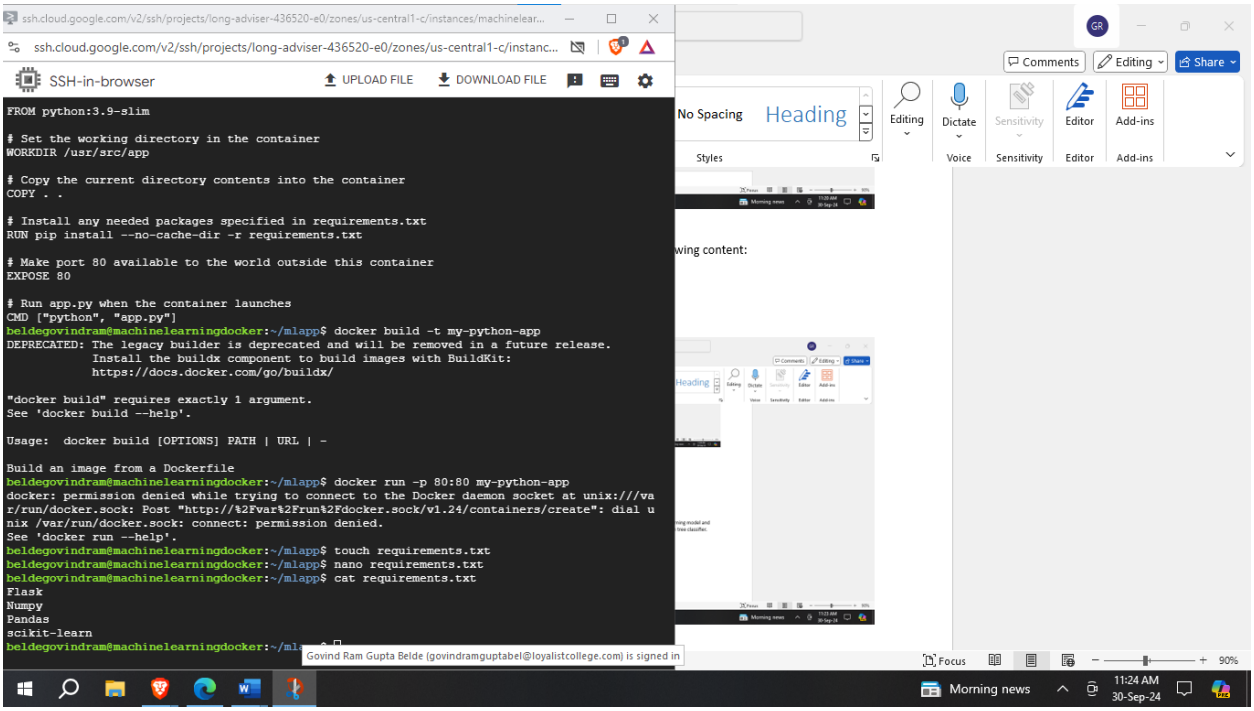
Govind Ram Gupta Belde (govindramguptabel@loyalistcollege.com) is signed in



3. **Create requirements.txt File**
   - Create a **requirements.txt** file with the following content:

Flask
Numpy
Pandas
scikit-learn

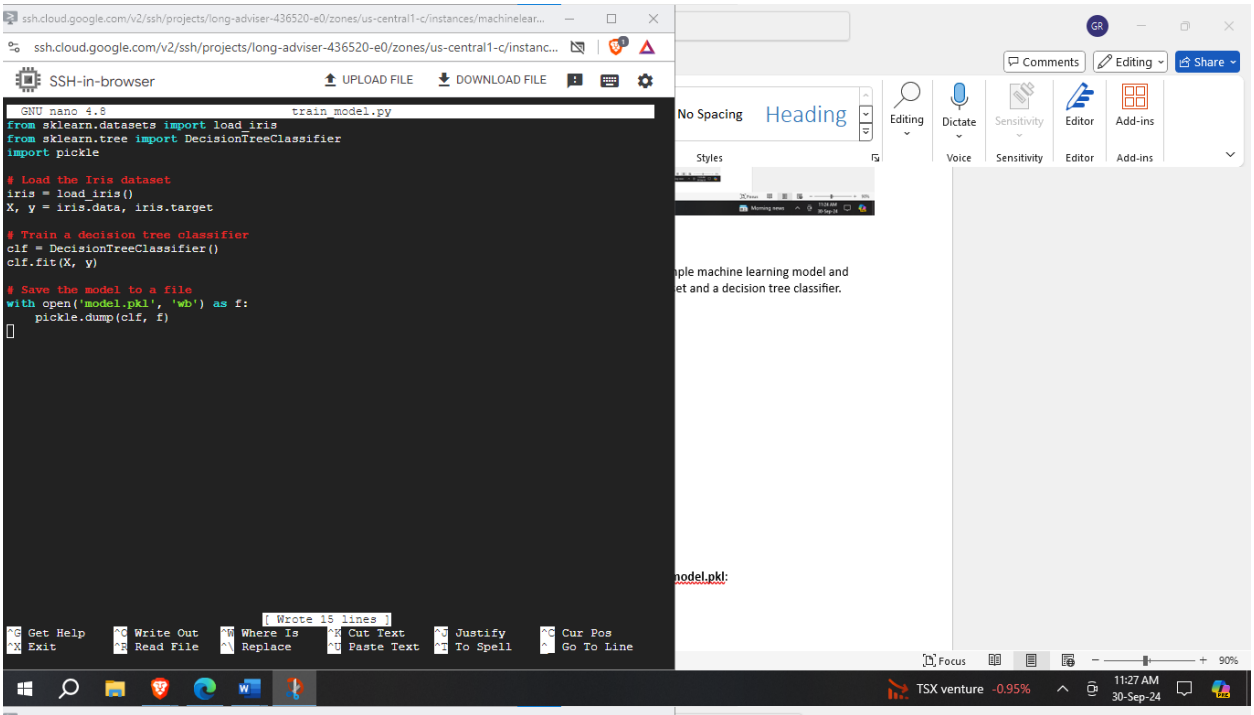


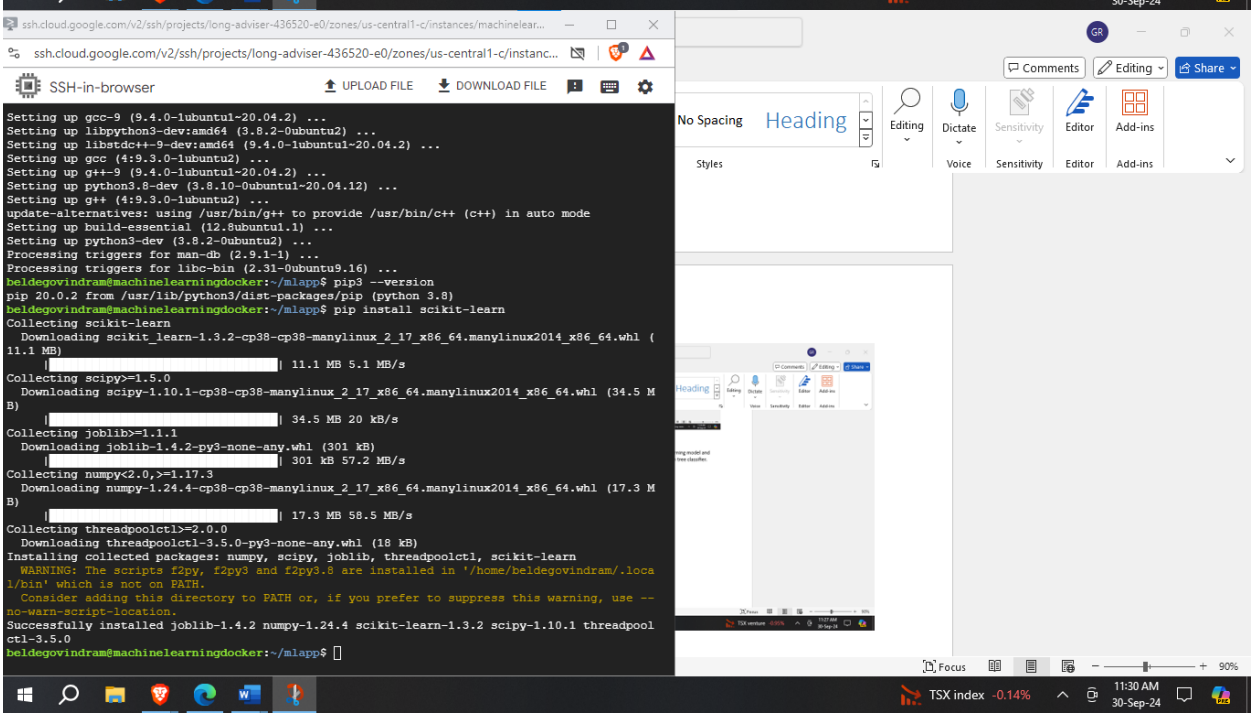


Step 4: Develop the Machine Learning Application

1. **Create a Simple ML Model**
    - Create a script **train_model.py** to train a simple machine learning model and save it. For simplicity, we'll use the Iris dataset and a decision tree classifier.

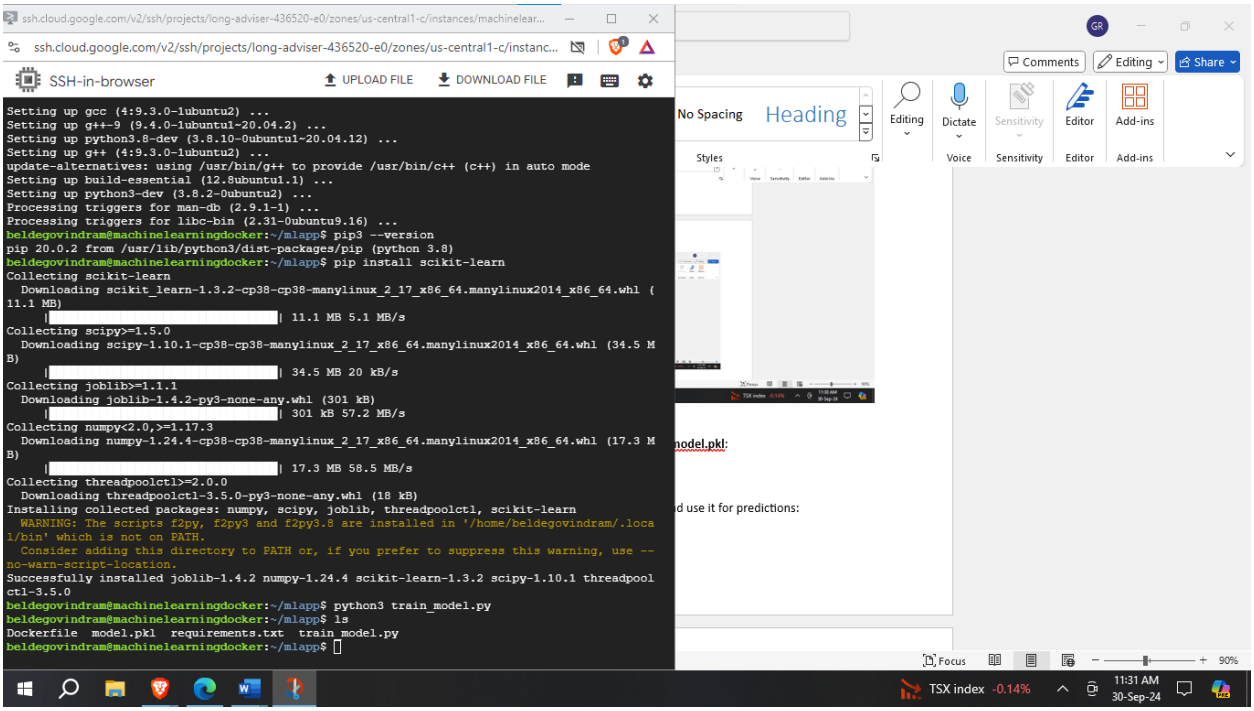
```
from sklearn.datasets import load_iris
from sklearn.tree import DecisionTreeClassifier
import pickle

# Load the Iris dataset
iris = load_iris()
X, y = iris.data, iris.target

# Train a decision tree classifier
clf = DecisionTreeClassifier() clf.fit(X, y)

# Save the model to a file
with open('model.pkl', 'wb') as f:
pickle.dump(clf, f)
```





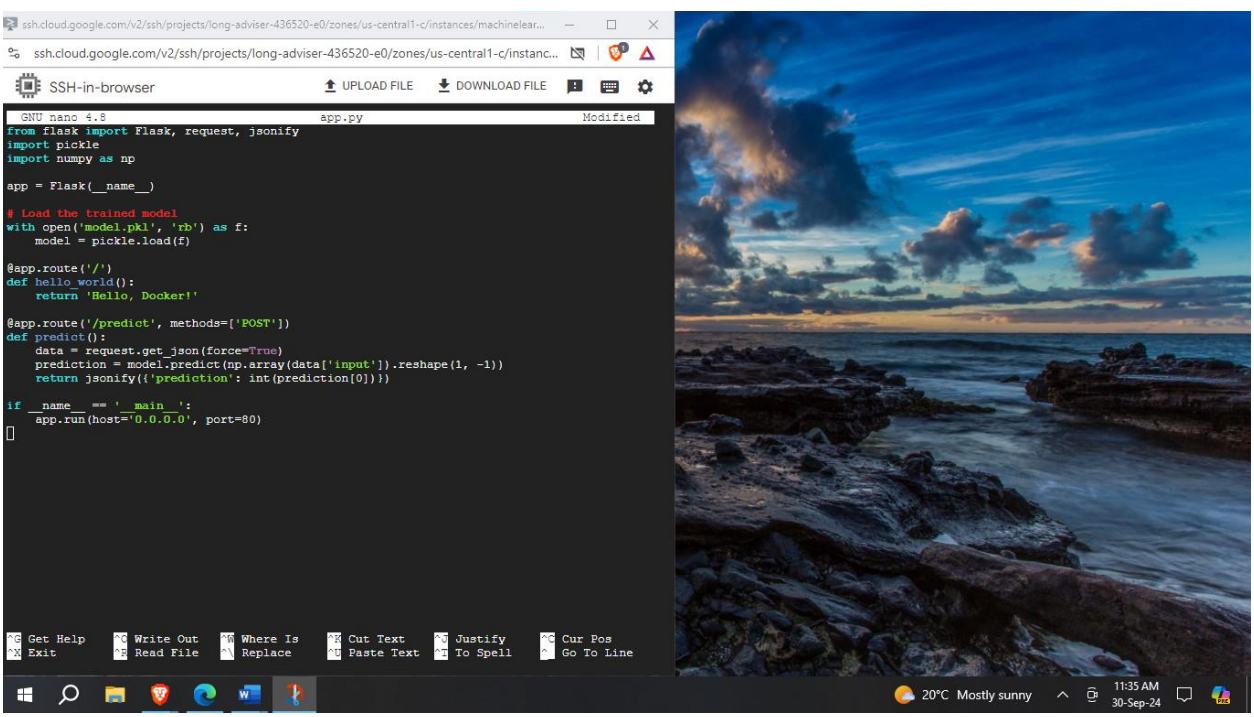
2. **Run the Model Training Script**
   - Run the **train_model.py** script to generate **model.pkl**:

python train_model.py



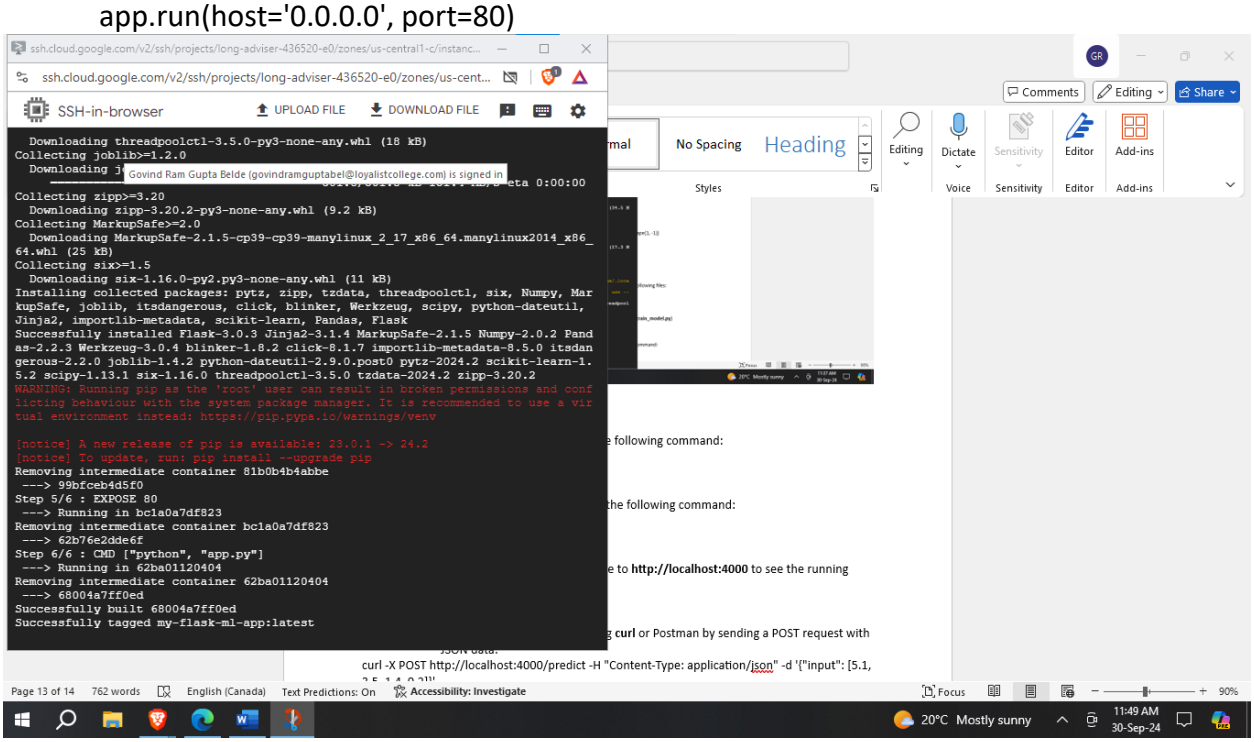
Sccessfully trained the model

3. **Integrate the Model into the Flask App**
    - Update **app.py** to load the trained model and use it for predictions:



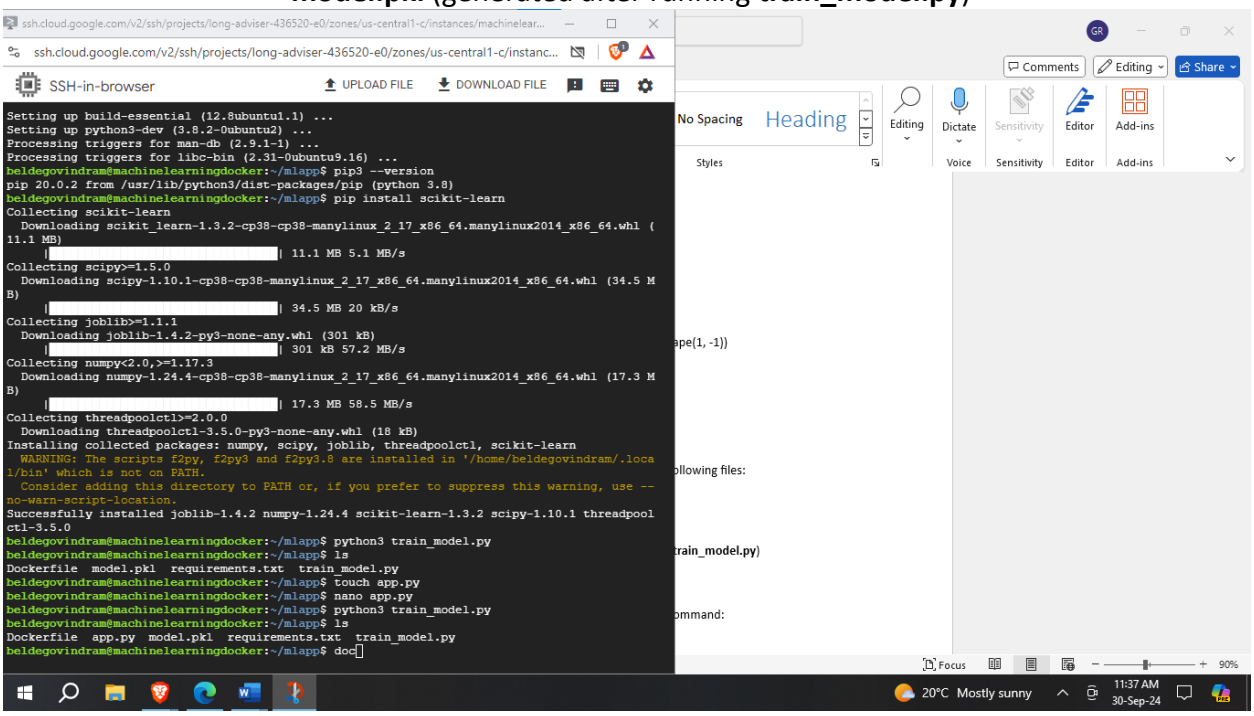
from flask import Flask, request, jsonify

```
import pickle
import numpy as np

app = Flask(__name__)

# Load the trained model
with open('model.pkl', 'rb') as f:
        model = pickle.load(f)

@app.route('/')
def hello_world():
    return 'Hello, Docker!'

@app.route('/predict', methods=['POST'])
def predict():
    data = request.get_json(force=True)
    prediction = model.predict(np.array(data['input']).reshape(1, -1))
    return jsonify({'prediction': int(prediction[0])})

    if __name__ == '__main__':
        app.run(host='0.0.0.0', port=80)
```



4. **Update the Project Directory**
    - Ensure your project directory contains the following files:
        - **Dockerfile**
        - **requirements.txt**

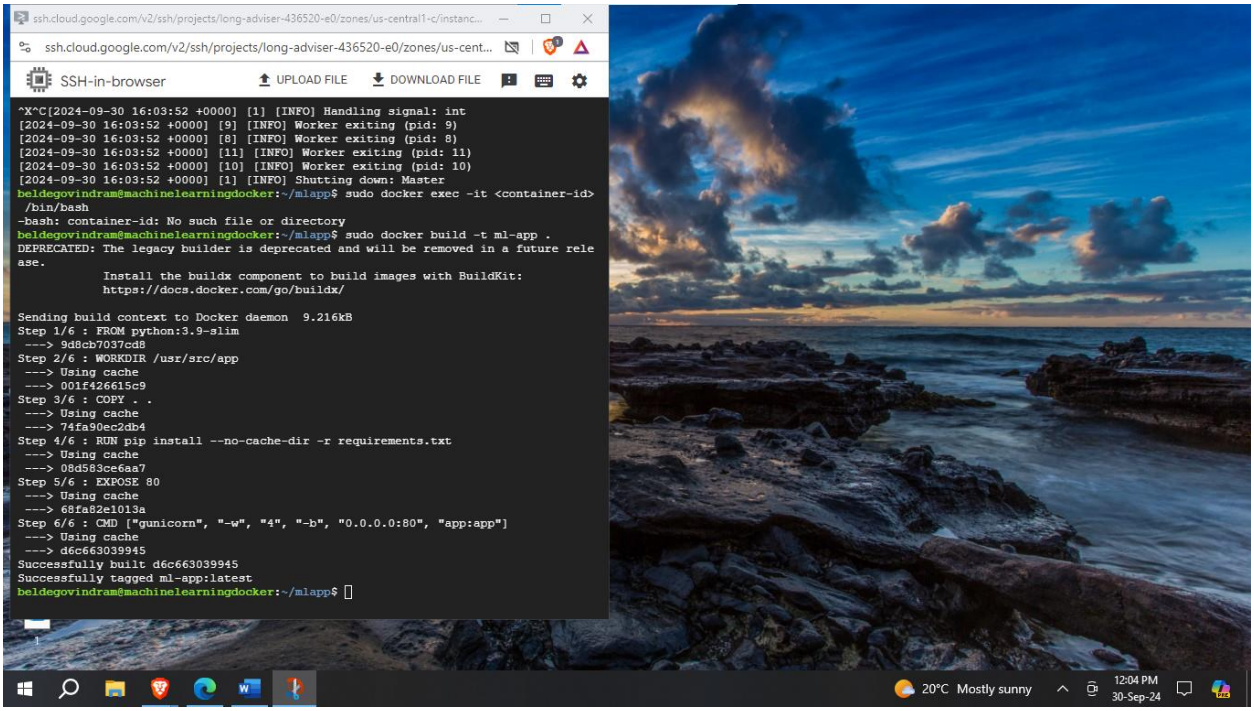
- **train_model.py**
- **app.py**
- **model.pkl** (generated after running **train_model.py**)



Step 5: Build and Run the Docker Container

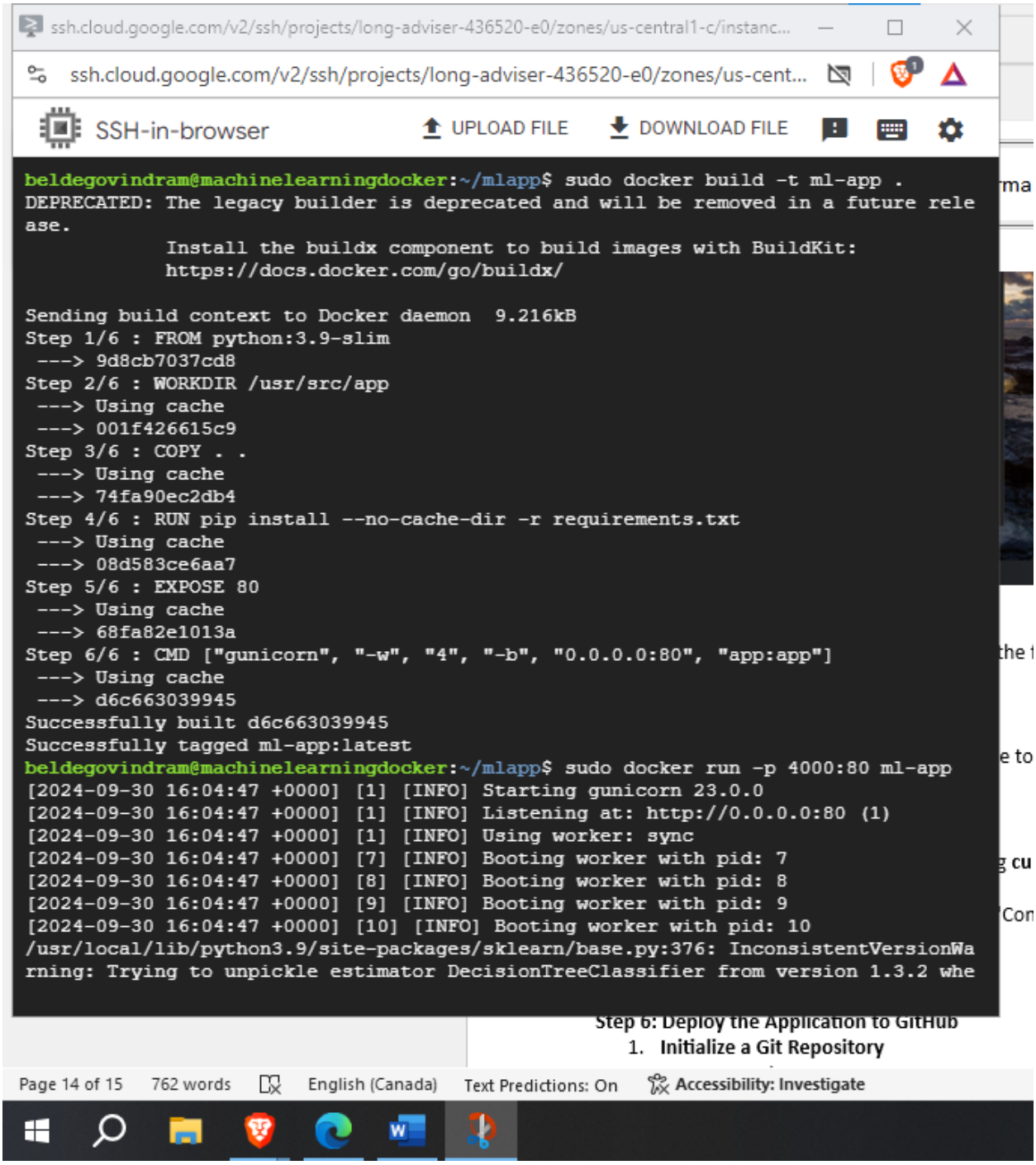
1. **Build the Docker Image**
   - Build the Docker image with the following command:

sudo docker build -t ml-app .

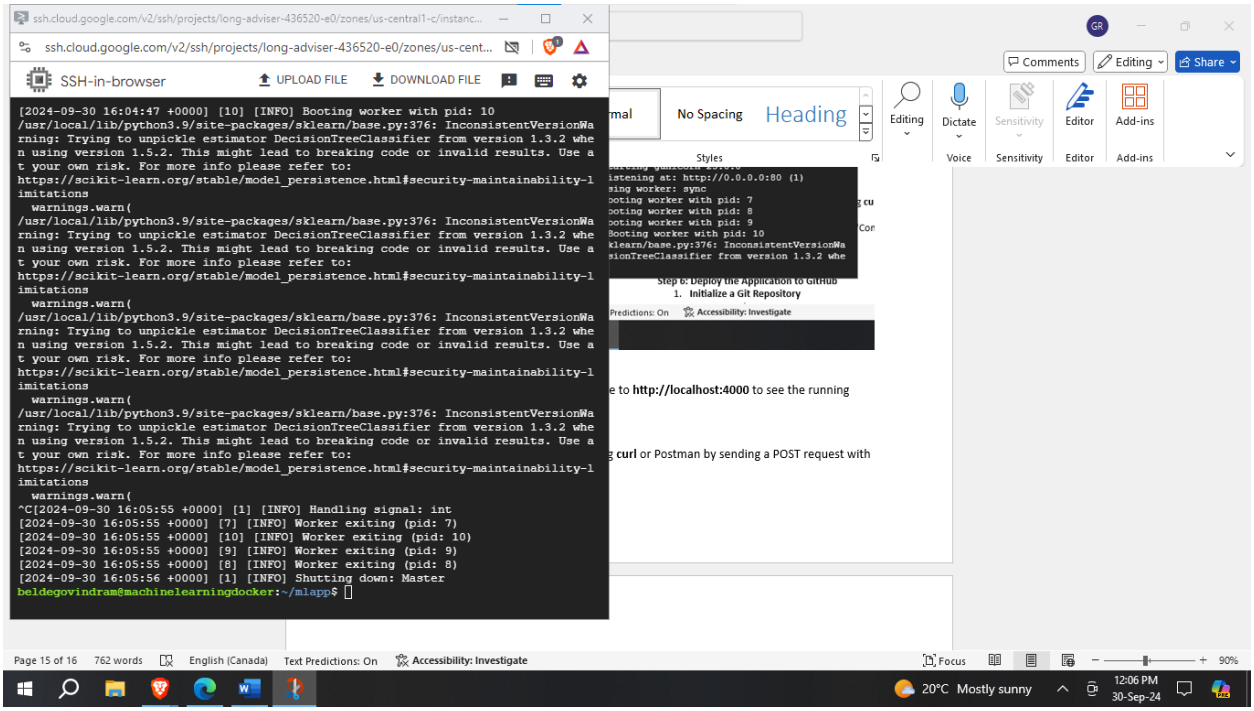


2. **Run the Docker Container**
    - Run the Docker container with the following command:

sudo docker run -p 4000:80 ml-app



3. **Access the Application**
    - Open your browser and navigate to **http://localhost:4000** to see the running application.



```
[2024-09-30 16:04:47 +0000] [10] [INFO] Booting worker with pid: 10
/usr/local/lib/python3.9/site-packages/sklearn/base.py:376: InconsistentVersionWa
rning: Trying to unpickle estimator DecisionTreeClassifier from version 1.3.2 whe
n using version 1.5.2. This might lead to breaking code or invalid results. Use a
t your own risk. For more info please refer to:
https://scikit-learn.org/stable/model_persistence.html#security-maintainability-l
imitations
  warnings.warn(
/usr/local/lib/python3.9/site-packages/sklearn/base.py:376: InconsistentVersionWa
rning: Trying to unpickle estimator DecisionTreeClassifier from version 1.3.2 whe
n using version 1.5.2. This might lead to breaking code or invalid results. Use a
t your own risk. For more info please refer to:
https://scikit-learn.org/stable/model_persistence.html#security-maintainability-l
imitations
  warnings.warn(
/usr/local/lib/python3.9/site-packages/sklearn/base.py:376: InconsistentVersionWa
rning: Trying to unpickle estimator DecisionTreeClassifier from version 1.3.2 whe
n using version 1.5.2. This might lead to breaking code or invalid results. Use a
t your own risk. For more info please refer to:
https://scikit-learn.org/stable/model_persistence.html#security-maintainability-l
imitations
  warnings.warn(
/usr/local/lib/python3.9/site-packages/sklearn/base.py:376: InconsistentVersionWa
rning: Trying to unpickle estimator DecisionTreeClassifier from version 1.3.2 whe
n using version 1.5.2. This might lead to breaking code or invalid results. Use a
t your own risk. For more info please refer to:
https://scikit-learn.org/stable/model_persistence.html#security-maintainability-l
imitations
  warnings.warn(
^C[2024-09-30 16:05:55 +0000] [1] [INFO] Handling signal: int
[2024-09-30 16:05:55 +0000] [7] [INFO] Worker exiting (pid: 7)
[2024-09-30 16:05:55 +0000] [10] [INFO] Worker exiting (pid: 10)
[2024-09-30 16:05:55 +0000] [9] [INFO] Worker exiting (pid: 9)
[2024-09-30 16:05:55 +0000] [8] [INFO] Worker exiting (pid: 8)
[2024-09-30 16:05:56 +0000] [1] [INFO] Shutting down: Master
beldegovindram@machinelearningdocker:~/mlapp$
```

4. **Test the ML Endpoint**
    - Test the **/predict** endpoint using **curl** or Postman by sending a POST request with JSON data:

```
curl -X POST http://localhost:4000/predict -H "Content-Type: application/json" -d '{"input": [5.1, 3.5, 1.4, 0.2]}'
```

Step 6: Deploy the Application to GitHub

1. **Initialize a Git Repository**
    - Initialize a Git repository in your project directory:

```
git init
```

2. **Add All Files and Commit**
    - Add all files to the repository and commit:

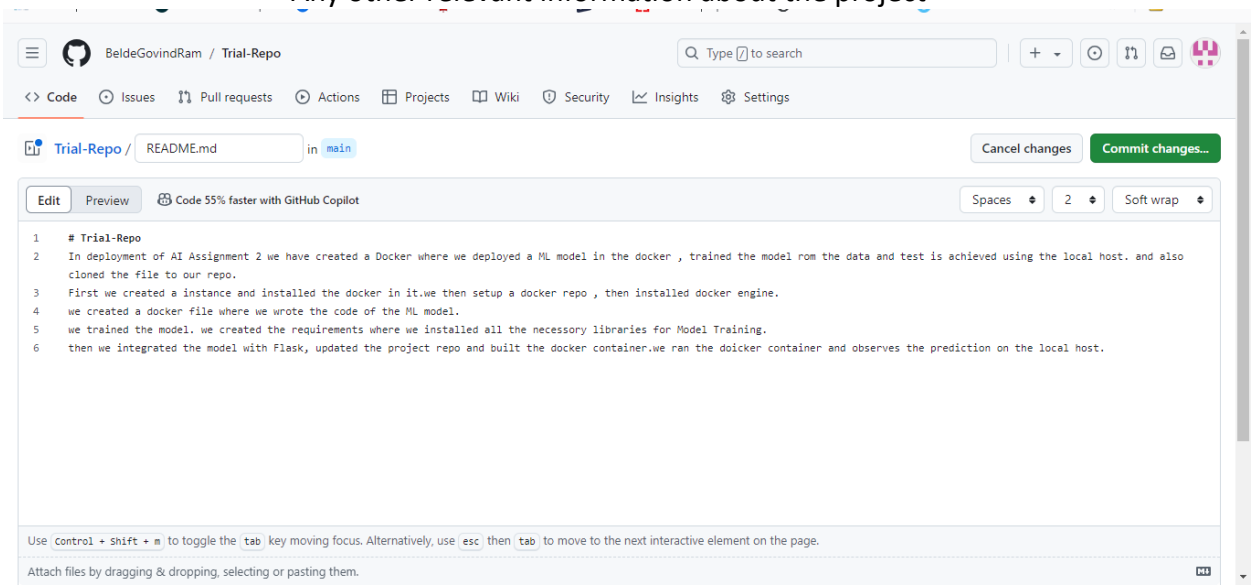
```
git add .
git commit -m "Initial commit"
```

3. **Create a New Repository on GitHub**
    - Create a new repository on GitHub and follow the instructions to push your local repository to GitHub:

```
git remote add origin https://github.com/yourusername/your-repository.git
git branch -M main
git push -u origin main
```

Step 7: Document the Process

1. **Create a README.md File**
    - Document the process in a **README.md** file in your repository. Include the following:
        - Overview of the project
        - Instructions to build and run the Docker container
        - Instructions to test the ML endpoint
        - Any other relevant information about the project



Submission

- Take screenshots of every step you perform and paste in the submission word/pdf file.
- Submit the GitHub repository link of your project.
- Ensure your repository is public and the README.md file is well-documented.