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IBM PROJECT 2022

#IMPORT LIBRARIES

pwd

```
'/home/wsuser/work'
```

```
!pip install keras==2.2.4
!pip install tensorflow
!pip install numpy
```

```
Collecting keras==2.2.4
  Downloading Keras-2.2.4-py2.py3-none-any.whl (312 kB)
ent already satisfied: keras-preprocessing>=1.0.5 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
keras==2.2.4) (1.1.2)
Requirement already satisfied: scipy>=0.14 in /opt/conda/envs/Python-
3.9/lib/python3.9/site-packages (from keras==2.2.4) (1.7.3)
Requirement already satisfied: pyyaml in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
keras==2.2.4) (5.4.1)
Requirement already satisfied: six>=1.9.0 in /opt/conda/envs/Python-
3.9/lib/python3.9/site-packages (from keras==2.2.4) (1.15.0)
Requirement already satisfied: numpy>=1.9.1 in /opt/conda/envs/Python-
3.9/lib/python3.9/site-packages (from keras==2.2.4) (1.20.3)
Requirement already satisfied: h5py in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
keras==2.2.4) (3.2.1)
Installing collected packages: keras-applications, keras
  Attempting uninstall: keras
    Found existing installation: keras 2.7.0
    Uninstalling keras-2.7.0:
      Successfully uninstalled keras-2.7.0
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 2.7.2 requires keras<2.8,>=2.7.0, but you have keras 2.2.4
which is incompatible.
Successfully installed keras-2.2.4 keras-applications-1.0.8
Requirement already satisfied: tensorflow in /opt/conda/envs/Python-
3.9/lib/python3.9/site-packages (2.7.2)
Requirement already satisfied: numpy>=1.14.5 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
```

```
tensorflow) (1.20.3)
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)
Collecting keras<2.8,>=2.7.0
  Downloading keras-2.7.0-py2.py3-none-any.whl (1.3 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: wheel<1.0,>=0.32.0 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
tensorflow) (0.37.0)
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)
Requirement already satisfied: tensorflow-estimator<2.8,~=2.7.0 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
tensorflow) (2.7.0)
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: wrapt>=1.11.0 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
tensorflow) (1.12.1)
Requirement already satisfied: absl-py>=0.4.0 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
tensorflow) (0.12.0)
Requirement already satisfied: gast<0.5.0,>=0.2.1 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
tensorflow) (0.4.0)
Requirement already satisfied: tensorboard~=2.7 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
tensorflow) (2.7.0)
Requirement already satisfied: flatbuffers<3.0,>=1.12 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
tensorflow) (2.0)
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: six>=1.12.0 in /opt/conda/envs/Python-
3.9/lib/python3.9/site-packages (from tensorflow) (1.15.0)
Requirement already satisfied: protobuf>=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)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.21.0 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
tensorflow) (0.23.1)
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: 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: werkzeug>=0.11.15 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
tensorboard~=2.7->tensorflow) (2.0.2)
Requirement already satisfied: setuptools>=41.0.0 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
tensorboard~=2.7->tensorflow) (58.0.4)
Requirement already satisfied: google-auth<3,>=1.6.3 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
tensorboard~=2.7->tensorflow) (1.23.0)
Requirement already satisfied: markdown>=2.6.8 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
tensorboard~=2.7->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~=2.7->tensorflow) (1.6.0)
Requirement already satisfied: requests<3,>=2.21.0 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from
tensorboard~=2.7->tensorflow) (2.26.0)
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~=2.7->tensorflow) (0.6.1)
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~=2.7->tensorflow) (0.4.4)
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~=2.7->tensorflow) (0.2.8)
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~=2.7->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~=2.7->tensorflow) (4.7.2)
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~=2.7->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~=2.7->tensorflow)
(0.4.8)
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~=2.7->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~=2.7->tensorflow) (3.3)
```

```
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~=2.7->tensorflow) (2022.9.24)
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~=2.7->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~=2.7-
>tensorflow) (3.2.1)
Installing collected packages: keras
  Attempting uninstall: keras
    Found existing installation: Keras 2.2.4
    Uninstalling Keras-2.2.4:
      Successfully uninstalled Keras-2.2.4
Successfully installed keras-2.7.0
Requirement already satisfied: numpy in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (1.20.3)
```

```
#for working with arrays
import numpy as np
#open source used for both ML and DL for computation
import tensorflow
#mnist dataset
from tensorflow.keras.datasets import mnist
#it is a plain stack of layers
from tensorflow.keras.models import Sequential
#A Layer consists of a tensor- in tensor-out computat ion function
from tensorflow.keras import layers
#Dense-Dense Layer is the regular deeply connected layers
#faltten -used fot flattening the input or change the dimension
from tensorflow.keras.layers import Dense, Flatten
#Convolutional Layer
from tensorflow.keras.layers import Conv2D
#Used for one-hot encoding
from keras. utils import np_utils
#for data visualization
import matplotlib.pyplot as plt
```

#LOADING DATA

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

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-
keras-datasets/mnist.npz
11493376/11490434 [==============================] - 0s 0us/step
11501568/11490434 [==============================] - 0s 0us/step
```

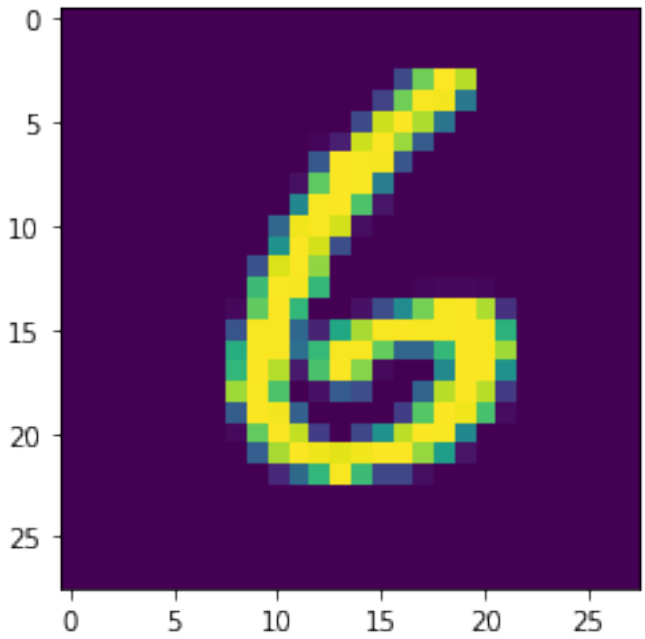
```
#shape is used for give the dimension values #60000-rows 28x28-pixels
print(x_train.shape)
print(x_test.shape)

(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,
3,
         18,  18,  18, 126, 136, 175,  26, 166, 255, 247, 127,   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,  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,  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,  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,  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, 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,  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,
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,
         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,  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,
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,
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,  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,  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]], dtype=uint8)
```

```
#Plotting the image
plt.imshow(x_train[6000])
```

```
<matplotlib.image.AxesImage at 0x7fae6c723370>
```




```
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')

#Storing number of classes in a variable
number_of_classes = 10

#converts the output in binary format
y_train = np_utils.to_categorical (y_train, number_of_classes)
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)
```

#Training 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 [==============================] - 116s 61ms/step - loss:
0.1835 - accuracy: 0.9554 - val_loss: 0.0853 - val_accuracy: 0.9731
Epoch 2/5
1875/1875 [==============================] - 108s 58ms/step - loss:
0.0655 - accuracy: 0.9802 - val_loss: 0.0904 - val_accuracy: 0.9721
Epoch 3/5
1875/1875 [==============================] - 109s 58ms/step - loss:
0.0493 - accuracy: 0.9848 - val_loss: 0.0806 - val_accuracy: 0.9782
Epoch 4/5
1875/1875 [==============================] - 107s 57ms/step - loss:
0.0343 - accuracy: 0.9888 - val_loss: 0.1063 - val_accuracy: 0.9758
Epoch 5/5
1875/1875 [==============================] - 108s 57ms/step - loss:
0.0285 - accuracy: 0.9906 - val_loss: 0.1065 - val_accuracy: 0.9755

<keras.callbacks.History at 0x7fae6cdbbdf0>
```

```
# 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) :
[0.10647186636924744, 0.9754999876022339]
```

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

```
[[2.8257352e-15 3.8920937e-12 3.4901258e-17 9.5643159e-08 8.2597093e-
05
```

```
  1.3513713e-09 1.1154587e-12 1.3680778e-06 6.3232153e-09 9.9991596e-
01]]
```

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

```
[9]
```

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

```
9
```

#Save the model

```
# Save the model
model.save('mnistCNN.h5')
```

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

```
mnistCNN.h5
```

```
ls -1
```

```
handwritten/
handwritten-model_new.tgz
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: requests in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-
machine-learning-client) (2.26.0)
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: boto3 in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-
machine-learning-client) (1.18.21)
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: certifi in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-
machine-learning-client) (2022.9.24)
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: 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: lomond in
/opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-
machine-learning-client) (0.3.3)
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: 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: 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: 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-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: 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: 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
```

```
from ibm_watson_machine_learning import APIClient
wml_credentials = {
                   "url":"https://us-south.ml.cloud.ibm.com",
                   "apikey":"Ng-
```

```
dOM88M0xel7_C2vWXwLR0mPlNgCJRbnXJu4TNg-sP"
                   }
client = APIClient(wml_credentials)

client = APIClient(wml_credentials)

def guid_from_space_name(client, space_name):
    space = client.spaces.get_details()
    return(next(item for item in space['resources'] if item['entity']
['name'] == space_name)['metadata']['id'])

space_uid = guid_from_space_name(client, 'models')
print("Space UID = "+ space_uid)

Space UID = c3803a62-7d77-4c36-8b91-12684f81243c

client.set.default_space(space_uid)

'SUCCESS'

client.software_specifications.list()

------------------------------  ------------------------------------
----
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
autoai-kb_rt22.2-py3.10         125b6d9a-5b1f-5e8d-972a-b251688ccf40
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
autoai-ts_rt22.2-py3.10        396b2e83-0953-5b86-9a55-7ce1628a406f
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
pytorch-onnx_rt22.2-py3.10     40e73f55-783a-5535-b3fa-0c8b94291431
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
runtime-22.2-py3.10-xc        5e8cddff-db4a-5a6a-b8aa-2d4af9864dab
base
autoai-kb_3.1-py3.7           632d4b22-10aa-5180-88f0-f52dfb6444d7
base
----------------------------  ------------------------------------
----
Note: Only first 50 records were displayed. To display more use
'limit' parameter.
```

```
software_spec_uid =
client.software_specifications.get_uid_by_name("tensorflow_rt22.1-
py3.9")
software_spec_uid
```

```
'acd9c798-6974-5d2f-a657-ce06e986df4d'
```

```
model_details = client.repository.store_model(model='handwritten-
model_new.tgz', meta_props={
client.repository.ModelMetaNames.NAME: "CNN",
client.repository.ModelMetaNames.TYPE: "tensorflow_2.7",
client.repository.ModelMetaNames.SOFTWARE_SPEC_UID:software_spec_uid})
model_id = client.repository.get_model_uid(model_details)
```

```
This method is deprecated, please use get_model_id()
```

```
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': '2022-11-19T13:08:19.466Z',
  'id': '9b33597e-9f93-47a6-8b60-7e9c07a30c7f',
  'modified_at': '2022-11-19T13:08:21.422Z',
  'name': 'CNN',
  'owner': 'IBMid-668000CYW6',
  'resource_key': 'cd4316d6-e97e-40d2-bad4-5c8e6907e22a',
  'space_id': 'c3803a62-7d77-4c36-8b91-12684f81243c'},
 'system': {'warnings': []}}
```

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

```
'9b33597e-9f93-47a6-8b60-7e9c07a30c7f'
```

```
client.repository.download(model_id,'Handwritten_recognition_IBM.tar.g
z')
```

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

```
'/home/wsuser/work/Handwritten_recognition_IBM.tar.gz'
```

```
ls
```

```
DigitRecog_IBM_model.tar.gz  handwritten-model_new.tgz
mnistCNN.h5
handwritten/                 Handwritten_recognition_IBM.tar.gz
```

Testing the 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
```

```
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']

img = Image.open(streaming_body_1).convert("L")
img = img.resize( (28,28) )
img
```

```
im2arr = np.array(img)
im2arr = im2arr.reshape(1, 28, 28, 1)

pred = model.predict(im2arr)
print(pred)
```

```
[[1.0000000e+00 2.8967338e-14 7.1253406e-11 1.0437016e-16 6.6939720e-
14
  3.4915980e-13 2.4058176e-11 1.0207940e-14 4.1624935e-09 2.3613622e-
13]]

print(np.argmax(pred, axis=1))

[0]
```