lets first import the dataset from sklearn

In [1]:

```
from sklearn.datasets import fetch_openml
```

create instance of mnist dataset

In [2]:

```
mnist = fetch_openml('mnist_784')
```

In [3]:

```
mnist['data']
```

Out[3]:

```
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.]])
```

In [4]:

```
mnist['target']
```

Out[4]:

```
array(['5', '0', '4', ..., '4', '5', '6'], dtype=object)
```

lets split the dataset into training and testing

In [5]:

```
# lets import train_test_split function
from sklearn.model_selection import train_test_split
```

In [6]:

```
t_size = 0.20 # 20% of total data is used for testing
x_train, x_test, y_train, y_test = train_test_split(mnist['data'], mnist['target'],
test_size = t_size, stratify = mnist['target'])
```

let's check the shape of training and testing data

In [7]:

```
x_train.shape
```

Out[7]:

```
(56000, 784)
```

In [8]:

```
x_test.shape
```

Out[8]:

```
(14000, 784)
```

In [9]:

```
y_train.shape
```

Out[9]:

```
(56000,)
```

In [10]:

```
y_test.shape
```

Out[10]:

```
(14000,)
```

let's see how our data looks like

In [11]:

```
import matplotlib
import matplotlib.pyplot as plt
%matplotlib inline
```

In [12]:

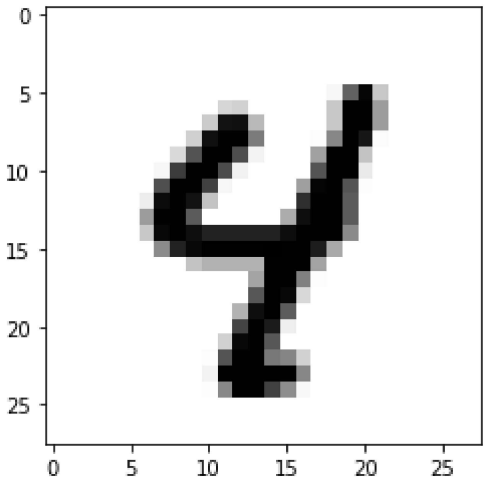
```
some_digit = x_train[25000]
some_digit_image = some_digit.reshape(28,28)

# 28x28 because we have all digits in a matrix form also resize it to plot
```

In [13]:

```
plt.imshow(some_digit_image, cmap = matplotlib.cm.binary , interpolation = 'nearest'
)
```

Out[13]:

```
<matplotlib.image.AxesImage at 0x1815f9e6fc8>
```



Scaling the data

In [14]:

```
from sklearn.preprocessing import StandardScaler,MinMaxScaler
scaler = StandardScaler()
```

In [15]:

```
x_train_stdsc = scaler.fit_transform(x_train)
x_test_stdsc = scaler.fit_transform(x_test)
```

For this model we are using (Multi Layer Perceptron) MLP classifier

In [16]:

```
# import the classifier
from sklearn.neural_network import MLPClassifier
```

setting hyperparameters of the network

In [17]:

```
mlp = MLPClassifier(hidden_layer_sizes=(50,),learning_rate_init=0.001,max_iter=5000)
```

let's train the model with scaled data

In [18]:

```
mlp.fit(x_train_stdsc,y_train)
```

Out[18]:

```
MLPClassifier(activation='relu', alpha=0.0001, batch_size='auto', beta_1
=0.9,
              beta_2=0.999, early_stopping=False, epsilon=1e-08,
              hidden_layer_sizes=(50,), learning_rate='constant',
              learning_rate_init=0.001, max_iter=5000, momentum=0.9,
              n_iter_no_change=10, nesterovs_momentum=True, power_t=0.5,
              random_state=None, shuffle=True, solver='adam', tol=0.000
1,
              validation_fraction=0.1, verbose=False, warm_start=False)
```

Predict the response for test dataset

In [19]:

```
y_pred = mlp.predict(x_test_stdsc) #scaled
```

Checking model performance

In [20]:

```
from sklearn.metrics import classification_report,confusion_matrix,accuracy_score
```

Accuracy

In [21]:

```
print("\nAccuracy:",accuracy_score(y_test, y_pred))
```

```
Accuracy: 0.9673571428571428
```

Confusion Matrix

In [22]:

```
print('\nConfusion Matrix is:\n',confusion_matrix(y_test, y_pred))
```

```
Confusion Matrix is:
 [[1355    0    1    0    1    9    4    5    3    3]
 [   0 1551    8    2    2    2    0    6    3    1]
 [   4    8 1340    7    6    4    5   12    8    4]
 [   2    3   19 1367    1   12    1    8    9    6]
 [   0    2    4    0 1323    0    7    3    5   21]
 [   4    3    2   19    3 1205   13    0    6    8]
 [   4    1    5    2    5    5 1347    1    5    0]
 [   1    3    8    2    5    1    0 1421    2   15]
 [   3    8    9   17    3   10    5    1 1302    7]
 [   3    1    3   10   15    8    0   13    7 1332]]
```

Classification Report

In [23]:

```
print('\nClassification Report:\n',classification_report(y_test, y_pred))
```

```
Classification Report:
               precision    recall  f1-score   support

           0       0.98      0.98      0.98      1381
           1       0.98      0.98      0.98      1575
           2       0.96      0.96      0.96      1398
           3       0.96      0.96      0.96      1428
           4       0.97      0.97      0.97      1365
           5       0.96      0.95      0.96      1263
           6       0.97      0.98      0.98      1375
           7       0.97      0.97      0.97      1458
           8       0.96      0.95      0.96      1365
           9       0.95      0.96      0.96      1392

    accuracy                           0.97     14000
   macro avg       0.97      0.97      0.97     14000
weighted avg       0.97      0.97      0.97     14000
```

Mean Squared Error

In [24]:

```
from sklearn.metrics import mean_squared_error
import numpy as np
```

In [25]:

```
# To calculate MSE value we have to first convert string targets to int to
# perform calculations

y_test_int = y_test.astype(np.int8)
y_pred_int = y_pred.astype(np.int8)
```

In [26]:

```
mse = mean_squared_error(y_test_int,y_pred_int)
print("Mean Squared Error: ",mse)
```

```
Mean Squared Error:  0.5725
```

Accuracy : 97%

F1 Score : 0.98

MSE : 0.5725