

Project Development PhaseSprint-4

Date	19 November 2022
Team ID	PNT2022TMID39478
Project Name	A Novel Method for Handwritten Digit Recognition System

The screenshot displays a Google Colab environment with the following components:

- Browser Tabs:** Hand_written_recognition_system, Service Details - IBM Cloud, IBM Watson Knowledge Catalog.
- URL:** colab.research.google.com/drive/1Q1t9j16TUXvKliBgwBKyK2LrWpGrzKYPI#scrollTo=rXL4UjCs3ZvT
- Notebook Title:** Hand_written_recognition_system.ipynb
- Files Panel:** Lists files including models, sample_data, MNIST-dataset.zip, RECOGNITION_SYSTEM.tar.gz, mnistCNN.h5, mnistCNN.tgz, mnist_test.csv, and mnist_train.csv.
- Code Cell 1:**

```
[1] !unzip '/content/MNIST-dataset.zip'
```

Archive: /content/MNIST-dataset.zip
replace mnist_test.csv? [y]es, [n]o, [A]ll, [N]one, [r]ename:

Importing Necessary Libraries

```
[1] import numpy #used for numerical analysis
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
#Flatten-used for flattening the input or change the dimension
from tensorflow.keras.layers import Conv2D #convolutional layer
from keras.optimizers import Adam #optimizer
from keras.utils import np_utils #used for one-hot coding
```

Load Data

```
[2] (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>
11490434/11490434 [*****] - 0s 0us/step

4s completed at 9:58 PM

Hand_written_recognition_system.ipynb

Files

- models
- sample_data
- MNIST-dataset.zip
- RECOGNITION_SYSTEM.tar.gb
- mnistCNN.h5
- mnistCNN.tgz
- mnist_test.csv
- mnist_train.csv

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```

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

```
[3] print(x_train.shape)#shape is used for give the dimension values #60000-rows 28x28-pixels paint
(60000, 28, 28)
(10000, 28, 28)
(60000, 28, 28)
(10000, 28, 28)
```

Understanding the data

```
[4] x_train[0] #printing the first image
```

```
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, 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,
```

4s completed at 9:58 PM

Hand_written_recognition_system.ipynb

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Understanding the data

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[4] x_train[0] #printing the first image
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```
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, 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, 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, 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, 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, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0],
[ 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 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]
```

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Files

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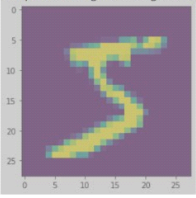
Code

```
[5] y_train[0] #print the label of first image
```

5

```
[6] import matplotlib.pyplot as plt #used for data visualization
plt.imshow(x_train[0]) #ploting the Index=0 image
```

matplotlib.image.AxesImage at 0x7f048ac368d0>



Reshaping Dataset

```
[7]
```

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Code

Reshaping Dataset

```
[7] #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')
```

One-Hot Encoding

```
[8] #one hot encode
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)
```

y_train[0]

```
array([0., 0., 0., 0., 0., 1., 0., 0., 0., 0.], dtype=float32)
```

Creating the Model

```
[10] #create model
model=Sequential()
```

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RAM Disk Editing

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Creating the Model

```
[10] #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'))
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

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

Fitting the Model

```
[12] #fit the model
model.fit(x_train,y_train, validation_data=(X_test,y_test),epochs=5,batch_size=32)
```

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Fitting the Model

```
[12] #fit the model
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```

Epoch 1/5
1875/1875 [=====] - 15s 4ms/step - loss: 0.2068 - accuracy: 0.9524 - val_loss: 0.0932 - val_accuracy: 0.9703
Epoch 2/5
1875/1875 [=====] - 7s 4ms/step - loss: 0.0712 - accuracy: 0.9783 - val_loss: 0.0846 - val_accuracy: 0.9754
Epoch 3/5
1875/1875 [=====] - 7s 4ms/step - loss: 0.0488 - accuracy: 0.9850 - val_loss: 0.0902 - val_accuracy: 0.9758
Epoch 4/5
1875/1875 [=====] - 7s 4ms/step - loss: 0.0380 - accuracy: 0.9876 - val_loss: 0.0981 - val_accuracy: 0.9764
Epoch 5/5
1875/1875 [=====] - 7s 4ms/step - loss: 0.0295 - accuracy: 0.9908 - val_loss: 0.1189 - val_accuracy: 0.9758
<keras.callbacks.History at 0x7f048ab98f10>

Observing the Metrics

```
[13] # 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):
[0.1188814714550972, 0.975799977793884]

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Observing the Metrics

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print("Metrics (Test loss & Test Accuracy): ")
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Metrics (Test loss & Test Accuracy):
[0.1188814714550972, 0.975799977793884]
```

Predicting the Output

```
[14] prediction=model.predict(x_train[:4])
print(prediction)

1/1 [-----] - 0s 106ms/step
[[[7.78131967e-14 1.38139890e-16 2.82195464e-15 4.85788121e-08
  7.94575552e-18 1.00000000e+00 4.23404242e-15 4.90271411e-14
  4.07516062e-13 1.06077832e-13]
 [9.9999762e-01 3.98558106e-14 2.84674428e-07 1.19939399e-14
  1.09890455e-16 4.11795198e-14 5.35580824e-09 1.34271697e-14
  2.36906033e-11 4.05702956e-08]
 [3.04074148e-22 5.88078588e-12 4.89856454e-11 1.44797707e-11
  9.99945164e-01 1.14840726e-09 3.65999413e-14 3.68996353e-08
  2.84338307e-06 5.19595487e-05]
 [6.12248329e-19 1.00000000e+00 1.74935499e-09 4.14037679e-17
  1.82656947e-08 8.82764239e-13]]]
```

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Predicting the Output

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[[[7.78131967e-14 1.38139890e-16 2.82195464e-15 4.85788121e-08
  7.94575552e-18 1.00000000e+00 4.23404242e-15 4.90271411e-14
  4.07516062e-13 1.06077832e-13]
 [9.9999762e-01 3.98558106e-14 2.84674428e-07 1.19939399e-14
  1.09890455e-16 4.11795198e-14 5.35580824e-09 1.34271697e-14
  2.36906033e-11 4.05702956e-08]
 [3.04074148e-22 5.88078588e-12 4.89856454e-11 1.44797707e-11
  9.99945164e-01 1.14840726e-09 3.65999413e-14 3.68996353e-08
  2.84338307e-06 5.19595487e-05]
 [6.12248329e-19 1.00000000e+00 1.74935499e-09 4.14037679e-17
  7.87404256e-12 1.85430822e-15 2.04139245e-12 1.35510429e-12
  1.82656947e-08 8.82764239e-13]]]
```

```
[15] import numpy as np
print(np.argmax(prediction, axis=1)) #print our label from first 4 images
print(y_test[:4]) #printing the actual labels

[5 0 4 1]
[[0. 0. 0. 0. 0. 0. 1. 0. 0.]
 [0. 0. 1. 0. 0. 0. 0. 0. 0.]
 [0. 1. 0. 0. 0. 0. 0. 0. 0.]
 [1. 0. 0. 0. 0. 0. 0. 0. 0.]]
```

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Service Details - IBM Cloud

IBM Watson Knowledge Catalog

colab.research.google.com/drive/1Qt9j16TUXvKlBgwBKyK2LWpGrzKYPI#scrollTo=CDcUdDzm4Jf

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RAM Disk

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Files

models

sample_data

MNIST-dataset.zip

RECOGNITION_SYSTEM.tar.gz

mnistCNN.h5

mnistCNN.tgz

mnist_test.csv

mnist_train.csv

Disk 55.34 GB available

Saving the Model

```
[34] # save the model
model.save('mnistCNN.h5')

[35] # saving in tar
!tar -zcvf mnistCNN.tgz mnistCNN.h5

mnistCNN.h5

IBM Deployment

[36] !pip install watson-machine-learning-client

Requirement already satisfied: urllib3 in /usr/local/lib/python3.7/dist-packages (from watson-machine-learning-client) (1.24.3)
Requirement already satisfied: pandas in /usr/local/lib/python3.7/dist-packages (from watson-machine-learning-client) (1.3.5)
Requirement already satisfied: tabulate in /usr/local/lib/python3.7/dist-packages (from watson-machine-learning-client) (0.8.10)
Collecting s3transfer<0.7.0,>=0.6.0
  Downloading s3transfer-0.6.0-py3-none-any.whl (79 kB)
    |████████████████████████████████████████| 79 kB 10.4 MB/s
Collecting boto3<1.30.0,>=1.29.13
  Downloading boto3-1.29.13-py3-none-any.whl (9.9 MB)
    |████████████████████████████████████████| 9.9 MB 61.7 MB/s
Collecting jmespath<2.0.0,>=0.7.1
  Downloading jmespath-1.0.1-py3-none-any.whl (20 kB)
Requirement already satisfied: python-dateutil<3.0.0,>=2.1 in /usr/local/lib/python3.7/dist-packages (from boto3->urllib3) (2.8.1)
Requirement already satisfied: six in /usr/local/lib/python3.7/dist-packages (from python-dateutil->six) (1.16.0)
4s completed at 9:58 PM
```

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Service Details - IBM Cloud

IBM Watson Knowledge Catalog

colab.research.google.com/drive/1Qt9j16TUXvKlBgwBKyK2LWpGrzKYPI#scrollTo=jjAHw18tzPza

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Requirement already satisfied: tabulate in /usr/local/lib/python3.7/dist-packages (from watson-machine-learning-client) (0.8.10)
Collecting s3transfer<0.7.0,>=0.6.0
  Downloading s3transfer-0.6.0-py3-none-any.whl (79 kB)
    |████████████████████████████████████████| 79 kB 10.4 MB/s
Collecting boto3<1.30.0,>=1.29.13
  Downloading boto3-1.29.13-py3-none-any.whl (9.9 MB)
    |████████████████████████████████████████| 9.9 MB 61.7 MB/s
Collecting jmespath<2.0.0,>=0.7.1
  Downloading jmespath-1.0.1-py3-none-any.whl (20 kB)
Requirement already satisfied: python-dateutil<3.0.0,>=2.1 in /usr/local/lib/python3.7/dist-packages (from boto3->urllib3) (2.8.1)
Requirement already satisfied: six in /usr/local/lib/python3.7/dist-packages (from python-dateutil->six) (1.16.0)
Collecting urllib3
  Downloading urllib3-1.26.12-py2.py3-none-any.whl (140 kB)
    |████████████████████████████████████████| 140 kB 65.2 MB/s
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/dist-packages (from python-dateutil->six) (1.16.0)
Collecting ibm-cos-sdk-core==2.12.0
  Downloading ibm-cos-sdk-core-2.12.0.tar.gz (956 kB)
    |████████████████████████████████████████| 956 kB 63.8 MB/s
Collecting ibm-cos-sdk-s3transfer==2.12.0
  Downloading ibm-cos-sdk-s3transfer-2.12.0.tar.gz (135 kB)
    |████████████████████████████████████████| 135 kB 67.9 MB/s
Collecting jmespath<2.0.0,>=0.7.1
  Downloading jmespath-0.10.0-py3-none-any.whl (24 kB)
Collecting requests
  Downloading requests-2.28.1-py3-none-any.whl (62 kB)
4s completed at 9:58 PM
```

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- mnist_train.csv

```
[37] !pip install ibm_watson_machine_learning
```

Downloading ibm-cos-sdk-2.7.0.tar.gz (51 kB)
Requirement already satisfied: certifi in /usr/local/lib/python3.7/dist-packages (from ibm_watson_machine_learning) (2022.9.24)
Requirement already satisfied: urllib3 in /usr/local/lib/python3.7/dist-packages (from ibm_watson_machine_learning) (1.26.12)
Requirement already satisfied: tabulate in /usr/local/lib/python3.7/dist-packages (from ibm_watson_machine_learning) (0.8.10)
Requirement already satisfied: requests in /usr/local/lib/python3.7/dist-packages (from ibm_watson_machine_learning) (2.28.1)
Requirement already satisfied: importlib-metadata in /usr/local/lib/python3.7/dist-packages (from ibm_watson_machine_learning) (4.13.0)
Requirement already satisfied: pandas<1.5.0,>=0.24.2 in /usr/local/lib/python3.7/dist-packages (from ibm_watson_machine_learning) (1.3.5)
Requirement already satisfied: lxml in /usr/local/lib/python3.7/dist-packages (from ibm_watson_machine_learning) (0.3.3)
Collecting ibm-cos-sdk-core==2.7.0
Downloading ibm-cos-sdk-core-2.7.0.tar.gz (824 kB)
Collecting ibm-cos-sdk-s3transfer==2.7.0
Downloading ibm-cos-sdk-s3transfer-2.7.0.tar.gz (133 kB)
Requirement already satisfied: jmespath<1.0.0,>=0.7.1 in /usr/local/lib/python3.7/dist-packages (from ibm-cos-sdk==2.7.*->ibm_watson_machine_learning) (0.16.0)
Requirement already satisfied: docutils<0.16,>=0.10
Collecting docutils==0.15.2
Requirement already satisfied: python-dateutil<3.0.0,>=2.1 in /usr/local/lib/python3.7/dist-packages (from ibm-cos-sdk-core==2.7.0->ibm-cos-sdk-core) (2.8.1)
Requirement already satisfied: pytz>=2017.3 in /usr/local/lib/python3.7/dist-packages (from pandas<1.5.0,>=0.24.2->ibm_watson_machine_learning) (2022.7.1)
Requirement already satisfied: numpy>=1.17.3 in /usr/local/lib/python3.7/dist-packages (from pandas<1.5.0,>=0.24.2->ibm_watson_machine_learning) (1.24.3)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/dist-packages (from python-dateutil<3.0.0,>=2.1->ibm-cos-sdk-core==2.7.0->ibm-cos-sdk-core) (1.16.0)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.7/dist-packages (from requests->ibm_watson_machine_learning) (3.4)
Requirement already satisfied: charset-normalizer<3,>=2 in /usr/local/lib/python3.7/dist-packages (from requests->ibm_watson_machine_learning) (2.0.12)
Requirement already satisfied: typing-extensions>=3.6.4 in /usr/local/lib/python3.7/dist-packages (from importlib-metadata->ibm_watson_machine_learning) (4.5.0)
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.7/dist-packages (from importlib-metadata->ibm_watson_machine_learning) (3.10.0)
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in /usr/local/lib/python3.7/dist-packages (from packaging->ibm_watson_machine_learning) (3.1.0)
Building wheels for collected packages: ibm-cos-sdk, ibm-cos-sdk-core, ibm-cos-sdk-s3transfer
Successfully built ibm-cos-sdk ibm-cos-sdk-core ibm-cos-sdk-s3transfer
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- mnist_train.csv

```
[38] from ibm_watson_machine_learning import APIClient
```

```
wml_credentials = {  
    "url": "https://eu-gb.ml.cloud.ibm.com",  
    "apikey": "cd_XZATXEB4A10AgVOHMAyF496P2vIFXeqRLHvt-uaj"  
}
```

```
client=APIClient(wml_credentials)
```

Python 3.7 and 3.8 frameworks are deprecated and will be removed in a future release. Use Python 3.9 framework instead.

```
[39] client.spaces.get_details()
```

```
{  
  'resources': [  
    {'entity': {'compute': {'crn': 'crn:vi:bluemix:public:pm-20:eu-gb:a/9486372b436d4f81b6f6810c9b23324b:f437aad0-ee9a-4b67-b77b-3f2365c35d1e':,  
      'guid': 'f437aad0-ee9a-4b67-b77b-3f2365c35d1e',  
      'name': 'Watson Machine Learning-h8',  
      'type': 'machine_learning'}},  
    'description': '',  
    'name': 'digitrecognition',  
    'scope': {'bss_account_id': '9486372b436d4f81b6f6810c9b23324b'},  
    'stage': {'production': False},  
    'status': {'state': 'active'},  
    'storage': {'properties': {'bucket_name': 'e2d65e94-47c2-4c40-87e4-837d87b2b20f',  
      'bucket_region': 'eu-gb-standard',  
      'credentials': {'admin': {'access_key_id': 'cdc503054dfb403d97da94b12e0ddedd',  
        'api_key': 'I6VP8f951HQDKA1BxDZBUPAAeeIDzAqZD4Z-DHvWm1g',  
        'secret_access_key': '55f023efb6cb93dc2836b5b72ceb6b4b367b6add1c05065',  
        'service_id': 'ServiceId-0fd9c411-35c7-4d53-aa32-b926c54fba6'},  
        'token': 'f437aad0-ee9a-4b67-b77b-3f2365c35d1e'}}}}}]
```

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- MNIST-dataset.zip
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- mnistCNN.h5
- mnistCNN.tgz
- mnist_test.csv
- mnist_train.csv

```
[39] client.spaces.get_details()

{'resources': [{'entity': {'compute': [{'crn': 'crn:v1:bluemix:public:pm-28:eu-gb:a/9486372b436d4f81b6f6810c9b23324b:f437aad0-ee9a-4b67-b77b-3f2365c35d1e':,
    'guid': 'f437aad0-ee9a-4b67-b77b-3f2365c35d1e',
    'name': 'Watson Machine Learning-h8',
    'type': 'machine_learning'}],
    'description': '',
    'name': 'digitrecognition',
    'scope': {'bss_account_id': '9486372b436d4f81b6f6810c9b23324b'},
    'stage': {'production': False},
    'status': {'state': 'active'},
    'storage': {'properties': {'bucket_name': 'e2d65e94-47c2-4c40-87e4-837d87b2b20f',
    'bucket_region': 'eu-gb-standard',
    'credentials': {'admin': {'access_key_id': 'cdc503054dfb403d97da94b12e0ddedd',
    'api_key': 'T0VP8f951HQKAI8dZ8UPa0ee1J7Aqj0AZ2-DHvWm1g',
    'secret_access_key': '55f023efb6cb93dc2836b5b72cebe6b4b367b6add1c05065',
    'service_id': 'ServiceId-0fd9c411-35c7-4d53-aa32-b926c54fbae6'},
    'editor': {'access_key_id': 'ab51ff45b61a4c4585ff5c7ab389c408',
    'api_key': 'aj8tRiXaHwUwTj3RzF_UFTUXBq54pdvJpLmKInw91',
    'resource_key_crn': 'crn:v1:bluemix:public:cloud-object-storage:global:a/9486372b436d4f81b6f6810c9b23324b:a10800c7-b00e-404a-92cc-65f5b7ba03c9':,
    'secret_access_key': '153b63bf08e934dfb3959013f773bfa59cbbc1e0f72261d',
    'service_id': 'ServiceId-a064acff-c04b-4c03-b1df-5cb962f18d34'},
    'viewer': {'access_key_id': 'dbc3f6aeac4d833b1ec3ff33c1feb4f',
    'api_key': '0yDRUHVlyuDOEF3rQfw_fjAC2w0hKvZ4dHtTC_ScAkwu',
    'resource_key_crn': 'crn:v1:bluemix:public:cloud-object-storage:global:a/9486372b436d4f81b6f6810c9b23324b:a10800c7-b00e-404a-92cc-65f5b7ba03c9':,
    'secret_access_key': 'ef7e338fc8810b10f447f0870c26eb0f1e40e8e27e3668e',
    'service_id': 'ServiceId-c79f44f1-d5ad-4b53-adf9-5de3703a2a92'}],
    'endpoint_url': 'https://s3.eu-gb-cloud-object-storage.appdomain.cloud',
    'guid': 'a10800c7-b00e-404a-92cc-65f5b7ba03c9'}
```

Hand_written_recognition_system.ipynb

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

[43] space_uid = guid_sapce_name(client,'digitrecognition')
      space_uid

'4ecdeb91-3d3e-4d86-baad-d1345f264945'

[44] client.set_default_space(space_uid)

'success'

[45] 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-e07b6b5ff687 base
spark-mllib_3.0-scala_2.12 09facff6-90a7-5899-b9ed-1ef348aebdee base
pytorch-onnx_rt22.1-py3.9 0b848dd4-e681-5599-bd41-b5f6fcccc6471 base
ai-function_0.1-py3.6 0cdeb0f1e-5376-4f4d-92dd-da3b69aa9bda base
shiny-r3.6          0e6e79df-875e-4f24-8ae9-62dc2148306 base
tensorflow_2.4-py3.7-horovod 1092590a-307d-563d-9b62-4eb7d64b3f22 base
pytorch_1.1-py3.6 10ac12d6-6b30-4ccd-8392-3e922c096a92 base
```


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[45] client.software_specifications.list()

NAME	ASSET_ID	TYPE
default_py3.6	0062b8c9-8b7d-44a0-a9b9-46c416adcb9	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	09c5a100-9c1e-4473-a344-eb7b6e5ff687	base
spark-mllib_3.0-scala_2.12	09facff0-90a7-5899-b9ed-1ef348aebdee	base
pytorch-onnx_rt22.1-py3.9	0b848dd4-e681-5599-be41-b5f6fcc6471	base
ai-function_0.1-py3.6	0cdeb0fe-5376-4f4d-92dd-da3b69aa9bda	base
shiny-r3.6	0ee679df-875e-4f24-8ae9-62dcd2148306	base
tensorflow_2.4-py3.7-horovod	1092590a-307d-563d-9b62-4eb7d64b3f22	base
pytorch_1.1-py3.6	10ac12d6-6b30-4ccd-8392-3e922c09e6a92	base
tensorflow_1.15-py3.6-ddl	111e41b3-de2d-5422-adde-bf775828cab7	base
autoai-kb_rt22.2-py3.10	125b6d9a-5b1f-5e84-972a-b251688ccf40	base
runtime-22.1-py3.9	12b83a17-24d8-5082-90ef-0ab31bfbd3cb	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-c97-56da-b8e0-39c3880dbbe7	base
kernel-spark3.3-r3.6	1c9e454a-f216-59dd-a20e-474a5cdf5988	base
pytorch-onnx_rt22.1-py3.9-edt	1d362186-7ad5-5b59-8bdc-9d8880bde37f	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-da66306ce558	base
do_py3.8	295addb5-9ef9-547e-9bfa-92ae3563e720	base
autoai-ts_3.8-py3.8	2a8bc932-798f-5ae9-abdc-15e8e2a07f05	base
tensorflow_1.15-py3.6	2b73a275-7cbf-420b-a912-eae7f43e60bc	base
kernel-spark3.3-py3.9	2b7961e2-e3b1-5a8c-a491-482c8368839a	base
nvtorch_1.2-nv3.6	2c8ef57d-2687-4b7d-acc0-01f94976d4c1	base

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[48] software_space_uid = client.software_specifications.get_uid_by_name('tensorflow_rt22.1-py3.9')

software_space_uid

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

[52] model_details = client.repository.store_model(model='mnistCNN.tgz', meta_props={

client.repository.ModelMetaNames.NAME: "Handwritten Digit",

client.repository.ModelMetaNames.TYPE: "tensorflow_2.7",

client.repository.ModelMetaNames.SOFTWARE_SPEC_UID: software_space_uid

})

[53] 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': '2022-11-19T16:25:42.199Z',

'id': '60f6932b-8cf7-456d-b074-390397091ce5',

'modified_at': '2022-11-19T16:25:45.841Z',

'name': 'Handwritten Digit',

'owner': 'IBMId-666002L43C',

'resource_key': '416bc30e-37c0-4681-bfa7-972bbc189853',

'space_id': '4ecddeb91-3d3e-4d86-baad-d1345f264945'},

'system': {'warnings': []}}

[55] model_id = client.repository.get_model_id(model_details)

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Files

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- mnist_train.csv

```
[55] model_id = client.repository.get_model_id(model_details)
      model_id

'60f6932b-8cf7-456d-b974-390397091ce5'

[56] client.repository.download(model_id, 'RECOGNITION_SYSTEM.tar.gb')

Successfully saved model content to file: 'RECOGNITION_SYSTEM.tar.gb'
'/content/RECOGNITION_SYSTEM.tar.gb'
```

4s completed at 9:58 PM

RECOGNITION_SYS...gb

21°C Mostly cloudy

IBM Deployment:

Hand_written_recognition_system.ipynb

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- Build and manage ML models with Watson Studio
- Query data anywhere with Watson Query

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- New Runtime 2022 release for Python 3.10 and R 4.2
- Spark 3.3 replaces Spark 3.2 for Watson Studio and Watson Machine Learning
- Refine data from a selected Excel worksheet in a connection or a connected data asset (Data Refinement)

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