Date	8 November , 2022
Project Name	A Novel Method For Handwritten Recognition System
Team ID	PNT2022MID16587

IBM cloud deployment

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) ent
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) ent 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)
anylinux2010_x86_64.whl (14.1 MB)
ent 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) ent 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
ERROR: pip's dependency resolver does not currently take into account
all the packages that are installed. This behaviour is the source of
```

```
the following dependency conflicts.
tensorflow-text 2.7.3 requires tensorflow<2.8,>=2.7.0, but you have
tensorflow 2.10.0 which is incompatible.
tensorflow-metadata 1.5.0 requires absl-py<0.13,>=0.9, but you have
absl-py 1.3.0 which is incompatible.
autoai-ts-libs 1.1.9 requires tensorflow<2.8,>=2.7.0; python_version
>= "3.9", but you have tensorflow 2.10.0 which is incompatible.
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 computat ion funct ion
from tensorflow.keras.layers import Dense, Flatten #Dense-Dense Layer
is the regular deeply connected r
```

```
                                    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,
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,
```

```
 #faltten -used fot 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]
                                              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,         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,

                18, 18, 18, 126, 136, 175, 26, 166, 255, 247, 127, 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, 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, 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,
253,
          253, 198, 182, 247, 241,      0,
0,
          0, 0],                        0,
         [ 0, 0, 0, 0, 0,
253,
           205, 11, 0, 43, 154,         0,
0,
          0, 0],                        0,
          [ 0,    0, 0,    0,   0,
253,
           90,    0, 0,    0,   0,
0,
           0,   0],
           0,   0,   0,   0,   0,
253,
          190,   2,   0,   0,   0,
                                        0,   0,   0,    0, 0, 11,
190,
          253, 70,   0,                 0,   0,   0,    0, 0,    0,
0,
          0, 0],
```

```
0, 18, 219, 253, 253, 253,

0, 0, 0, 0, 0, 0,

0, 0, 80, 156, 107, 253,

0, 0, 0, 0, 0, 0,

                0, 14,    1, 154,

                0,   0,   0,    0,

                0,   0,    0, 139,
```

```
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,

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,   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, 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, 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, 249, 253, 249, 64,

                                             0,   0,   0,   0,
39,   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,

         148, 229, 253, 253, 253, 250, 182, 0,
                                                    0, 24, 114,
           0, 0],
      [0,   0, 0,   0, 0,   0,   0,
                                  0, 0,

                                  0, 0,

       [0, 0, 0,

                                       0, 0, 0, 0, 0, 0, 0,

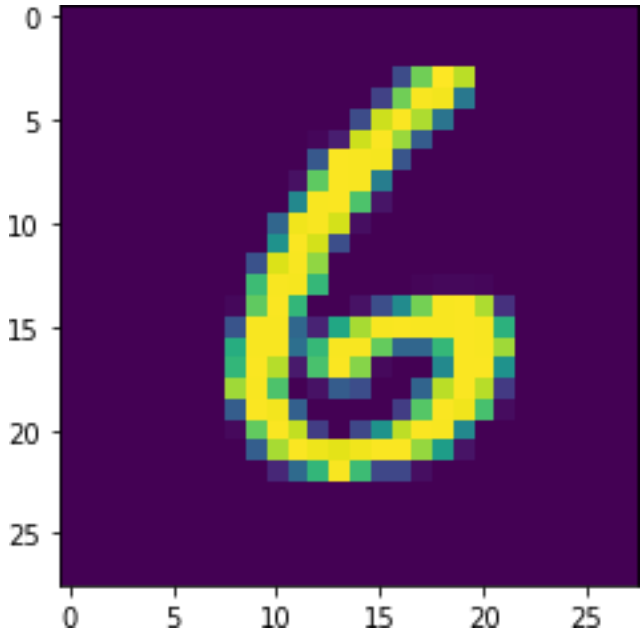
```
0,
           0, 0],
             [ 0, 0, 0, 0, 0, 0,

                              0, 0, 0,
221,                                                          0,  0,     0,
         253, 253, 253, 253, 201, 78,              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, 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, 55, 172, 226, 253, 253, 253, 253, 244,
 133,
                              0, 0, 0, 0, 0, 0, 0, 0, 0,
                 11, 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]], dtype=uint8)


 0,


 0,
```

```
plt.imshow(x_train[6000])       #ploting the index=image
```

```
 <matplotlib.image.AxesImage at 0x7f0004821880>
```




```
np.argmax(y_train[6000])
```

```
0
```

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
```

```
<keras.callbacks.History at 0x7f0004e4a640>
```

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)
```

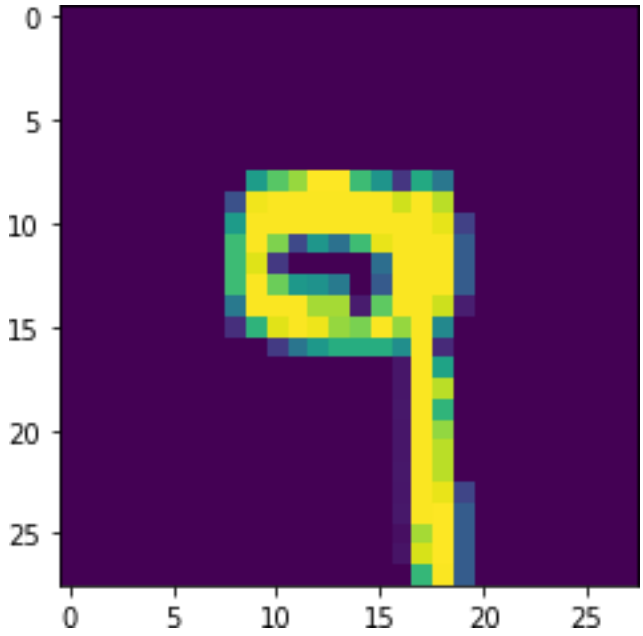
```
Metrics (Test loss &Test Accuracy) :
[0.09910603612661362, 0.977400004863739]
```

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])
```

```
<matplotlib.image.AxesImage at 0x7f00044a3370>
```




```
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) ent 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
```

```
<ibm_watson_machine_learning.client.APIClient at 0x7f00044af820>
```

```
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':
'84b0b128f52e57c025e6517604a06212b8d19f0b349eeea3',
        'service_id': 'ServiceId-4e1f87ab-27bc-4654-b6ea-
667a8640c7e0'},
       'viewer': {'access_key_id': '558109e942fb4b1eb020c881f04d8588',
        'api_key': 'zWS-VZ_d9GfkDt1XnCmWoOA6liYXNnGtrPwJt2fI0UI5',
        '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': 'bmcos_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 base                  0062b8c9-8b7d-44a0-a9b9-46c416adcbd9

kernel-spark3.2-scala2.12 base      020d69ce-7ac1-5e68-ac1a-31189867356a
```

```
pytorch-onnx_1.3-py3.7-edt base  069ea134-3346-5748-b513-49120e15d288
scikit-learn_0.20-py3.6 base     09c5a1d0-9c1e-4473-a344-eb7b665ff687
spark-mllib_3.0-scala_2.12 base  09f4cff0-90a7-5899-b9ed-1ef348aebdee
pytorch-onnx_rt22.1-py3.9 base   0b848dd4-e681-5599-be41-b5f6fccc6471
ai-function_0.1-py3.6 base       0cdb0f1e-5376-4f4d-92dd-da3b69aa9bda
shiny-r3.6 base                  0e6e79df-875e-4f24-8ae9-62dcc2148306
tensorflow_2.4-py3.7-horovod base1092590a-307d-563d-9b62-4eb7d64b3f22
pytorch_1.1-py3.6 base           10ac12d6-6b30-4ccd-8392-3e922c096a92
tensorflow_1.15-py3.6-ddl base   111e41b3-de2d-5422-a4d6-bf776828c4b7
runtime-22.1-py3.9 base          12b83a17-24d8-5082-900f-0ab31fbfd3cb
scikit-learn_0.22-py3.6 base     154010fa-5b3b-4ac1-82af-4d5ee5abbc85
default_r3.6 base                1b70aec3-ab34-4b87-8aa0-a4a3c8296a36
pytorch-onnx_1.3-py3.6 base      1bc6029a-cc97-56da-b8e0-39c3880dbbe7
kernel-spark3.3-r3.6 base        1c9e5454-f216-59dd-a20e-474a5cdf5988
pytorch-onnx_rt22.1-py3.9-edt    1d362186-7ad5-5b59-8b6c-9d0880bde37f
base
tensorflow_2.1-py3.6 base        1eb25b84-d6ed-5dde-b6a5-3fbdf1665666
spark-mllib_3.2 base             20047f72-0a98-58c7-9ff5-a77b012eb8f5
tensorflow_2.4-py3.8-horovod base217c16f6-178f-56bf-824a-b19f20564c49
runtime-22.1-py3.9-cuda base     26215f05-08c3-5a41-a1b0-da66306ce658
do_py3.8                         295addb5-9ef9-547e-9bf4-92ae3563e720
```

base

autoai-ts_3.8-py3.8	base	2aa0c932-798f-5ae9-abd6-15e0c2402fb5
tensorflow_1.15-py3.6	base	2b73a275-7cbf-420b-a912-eae7f436e0bc
kernel-spark3.3-py3.9	base	2b7961e2-e3b1-5a8c-a491-482c8368839a
pytorch_1.2-py3.6	base	2c8ef57d-2687-4b7d-acce-01f94976dac1
spark-mllib_2.3	base	2e51f700-bca0-4b0d-88dc-5c6791338875
pytorch-onnx_1.1-py3.6-edt	base	32983cea-3f32-4400-8965-dde874a8d67e
spark-mllib_3.0-py37	base	36507ebe-8770-55ba-ab2a-eafe787600e9
spark-mllib_2.4	base	390d21f8-e58b-4fac-9c55-d7ceda621326
xgboost_0.82-py3.6	base	39e31acd-5f30-41dc-ae44-60233c80306e
pytorch-onnx_1.2-py3.6-edt	base	40589d0e-7019-4e28-8daa-fb03b6f4fe12
default_r36py38	base	41c247d3-45f8-5a71-b065-8580229facf0
autoai-ts_rt22.1-py3.9	base	4269d26e-07ba-5d40-8f66-2d495b0c71f7
autoai-obm_3.0	base	42b92e18-d9ab-567f-988a-4240ba1ed5f7
pmml-3.0_4.3	base	493bcb95-16f1-5bc5-bee8-81b8af80e9c7
spark-mllib_2.4-r_3.6	base	49403dff-92e9-4c87-a3d7-a42d0021c095
xgboost_0.90-py3.6	base	4ff8d6c2-1343-4c18-85e1-689c965304d3
pytorch-onnx_1.1-py3.6	base	50f95b2a-bc16-43bb-bc94-b0bed208c60b
autoai-ts_3.9-py3.8	base	52c57136-80fa-572e-8728-a5e7cbb42cde
spark-mllib_2.4-scala_2.11	base	55a70f99-7320-4be5-9fb9-9edb5a443af5
spark-mllib_3.0	base	5c1b0ca2-4977-5c2e-9439-ffd44ea8ffe9

base

autoai-obm_2.0	base	5c2e37fa-80b8-5e77-840f-d912469614ee
spss-modeler_18.1	base	5c3cad7e-507f-4b2a-a9a3-ab53a21dee8b
cuda-py3.8	base	5d3232bf-c86b-5df4-a2cd-7bb870a1cd4e
autoai-kb_3.1-py3.7	base	632d4b22-10aa-5180-88f0-f52dfb6444d7
pytorch-onnx_1.7-py3.8		634d3cdc-b562-5bf9-a2d4-ea90a478456b
spark-mllib_2.3-r_3.6	base	6586b9e3-ccd6-4f92-900f-0f8cb2bd6f0c
tensorflow_2.4-py3.7	base	65e171d7-72d1-55d9-8ebb-f813d620c9bb
spss-modeler_18.2	base	687eddc9-028a-4117-b9dd-e57b36f1efa5
pytorch-onnx_1.2-py3.6	base	692a6a4d-2c4d-45ff-a1ed-b167ee55469a
spark-mllib_2.3-scala_2.11	base	7963efe5-bbec-417e-92cf-0574e21b4e8d
spark-mllib_2.4-py37	base	7abc992b-b685-532b-a122-a396a3cdbaab
caffe_1.0-py3.6	base	7bb3dbe2-da6e-4145-918d-b6d84aa93b6b
pytorch-onnx_1.7-py3.7	base	812c6631-42b7-5613-982b-02098e6c909c
cuda-py3.6	base	82c79ece-4d12-40e6-8787-a7b9e0f62770
tensorflow_1.15-py3.6-horovod	base	8964680e-d5e4-5bb8-919b-8342c6c0dfd8
hybrid_0.1	base	8c1a58c6-62b5-4dc4-987a-df751c2756b6
pytorch-onnx_1.3-py3.7	base	8d5d8a87-a912-54cf-81ec-3914adaa988d
caffe-ibm_1.0-py3.6	base	8d863266-7927-4d1e-97d7-56a7f4c0a19b
spss-modeler_17.1	base	902d0051-84bd-4af6-ab6b-8f6aa6fdeabb
do_12.10	base	9100fd72-8159-4eb9-8a0b-a87e12eefa36

base

do_py3.7	base	9447fa8b-2051-4d24-9eef-5acb0e3c59f8
spark-mllib_3.0-r_3.6	base	94bb6052-c837-589d-83f1-f4142f219e32
cuda-py3.7-opence	base	94e9652b-7f2d-59d5-ba5a-23a414ea488f
nlp-py3.8	base	96e60351-99d4-5a1c-9cc0-473ac1b5a864
cuda-py3.7	base	9a44990c-1aa1-4c7d-baf8-c4099011741c
hybrid_0.2	base	9b3f9040-9cee-4ead-8d7a-780600f542f7
spark-mllib_3.0-py38	base	9f7a8fc1-4d3c-5e65-ab90-41fa8de2d418
autoai-kb_3.3-py3.7	base	a545cca3-02df-5c61-9e88-998b09dc79af
spark-mllib_3.0-py39	base	a6082a27-5acc-5163-b02c-6b96916eb5e0
runtime-22.1-py3.9-do		a7e7dbf1-1d03-5544-994d-e5ec845ce99a

```
base
default_py3.8 base                ab9e1b80-f2ce-592c-a7d2-4f2344f77194

tensorflow_rt22.1-py3.9 base      acd9c798-6974-5d2f-a657-ce06e986df4d

kernel-spark3.2-py3.9 base        ad7033ee-794e-58cf-812e-a95f4b64b207

autoai-obm_2.0 with Spark 3.0     af10f35f-69fa-5d66-9bf5-acb58434263a
base
default_py3.7_opence base         c2057dd4-f42c-5f77-a02f-72bdbd3282c9

tensorflow_2.1-py3.7 base         c4032338-2a40-500a-beef-b01ab2667e27

do_py3.7_opence base              cc8f8976-b74a-551a-bb66-6377f8d865b4

spark-mllib_3.3 base              d11f2434-4fc7-58b7-8a62-755da64fdaf8

autoai-kb_3.0-py3.6 base          d139f196-e04b-5d8b-9140-9a10ca1fa91a

spark-mllib_3.0-py36 base         d82546d5-dd78-5fbb-9131-2ec309bc56ed

autoai-kb_3.4-py3.8 base          da9b39c3-758c-5a4f-9cfd-457dd4d8c395

kernel-spark3.2-r3.6 base         db2fe4d6-d641-5d05-9972-73c654c60e0a

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 base          deef04f0-0c42-5147-9711-89f9904299db

tensorflow_2.1-py3.7-horovod      e384fce5-fdd1-53f8-bc71-11326c9c635f
base
default_py3.7 base                e4429883-c883-42b6-87a8-f419d64088cd

do_22.1 base                      e51999ba-6452-5f1f-8287-17228b88b652

autoai-obm_3.2 base               eae86aab-da30-5229-a6a6-1d0d4e368983

do_20.1 base                      f686cdd9-7904-5f9d-a732-01b0d6b10dc5

scikit-learn_0.19-py3.6 base      f963fa9d-4bb7-5652-9c5d-8d9289ef6ad9

tensorflow_2.4-py3.8 base         fe185c44-9a99-5425-986b-59bd1d2eda46
----------------------------------  ----------------------------------------
-----

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-LCHXS3QPMaWArILi18FdSyGT',
    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]
```