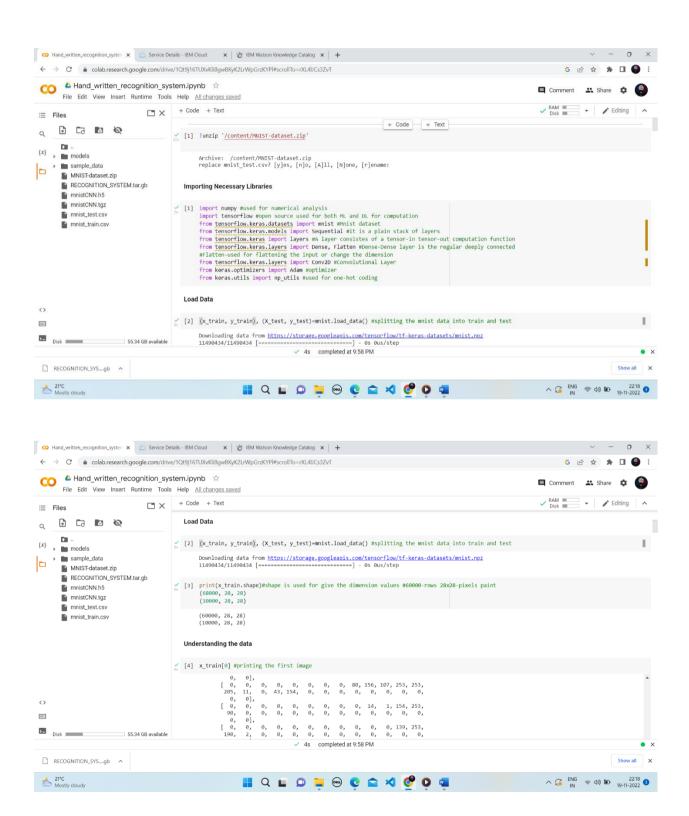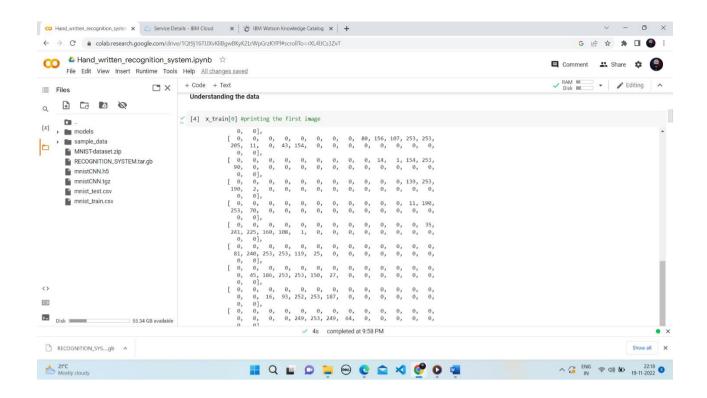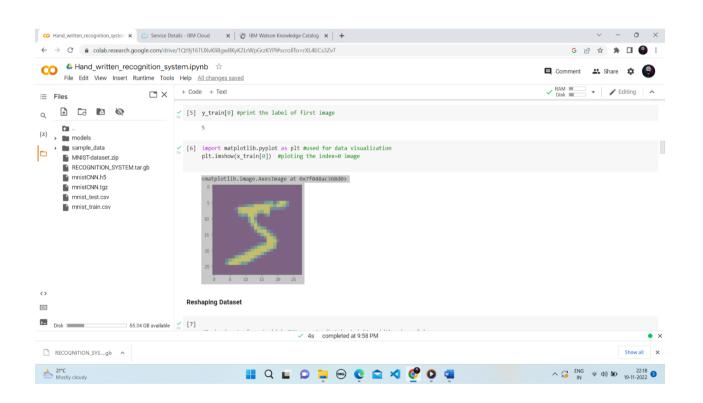# Project Development Phase
Sprint-4

Date	19 November 2022
Team ID	PNT2022TMID40411
Project Name	A Novel Method for Handwritten Digit Recognition System

Hand_written_recognition_system.ipynb ☆

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Files

{x} 📁 ..
   ▸ 📁 models
   ▸ 📁 sample_data
   📄 MNIST-dataset.zip
   📄 RECOGNITION_SYSTEM.tar.gb
   📄 mnistCNN.h5
   📄 mnistCNN.tgz
   📄 mnist_test.csv
   📄 mnist_train.csv

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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,   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,  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,  249,  253,  249,   64,    0,    0,    0,    0,    0,
          0,    0]
```

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{x} 📁 ..
   ▸ 📁 models
   ▸ 📁 sample_data
   📄 MNIST-dataset.zip
   📄 RECOGNITION_SYSTEM.tar.gb
   📄 mnistCNN.h5
   📄 mnistCNN.tgz
   📄 mnist_test.csv
   📄 mnist_train.csv

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

     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, 0.9757999777793884]
```

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]
      [9.99997762e-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
```

Hand_written_recognition_system.ipynb
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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]
      [9.99999762e-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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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 botocore<1.30.0,>=1.29.13
       Downloading botocore-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 botocore<1.30.0,>=1.29.13->boto3->wa
```

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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 botocore<1.30.0,>=1.29.13
  Downloading botocore-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 botocore<1.30.0,>=1.29.13->boto3->wa
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<3.0.0,>=2.1->botocore<1.30.0,>=1.29.13->
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-py2.py3-none-any.whl (24 kB)
Collecting requests
  Downloading requests-2.28.1-py3-none-any.whl (62 kB)
```

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

```
  Downloading ibm-cos-sdk-2.7.0.tar.gz (51 kB)
     |████████████████████████████████| 51 kB 896 kB/s
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: lomond 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)
     |████████████████████████████████| 824 kB 54.9 MB/s
Collecting ibm-cos-sdk-s3transfer==2.7.0
  Downloading ibm-cos-sdk-s3transfer-2.7.0.tar.gz (133 kB)
     |████████████████████████████████| 133 kB 67.7 MB/s
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_le
Collecting docutils<0.16,>=0.10
  Downloading docutils-0.15.2-py3-none-any.whl (547 kB)
     |████████████████████████████████| 547 kB 69.1 MB/s
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
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
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
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->
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.7/dist-packages (from requests->ibm_watson_machine_learning) (2.10)
Requirement already satisfied: charset-normalizer<3,>=2 in /usr/local/lib/python3.7/dist-packages (from requests->ibm_watson_machine_learning)
Requirement already satisfied: typing-extensions>=3.6.4 in /usr/local/lib/python3.7/dist-packages (from importlib-metadata->ibm_watson_machine
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.7/dist-packages (from importlib-metadata->ibm_watson_machine_learning) (3.10
Requirement already satisfied: pyparsing!=3.0.5,>=2.0.2 in /usr/local/lib/python3.7/dist-packages (from packaging->ibm_watson_machine_learning
Building wheels for collected packages: ibm-cos-sdk, ibm-cos-sdk-core, ibm-cos-sdk-s3transfer
```

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＋ Code ＋ Text

Files

..
📁 models
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📄 mnistCNN.h5
📄 mnistCNN.tgz
📄 mnist_test.csv
📄 mnist_train.csv

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```
Successfully installed docutils-0.15.2 ibm-cos-sdk-2.7.0 ibm-cos-sdk-core-2.7.0 ibm-cos-sdk-s3transfer-2.7.0 ibm-watson-machine-learning-1.0.2…
```

```python
[38]  from ibm_watson_machine_learning import APIClient
      wml_credentials = {
          "url":"https://eu-gb.ml.cloud.ibm.com",
          "apikey":"Cd_XZAtXE84A1OAgYOhMAYFe496P2viFxEqRLHvt-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.

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

{'resources': [{'entity': {'compute': [{'crn': 'crn:v1: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': 'I6YP8fn951HQDKAIBxD2BUPaAeeIdZAqzD4Z-DhVwnig',
       'secret_access_key': '55f023efb6cbb93dc2836b5b72ceb6b4b367b6add1c05065',
       'service_id': 'ServiceId-0fd9c411-35c7-4d53-aa32-b926c54fbea6'},
      'editor': {'access key id': 'ab51ff45b61a4c4595ff5c7ab389c4d8'

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

{'resources': [{'entity': {'compute': [{'crn': 'crn:v1: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': 'I6YP8fn951HQDKAIBxD2BUPaAeeIdZAqzD4Z-DhVwnig',
       'secret_access_key': '55f023efb6cbb93dc2836b5b72ceb6b4b367b6add1c05065',
       'service_id': 'ServiceId-0fd9c411-35c7-4d53-aa32-b926c54fbea6'},
      'editor': {'access_key_id': 'ab51ff45b61a4c4595ff5c7ab389c4d8',
       'api_key': 'aj8tRiXaHuNawTU3RzF_UFtUX8qs4pdWjpLmKinvw91_',
       'resource_key_crn': 'crn:v1:bluemix:public:cloud-object-storage:global:a/9486372b436d4f81b6f6810c9b23324b:a10800c7-b00e-404a-92cc-65f5b7ba03c9::',
       'secret_access_key': '153b63bdf0be934dfb3959013f773bfa59cbbc1e0f72261d',
       'service_id': 'ServiceId-a064acff-c04b-4c03-b1df-5cb962f18d34'}},
      'viewer': {'access_key_id': 'dbc3f6aeeac44833b1ec3ff33c1feb4f',
       'api_key': '0YdRUHVLyuDOEF3rQFw_fjAC2w0hkVZ4dNtTC_5cAkwu',
       'resource_key_crn': 'crn:v1:bluemix:public:cloud-object-storage:global:a/9486372b436d4f81b6f6810c9b23324b:a10800c7-b00e-404a-92cc-65f5b7ba03c9::',
       'secret_access_key': 'ef7e338fc8810b10f347ff0870c26eb8f1e49e8e27e3668e',
       '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',

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RECOGNITION_SYS...gb ∧   Show all

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```python
[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'])
```

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

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

```python
[44] client.set.default_space(space_uid)
```

    'SUCCESS'

```python
[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-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
```

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```python
[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-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
```

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Files

```
[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-b974-390397091ce5',
  'modified_at': '2022-11-19T16:25:45.841Z',
  'name': 'HandWritten Digit',
  'owner': 'IBMid-666002L43C',
  'resource_key': '416bc30e-37c0-4681-bfa7-972bbc189853',
  'space_id': '4ecdeb91-3d3e-4d86-baad-d1345f264945'},
 'system': {'warnings': []}}
```

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

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```
[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'
```

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IBM Deployment: