Feedforward neural network

In [ ]:
```
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```

In [ ]:
```
!pip install keras
```

Import the packages

In [3]:
```
import numpy as np
from keras.datasets import mnist
from keras.models import Sequential
from keras.layers import Dense
```

Load the training and testing data (MNIST

In [8]:
```
(x_train, y_train),(x_test,
                    y_test) = mnist.load_data()
```

In [9]:
```
x_train.shape
```

Out[9]:
```
(60000, 28, 28)
```

In [10]:
```
x_test.shape
```

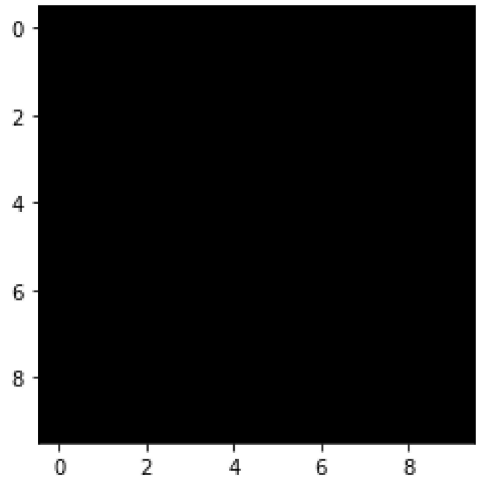
Out[10]:
```
(10000, 28, 28)
```

In [11]:
```
import matplotlib.pyplot as plt
```

In [14]:
```
x = np.zeros(100).reshape(10,10)
```

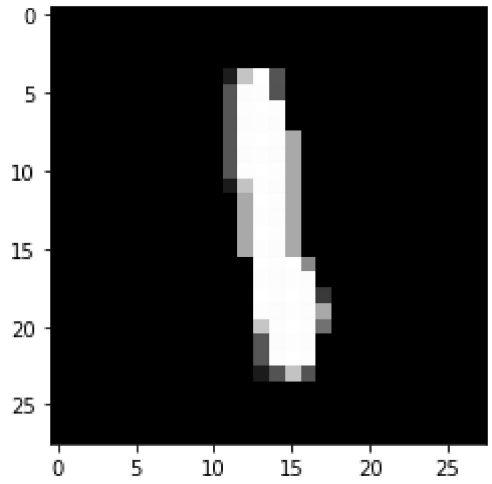
In [16]:
```
plt.imshow(x, cmap='gray')
```

Out[16]:
```
<matplotlib.image.AxesImage at 0x7fddd91081f0>
```



In [23]:
```
plt.imshow(x_train[200], cmap='gray')
```

Out[23]:
```
<matplotlib.image.AxesImage at 0x7fddd96a48e0>
```

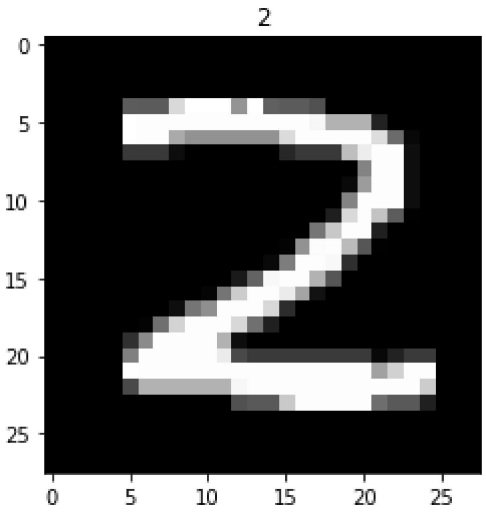


In [24]:
```
y_train[200]
```

Out[24]:
```
1
```

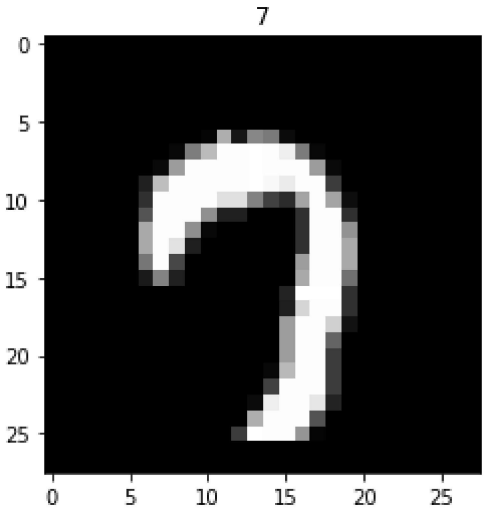
In [27]:
```
plt.imshow(x_train[220], cmap='gray')
plt.title(y_train[220])
```

Out[27]: Text(0.5, 1.0, '2')



In [28]:
```
plt.imshow(x_test[220], cmap='gray')
plt.title(y_test[220])
```

Out[28]: Text(0.5, 1.0, '7')



In [29]:
```
x = np.array([[2,3,5],[8,9,0]])
```

In [30]:
```
x
```

Out[30]:
```
array([[2, 3, 5],
       [8, 9, 0]])
```

In [31]:
```
x.shape
```

Out[31]: (2, 3)

In [34]:
```
x = x.flatten()
x
```

Out[34]:
```
array([2, 3, 5, 8, 9, 0])
```

In [35]:
```
x.shape
```

Out[35]:
```
(6,)
```

In [36]:
```
img = x_train[3]
```

In [37]:
```
img.shape
```

Out[37]:
```
(28, 28)
```

In [38]:
```
img = img.flatten()
img.shape
```

Out[38]:
```
(784,)
```

In [39]:
```
x_train = x_train.reshape(60000, 784)
x_test = x_test.reshape(10000, 784)
```

In [40]:
```
x_train.shape
```

Out[40]:
```
(60000, 784)
```

In [41]:
```
x = np.array([8,6,5,7,0,3,4,2])
```

In [42]:
```
x/8
```

Out[42]:
```
array([1.   , 0.75 , 0.625, 0.875, 0.   , 0.375, 0.5  , 0.25 ])
```

In [43]:
```
x_train = x_train / 255
```

In [44]:
```
x_test = x_test / 255
```

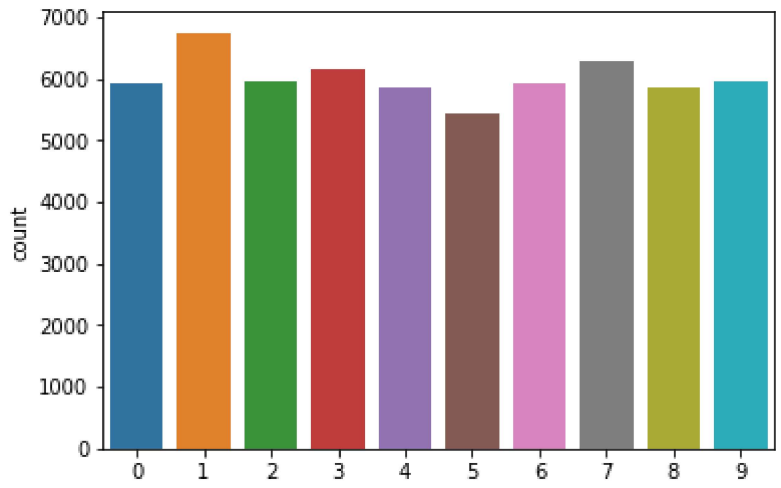
In [46]:
```
set(y_train)
```

Out[46]:
```
{0, 1, 2, 3, 4, 5, 6, 7, 8, 9}
```

In [47]:
```
import seaborn as sns
```

In [48]:
```
sns.countplot(x = y_train)
```

Out[48]: <AxesSubplot:ylabel='count'>



In [49]:
```
from collections import Counter
Counter(y_train)
```

Out[49]:
```
Counter({5: 5421,
         0: 5923,
         4: 5842,
         1: 6742,
         9: 5949,
         2: 5958,
         3: 6131,
         6: 5918,
         7: 6265,
         8: 5851})
```

In [50]:
```
from keras.utils import to_categorical
```

In [51]:
```
x = [0,2,2,1,0,1,2]
```

In [52]:
```
to_categorical(x)
```

Out[52]:
```
array([[1., 0., 0.],
       [0., 0., 1.],
       [0., 0., 1.],
       [0., 1., 0.],
       [1., 0., 0.],
       [0., 1., 0.],
       [0., 0., 1.]], dtype=float32)
```

In [53]:
```
y_train = to_categorical(y_train)
y_test = to_categorical(y_test)
```

In [55]:
```
y_train.shape
```

Out[55]:
```
(60000, 10)
```

In [56]:
```
y_test.shape
```

Out[56]:
```
(10000, 10)
```

Define the network architecture

In [71]:
```
# Object of neural network
model = Sequential()

# Input Layer
model.add(Dense(784, input_shape=(784,),
          activation='relu'))

# Hidden Layer-1
model.add(Dense(256, activation='relu'))

# Output Layer
model.add(Dense(10, activation='softmax'))
```

In [72]:
```
model.summary()
```

```
Model: "sequential_8"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_18 (Dense)            (None, 784)               615440

 dense_19 (Dense)            (None, 256)               200960

 dense_20 (Dense)            (None, 10)                2570

=================================================================
Total params: 818,970
Trainable params: 818,970
Non-trainable params: 0
_________________________________________________________________
```

Compile the model

In [75]:
```
model.compile(loss='categorical_crossentropy',
              optimizer='adam',
              metrics = ['accuracy'])
```

Train the model

In [76]:
```
history = model.fit(x_train, y_train, epochs=10,
          batch_size=10)
```

```
Epoch 1/10
6000/6000 [==============================] - 52s 8ms/step - loss: 0.1295 - ac
curacy: 0.9618
Epoch 2/10
6000/6000 [==============================] - 51s 8ms/step - loss: 0.0820 - ac
curacy: 0.9752
Epoch 3/10
6000/6000 [==============================] - 51s 8ms/step - loss: 0.0627 - ac
curacy: 0.9810
Epoch 4/10
6000/6000 [==============================] - 51s 8ms/step - loss: 0.0537 - ac
curacy: 0.9847
Epoch 5/10
6000/6000 [==============================] - 51s 9ms/step - loss: 0.0441 - ac
curacy: 0.9872
Epoch 6/10
6000/6000 [==============================] - 51s 9ms/step - loss: 0.0414 - ac
curacy: 0.9883
Epoch 7/10
6000/6000 [==============================] - 52s 9ms/step - loss: 0.0373 - ac
curacy: 0.9901
Epoch 8/10
6000/6000 [==============================] - 51s 9ms/step - loss: 0.0349 - ac
curacy: 0.9908
Epoch 9/10
6000/6000 [==============================] - 51s 9ms/step - loss: 0.0340 - ac
curacy: 0.9920
Epoch 10/10
6000/6000 [==============================] - 52s 9ms/step - loss: 0.0308 - ac
curacy: 0.9928
```

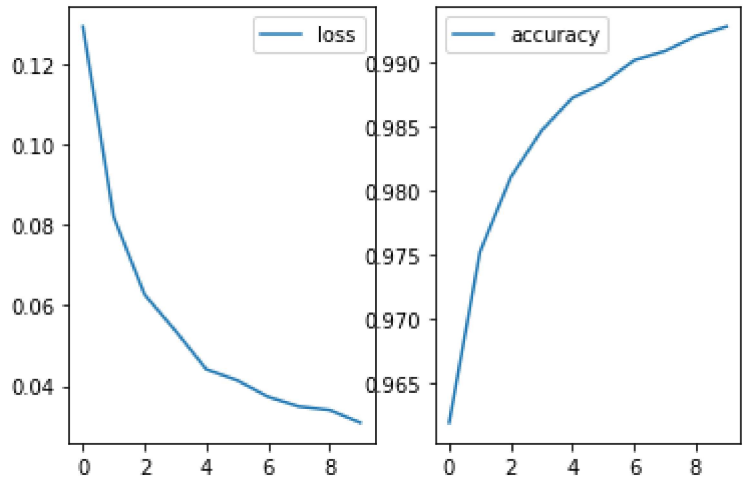
In [80]:
```
history.history
```

Out[80]:
```
{'loss': [0.129514679312706,
  0.08201663196086884,
  0.06271802634000778,
  0.05371781066060066,
  0.04413919150829315,
  0.041412871330976486,
  0.03728529065847397,
  0.0348687469959259,
  0.03398720920085907,
  0.030815543606877327],
 'accuracy': [0.9618333578109741,
  0.9751666784286499,
  0.9810166954994202,
  0.9846500158309937,
  0.9872000217437744,
  0.988349974155426,
  0.9901333451271057,
  0.9908499717712402,
  0.9920166730880737,
  0.9927666783332825]}
```

In [87]:
```
plt.subplot(1,2,1)
plt.plot(history.history['loss'], label='loss')
plt.legend()

plt.subplot(1,2,2)
plt.plot(history.history['accuracy'],
         label='accuracy')
plt.legend()
```

Out[87]:
```
<matplotlib.legend.Legend at 0x7fdd9a1a1700>
```



In [86]:
```
model.evaluate(x_test, y_test, batch_size=1)
```

```
10000/10000 [==============================] - 22s 2ms/step - loss: 0.1254 -
accuracy: 0.9771
```

Out[86]:
```
[0.1253618448972702, 0.9771000146865845]
```

In [ ]:
```

```