

TEAM ID: PNT2022TMID43571

Importing the required libraries

```
!pip install tensorflow --upgrade
```

Requirement already satisfied: tensorflow in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (2.7.2)

Collecting tensorflow

Downloading tensorflow-2.10.0-cp39-cp39-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (578.1 MB)

| 578.1 MB 40 kB/s /s eta 0:00:01B 15.2 MB/s eta 0:00:34 | | 84.6 MB 15.2 MB/s eta 0:00:33 | | 90.0 MB 15.2 MB/s eta 0:00:33 | | 177.6 MB 103.6 MB/s eta 0:00:04| 280.1 MB 104.4 MB/s eta 0:00:03/s eta 0:00:03

Requirement already satisfied: termcolor>=1.1.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (1.1.0)

Requirement already satisfied: flatbuffers>=2.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (2.0)

Requirement already satisfied: gast<=0.4.0,>=0.2.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (0.4.0)

Requirement already satisfied: keras-preprocessing>=1.1.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (1.1.2)

Requirement already satisfied: numpy>=1.20 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (1.20.3)

Requirement already satisfied: grpcio<2.0,>=1.24.3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (1.42.0)

Collecting absl-py>=1.0.0

Downloading absl_py-1.3.0-py3-none-any.whl (124 kB)

124 kB 83.1 MB/s eta 0:00:01

Requirement already satisfied: astunparse>=1.6.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (1.6.3)

Requirement already satisfied: six>=1.12.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (1.15.0)

Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (0.23.1)

Collecting keras<2.11,>=2.10.0

Downloading keras-2.10.0-py2.py3-none-any.whl (1.7 MB)

1.7 MB 88.2 MB/s eta 0:00:01

Collecting libclang>=13.0.0

Downloading libclang-14.0.6-py2.py3-none-manylinux2010_x86_64.whl (14.1 MB)

14.1 MB 78.8 MB/s eta 0:00:01

Collecting tensorboard<2.11,>=2.10

Downloading tensorboard-2.10.1-py3-none-any.whl (5.9 MB)

5.9 MB 69.7 MB/s eta 0:00:01

Requirement already satisfied: opt-einsum>=2.3.2 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (3.3.0)

Requirement already satisfied: setuptools in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (58.0.4)

Requirement already satisfied: packaging in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (21.3)

Requirement already satisfied: typing-extensions>=3.6.6 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (4.1.1)

Requirement already satisfied: google-pasta>=0.1.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (0.2.0)

Requirement already satisfied: protobuf<3.20,>=3.9.2 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (3.19.1)

Requirement already satisfied: h5py>=2.9.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (3.2.1)

Collecting tensorflow-estimator<2.11,>=2.10.0

Downloading tensorflow_estimator-2.10.0-py2.py3-none-any.whl (438 kB)

438 kB 83.2 MB/s eta 0:00:01

Requirement already satisfied: wrapt>=1.11.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorflow) (1.12.1)

Requirement already satisfied: wheel<1.0,>=0.23.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from astunparse>=1.6.0->tensorflow) (0.37.0)

Requirement already satisfied: google-auth<3,>=1.6.3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorboard<2.11,>=2.10->tensorflow) (1.23.0)

Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorboard<2.11,>=2.10->tensorflow) (0.4.4)

Requirement already satisfied: tensorboard-data-server<0.7.0,>=0.6.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorboard<2.11,>=2.10->tensorflow) (0.6.1)

Requirement already satisfied: requests<3,>=2.21.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorboard<2.11,>=2.10->tensorflow) (2.26.0)

Requirement already satisfied: markdown<=2.6.8 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorboard<2.11,>=2.10->tensorflow) (3.3.3)

Requirement already satisfied: tensorboard-plugin-wit<=1.6.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorboard<2.11,>=2.10->tensorflow) (1.6.0)

Requirement already satisfied: werkzeug<=1.0.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from tensorboard<2.11,>=2.10->tensorflow) (2.0.2)

Requirement already satisfied: cachetools<5.0,>=2.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from google-auth<3,>=1.6.3->tensorboard<2.11,>=2.10->tensorflow) (4.2.2)

Requirement already satisfied: rsa<5,>=3.1.4 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from google-auth<3,>=1.6.3->tensorboard<2.11,>=2.10->tensorflow) (4.7.2)

Requirement already satisfied: pyasn1-modules<=0.2.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from google-auth<3,>=1.6.3->tensorboard<2.11,>=2.10->tensorflow) (0.2.8)

Requirement already satisfied: requests-oauthlib<=0.7.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from google-auth-oauthlib<0.5,>=0.4.1->tensorboard<2.11,>=2.10->tensorflow) (1.3.0)

Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from pyasn1-modules<=0.2.1->google-auth<3,>=1.6.3->tensorboard<2.11,>=2.10->tensorflow) (0.4.8)

Requirement already satisfied: certifi<=2017.4.17 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests<3,>=2.21.0->tensorboard<2.11,>=2.10->tensorflow) (2022.9.24)

Requirement already satisfied: charset-normalizer<=2.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests<3,>=2.21.0->tensorboard<2.11,>=2.10->tensorflow) (2.0.4)

Requirement already satisfied: idna<4,>=2.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests<3,>=2.21.0->tensorboard<2.11,>=2.10->tensorflow) (3.3)

Requirement already satisfied: urllib3<1.27,>=1.21.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests<3,>=2.21.0->tensorboard<2.11,>=2.10->tensorflow) (1.26.7)

Requirement already satisfied: oauthlib<=3.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests-oauthlib<=0.7.0->google-auth-oauthlib<0.5,>=0.4.1->tensorboard<2.11,>=2.10->tensorflow) (3.2.1)

Requirement already satisfied: pyparsing<=3.0.5,>=2.0.2 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from packaging->tensorflow) (3.0.4)

Installing collected packages: absl-py, tensorflow-estimator, tensorboard, libclang, keras, tensorflow

Attempting uninstall: absl-py

Found existing installation: absl-py 0.12.0

Uninstalling absl-py-0.12.0:

Successfully uninstalled absl-py-0.12.0

Attempting uninstall: tensorflow-estimator

Found existing installation: tensorflow-estimator 2.7.0

Uninstalling tensorflow-estimator-2.7.0:

Successfully uninstalled tensorflow-estimator-2.7.0

Attempting uninstall: tensorboard

Found existing installation: tensorboard 2.7.0

Uninstalling tensorboard-2.7.0:

Successfully uninstalled tensorboard-2.7.0

Attempting uninstall: keras

Found existing installation: Keras 2.2.4

Uninstalling Keras-2.2.4:

Successfully uninstalled Keras-2.2.4

Attempting uninstall: tensorflow

Found existing installation: tensorflow 2.7.2

Uninstalling tensorflow-2.7.2:

Successfully uninstalled tensorflow-2.7.2

Successfully installed absl-py-1.3.0 keras-2.10.0 libclang-14.0.6 tensorboard-2.10.1 tensorflow-2.10.0 tensorflow-estimator-2.10.0

```
import numpy as np
```

```
import tensorflow #open source used for both ML and DL for computation
```

```
from tensorflow.keras.datasets import mnist #mnist dataset
```

```
from tensorflow.keras.models import Sequential #it is a plain stack of layers
```

```
from tensorflow.keras import layers #A Layer consists of a tensor- in tensor-out computation function
```

```
from tensorflow.keras.layers import Dense, Flatten #Dense-Dense Layer is the regular deeply connected r
```

```
#flatten -used for flattening the input or change the dimension
```

```
from tensorflow.keras.layers import Conv2D #convolutional Layer
```

```
from keras.utils import np_utils #used for one-hot encoding
```

```
import matplotlib.pyplot as plt #used for data visualization
```

Load data

```
(x_train, y_train), (x_test, y_test)=mnist.load_data () #splitting the mnist data into train and test
```

Downloading data from <https://storage.googleapis.com/tensorflow/tf-keras-datasets/mnist.npz>

```
11493376/11490434 [=====] - 0s 0us/step
```

```
11501568/11490434 [=====] - 0s 0us/step
```

```
print (x_train.shape) #shape is used for give the dimens ion values #60000-rows 28x28-pixels
```

```
print (x_test.shape)
```

```
(60000, 28, 28)
```

```
(10000, 28, 28)
```

```
x_train[0]
```

```
array([[ 0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,
```

```
        0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,
```

```
        0,  0],
```

```
[ 0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,
```

```
        0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,
```

```
        0,  0],
```

```
[ 0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,
```

```
        0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,
```

```
        0,  0],
```

```
[ 0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,
```

```
        0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,
```

```
        0,  0],
```

```
[ 0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,
```

```
        0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,
```

```
        0,  0],
```

```
[ 0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  3,
```

```
        18, 18, 18, 126, 136, 175, 26, 166, 255, 247, 127,  0,  0,
```

```
        0,  0],
```

```
[ 0,  0,  0,  0,  0,  0,  0,  0,  0, 30, 36, 94, 154, 170,
```

```
        253, 253, 253, 253, 253, 225, 172, 253, 242, 195, 64,  0,  0,
```

```
        0,  0],
```

[0, 0, 0, 0, 0, 0, 0, 0, 49, 238, 253, 253, 253, 253,
253, 253, 253, 253, 251, 93, 82, 82, 56, 39, 0, 0, 0,
0, 0],

[0, 0, 0, 0, 0, 0, 0, 0, 18, 219, 253, 253, 253, 253,
253, 198, 182, 247, 241, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0],

[0, 0, 0, 0, 0, 0, 0, 0, 0, 80, 156, 107, 253, 253,
205, 11, 0, 43, 154, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0],

[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 14, 1, 154, 253,
90, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0],

[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 139, 253,
190, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0],

[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 11, 190,
253, 70, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0],

[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 35,
241, 225, 160, 108, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0],

[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
81, 240, 253, 253, 119, 25, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0],

[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 45, 186, 253, 253, 150, 27, 0, 0, 0, 0, 0, 0, 0,
0, 0],

[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 16, 93, 252, 253, 187, 0, 0, 0, 0, 0, 0, 0,
0, 0],

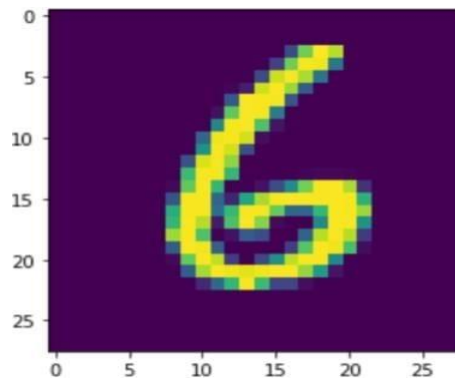
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,

0, 0, 0, 0, 249, 253, 249, 64, 0, 0, 0, 0, 0,
0, 0],
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 46, 130, 183, 253, 253, 207, 2, 0, 0, 0, 0, 0,
0, 0],
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 39,
148, 229, 253, 253, 253, 250, 182, 0, 0, 0, 0, 0, 0,
0, 0],
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 24, 114, 221,
253, 253, 253, 253, 201, 78, 0, 0, 0, 0, 0, 0, 0,
0, 0],
[0, 0, 0, 0, 0, 0, 0, 0, 0, 23, 66, 213, 253, 253,
253, 253, 198, 81, 2, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0],
[0, 0, 0, 0, 0, 0, 18, 171, 219, 253, 253, 253, 253,
195, 80, 9, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0],
[0, 0, 0, 0, 55, 172, 226, 253, 253, 253, 253, 244, 133,
11, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0],
[0, 0, 0, 0, 136, 253, 253, 253, 212, 135, 132, 16, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0],
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0],
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0],
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0],

```

0, 0]], dtype=uint8)
plt.imshow(x_train[6000]) #ploting the index=image
np.argmax(y_train[6000])

```



Reshaping Dataset

```

#Reshaping to format which CNN expects (batch, height, width, channels)
x_train=x_train.reshape (60000, 28, 28, 1).astype('float32')
x_test=x_test.reshape (10000, 28, 28, 1).astype ('float32')

```

Applying One Hot Encoding

```

number_of_classes = 10 #storing the no of classes in a variable
y_train = np_utils.to_categorical (y_train, number_of_classes) #converts the output in binary format
y_test = np_utils.to_categorical (y_test, number_of_classes)

```

Add CNN Layers

```

#create model
model=Sequential ()
#adding model Layer
model.add(Conv2D(64, (3, 3), input_shape=(28, 28, 1), activation='relu'))
model.add(Conv2D(32, (3, 3), activation = 'relu'))
#flatten the dimension of the image
model.add(Flatten())
#output layer with 10 neurons
model.add(Dense(number_of_classes,activation = 'softmax'))

```

Compiling the model

```

#Compile model

```



```
model.compile(loss= 'categorical_crossentropy', optimizer="Adam", metrics=['accuracy'])
```

```
x_train = np.asarray(x_train)
```

```
y_train = np.asarray(y_train)
```

Train the model

```
#fit the model
```

```
model.fit(x_train, y_train, validation_data=(x_test, y_test), epochs=5, batch_size=32)
```

Epoch 1/5

```
1875/1875 [=====] - 126s 67ms/step - loss: 0.2690 - accuracy: 0.9514  
- val_loss: 0.0884 - val_accuracy: 0.9728
```

Epoch 2/5

```
1875/1875 [=====] - 125s 66ms/step - loss: 0.0676 - accuracy: 0.9789  
- val_loss: 0.0803 - val_accuracy: 0.9788
```

Epoch 3/5

```
1875/1875 [=====] - 125s 67ms/step - loss: 0.0458 - accuracy: 0.9852  
- val_loss: 0.0791 - val_accuracy: 0.9788
```

Epoch 4/5

```
1875/1875 [=====] - 125s 67ms/step - loss: 0.0387 - accuracy: 0.9883  
- val_loss: 0.1079 - val_accuracy: 0.9759
```

Epoch 5/5

```
1875/1875 [=====] - 125s 67ms/step - loss: 0.0280 - accuracy: 0.9909  
- val_loss: 0.0991 - val_accuracy: 0.9774
```

Observing the metrics

```
# Final evaluation of the model
```

```
metrics = model.evaluate(x_test, y_test, verbose=0)
```

```
print("Metrics (Test loss &Test Accuracy) : ")
```

```
print(metrics)
```

```
Metrics (Test loss &Test Accuracy) :
```

```
[0.09910603612661362, 0.977400004863739]
```

Test The Model

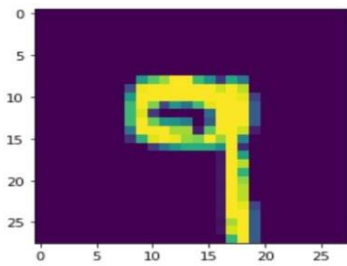
```
prediction=model.predict(x_test[6000:6001])
```

```
print(prediction)
```

```
[[9.1516389e-13 8.1778777e-19 2.4542002e-14 1.7823329e-07 5.2257418e-04
```

```
5.8763407e-09 6.2800168e-17 3.1880148e-07 6.3142506e-03 9.9316275e-01]]
```

```
plt.imshow(x_test[6000])
```



```
import numpy as np
```

```
print(np.argmax(prediction, axis=1)) #printing our Labels from first 4 images
```

```
[9]
```

```
np.argmax(y_test[6000:6001]) #printing the actual labels
```

```
9
```

Save The model

```
# Save the model
```

```
model.save('models/mnistCNN.h5')
```

```
cd models
```

```
/home/wsuser/work/models
```

```
!tar -zcvf handwritten-digit-recognition-model_new.tgz mnistCNN.h5
```

```
mnistCNN.h5
```

```
!pip install watson-machine-learning-client --upgrade
```

```
Collecting watson-machine-learning-client
```

```
  Downloading watson_machine_learning_client-1.0.391-py3-none-any.whl (538 kB)
```

```
    538 kB 21.5 MB/s eta 0:00:01
```

```
Requirement already satisfied: lomond in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages  
(from watson-machine-learning-client) (0.3.3)
```

```
Requirement already satisfied: boto3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages  
(from watson-machine-learning-client) (1.18.21)
```

```
Requirement already satisfied: tqdm in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages  
(from watson-machine-learning-client) (4.62.3)
```

```
Requirement already satisfied: pandas in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages  
(from watson-machine-learning-client) (1.3.4)
```

```
Requirement already satisfied: tabulate in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages  
(from watson-machine-learning-client) (0.8.9)
```

Requirement already satisfied: certifi in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (2022.9.24)

Requirement already satisfied: urllib3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (1.26.7)

Requirement already satisfied: ibm-cos-sdk in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (2.11.0)

Requirement already satisfied: requests in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (2.26.0)

Requirement already satisfied: botocore<1.22.0,>=1.21.21 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from boto3->watson-machine-learning-client) (1.21.41)

Requirement already satisfied: s3transfer<0.6.0,>=0.5.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from boto3->watson-machine-learning-client) (0.5.0)

Requirement already satisfied: jmespath<1.0.0,>=0.7.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from boto3->watson-machine-learning-client) (0.10.0)

Requirement already satisfied: python-dateutil<3.0.0,>=2.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from botocore<1.22.0,>=1.21.21->boto3->watson-machine-learning-client) (2.8.2)

Requirement already satisfied: six>=1.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from python-dateutil<3.0.0,>=2.1->botocore<1.22.0,>=1.21.21->boto3->watson-machine-learning-client) (1.15.0)

Requirement already satisfied: ibm-cos-sdk-s3transfer==2.11.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ibm-cos-sdk->watson-machine-learning-client) (2.11.0)

Requirement already satisfied: ibm-cos-sdk-core==2.11.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from ibm-cos-sdk->watson-machine-learning-client) (2.11.0)

Requirement already satisfied: charset-normalizer~=2.0.0 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->watson-machine-learning-client) (2.0.4)

Requirement already satisfied: idna<4,>=2.5 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from requests->watson-machine-learning-client) (3.3)

Requirement already satisfied: pytz>=2017.3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from pandas->watson-machine-learning-client) (2021.3)

Requirement already satisfied: numpy>=1.17.3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from pandas->watson-machine-learning-client) (1.20.3)

Installing collected packages: watson-machine-learning-client

Successfully installed watson-machine-learning-client-1.0.391

Cloud deploy

```
from ibm_watson_machine_learning import APIClient
```

```
credentials = {
```

```

"url":"https://jp-tok.ml.cloud.ibm.com",
"apikey":"BHyalu2c7JN6n9cnvAVULvSKRYFVLMQ_m51toZ9Yk0nS"
}
client = APIClient(credentials)
client
client.spaces.get_details()
{'resources': [{'entity': {'compute': {'crn': 'crn:v1:bluemix:public:pm-20:jp-
tok:a/53f9f6400d0d44889534e8abcd2dfe39:0f4376b6-c944-4b27-b23e-48b54d8f4bbd::',
'guid': '0f4376b6-c944-4b27-b23e-48b54d8f4bbd',
'name': 'Watson Machine Learning-sp',
'type': 'machine_learning'}},
'description': '',
'name': 'digitrecognition',
'scope': {'bss_account_id': '53f9f6400d0d44889534e8abcd2dfe39'},
'stage': {'production': False},
'status': {'state': 'active'},
'storage': {'properties': {'bucket_name': '63888f6f-d1ef-475c-a8d8-a2e4957bb673',
'bucket_region': 'jp-tok-standard',
'credentials': {'admin': {'access_key_id': '834b3358ebb945fb9ebbb4020cd2bf0e',
'api_key': '2JONUuuPfYzZzPGzTp1J7dwwjNTpkOsyxdW5gx_vml3m',
'secret_access_key': '1ed5b29fdd6c65b48ca72963b6177133ce51a7b23acdcaa5',
'service_id': 'ServiceId-a2495f73-f36b-4fa1-9991-976f110c1a4f'},
'editor': {'access_key_id': 'b56d445c54794369b2a4e0115e166605',
'api_key': 'wcwCBLp8z4xpgnsEDeUCOZquAovrWhXu2wcF9Kz5Vhpe',
'resource_key_crn': 'crn:v1:bluemix:public:cloud-object-
storage:global:a/53f9f6400d0d44889534e8abcd2dfe39:d8fa8aee-cd61-4757-9543-a61f55971074::',
'secret_access_key': '84b0b128f52e57c025e6517604a06212b8d19f0b349eeeea3',
'service_id': 'ServiceId-4e1f87ab-27bc-4654-b6ea-667a8640c7e0'},
'viewer': {'access_key_id': '558109e942fb4b1eb020c881f04d8588',
'api_key': 'zWS-VZ_d9GfkDt1XnCmWoOA6liYXNnGtrPwJt2fl0UI5',
'resource_key_crn': 'crn:v1:bluemix:public:cloud-object-
storage:global:a/53f9f6400d0d44889534e8abcd2dfe39:d8fa8aee-cd61-4757-9543-a61f55971074::',

```

```

'secret_access_key': '3e2d27ab9d4041707cfa721daa638d1ad57f42ab8df94c09',
'service_id': 'ServiceId-93177c88-86e2-470d-b5bf-3aed99d093a8'}},
'endpoint_url': 'https://s3.jp-tok.cloud-object-storage.appdomain.cloud',
'guid': 'd8fa8aee-cd61-4757-9543-a61f55971074',
'resource_crn': 'crn:v1:bluemix:public:cloud-object-
storage:global:a/53f9f6400d0d44889534e8abcd2dfe39:d8fa8aee-cd61-4757-9543-a61f55971074::',
'type': 'bmcoss_object_storage'}},
'metadata': {'created_at': '2022-10-31T10:33:07.575Z',
'creator_id': 'IBMid-667000CZ2Y',
'id': 'aa24227a-9f01-493f-90e6-1b6132057fc6',
'updated_at': '2022-10-31T10:33:25.148Z',
'url': '/v2/spaces/aa24227a-9f01-493f-90e6-1b6132057fc6'}}}}

```

```

def guid_from_space_name(client,deploy):
    space = client.spaces.get_details()
    return (next(item for item in space['resources'] if item['entity']['name']==deploy)['metadata']['id'])
space_uid = guid_from_space_name(client,'digitrecognition')
print("Space UID = " + space_uid)
Space UID = aa24227a-9f01-493f-90e6-1b6132057fc6
client.set.default_space(space_uid)
'SUCCESS'
client.software_specifications.list(limit=100)

```

```

-----
NAME                ASSET_ID                TYPE
default_py3.6       0062b8c9-8b7d-44a0-a9b9-46c416adcbd9 base
kernel-spark3.2-scala2.12  020d69ce-7ac1-5e68-ac1a-31189867356a base
pytorch-onnx_1.3-py3.7-edt  069ea134-3346-5748-b513-49120e15d288 base
scikit-learn_0.20-py3.6    09c5a1d0-9c1e-4473-a344-eb7b665ff687 base
spark-mllib_3.0-scala_2.12  09f4cff0-90a7-5899-b9ed-1ef348aebdee base
pytorch-onnx_rt22.1-py3.9   0b848dd4-e681-5599-be41-b5f6fccc6471 base
ai-function_0.1-py3.6      0cdb0f1e-5376-4f4d-92dd-da3b69aa9bda base
shiny-r3.6             0e6e79df-875e-4f24-8ae9-62dcc2148306 base

```

tensorflow_2.4-py3.7-horovod	1092590a-307d-563d-9b62-4eb7d64b3f22	base
pytorch_1.1-py3.6	10ac12d6-6b30-4ccd-8392-3e922c096a92	base
tensorflow_1.15-py3.6-ddl	111e41b3-de2d-5422-a4d6-bf776828c4b7	base
runtime-22.1-py3.9	12b83a17-24d8-5082-900f-0ab31fbfd3cb	base
scikit-learn_0.22-py3.6	154010fa-5b3b-4ac1-82af-4d5ee5abbc85	base
default_r3.6	1b70aec3-ab34-4b87-8aa0-a4a3c8296a36	base
pytorch-onnx_1.3-py3.6	1bc6029a-cc97-56da-b8e0-39c3880dbbe7	base
kernel-spark3.3-r3.6	1c9e5454-f216-59dd-a20e-474a5cdf5988	base
pytorch-onnx_rt22.1-py3.9-edt	1d362186-7ad5-5b59-8b6c-9d0880bde37f	base
tensorflow_2.1-py3.6	1eb25b84-d6ed-5dde-b6a5-3fbdf1665666	base
spark-mllib_3.2	20047f72-0a98-58c7-9ff5-a77b012eb8f5	base
tensorflow_2.4-py3.8-horovod	217c16f6-178f-56bf-824a-b19f20564c49	base
runtime-22.1-py3.9-cuda	26215f05-08c3-5a41-a1b0-da66306ce658	base
do_py3.8	295addb5-9ef9-547e-9bf4-92ae3563e720	base
autoai-ts_3.8-py3.8	2aa0c932-798f-5ae9-abd6-15e0c2402fb5	base
tensorflow_1.15-py3.6	2b73a275-7cbf-420b-a912-eae7f436e0bc	base
kernel-spark3.3-py3.9	2b7961e2-e3b1-5a8c-a491-482c8368839a	base
pytorch_1.2-py3.6	2c8ef57d-2687-4b7d-acce-01f94976dac1	base
spark-mllib_2.3	2e51f700-bca0-4b0d-88dc-5c6791338875	base
pytorch-onnx_1.1-py3.6-edt	32983cea-3f32-4400-8965-dde874a8d67e	base
spark-mllib_3.0-py37	36507ebe-8770-55ba-ab2a-eafe787600e9	base
spark-mllib_2.4	390d21f8-e58b-4fac-9c55-d7ceda621326	base
xgboost_0.82-py3.6	39e31acd-5f30-41dc-ae44-60233c80306e	base
pytorch-onnx_1.2-py3.6-edt	40589d0e-7019-4e28-8daa-fb03b6f4fe12	base
default_r36py38	41c247d3-45f8-5a71-b065-8580229facf0	base
autoai-ts_rt22.1-py3.9	4269d26e-07ba-5d40-8f66-2d495b0c71f7	base
autoai-obm_3.0	42b92e18-d9ab-567f-988a-4240ba1ed5f7	base
pmml-3.0_4.3	493bcb95-16f1-5bc5-bee8-81b8af80e9c7	base
spark-mllib_2.4-r_3.6	49403dff-92e9-4c87-a3d7-a42d0021c095	base
xgboost_0.90-py3.6	4ff8d6c2-1343-4c18-85e1-689c965304d3	base
pytorch-onnx_1.1-py3.6	50f95b2a-bc16-43bb-bc94-b0bed208c60b	base

autoai-ts_3.9-py3.8	52c57136-80fa-572e-8728-a5e7cbb42cde	base
spark-mllib_2.4-scala_2.11	55a70f99-7320-4be5-9fb9-9edb5a443af5	base
spark-mllib_3.0	5c1b0ca2-4977-5c2e-9439-ffd44ea8ffe9	base
autoai-obm_2.0	5c2e37fa-80b8-5e77-840f-d912469614ee	base
spss-modeler_18.1	5c3cad7e-507f-4b2a-a9a3-ab53a21dee8b	base
cuda-py3.8	5d3232bf-c86b-5df4-a2cd-7bb870a1cd4e	base
autoai-kb_3.1-py3.7	632d4b22-10aa-5180-88f0-f52dfb6444d7	base
pytorch-onnx_1.7-py3.8	634d3cdc-b562-5bf9-a2d4-ea90a478456b	base
spark-mllib_2.3-r_3.6	6586b9e3-ccd6-4f92-900f-0f8cb2bd6f0c	base
tensorflow_2.4-py3.7	65e171d7-72d1-55d9-8ebb-f813d620c9bb	base
spss-modeler_18.2	687eddc9-028a-4117-b9dd-e57b36f1efa5	base
pytorch-onnx_1.2-py3.6	692a6a4d-2c4d-45ff-a1ed-b167ee55469a	base
spark-mllib_2.3-scala_2.11	7963efe5-bbec-417e-92cf-0574e21b4e8d	base
spark-mllib_2.4-py37	7abc992b-b685-532b-a122-a396a3cdbaab	base
caffe_1.0-py3.6	7bb3dbe2-da6e-4145-918d-b6d84aa93b6b	base
pytorch-onnx_1.7-py3.7	812c6631-42b7-5613-982b-02098e6c909c	base
cuda-py3.6	82c79ece-4d12-40e6-8787-a7b9e0f62770	base
tensorflow_1.15-py3.6-horovod	8964680e-d5e4-5bb8-919b-8342c6c0dfd8	base
hybrid_0.1	8c1a58c6-62b5-4dc4-987a-df751c2756b6	base
pytorch-onnx_1.3-py3.7	8d5d8a87-a912-54cf-81ec-3914adaa988d	base
caffe-ibm_1.0-py3.6	8d863266-7927-4d1e-97d7-56a7f4c0a19b	base
spss-modeler_17.1	902d0051-84bd-4af6-ab6b-8f6aa6fdeabb	base
do_12.10	9100fd72-8159-4eb9-8a0b-a87e12eefa36	base
do_py3.7	9447fa8b-2051-4d24-9eef-5acb0e3c59f8	base
spark-mllib_3.0-r_3.6	94bb6052-c837-589d-83f1-f4142f219e32	base
cuda-py3.7-opence	94e9652b-7f2d-59d5-ba5a-23a414ea488f	base
nlp-py3.8	96e60351-99d4-5a1c-9cc0-473ac1b5a864	base
cuda-py3.7	9a44990c-1aa1-4c7d-baf8-c4099011741c	base
hybrid_0.2	9b3f9040-9cee-4ead-8d7a-780600f542f7	base
spark-mllib_3.0-py38	9f7a8fc1-4d3c-5e65-ab90-41fa8de2d418	base
autoai-kb_3.3-py3.7	a545cca3-02df-5c61-9e88-998b09dc79af	base

spark-mllib_3.0-py39	a6082a27-5acc-5163-b02c-6b96916eb5e0	base
runtime-22.1-py3.9-do	a7e7dbf1-1d03-5544-994d-e5ec845ce99a	base
default_py3.8	ab9e1b80-f2ce-592c-a7d2-4f2344f77194	base
tensorflow_rt22.1-py3.9	acd9c798-6974-5d2f-a657-ce06e986df4d	base
kernel-spark3.2-py3.9	ad7033ee-794e-58cf-812e-a95f4b64b207	base
autoai-obm_2.0 with Spark 3.0	af10f35f-69fa-5d66-9bf5-acb58434263a	base
default_py3.7_opence	c2057dd4-f42c-5f77-a02f-72bdbd3282c9	base
tensorflow_2.1-py3.7	c4032338-2a40-500a-beef-b01ab2667e27	base
do_py3.7_opence	cc8f8976-b74a-551a-bb66-6377f8d865b4	base
spark-mllib_3.3	d11f2434-4fc7-58b7-8a62-755da64fdaf8	base
autoai-kb_3.0-py3.6	d139f196-e04b-5d8b-9140-9a10ca1fa91a	base
spark-mllib_3.0-py36	d82546d5-dd78-5fbb-9131-2ec309bc56ed	base
autoai-kb_3.4-py3.8	da9b39c3-758c-5a4f-9cfd-457dd4d8c395	base
kernel-spark3.2-r3.6	db2fe4d6-d641-5d05-9972-73c654c60e0a	base
autoai-kb_rt22.1-py3.9	db6afe93-665f-5910-b117-d879897404d9	base
tensorflow_rt22.1-py3.9-horovod	dda170cc-ca67-5da7-9b7a-cf84c6987fae	base
autoai-ts_1.0-py3.7	deef04f0-0c42-5147-9711-89f9904299db	base
tensorflow_2.1-py3.7-horovod	e384fce5-fdd1-53f8-bc71-11326c9c635f	base
default_py3.7	e4429883-c883-42b6-87a8-f419d64088cd	base
do_22.1	e51999ba-6452-5f1f-8287-17228b88b652	base
autoai-obm_3.2	eae86aab-da30-5229-a6a6-1d0d4e368983	base
do_20.1	f686cdd9-7904-5f9d-a732-01b0d6b10dc5	base
scikit-learn_0.19-py3.6	f963fa9d-4bb7-5652-9c5d-8d9289ef6ad9	base
tensorflow_2.4-py3.8	fe185c44-9a99-5425-986b-59bd1d2eda46	base

```

-----
software_space_uid = client.software_specifications.get_uid_by_name('tensorflow_rt22.1-py3.9')
software_space_uid
'acd9c798-6974-5d2f-a657-ce06e986df4d'

model_details = client.repository.store_model(model='handwritten-digit-recognition-
model_new.tgz',meta_props={

    client.repository.ModelMetaNames.NAME:"CNN Digit recognition model",

```



```
client.repository.ModelMetaNames.TYPE:"tensorflow_2.7",
client.repository.ModelMetaNames.SOFTWARE_SPEC_UID:software_space_uid
})
```

```
model_details
```

```
{'entity': {'hybrid_pipeline_software_specs': [],
'software_spec': {'id': 'acd9c798-6974-5d2f-a657-ce06e986df4d',
'name': 'tensorflow_rt22.1-py3.9'},
'type': 'tensorflow_2.7'},
'metadata': {'created_at': '2022-11-01T10:15:40.847Z',
'id': '97d463b1-45ee-47f7-b8af-aed338794ce1',
'modified_at': '2022-11-01T10:15:44.197Z',
'name': 'CNN Digit recognition model',
'owner': 'IBMid-667000CZ2Y',
'resource_key': '84636ddb-9fa8-47e4-8fa4-3c36731e2fe6',
'space_id': 'aa24227a-9f01-493f-90e6-1b6132057fc6'},
'system': {'warnings': []}}
```

```
model_id = client.repository.get_model_id(model_details)
```

```
model_id
```

```
'97d463b1-45ee-47f7-b8af-aed338794ce1'
```

```
client.repository.download(model_id,'DigitRecog_IBM_model.tar.gz')
```

```
Successfully saved model content to file: 'DigitRecog_IBM_model.tar.gz'
```

```
'/home/wsuser/work/models/DigitRecog_IBM_model.tar.gz'
```

```
ls
```

```
DigitRecog_IBM_model.tar.gz      mnistCNN.h5
```

```
handwritten-digit-recognition-model_new.tgz
```

TEST MODEL

```
from tensorflow.keras.models import load_model
```

```
from keras.preprocessing import image
```

```
from PIL import Image
```

```
import numpy as np
```

```
model = load_model("mnistCNN.h5")
```

```

import os, types

import pandas as pd

from botocore.client import Config

import ibm_boto3

def _iter_(self): return 0

# @hidden_cell

# The following code accesses a file in your IBM Cloud Object Storage. It includes your credentials.
# You might want to remove those credentials before you share the notebook.

cos_client = ibm_boto3.client(service_name='s3',
                               ibm_api_key_id='is_QZGPYU8oxZr3W-td-LCHXS3QPMaWArLi18FdSyGT',
                               ibm_auth_endpoint="https://iam.cloud.ibm.com/oidc/token",
                               config=Config(signature_version='oauth'),
                               endpoint_url='https://s3.private.ap.cloud-object-storage.appdomain.cloud')

bucket = 'handwrittenimagerecognition-donotdelete-pr-8tlrnykut46vpi'
object_key = 'mnist-dataset-1024x424 (2).png'
streaming_body_1 = cos_client.get_object(Bucket=bucket, Key=object_key)['Body']

# Your data file was loaded into a botocore.response.StreamingBody object.

# Please read the documentation of ibm_boto3 and pandas to learn more about the possibilities to
load the data.

# ibm_boto3 documentation: https://ibm.github.io/ibm-cos-sdk-python/
# pandas documentation: http://pandas.pydata.org/

img = Image.open(streaming_body_1).convert("L") # convert image to monochrome
img = img.resize( (28,28) ) # resizing of input image

img

im2arr = np.array(img) #converting to image
im2arr = im2arr.reshape(1, 28, 28, 1) #reshaping according to our requirement
pred = model.predict(im2arr)

print(pred)

[[1.0000000e+00 5.3912803e-17 3.9648812e-11 2.0051219e-16 5.1053910e-18

```

```
2.9315760e-12 7.0849349e-13 2.0999634e-16 2.9204243e-09 7.4729778e-11]]
```

```
print(np.argmax(pred, axis=1)) #printing our Labels
```

```
[0]
```