```python
import tensorflow as tf
from tensorflow import keras

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
```
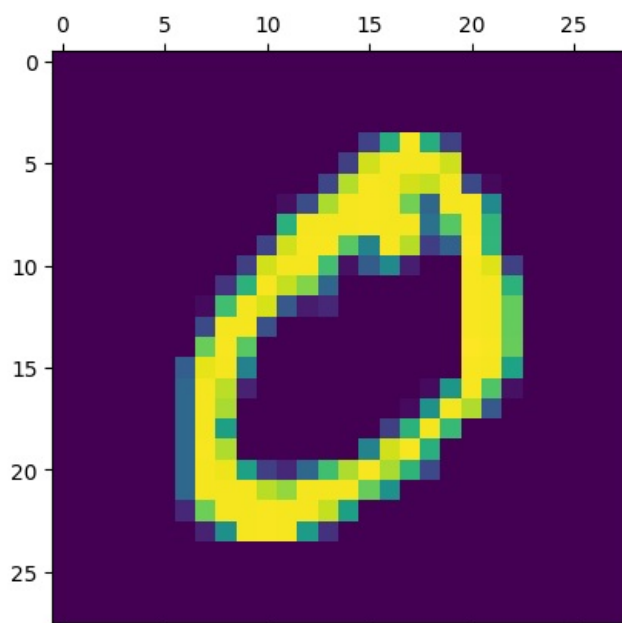
2022-11-01 14:36:44.589810: I tensorflow/core/platform/cpu_feature_guard.cc:193] This TensorFlow binary is opti
mized with oneAPI Deep Neural Network Library (oneDNN) to use the following CPU instructions in performance-cri
tical operations: AVX2 FMA
To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.
2022-11-01 14:36:44.771420: E tensorflow/stream_executor/cuda/cuda_blas.cc:2981] Unable to register cuBLAS fact
ory: Attempting to register factory for plugin cuBLAS when one has already been registered
2022-11-01 14:36:45.626329: W tensorflow/stream_executor/platform/default/dso_loader.cc:64] Could not load dyna
mic library 'libnvinfer.so.7'; dlerror: libnvinfer.so.7: cannot open shared object file: No such file or direct
ory
2022-11-01 14:36:45.626419: W tensorflow/stream_executor/platform/default/dso_loader.cc:64] Could not load dyna
mic library 'libnvinfer_plugin.so.7'; dlerror: libnvinfer_plugin.so.7: cannot open shared object file: No such
file or directory
2022-11-01 14:36:45.626430: W tensorflow/compiler/tf2tensorrt/utils/py_utils.cc:38] TF-TRT Warning: Cannot dlop
en some TensorRT libraries. If you would like to use Nvidia GPU with TensorRT, please make sure the missing lib
raries mentioned above are installed properly.

```python
mnist =tf.keras.datasets.mnist
(x_train,y_train),(x_test,y_test)=mnist.load_data()
```

```python
plt.matshow(x_train[1])
print(mnist)
```

```
<module 'keras.api._v2.keras.datasets.mnist' from '/home/tech-support/.local/lib/python3.10/site-packages/keras
/api/_v2/keras/datasets/mnist/__init__.py'>
```



```python
x_train =x_train/255
x_test=x_test/255
```

```python
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.        ,
```

```
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       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        ],
      [0.        , 0.        , 0.        , 0.        , 0.        ,
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       0.65098039, 1.        , 0.96862745, 0.49803922, 0.        ,
       0.        , 0.        , 0.        ],
      [0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.11764706, 0.14117647,
       0.36862745, 0.60392157, 0.66666667, 0.99215686, 0.99215686,
       0.99215686, 0.99215686, 0.99215686, 0.88235294, 0.6745098 ,
       0.99215686, 0.94901961, 0.76470588, 0.25098039, 0.        ,
       0.        , 0.        , 0.        ],
      [0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.19215686, 0.93333333, 0.99215686,
       0.99215686, 0.99215686, 0.99215686, 0.99215686, 0.99215686,
       0.99215686, 0.99215686, 0.98431373, 0.36470588, 0.32156863,
       0.32156863, 0.21960784, 0.15294118, 0.        , 0.        ,
       0.        , 0.        , 0.        ],
      [0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.07058824, 0.85882353, 0.99215686,
       0.99215686, 0.99215686, 0.99215686, 0.99215686, 0.77647059,
       0.71372549, 0.96862745, 0.94509804, 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        ],
      [0.        , 0.        , 0.        , 0.        , 0.        ,
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       0.41960784, 0.99215686, 0.99215686, 0.80392157, 0.04313725,
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       0.        , 0.        , 0.        , 0.        , 0.        ,
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       0.        , 0.        , 0.        , 0.        , 0.05490196,
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       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        ],
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       0.        , 0.        , 0.        ],
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       0.        , 0.        , 0.        ],
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       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        ],
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       0.72941176, 0.99215686, 0.99215686, 0.58823529, 0.10588235,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        ],
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       0.        , 0.        , 0.        , 0.        , 0.        ,
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       0.0627451 , 0.36470588, 0.98823529, 0.99215686, 0.73333333,
       0.        , 0.        , 0.        , 0.        , 0.        ,
       0.        , 0.        , 0.        ],
```

```
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             0.        , 0.        , 0.        , 0.        , 0.        ,
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             0.        , 0.        , 0.        ],
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             0.99215686, 0.99215686, 0.99215686, 0.98039216, 0.71372549,
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             0.77647059, 0.31764706, 0.00784314, 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        ],
            [0.        , 0.        , 0.        , 0.        , 0.        ,
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             0.99215686, 0.99215686, 0.99215686, 0.76470588, 0.31372549,
             0.03529412, 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
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             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        ],
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             0.51764706, 0.0627451 , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        ],
            [0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        ],
            [0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        ],
            [0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        , 0.        , 0.        ,
             0.        , 0.        , 0.        ]])
```

```python
In [ ]: model=keras.Sequential([keras.layers.Flatten(input_shape=(28,28)),
                                 keras.layers.Dense(128, activation='relu'),
                                 keras.layers.Dense(10,activation='softmax')
                                 ])
        model.summary()
```

```
Model: "sequential"

_____
 Layer (type)                Output Shape              Param #
=================================================================
 flatten (Flatten)           (None, 784)               0

 dense (Dense)               (None, 128)               100480

 dense_1 (Dense)             (None, 10)                1290

=================================================================
Total params: 101,770
Trainable params: 101,770
Non-trainable params: 0
_____
```

```
2022-11-01 14:36:47.654621: E tensorflow/stream_executor/cuda/cuda_driver.cc:265] failed call to cuInit: CUDA_E
RROR_NO_DEVICE: no CUDA-capable device is detected
2022-11-01 14:36:47.654662: I tensorflow/stream_executor/cuda/cuda_diagnostics.cc:156] kernel driver does not a
ppear to be running on this host (turing-machine): /proc/driver/nvidia/version does not exist
2022-11-01 14:36:47.655086: I tensorflow/core/platform/cpu_feature_guard.cc:193] This TensorFlow binary is opti
mized with oneAPI Deep Neural Network Library (oneDNN) to use the following CPU instructions in performance-cri
tical operations:  AVX2 FMA
To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.
```

In [ ]:
```python
model.compile(optimizer='sgd',
              loss='sparse_categorical_crossentropy',
              metrics=['accuracy'])
```

In [ ]:
```python
history=model.fit(x_train,y_train,validation_data=(x_test,y_test),epochs=10)
```

```
Epoch 1/10
```
```
2022-11-01 14:36:47.896497: W tensorflow/core/framework/cpu_allocator_impl.cc:82] Allocation of 188160000 excee
ds 10% of free system memory.
```
```
1875/1875 [==============================] - 3s 2ms/step - loss: 0.6578 - accuracy: 0.8381 - val_loss: 0.3564 -
val_accuracy: 0.9041
Epoch 2/10
1875/1875 [==============================] - 3s 2ms/step - loss: 0.3353 - accuracy: 0.9067 - val_loss: 0.2906 -
val_accuracy: 0.9188
Epoch 3/10
1875/1875 [==============================] - 3s 1ms/step - loss: 0.2856 - accuracy: 0.9193 - val_loss: 0.2581 -
val_accuracy: 0.9281
Epoch 4/10
1875/1875 [==============================] - 3s 1ms/step - loss: 0.2554 - accuracy: 0.9280 - val_loss: 0.2370 -
val_accuracy: 0.9327
Epoch 5/10
1875/1875 [==============================] - 3s 1ms/step - loss: 0.2325 - accuracy: 0.9347 - val_loss: 0.2166 -
val_accuracy: 0.9391
Epoch 6/10
1875/1875 [==============================] - 3s 1ms/step - loss: 0.2137 - accuracy: 0.9398 - val_loss: 0.2031 -
val_accuracy: 0.9412
Epoch 7/10
1875/1875 [==============================] - 3s 1ms/step - loss: 0.1981 - accuracy: 0.9444 - val_loss: 0.1889 -
val_accuracy: 0.9453
Epoch 8/10
1875/1875 [==============================] - 3s 2ms/step - loss: 0.1850 - accuracy: 0.9480 - val_loss: 0.1785 -
val_accuracy: 0.9491
Epoch 9/10
1875/1875 [==============================] - 3s 1ms/step - loss: 0.1735 - accuracy: 0.9519 - val_loss: 0.1683 -
val_accuracy: 0.9514
Epoch 10/10
1875/1875 [==============================] - 3s 1ms/step - loss: 0.1633 - accuracy: 0.9543 - val_loss: 0.1620 -
val_accuracy: 0.9540
```

In [ ]:
```python
test_loss,test_acc=model.evaluate(x_test,y_test)
print("Loss=%.3f" %test_loss)
print("Accuracy=%.3f" %test_acc)
```

```
313/313 [==============================] - 0s 1ms/step - loss: 0.1620 - accuracy: 0.9540
Loss=0.162
Accuracy=0.954
```

In [ ]:
```python
import random
n=random.randint(0,9999)
plt.imshow(x_test[n])
plt.show
prediction=model.predict(x_test)
print("The handwritten number is %d" % np.argmax(prediction[n]))
```

```
313/313 [==============================] - 0s 862us/step
The handwritten number is 5
```
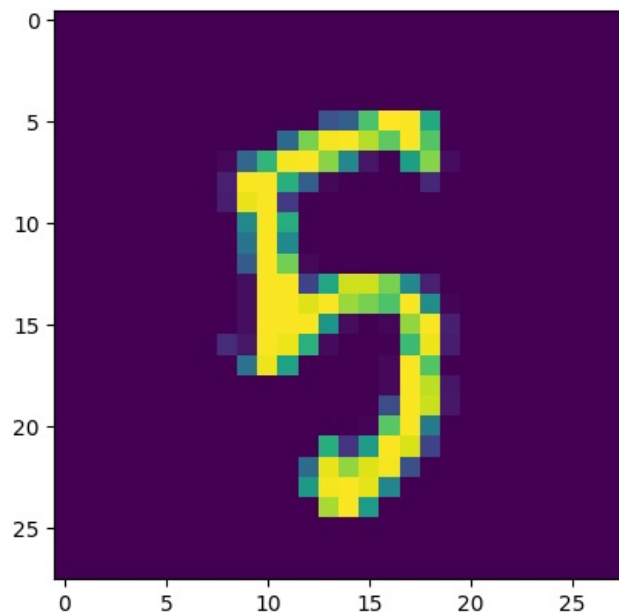
```
In [ ]: test_predict=model.predict(x_test)

        test_predict_labels=np.argmax(test_predict,axis=1)
        confusion_matrix=tf.math.confusion_matrix(labels=y_test,predictions=test_predict_labels)
        print('Confusion Matrix of the test:\n', confusion_matrix)
```

```
313/313 [==============================] - 0s 927us/step
Confusion Matrix of the test:
 tf.Tensor(
[[ 969    0    1    1    0    3    4    1    1    0]
 [   0 1116    3    2    0    1    4    2    7    0]
 [   6    1  987    6    6    2    4   10   10    0]
 [   0    0    9  961    0   10    0   10   17    3]
 [   2    1    8    0  934    0    9    3    4   21]
 [  10    1    1   21    2  832   10    1    9    5]
 [   9    3    3    0    5    8  925    2    3    0]
 [   3    8   24    4    3    1    0  966    2   17]
 [   4    1    5   10    5    8    9    8  923    1]
 [   9    8    2   11   26    5    1   11    9  927]], shape=(10, 10), dtype=int32)
```