In [1]:

```
import keras
import tensorflow as tf
from keras.datasets import mnist
from keras.models import Sequential
from keras.layers import Dense, Dropout, Flatten
from keras.layers import Conv2D, MaxPooling2D
import numpy as np
from tensorflow.keras import layers,models,datasets
import matplotlib.pyplot as plt
```

```
Using TensorFlow backend.
```

In [2]:

```
from keras.datasets import mnist
```

In [3]:

```
(x_train,y_train),(x_test,y_test)=mnist.load_data()
```

In [8]:

```
y_train[5]
```

Out[8]:

```
2
```

In [9]:

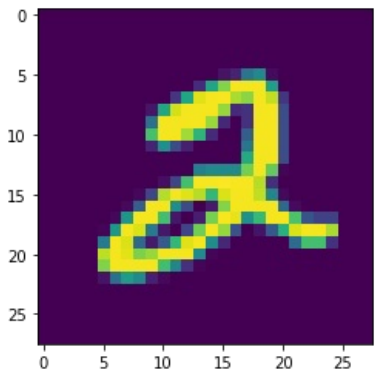
```
print(x_train.shape)
print(y_train.shape)
print(x_test.shape)
print(y_test.shape)
```

```
(60000, 28, 28)
(60000,)
(10000, 28, 28)
(10000,)
```

In [10]:

```
plt.imshow(x_train[5])
print(y_train[5])
```

```
2
```



In [11]:

```
print(x_train[0].shape[0])
print(x_train[0].shape[1])
```

```
28
28
```

In [12]:

```
x_train=x_train.reshape(60000,28,28,1)
x_test=x_test.reshape(10000,28,28,1)
```

In [13]:

```
input_shape=(28,28,1)
x_train=x_train.astype('float32')
x_test=x_test.astype('float32')
```

In [14]:

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

In [15]:

```
x_train[0]
```

Out[15]:

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```

In [16]:

```
from keras.utils import np_utils
y_train=np_utils.to_categorical(y_train)
y_test=np_utils.to_categorical(y_test)
print(y_train.shape)
print(y_test.shape)
```

```
(60000, 10)
(10000, 10)
```

In [17]:

```
y_train[0]
```

Out[17]:

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

In [18]:

```
y_train[2]
```

Out[18]:

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

In [21]:

```
y_train.shape[1]
```

Out[21]:

```
10
```

In [18]:

```
num_classes=y_train.shape[1]
num_pixels=x_train.shape[1]*x_train.shape[2]
```

In [19]:

```
from keras.layers import Dense,Dropout,Flatten
from keras.layers import Conv2D,MaxPool2D
from keras.optimizers import SGD
```

In [20]:

```
model = tf.keras.models.Sequential()
model.add(tf.keras.layers.Conv2D(filters = 32 ,kernel_size = 3,activation='relu', input_shape=input_shape))
model.add(tf.keras.layers.Conv2D(filters = 64,kernel_size = 3,activation='relu'))
model.add(tf.keras.layers.MaxPool2D(pool_size = (2,2), strides = 2))
model.add(tf.keras.layers.Dropout(0.25))
model.add(tf.keras.layers.Flatten())
model.add(tf.keras.layers.Dense(128,activation='relu'))
model.add(tf.keras.layers.Dropout(0.5))
model.add(tf.keras.layers.Dense(num_classes,activation='softmax'))
```

In [21]:

```
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 26, 26, 32)        320
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 24, 24, 64)        18496
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 12, 12, 64)        0
_________________________________________________________________
dropout (Dropout)            (None, 12, 12, 64)        0
_________________________________________________________________
flatten (Flatten)            (None, 9216)              0
_________________________________________________________________
dense (Dense)                (None, 128)               1179776
_________________________________________________________________
dropout_1 (Dropout)          (None, 128)               0
_________________________________________________________________
dense_1 (Dense)              (None, 10)                1290
=================================================================
Total params: 1,199,882
Trainable params: 1,199,882
Non-trainable params: 0
_________________________________________________________________
```

In [22]:

```
model.compile(optimizer='adam',loss='categorical_crossentropy',metrics=['accuracy'])
```

In [23]:

```
train=model.fit(x=x_train,y=y_train,batch_size=35,epochs=3,verbose=1,validation_data=(x_test,y_test))
```

```
Epoch 1/3
1715/1715 [==============================] - 318s 180ms/step - loss: 0.3788 - accuracy: 0.8807 - val
_loss: 0.0473 - val_accuracy: 0.9841
Epoch 2/3
1715/1715 [==============================] - 315s 183ms/step - loss: 0.0862 - accuracy: 0.9744 - val
_loss: 0.0374 - val_accuracy: 0.9884
Epoch 3/3
1715/1715 [==============================] - 313s 183ms/step - loss: 0.0646 - accuracy: 0.9808 - val
_loss: 0.0335 - val_accuracy: 0.9891
```

In [24]:

```
score=model.evaluate(x_test,y_test,verbose=0)
print(score[1])
```

```
0.9890999794006348
```

In [25]:

```
from keras.models import load_model
```

In [28]:

```
input_image=x_test[96]
input_image=input_image.reshape(1,28,28,1)
results=model.predict(input_image)
print(results)
print("predicted result :", results.argmax())
```

```
[[1.8905453e-06 9.7482103e-01 1.6436679e-05 4.2347659e-05 2.4621343e-02
  1.2551667e-05 2.4100174e-07 1.3553513e-04 1.9009935e-04 1.5852207e-04]]
predicted result : 1
```

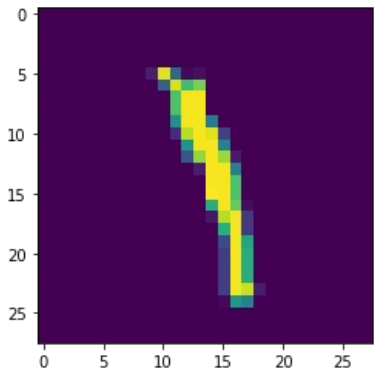
In [109]:

```
print("actual image")
plt.imshow(x_test[96])
```

```
actual image
```

Out[109]:

```
<matplotlib.image.AxesImage at 0x7fd490ebda50>
```



In [ ]:

```

```