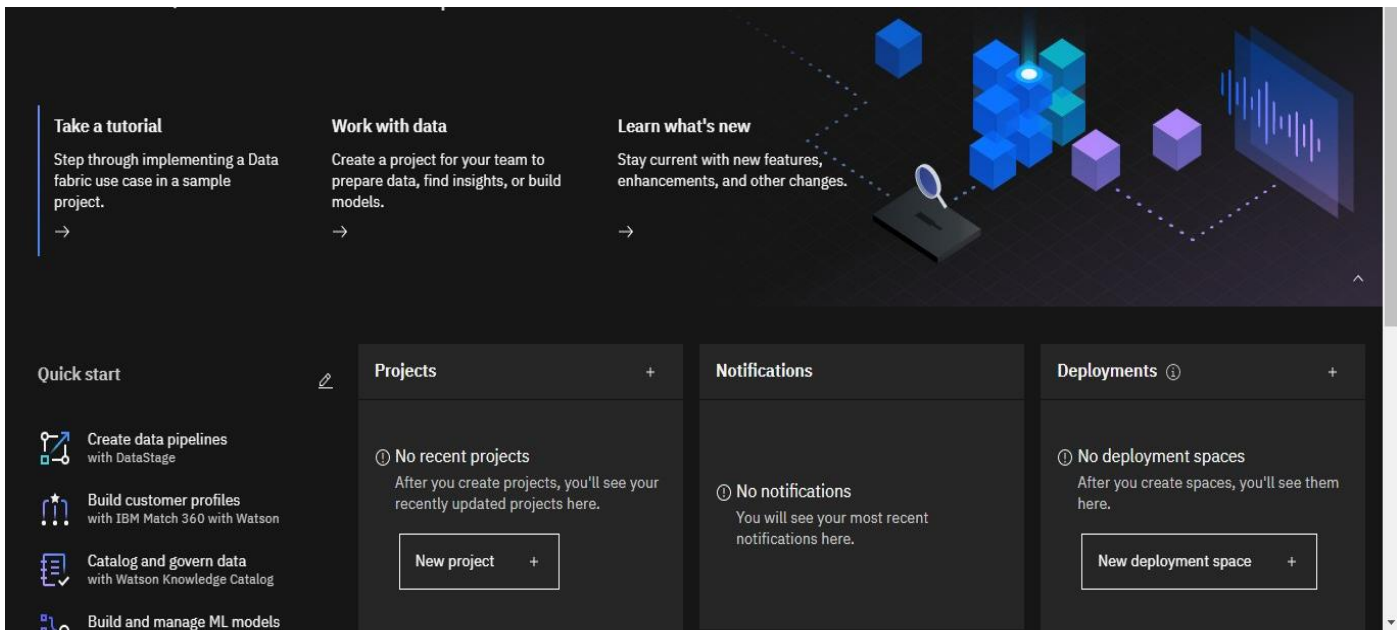
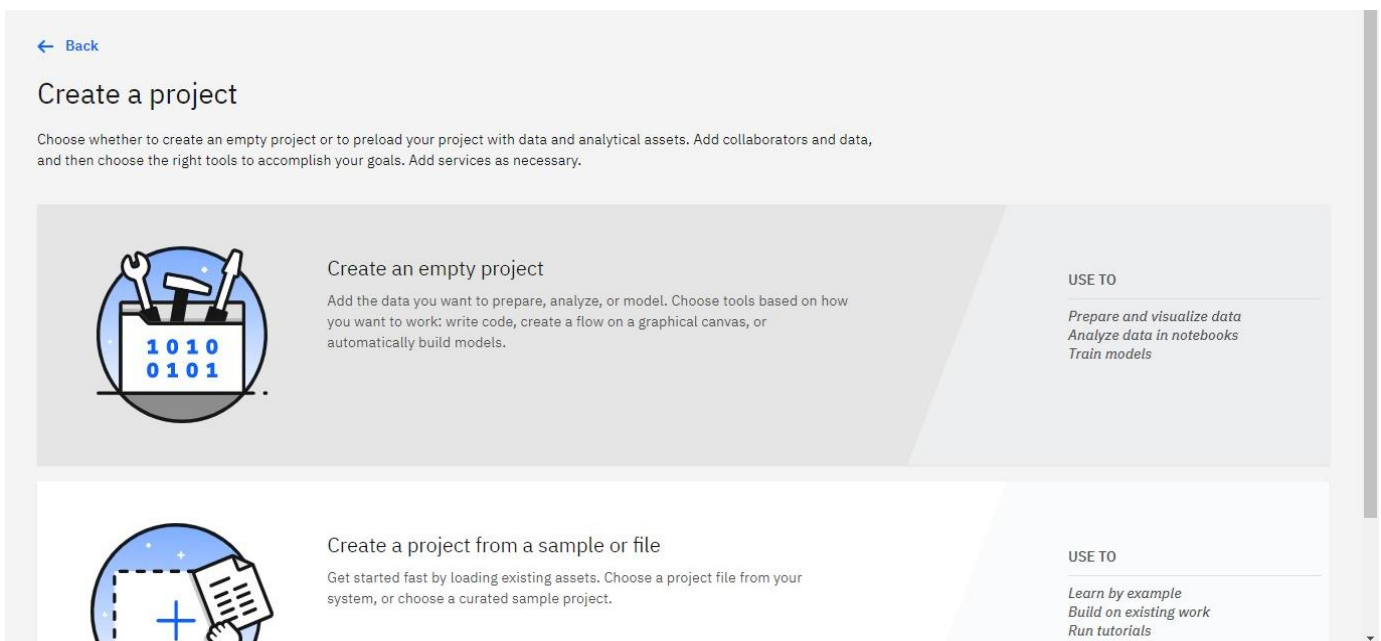


CREATING AN IBM WATSON STUDIO:

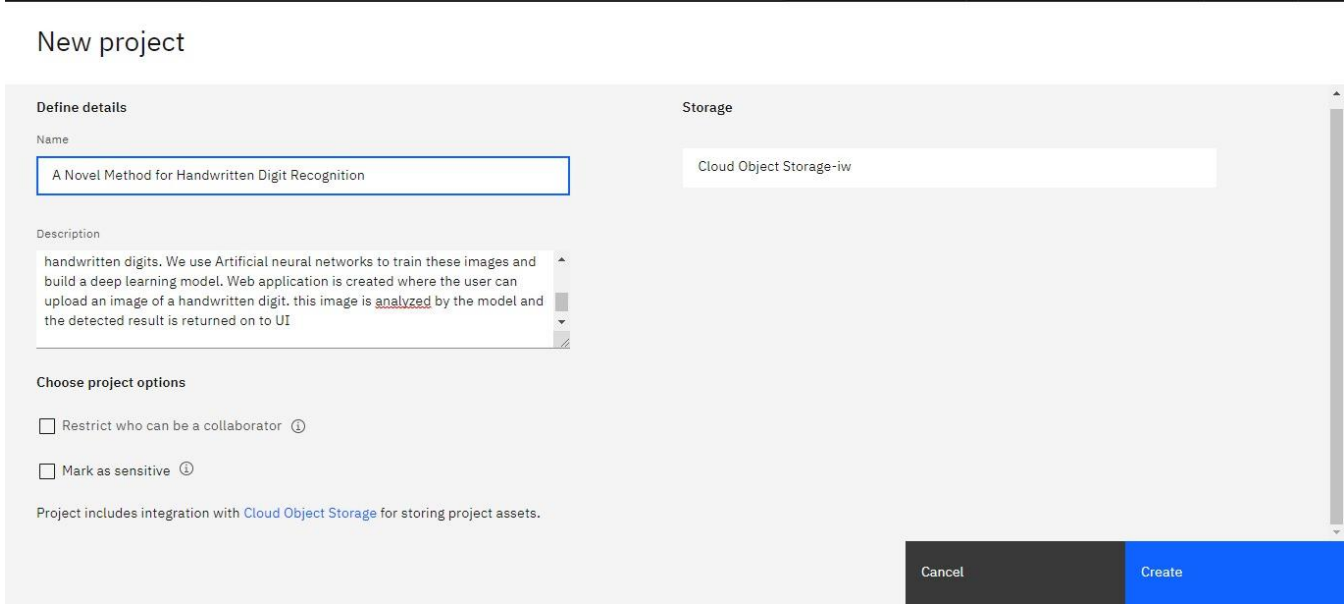
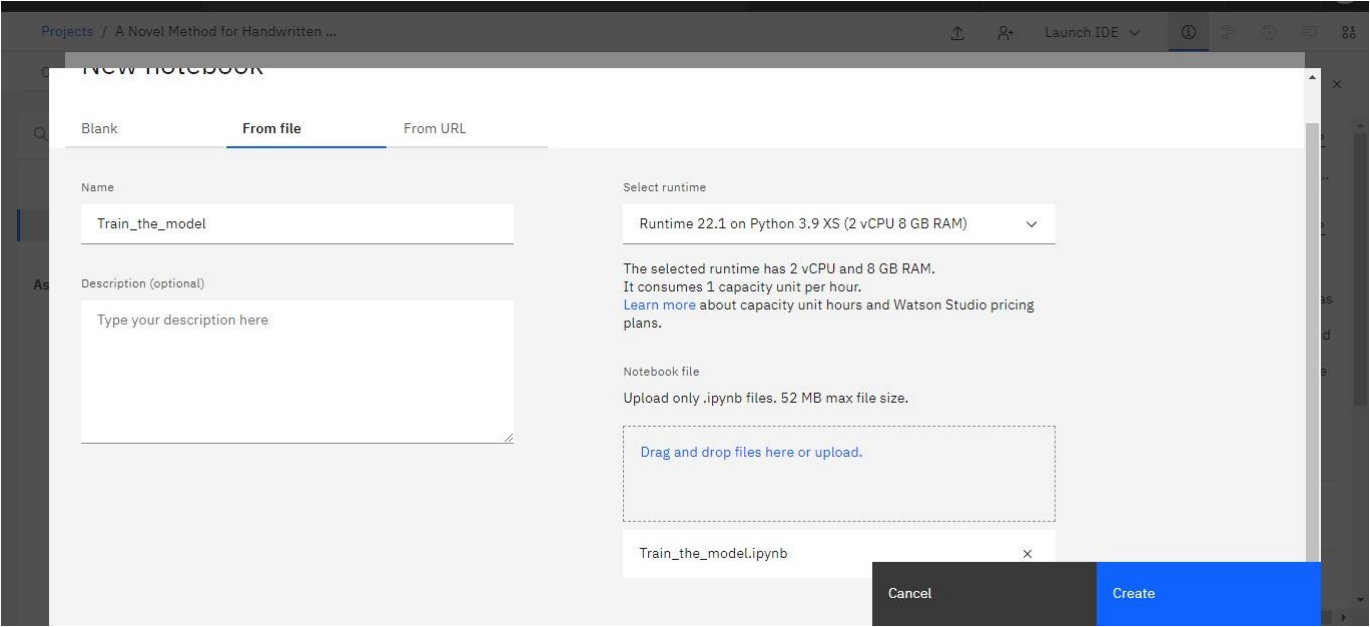
CREATING A PROJECT:



CREATING A NEW ENVIRONMENT



CREATING CLOUD SPACE:



TRAINING THE MODEL ON IBM CLOUD:

Projects / A Novel Method for Handwritten Digit Recognition

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In [1]:
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

from keras.utils import np_utils
from tensorflow.keras.datasets import mnist
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, Dense, Flatten
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.models import load_model
from PIL import Image, ImageOps

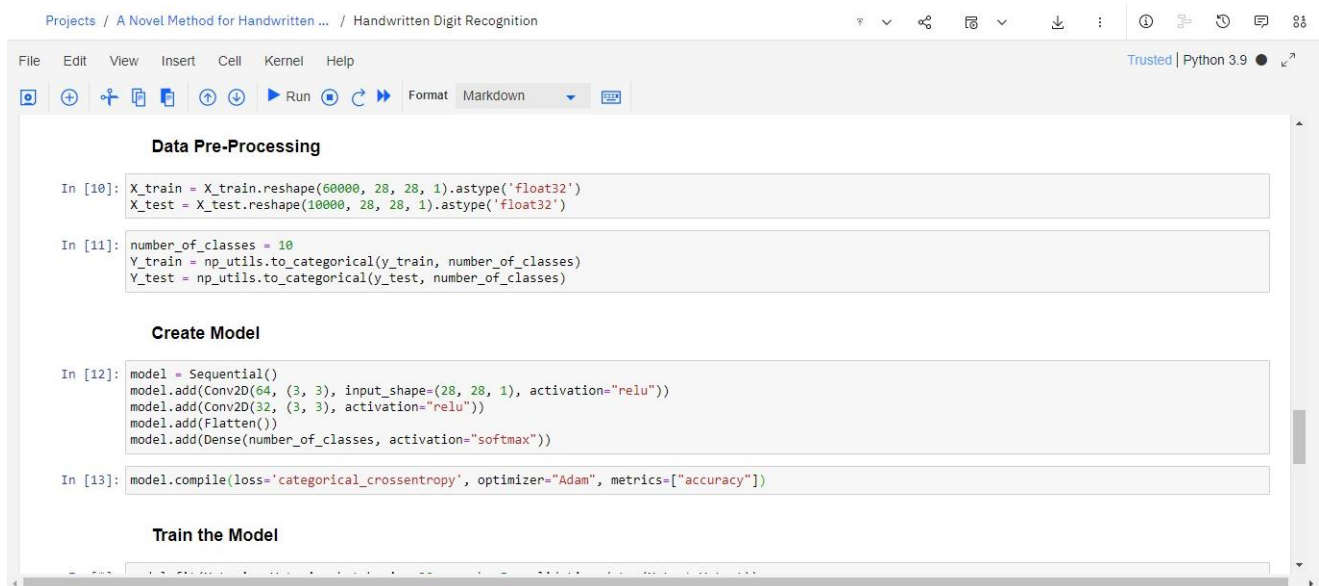
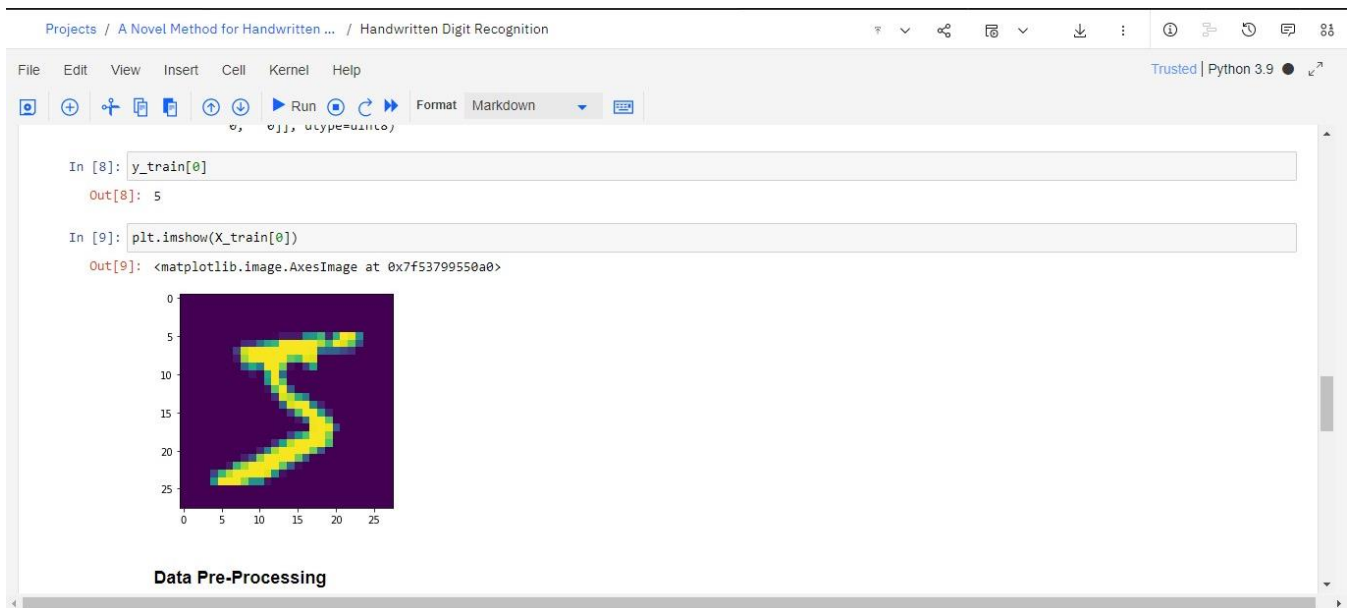
Load the data

In [5]: (X_train, y_train), (X_test, y_test) = mnist.load_data()

Data Analysis

In [6]: print(X_train.shape)
print(X_test.shape)

[illegible]



```
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In [*]: model.fit(X_train, Y_train, batch_size=32, epochs=5, validation_data=(X_test, Y_test))

Epoch 1/5
1875/1875 [=====] - 190s 101ms/step - loss: 0.2821 - accuracy: 0.9473 - val_loss: 0.0984 - val_accuracy: 0.9678
Epoch 2/5
1875/1875 [=====] - 191s 102ms/step - loss: 0.0737 - accuracy: 0.9774 - val_loss: 0.0760 - val_accuracy: 0.9763
Epoch 3/5
1875/1875 [=====] - 186s 99ms/step - loss: 0.0504 - accuracy: 0.9834 - val_loss: 0.0846 - val_accuracy: 0.9755
Epoch 4/5
1875/1875 [=====] - 188s 100ms/step - loss: 0.0373 - accuracy: 0.9881 - val_loss: 0.1391 - val_accuracy: 0.9625
Epoch 5/5
1267/1875 [=====>.....] - ETA: 59s - loss: 0.0256 - accuracy: 0.9923 ETA: 1:00 - loss: 0.0255 - a

Train the Model

In [ ]: metrics = model.evaluate(X_test, Y_test, verbose=0)
print("Metrics (Test Loss & Test Accuracy): ")
print(metrics)

In [ ]: prediction = model.predict(X_test[:4])
print(prediction)
```

```
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In [15]: metrics = model.evaluate(X_test, Y_test, verbose=0)
print("Metrics (Test Loss & Test Accuracy): ")
print(metrics)

Metrics (Test Loss & Test Accuracy):
[0.08687877655029297, 0.9807999730110168]

In [16]: prediction = model.predict(X_test[:4])
print(prediction)

[[5.09432931e-15 1.56521345e-20 7.35496906e-12 1.36783318e-09
 5.79286134e-22 1.02446433e-15 1.01120972e-21 1.00000000e+00
 9.58406006e-15 1.10001279e-11]
[1.01669286e-08 7.29183043e-08 9.99993801e-01 3.05165208e-13
 7.96790235e-16 2.02896849e-17 6.04845673e-06 3.74402691e-14
 1.11660945e-13 8.82754902e-14]
[3.54005977e-07 9.98027057e-01 3.29728266e-07 4.19751123e-09
 1.01197371e-03 3.50851333e-05 1.20187156e-06 2.09555239e-07
 2.37075274e-05 2.99694186e-10]
[1.00000000e+00 2.08214140e-18 1.09386729e-12 1.19749111e-16
 1.63756203e-10 8.57702418e-13 3.01977536e-08 1.70557578e-12
 1.17479572e-12 1.82323507e-08]]

In [17]: print(numpy.argmax(prediction, axis=1))
```

```
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Metrics (Test Loss & Test Accuracy):
[0.08687877655029297, 0.9807999730110168]

In [16]: prediction = model.predict(X_test[:4])
print(prediction)

[[5.09432931e-15 1.56521345e-20 7.35496906e-12 1.36783318e-09
 5.79286134e-22 1.02446433e-15 1.01120972e-21 1.00000000e+00
 9.58406006e-15 1.10001279e-11]
 [1.01669286e-08 7.29183043e-08 9.99993801e-01 3.05165208e-13
 7.96790235e-16 2.02896849e-17 6.04845673e-06 3.74402691e-14
 1.11660945e-13 8.82754902e-14]
 [3.54005977e-07 9.98927057e-01 3.29728266e-07 4.19751123e-09
 1.01197371e-03 3.50851333e-05 1.20187156e-06 2.09555239e-07
 2.37075274e-05 2.99694186e-10]
 [1.00000000e+00 2.08214140e-18 1.09386729e-12 1.19749111e-16
 1.63756203e-10 8.57702418e-13 3.01977536e-08 1.70557578e-12
 1.17479572e-12 1.82323507e-08]]

In [19]: print(np.argmax(prediction, axis=1))
print(Y_test[:4])

[7 2 1 0]
[[0. 0. 0. 0. 0. 0. 0. 1. 0. 0.]
 [0. 0. 1. 0. 0. 0. 0. 0. 0. 0.]
 [0. 1. 0. 0. 0. 0. 0. 0. 0. 0.]
 [1. 0. 0. 0. 0. 0. 0. 0. 0. 0.]]
```

```
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Save the model

In [20]: model.save("model.h5")

Converting to tar format

In [21]: !tar -zcvf Handwritten-Digit-Recognition_new.tgz model.h5
model.h5

In [22]: 1 ls -l
Handwritten-Digit-Recognition_new.tgz
model.h5

Installing Watson Machine Learning

In [ ]: !pip install watson-machine-learning-client --upgrade

Watson API credentials
```



```
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Installing watson machine learning

In [23]: !pip install watson-machine-learning-client --upgrade

Collecting watson-machine-learning-client
  Downloading watson_machine_learning_client-1.0.391-py3-none-any.whl (538 kB)
    538 kB 18.6 MB/s eta 0:00:01
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: requests in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (2.26.0)
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: 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: 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: boto3 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from watson-machine-learning-client) (1.18.21)
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: 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: 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: python-dateutil<3.0.0,>=2.1 in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (from botocore->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)
```

WATSON API CONFIGURATION:

```
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Watson API credentials

In [48]: from ibm_watson_machine_learning import APIClient
credentials = {
    "url": "https://us-south.ml.cloud.ibm.com",
    "apikey": "70UEqSzCfyJWJFI2TQe3QYmgM22A5lePUo3RT1puB27j"
}
client = APIClient(credentials)

In [49]: def guid_from_space_name(client, space_name):
space=client.spaces.get_details()
#print(spaces)
return(next(item for item in space['resources'] if item['entity']['name'] == space_name)['metadata']['id'])

In [50]: space_uid = guid_from_space_name(client, 'HandwrittenDigitRecognition')
print( "space_uid =" + space_uid)

space_uid =ea0a184f-43ea-4552-9599-61e24b551a41

In [51]: client.set.default_space(space_uid)

Out[51]: 'SUCCESS'

In [52]: 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_1.2-py3.6-edt	40589d0e-7019-4e28-8daa-fb03b6f4fe12	base
default_r36py38	41c247d3-45f8-5a71-b065-8500229facf0	base
autoai-ts_rt22.1-py3.9	4269d26e-07ba-5d40-8f66-2d495b0c71f7	base
autoai-obm_3.0	42b92e18-d9ab-567f-988a-4240ba1ed5f7	base
pmml-3.0_4.3	493bcb95-16f1-5bc5-bee8-81b8af80e9c7	base
spark-mllib_2.4-r_3.6	49403dff-92e9-4c87-a3d7-a42d0021c095	base
xgboost_0.90-py3.6	4ff8d6c2-1343-4c18-85e1-689c965304d3	base
pytorch-onnx_1.1-py3.6	50f95b2a-bc16-43bb-bc94-b0bed208c60b	base
autoai-ts_3.9-py3.8	52c57136-80fa-572e-8728-a5e7cbb42cde	base
spark-mllib_2.4-scala_2.11	55a70f99-7320-4be5-9fb9-9edb5a443af5	base
spark-mllib_3.0	5c1b0ca2-4977-5c2e-9439-ffd44ea8ffe9	base
autoai-obm_2.0	5c2e37fa-80b8-5e77-840f-d912469614ee	base
spss-modeler_18.1	5c3cad7e-507f-4b2a-a9a3-ab53a21dee8b	base
cuda-py3.8	5d3232bf-c86b-5df4-a2cd-7bb870a1cd4e	base
autoai-kb_3.1-py3.7	632d4b22-10aa-5180-88f0-f52dfb6444d7	base
pytorch-onnx_1.7-py3.8	634d3cdc-b562-5bf9-a2d4-ea90a478456b	base
spark-mllib_2.3-r_3.6	6586b9e3-ccd6-4f92-900f-0f8cb2bd6f0c	base
tensorflow_2.4-py3.7	65e171d7-72d1-55d9-8ebb-f813d620c9bb	base
spss-modeler_18.2	687eddc9-028a-4117-b9dd-e57b36f1efa5	base

Note: Only first 50 records were displayed. To display more use 'limit' parameter.

```
In [57]: software_spec_uid=client.software_specifications.get_uid_by_name("tensorflow_1.15-py3.6")
software_spec_uid
```

```
Out[57]: '2b73a275-7cbf-420b-a912-eae7f436e0bc'
```

```
In [58]: model_details=client.repository.store_model(model='Handwritten-Digit-Recognition_new.tgz',meta_props={
client.repository.ModelMetaNames.NAME:"CNN",
client.repository.ModelMetaNames.TYPE:"keras_2.2.4",
client.repository.ModelMetaNames.SOFTWARE_SPEC_UID:software_spec_uid})
model_id=client.repository.get_model_uid(model_details)
```