MNIST_digit_classification using Deep learning neural networks

MNIST stands for Mixed National Institute of Standards and Technology, which has produced a handwritten digits dataset. This is one of the most researched datasets in machine learning, and is used to classify handwritten digits. This dataset is helpful for predictive analytics because of its sheer size, allowing deep learning to work its magic efficiently. This dataset contains 60,000 training images and 10,000 testing images, formatted as 28 x 28 pixel monochrome images.

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In [1]:

```
# importing the required dependencies

import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import cv2
import matplotlib.image as mpimg
from PIL import Image
```

In [2]:

```
# Libraries for Deep_learning neural networks

import tensorflow as tf
tf.random.set_seed(3)
from tensorflow import keras
from keras.datasets import mnist
from tensorflow.math import confusion_matrix
```

In [3]:

```
# Loading the mnist dataset from keras.datasets
# The dataset is already processed, we get:
# x_train, y_train, x_test, y_test

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

In [4]:

```
type(x_train)
```

Out[4]:

```
numpy.ndarray
```

In [5]:

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

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

60000 are the no.of_images
(28,28) are the dimensions of the images
these are grayscale images

In [6]:

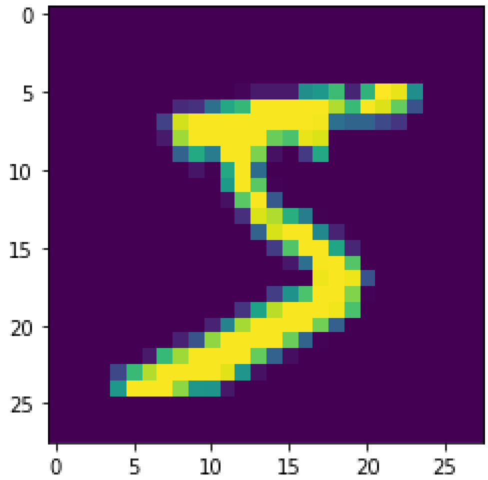
```
print(x_train)
print(y_train)
```

```
[[[0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  ...
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]]

 [[0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  ...
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]]

 [[0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  ...
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]]

 ...

 [[0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  ...
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]]

 [[0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  ...
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]]

 [[0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  ...
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]
  [0 0 0 ... 0 0 0]]]
[5 0 4 ... 5 6 8]
```

In [7]:

```
plt.imshow(x_train[0])
print(y_train[0])
```

5



In [8]:

```
# Image labels we have

print(y_train.shape, y_test.shape)

print(np.unique(y_train))
```

```
(60000,) (10000,)
[0 1 2 3 4 5 6 7 8 9]
```

We have 0 to 9 numbers in y_train

All the images are in the same dimension,
if not then we need to resize the images to a common dimension.

In [9]:

```
# scaling the values

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

When we so this scaling the values in the x_train and x_test are decreased to certain number,
this helps in faster processing and easy to compute

In [10]:

```
# Building the Neural Network

model = keras.Sequential([
    keras.layers.Flatten(input_shape = (28,28)),
    keras.layers.Dense(50, activation='relu'),      # relu = rectified linear unit activatio
    keras.layers.Dense(50, activation='relu'),
    keras.layers.Dense(10, activation='sigmoid')
])
```

In [11]:

```
# compiling the Neural Network

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

In [12]:

```
# trainnig the Neural Model

model.fit(x_train, y_train, epochs=10)
```

```
Epoch 1/10
1875/1875 [==============================] - 24s 5ms/step - loss: 0.3001 - a
ccuracy: 0.9135
Epoch 2/10
1875/1875 [==============================] - 9s 5ms/step - loss: 0.1342 - ac
curacy: 0.9600
Epoch 3/10
1875/1875 [==============================] - 8s 4ms/step - loss: 0.0988 - ac
curacy: 0.9699
Epoch 4/10
1875/1875 [==============================] - 9s 5ms/step - loss: 0.0804 - ac
curacy: 0.9749
Epoch 5/10
1875/1875 [==============================] - 7s 4ms/step - loss: 0.0682 - ac
curacy: 0.9793
Epoch 6/10
1875/1875 [==============================] - 8s 4ms/step - loss: 0.0584 - ac
curacy: 0.9815
Epoch 7/10
1875/1875 [==============================] - 8s 4ms/step - loss: 0.0499 - ac
curacy: 0.9840
Epoch 8/10
1875/1875 [==============================] - 8s 4ms/step - loss: 0.0444 - ac
curacy: 0.9856
Epoch 9/10
1875/1875 [==============================] - 8s 4ms/step - loss: 0.0397 - ac
curacy: 0.9866
Epoch 10/10
1875/1875 [==============================] - 9s 5ms/step - loss: 0.0337 - ac
curacy: 0.9890
```

Out[12]:

```
<keras.callbacks.History at 0x1aa8be258b0>
```

Training data accuracy = 98.9%

In [13]:

```
# Accuracy on the test data

loss, accuracy = model.evaluate(x_test, y_test)
print(accuracy)
```

```
313/313 [==============================] - 5s 5ms/step - loss: 0.0911 - accu
racy: 0.9751
0.9750999808311462
```

Test data accuracy = 97.2%

In [14]:

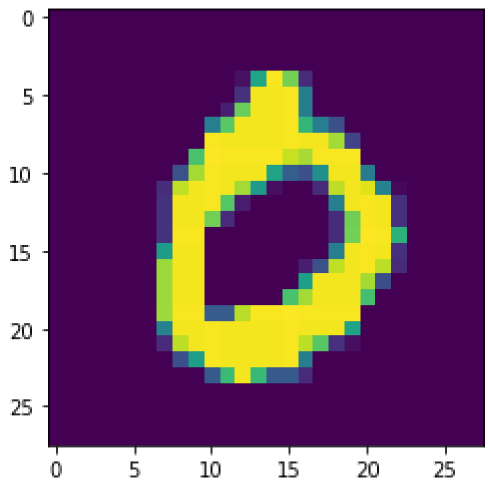
```
print(x_test.shape)
```

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

In [15]:

```
# Printing the test images to know about the image

plt.imshow(x_test[3])
print(y_test[3])
```

```
0
```



In [16]:

```
# Using the predict to predict the test data

y_pred = model.predict(x_test)
```

```
313/313 [==============================] - 1s 2ms/step
```

In [17]:

```
print(y_pred[1])
```

```
[2.2235874e-05 9.8635209e-01 9.9999982e-01 4.6433066e-03 1.7645797e-16
 6.2099059e-07 1.8522598e-05 1.1510921e-05 1.8164139e-04 2.2713525e-07]
```

In [18]:

```
print(y_pred.shape)
```

```
(10000, 10)
```

10000 are the no_of images
and
10 is the probabilties of 10 outcomes

In [19]:

```
# We use "np.argmax()" function that helps to get the max value in an numpy array
# Converting the prediction probabilty to class labels

y_pred_labels = [np.argmax(i) for i in y_pred]
print(y_pred_labels)
```

```
8, 4, 7, 1, 2, 4, 0, 2, 7, 4, 3, 3, 0, 0, 3, 1, 9, 6, 5, 2, 5, 9, 7, 9, 3,
0, 4, 2, 0, 7, 1, 1, 2, 1, 5, 3, 3, 9, 7, 8, 6, 3, 6, 1, 3, 8, 1, 0, 5, 1,
3, 1, 5, 5, 6, 1, 8, 5, 1, 7, 9, 4, 6, 2, 2, 5, 0, 6, 5, 6, 3, 7, 2, 0, 8,
8, 5, 4, 1, 1, 4, 0, 3, 3, 7, 6, 1, 6, 2, 1, 9, 2, 8, 6, 1, 9, 5, 2, 5, 4,
4, 2, 8, 3, 8, 2, 4, 5, 0, 3, 1, 7, 7, 5, 7, 9, 7, 1, 9, 2, 1, 4, 5, 9, 2,
0, 4, 9, 1, 4, 8, 1, 8, 4, 5, 9, 8, 8, 3, 7, 6, 0, 0, 3, 0, 2, 5, 6, 4, 9,
5, 3, 3, 2, 3, 9, 1, 2, 6, 8, 0, 5, 6, 6, 6, 3, 8, 8, 2, 7, 5, 8, 9, 6, 1,
8, 4, 1, 2, 5, 9, 1, 9, 7, 5, 4, 0, 8, 9, 9, 1, 0, 5, 2, 3, 7, 0, 9, 4, 0,
6, 3, 9, 5, 2, 1, 3, 1, 3, 6, 5, 7, 4, 2, 2, 6, 3, 2, 6, 5, 4, 8, 9, 7, 1,
3, 0, 3, 8, 3, 1, 9, 3, 4, 4, 6, 4, 2, 1, 8, 2, 5, 4, 8, 8, 4, 0, 0, 2, 3,
2, 7, 7, 0, 8, 7, 4, 4, 7, 9, 6, 9, 0, 9, 8, 0, 4, 6, 0, 6, 3, 5, 4, 8, 3,
3, 9, 3, 3, 3, 7, 8, 0, 2, 2, 1, 7, 0, 6, 5, 4, 3, 8, 0, 9, 6, 3, 8, 0, 9,
9, 6, 8, 6, 8, 5, 7, 8, 6, 0, 2, 6, 0, 2, 2, 3, 1, 9, 7, 5, 1, 0, 8, 4, 6,
2, 6, 7, 9, 3, 6, 9, 8, 2, 2, 9, 2, 7, 3, 5, 9, 1, 8, 0, 2, 0, 5, 2, 1, 3,
7, 6, 7, 1, 2, 5, 8, 0, 3, 7, 8, 4, 0, 9, 1, 8, 6, 7, 7, 4, 3, 4, 9, 1, 9,
5, 1, 7, 3, 9, 7, 6, 9, 1, 3, 7, 8, 3, 3, 6, 7, 2, 4, 5, 8, 5, 1, 1, 4, 4,
3, 1, 0, 7, 7, 0, 7, 9, 4, 4, 8, 5, 5, 4, 0, 8, 2, 1, 6, 8, 4, 5, 0, 4, 0,
6, 1, 7, 3, 2, 6, 7, 2, 6, 9, 3, 1, 4, 6, 2, 5, 4, 2, 0, 6, 2, 1, 7, 3, 4,
1, 0, 5, 4, 3, 1, 1, 7, 4, 9, 9, 4, 8, 4, 0, 2, 4, 5, 1, 1, 6, 4, 7, 1, 9,
```

In [20]:

```
# Confusion matrix

conf_mat = confusion_matrix(y_test, y_pred_labels)
print(conf_mat)
```

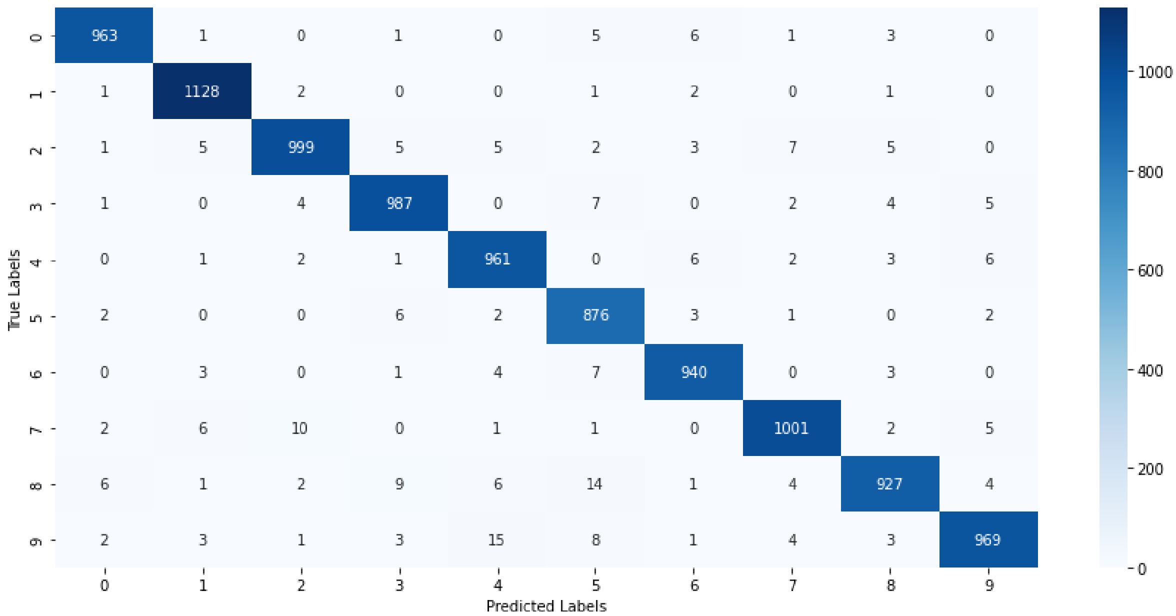
```
tf.Tensor(
[[ 963    1    0    1    0    5    6    1    3    0]
 [   1 1128    2    0    0    1    2    0    1    0]
 [   1    5  999    5    5    2    3    7    5    0]
 [   1    0    4  987    0    7    0    2    4    5]
 [   0    1    2    1  961    0    6    2    3    6]
 [   2    0    0    6    2  876    3    1    0    2]
 [   0    3    0    1    4    7  940    0    3    0]
 [   2    6   10    0    1    1    0 1001    2    5]
 [   6    1    2    9    6   14    1    4  927    4]
 [   2    3    1    3   15    8    1    4    3  969]], shape=(10, 10), dtype
=int32)
```

In [21]:

```
# Plotting the confusion matrix table of the predictions

plt.figure(figsize=(15,7))
sns.heatmap(conf_mat, annot=True, fmt='d', cmap='Blues')
plt.ylabel('True Labels')
plt.xlabel('Predicted Labels')
```

Out[21]:

```
Text(0.5, 42.0, 'Predicted Labels')
```

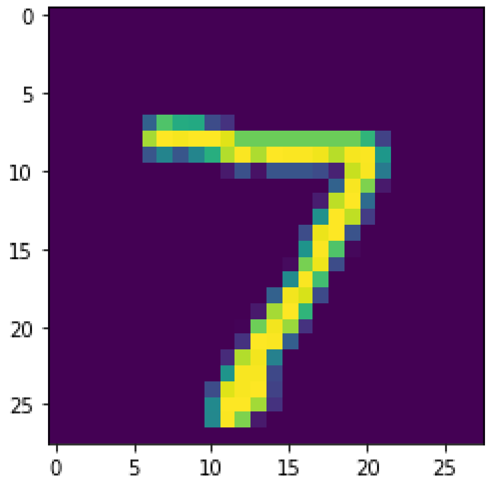


Building the Predictive system

In [22]:

```
# input the image path
input_image_path = 'c://users/santhosh reddy/desktop/untitled folder/mnist.png'

#reading the image with opencv library
input_image = cv2.imread(input_image_path)

# converting the image into grayscale using opencv
input_gray = cv2.cvtColor(input_image, cv2.COLOR_RGB2GRAY)

# Resizing the input given image
input_image_resized = cv2.resize(input_gray, (28,28))
plt.imshow(input_image_resized)

# Dividing the numpy data of the image with 255, for faster processing of the data
input_image_resized = input_image_resized/255

# Reshaping the image data numpy array
image_reshaped = np.reshape(input_image_resized, [1,28,28])

# Predicting the number using predict
input_pred = model.predict(image_reshaped)

# printing the input given image
input_pred_label = np.argmax(input_pred)
print(input_pred_label)
```

```
1/1 [==============================] - 0s 63ms/step
7
```



In [ ]:

```

```