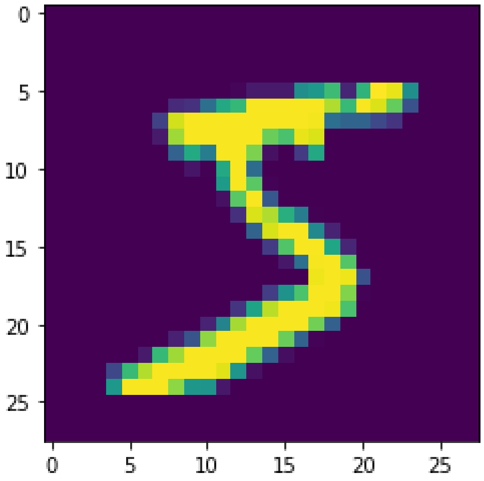
In [1]:

```
import keras
from keras.datasets import mnist
from keras.models import Sequential
from keras.layers import Dense, Dropout, Flatten
from keras.layers import Conv2D, MaxPooling2D
from keras import backend as K
```

In [2]:

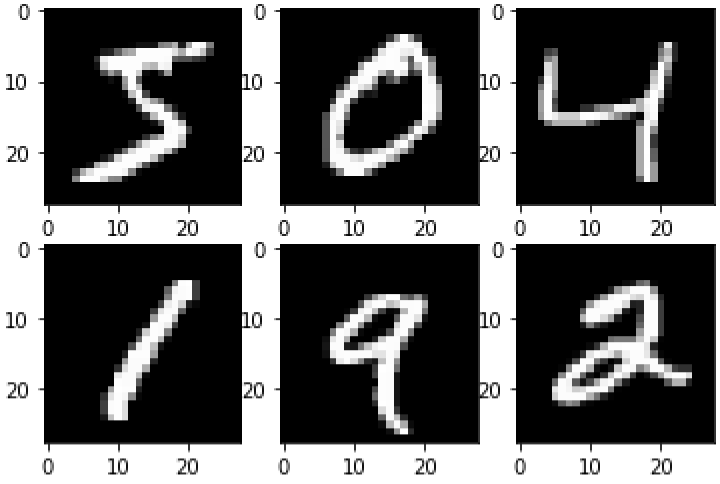
```
# loading the data, split between train and test sets
(x_train, y_train), (x_test, y_test) = mnist.load_data()
import matplotlib.pyplot as plt # to see one of the data set images
print('x_train:', x_train.shape,'y_train:' , y_train.shape , 'shape of first image in x_
```

```
x_train: (60000, 28, 28) y_train: (60000,) shape of first image in x_train AxesImage(54,
36;334.8x217.44) (28, 28)
```



In [3]:

```
#plot first six samples of MNIST training dataset as gray scale image
import matplotlib.pyplot as plt
for i in range (6):
    plt. subplot(int('23' + str(i+1)))
    plt.imshow(x_train[i], cmap=plt.get_cmap('gray') )
```



In [4]:

```
#Data pre-processing
#Next, we need to reshape our dataset inputs (X_train and X_test)
#to the shape that our model expects when we train the model.
#The first number is the number of images (60,000 for X_train and 10,000 for X_test).
#Then comes the shape of each image (28x28). The last number is 1, which signifies that
```

In [5]:

```
x_train = x_train.reshape(x_train.shape[0], 28, 28, 1)
x_test = x_test.reshape(x_test.shape[0], 28, 28, 1)
input_shape = (28, 28, 1)
```

In [6]:

```
# We need to 'one-hot-encode' our target variable.
# This means that a column will be created for each output category and a binary variabl
# For example, we saw that the first image in the dataset is a 5.
# This means that the sixth number in our array will have a 1 and the rest of the array
```

In [7]:

```
# convert class vectors to binary class matrices
#one-hot encode target column
y_train = keras.utils.to_categorical(y_train , 10)
y_test = keras.utils.to_categorical(y_test , 10)

x_train = x_train.astype('float32')
x_test = x_test.astype('float32')
x_train /= 255
x_test /= 255
print('x_train shape:', x_train.shape)
print(x_train.shape[0], 'train samples')
print(x_test.shape[0], 'test samples')
```

```
x_train shape: (60000, 28, 28, 1)
60000 train samples
10000 test samples
```

In [8]:

```
batch_size = 200
num_classes = 10
epochs = 10
model = Sequential()
model.add(Conv2D(32, kernel_size=(3, 3),activation='relu',input_shape=input_shape))
model.add(Conv2D(64, (3, 3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.25))
model.add(Flatten())
model.add(Dense(256, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(num_classes, activation='softmax'))

model.compile(loss=keras.losses.categorical_crossentropy,optimizer=keras.optimizers.Adad

hist = model.fit(x_train , y_train  ,batch_size=batch_size , epochs=epochs , verbose=1 ,
print("The model has successfully trained")
```

```
Epoch 1/10
300/300 [==============================] - 82s 270ms/step - loss: 2.2993 - accuracy: 0.1
161 - val_loss: 2.2650 - val_accuracy: 0.2319
Epoch 2/10
300/300 [==============================] - 117s 390ms/step - loss: 2.2456 - accuracy: 0.
2175 - val_loss: 2.2023 - val_accuracy: 0.4207
Epoch 3/10
300/300 [==============================] - 58s 193ms/step - loss: 2.1843 - accuracy: 0.3
175 - val_loss: 2.1288 - val_accuracy: 0.5608
Epoch 4/10
300/300 [==============================] - 55s 185ms/step - loss: 2.1102 - accuracy: 0.4
073 - val_loss: 2.0360 - val_accuracy: 0.6434
Epoch 5/10
300/300 [==============================] - 56s 186ms/step - loss: 2.0157 - accuracy: 0.4
861 - val_loss: 1.9163 - val_accuracy: 0.6978
Epoch 6/10
300/300 [==============================] - 56s 187ms/step - loss: 1.8944 - accuracy: 0.5
480 - val_loss: 1.7638 - val_accuracy: 0.7391
Epoch 7/10
300/300 [==============================] - 58s 195ms/step - loss: 1.7443 - accuracy: 0.5
997 - val_loss: 1.5804 - val_accuracy: 0.7661
Epoch 8/10
300/300 [==============================] - 58s 194ms/step - loss: 1.5754 - accuracy: 0.6
351 - val_loss: 1.3822 - val_accuracy: 0.7859
Epoch 9/10
300/300 [==============================] - 56s 186ms/step - loss: 1.4069 - accuracy: 0.6
```

```
584 - val_loss: 1.1920 - val_accuracy: 0.8005
Epoch 10/10
300/300 [==============================] - 56s 187ms/step - loss: 1.2502 - accuracy: 0.6
833 - val_loss: 1.0271 - val_accuracy: 0.8134
The model has successfully trained
```

In [9]:

```
score = model.evaluate(x_test, y_test, verbose=0)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

```
Test loss: 1.0271421670913696
Test accuracy: 0.8133999705314636
```

In [10]:

```
import os
os.chdir(r'C:\Users\HP\Downloads\model')
model.save('mnist.h5')
print("Saving the model as mnist.h5")
```

```
Saving the model as mnist.h5
```

In [ ]: