handwritten-digits-prediction

October 1, 2024

[1]:
```
import tensorflow
from tensorflow import keras
from tensorflow.keras import Sequential
from tensorflow.keras.layers import Dense,Flatten
```

[4]:
```
(X_train,y_train),(X_test,y_test) = keras.datasets.mnist.load_data()
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-
datasets/mnist.npz
11490434/11490434             4s
0us/step
```

[6]:
```
X_train.shape
```

[6]:
```
(60000, 28, 28)
```

[8]:
```
X_test.shape
```

[8]:
```
(10000, 28, 28)
```

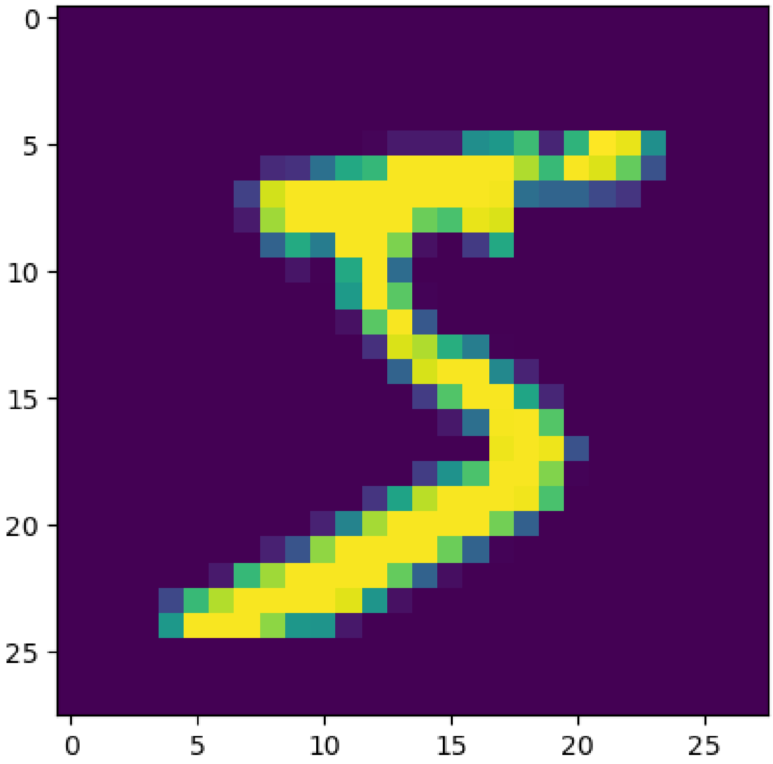
[14]:
```
y_train.shape , y_test.shape
```

[14]:
```
((60000,), (10000,))
```

[16]:
```
import matplotlib.pyplot as plt
```

[24]:
```
plt.imshow(X_train[0])
```

[24]:
```
<matplotlib.image.AxesImage at 0x2923fa61e50>
```



```
[26]: y_train[0]
```

```
[26]: 5
```

```
[28]: #scale the array value between 0-1
      X_train = X_train/255
      X_test = X_test/255
```

```
[30]: X_train
```

```
[30]: 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., 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., …, 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.]]])
```

0.0.1 Convert the 2d array into 1d array , convert the pixel 28 X 28 to 784 format for input

0.0.2 Build the nural network

[64]:

```
model = Sequential()

#flatten the 28X28 pixel into 784 1d array using flatten method
model.add(Flatten(input_shape=(28,28)))
model.add(Dense(128,activation='relu'))
model.add(Dense(32,activation='relu'))
model.add(Dense(10,activation='softmax'))
```

```
C:\Users\ARIFA\anaconda3\Lib\site-
packages\keras\src\layers\reshaping\flatten.py:37: UserWarning: Do not pass an
`input_shape`/`input_dim` argument to a layer. When using Sequential models,
prefer using an `Input(shape)` object as the first layer in the model instead.
  super().__init__(**kwargs)
```

[66]:

```
model.summary()
```

```
Model: "sequential_1"


 Layer (type)                         Output Shape                     Param #

 flatten_1 (Flatten)                  (None, 784)                            0

 dense_2 (Dense)                      (None, 128)                      100,480

 dense_3 (Dense)                      (None, 32)                         4,128

 dense_4 (Dense)                      (None, 10)                           330


 Total params: 104,938 (409.91 KB)

 Trainable params: 104,938 (409.91 KB)

 Non-trainable params: 0 (0.00 B)
```

[72]:

```
model.
 ↪compile(loss='sparse_categorical_crossentropy',optimizer='Adam',metrics=['accuracy'])
```

[74]:

```
history = model.fit(X_train,y_train,epochs=20,validation_split=0.2)
```

```
Epoch 1/20
1500/1500                 9s 4ms/step -
accuracy: 0.9969 - loss: 0.0094 - val_accuracy: 0.9759 - val_loss: 0.1343
Epoch 2/20
1500/1500                 5s 3ms/step -
accuracy: 0.9975 - loss: 0.0068 - val_accuracy: 0.9757 - val_loss: 0.1436
Epoch 3/20
1500/1500                 5s 3ms/step -
```

```
accuracy: 0.9979 - loss: 0.0059 - val_accuracy: 0.9758 - val_loss: 0.1511
Epoch 4/20
1500/1500             6s 4ms/step -
accuracy: 0.9979 - loss: 0.0063 - val_accuracy: 0.9728 - val_loss: 0.1765
Epoch 5/20
1500/1500             5s 3ms/step -
accuracy: 0.9969 - loss: 0.0093 - val_accuracy: 0.9755 - val_loss: 0.1548
Epoch 6/20
1500/1500             5s 3ms/step -
accuracy: 0.9979 - loss: 0.0078 - val_accuracy: 0.9740 - val_loss: 0.1727
Epoch 7/20
1500/1500             6s 4ms/step -
accuracy: 0.9984 - loss: 0.0050 - val_accuracy: 0.9751 - val_loss: 0.1667
Epoch 8/20
1500/1500             5s 3ms/step -
accuracy: 0.9983 - loss: 0.0048 - val_accuracy: 0.9745 - val_loss: 0.1689
Epoch 9/20
1500/1500             5s 4ms/step -
accuracy: 0.9974 - loss: 0.0084 - val_accuracy: 0.9763 - val_loss: 0.1663
Epoch 10/20
1500/1500             6s 4ms/step -
accuracy: 0.9977 - loss: 0.0068 - val_accuracy: 0.9717 - val_loss: 0.1878
Epoch 11/20
1500/1500             5s 3ms/step -
accuracy: 0.9979 - loss: 0.0065 - val_accuracy: 0.9765 - val_loss: 0.1564
Epoch 12/20
1500/1500             6s 4ms/step -
accuracy: 0.9990 - loss: 0.0026 - val_accuracy: 0.9757 - val_loss: 0.1810
Epoch 13/20
1500/1500             6s 4ms/step -
accuracy: 0.9971 - loss: 0.0097 - val_accuracy: 0.9772 - val_loss: 0.1658
Epoch 14/20
1500/1500             11s 4ms/step -
accuracy: 0.9981 - loss: 0.0058 - val_accuracy: 0.9773 - val_loss: 0.1726
Epoch 15/20
1500/1500             6s 4ms/step -
accuracy: 0.9979 - loss: 0.0065 - val_accuracy: 0.9747 - val_loss: 0.1793
Epoch 16/20
1500/1500             5s 3ms/step -
accuracy: 0.9974 - loss: 0.0082 - val_accuracy: 0.9737 - val_loss: 0.2135
Epoch 17/20
1500/1500             6s 4ms/step -
accuracy: 0.9983 - loss: 0.0052 - val_accuracy: 0.9774 - val_loss: 0.1727
Epoch 18/20
1500/1500             7s 4ms/step -
accuracy: 0.9984 - loss: 0.0051 - val_accuracy: 0.9769 - val_loss: 0.1729
Epoch 19/20
1500/1500             10s 4ms/step -
```

```
accuracy: 0.9988 - loss: 0.0041 - val_accuracy: 0.9762 - val_loss: 0.1844
Epoch 20/20
1500/1500            6s 4ms/step -
accuracy: 0.9981 - loss: 0.0058 - val_accuracy: 0.9773 - val_loss: 0.1803
```

[76]:

```
#predict the input probability
y_prob = model.predict(X_test)
```

```
313/313             1s 3ms/step
```

[78]:

```
y_pred = y_prob.argmax(axis=1)
#predicted labels
y_pred
```

[78]:

```
array([7, 2, 1, …, 4, 5, 6], dtype=int64)
```

[80]:

```
#Actual labels
y_test
```

[80]:

```
array([7, 2, 1, …, 4, 5, 6], dtype=uint8)
```

[82]:

```
from sklearn.metrics import accuracy_score
accuracy_score(y_test,y_pred)
```

[82]:

```
0.9776
```

[94]:

```
import matplotlib.pyplot as plt
```

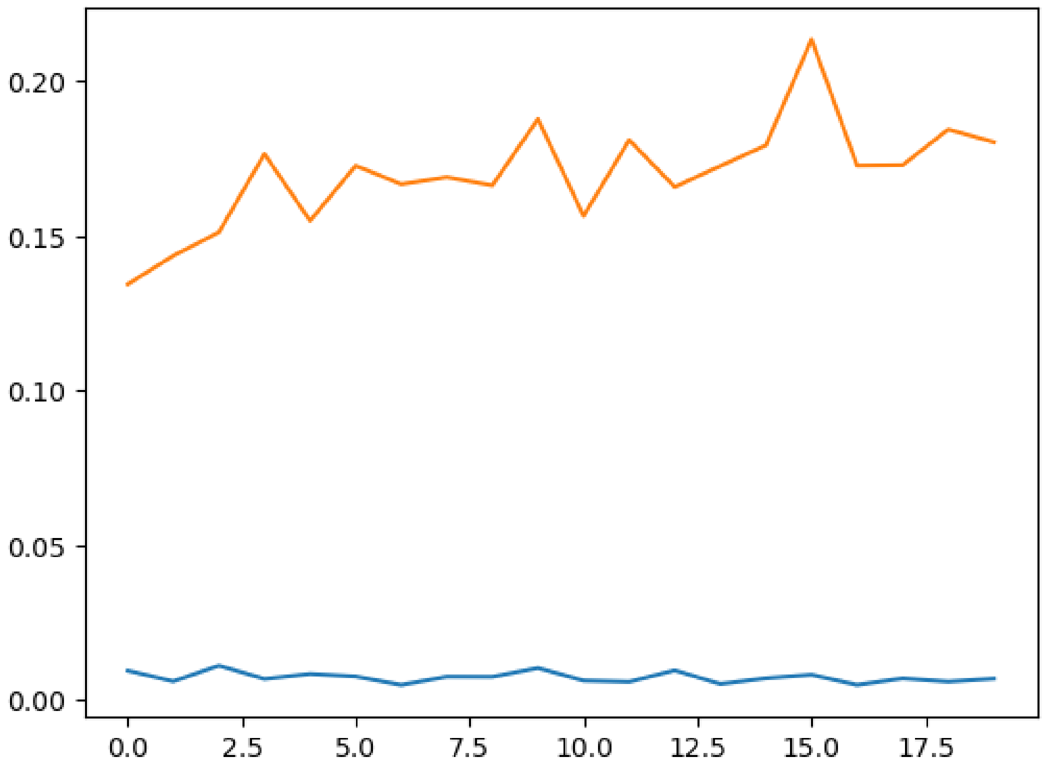
0.0.3 plot loss graph

[99]:

```
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
```

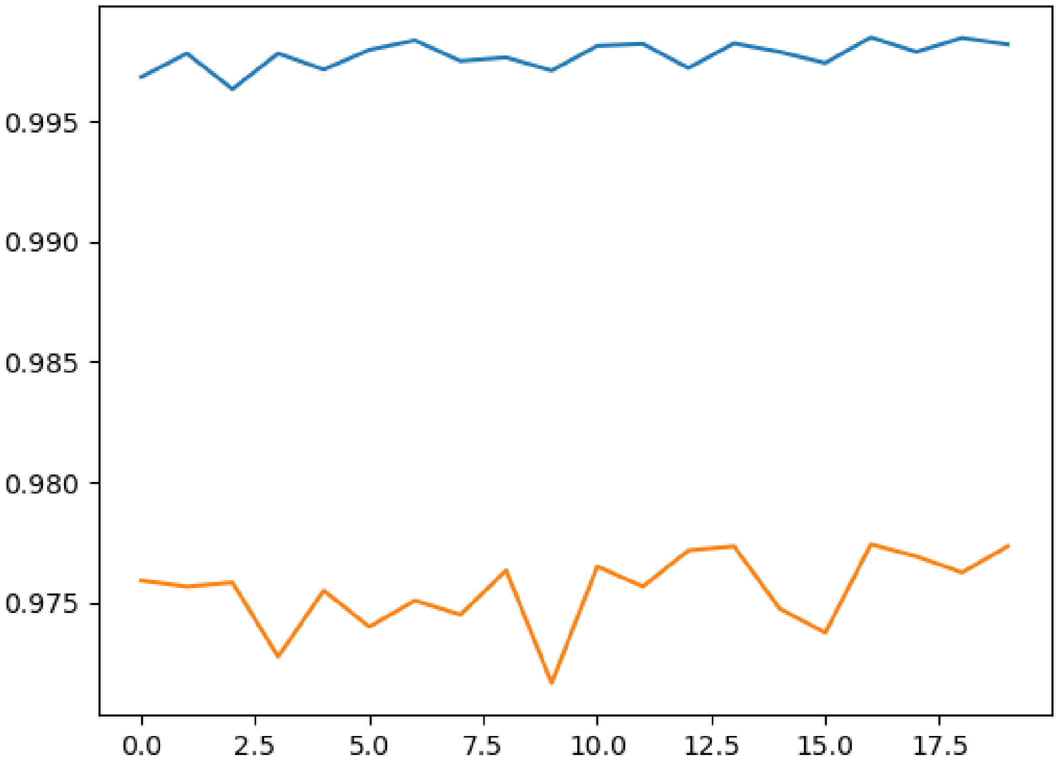
[99]:

```
[<matplotlib.lines.Line2D at 0x2925ac7ab70>]
```



```
[103]: plt.plot(history.history['accuracy'])
       plt.plot(history.history['val_accuracy'])
```

```
[103]: [<matplotlib.lines.Line2D at 0x2925ab49130>]
```



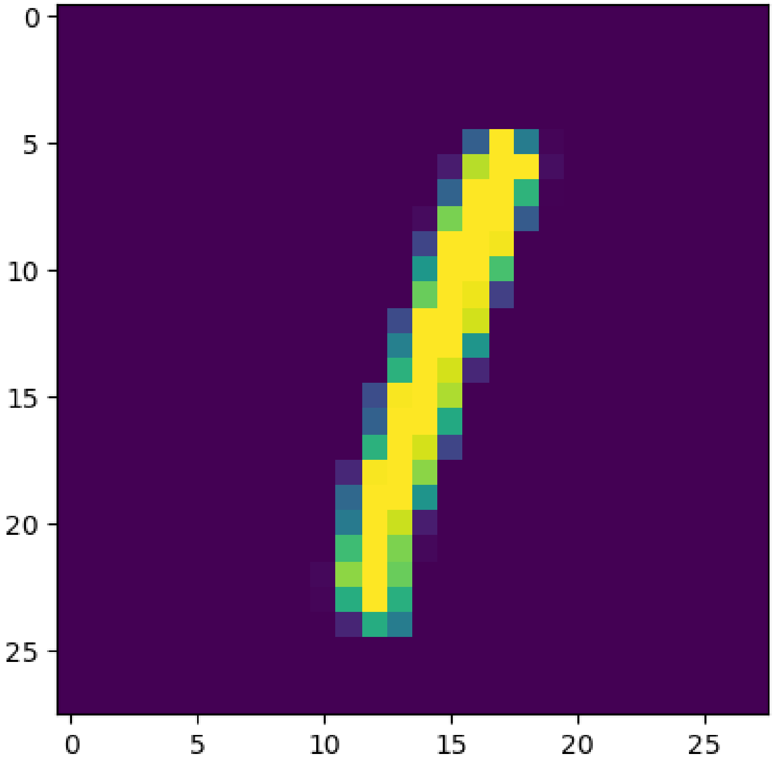
0.0.4 check the prediction

```
[88]: X_test[5]
```

```
[88]: 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.        ,
 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.        , 0.30196078, 0.99607843, 0.41960784, 0.01176471,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.0745098 , 0.89019608, 0.99607843, 0.99607843, 0.03529412,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.31764706, 0.99607843, 0.99607843, 0.64705882, 0.00392157,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.02745098,
 0.79607843, 0.99607843, 0.99607843, 0.28627451, 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.20784314,
 0.99607843, 0.99607843, 0.98039216, 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.5254902 ,
 0.99607843, 0.99607843, 0.70588235, 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.76862745,
 0.99607843, 0.97254902, 0.18823529, 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.22745098, 0.99607843,
 0.99607843, 0.92941176, 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.43529412, 0.99607843,
 0.99607843, 0.51764706, 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.63921569, 0.99607843,
 0.93333333, 0.10980392, 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.23529412, 0.98823529, 0.99607843,
 0.8745098 , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.30980392, 0.99607843, 0.99607843,
 0.60392157, 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.63921569, 0.99607843, 0.93333333,
 0.20784314, 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.10980392, 0.98823529, 0.99607843, 0.82352941,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.3372549 , 0.99607843, 0.99607843, 0.51372549,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.41176471, 0.99607843, 0.91764706, 0.07843137,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.68627451, 0.99607843, 0.8       , 0.01960784,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.01960784, 0.82745098, 0.99607843, 0.76862745, 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        ],
[0.        , 0.        , 0.        , 0.        , 0.        ,
 0.        , 0.        , 0.        , 0.        , 0.        ,
 0.01176471, 0.61960784, 0.99607843, 0.62745098, 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.        , 0.10196078, 0.61568627, 0.41960784, 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.        ]])
```

[105]:
```python
plt.imshow(X_test[5])
```

[105]:
```
<matplotlib.image.AxesImage at 0x2925ad17cb0>
```



[107]:
```python
y_test[5]
```

[107]:
```
1
```

[119]:
```python
#predict the output fro this image
y_pred = model.predict(X_test[5].reshape(1,28,28)).argmax(axis=1)
print(f"The number is {y_pred}")
```

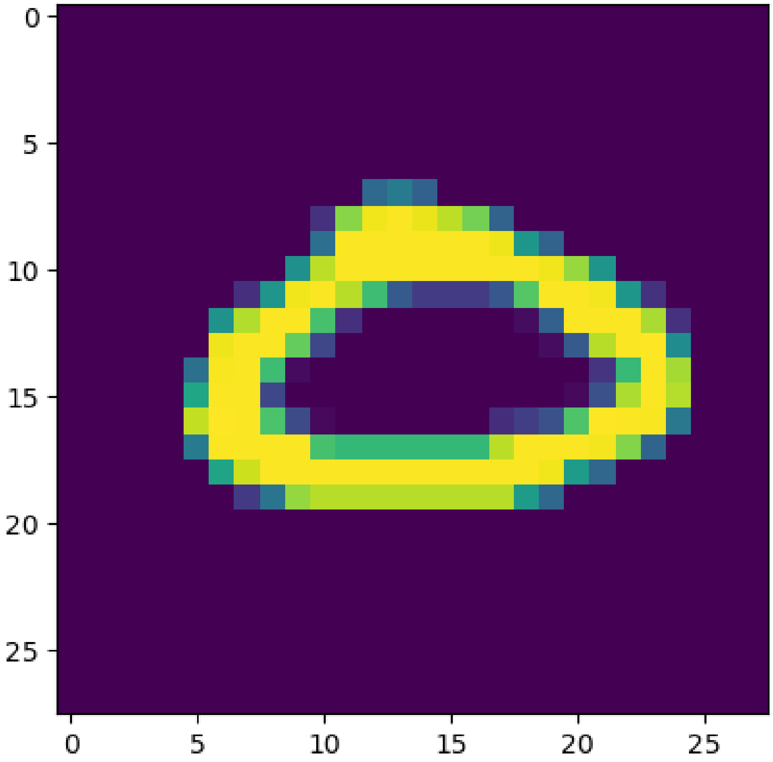
```
1/1              0s 40ms/step
The number is [1]
```

[121]:

```
plt.imshow(X_test[597])
```

[121]:

```
<matplotlib.image.AxesImage at 0x2923a1c7620>
```



0.1 Predict The Handwritten Digits

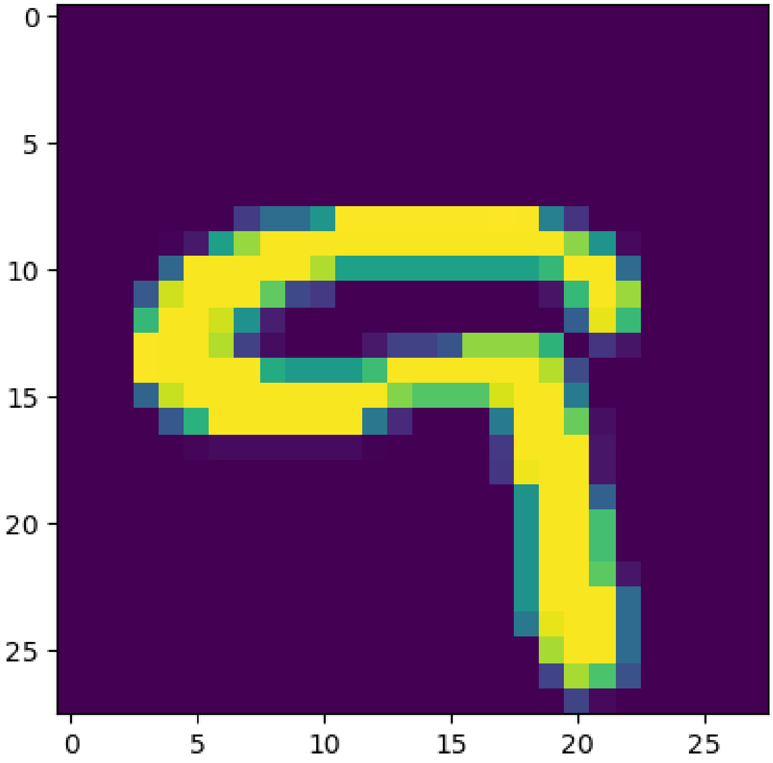
[140]:

```
img_num=int(input("Enter the image number :"))
y_pred = model.predict(X_test[img_num].reshape(1,28,28)).argmax(axis=1)
print("\nPrediction complete :\n")
print(f"The number is predicted as {y_pred}")
print(f"The actual number is {y_test[img_num]}\n")
print("The picture of the image : ")
plt.imshow(X_test[img_num])
```

```
Enter the image number : 2929

1/1              0s 37ms/step

Prediction complete :
```

```
The number is predicted as [9]
The actual number is 9

The picture of the image :
```

[140]: `<matplotlib.image.AxesImage at 0x2925bfe0e90>`



[142]:
```
pip install pandoc
```

```
Collecting pandocNote: you may need to restart the kernel to use updated
packages.

  Downloading pandoc-2.4.tar.gz (34 kB)
  Preparing metadata (setup.py): started
  Preparing metadata (setup.py): finished with status 'done'
Collecting plumbum (from pandoc)
  Downloading plumbum-1.8.3-py3-none-any.whl.metadata (10 kB)
Requirement already satisfied: ply in c:\users\arifa\anaconda3\lib\site-packages
(from pandoc) (3.11)
Requirement already satisfied: pywin32 in c:\users\arifa\anaconda3\lib\site-
packages (from plumbum->pandoc) (305.1)
Downloading plumbum-1.8.3-py3-none-any.whl (127 kB)
   ---------------------------------------- 0.0/127.6 kB ? eta -:--:--
   --------- ----------------------------- 30.7/127.6 kB 660.6 kB/s eta 0:00:01
   ---------------------------- ---------- 92.2/127.6 kB 880.9 kB/s eta 0:00:01
   -------------------------------------- 127.6/127.6 kB 838.3 kB/s eta 0:00:00
Building wheels for collected packages: pandoc
  Building wheel for pandoc (setup.py): started
  Building wheel for pandoc (setup.py): finished with status 'done'
  Created wheel for pandoc: filename=pandoc-2.4-py3-none-any.whl size=34823
sha256=2a72fc6daf1803f4958aab1cec07087db28175a1e1009bb47d08819105cd8fc2
  Stored in directory: c:\users\arifa\appdata\local\pip\cache\wheels\9c\2f\9f\b1
aac8c3e74b4ee327dc8c6eac5128996f9eadf586e2c0ba67
Successfully built pandoc
Installing collected packages: plumbum, pandoc
Successfully installed pandoc-2.4 plumbum-1.8.3
```

[ ]: