

In [1]:

```
import numpy as np
from keras.utils import np_utils
np.random.seed(10)
from keras.datasets import mnist
import matplotlib.pyplot as plt
from keras.models import Sequential
from keras.layers import Dense
```

Using TensorFlow backend.

```
C:\Users\User\anaconda3\envs\tensorflow\lib\site-packages\tensorflow\python\framework\dtypes.py:516: FutureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
    _np_qint8 = np.dtype([("qint8", np.int8, 1)])
C:\Users\User\anaconda3\envs\tensorflow\lib\site-packages\tensorflow\python\framework\dtypes.py:517: FutureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
    _np_quint8 = np.dtype([("quint8", np.uint8, 1)])
C:\Users\User\anaconda3\envs\tensorflow\lib\site-packages\tensorflow\python\framework\dtypes.py:518: FutureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
    _np_qint16 = np.dtype([("qint16", np.int16, 1)])
C:\Users\User\anaconda3\envs\tensorflow\lib\site-packages\tensorflow\python\framework\dtypes.py:519: FutureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
    _np_quint16 = np.dtype([("quint16", np.uint16, 1)])
C:\Users\User\anaconda3\envs\tensorflow\lib\site-packages\tensorflow\python\framework\dtypes.py:520: FutureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
    _np_qint32 = np.dtype([("qint32", np.int32, 1)])
C:\Users\User\anaconda3\envs\tensorflow\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:541: FutureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
    np_resource = np.dtype([("resource", np.ubyte, 1)])
C:\Users\User\anaconda3\envs\tensorflow\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:542: FutureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
    _np_qint8 = np.dtype([("qint8", np.int8, 1)])
C:\Users\User\anaconda3\envs\tensorflow\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:543: FutureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
    _np_quint8 = np.dtype([("quint8", np.uint8, 1)])
C:\Users\User\anaconda3\envs\tensorflow\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:544: FutureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
    _np_qint16 = np.dtype([("qint16", np.int16, 1)])
C:\Users\User\anaconda3\envs\tensorflow\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:545: FutureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
    _np_quint16 = np.dtype([("quint16", np.uint16, 1)])
C:\Users\User\anaconda3\envs\tensorflow\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:546: FutureWarning: Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
    _np_qint32 = np.dtype([("qint32", np.int32, 1)])
C:\Users\User\anaconda3\envs\tensorflow\lib\site-packages\tensorboard\compat\tensorflow_stub\dtypes.py:550: FutureWarning: Passing (type, 1) or '1type' as a synonym of type is
```

```
type is deprecated; in a future version of numpy, it will be understood as (type,
(1,)) / '(1,)type'.
np_resource = np.dtype([("resource", np.ubyte, 1)])
```

In [2]:

```
def show_image(image):
    fig = plt.gcf()
    fig.set_size_inches(2, 2)
    plt.imshow(image, cmap='binary')
    plt.show()

def show_images_labels_predictions(images,labels,
                                   predictions,start_id,num=10):
    plt.gcf().set_size_inches(12, 14)
    if num>25: num=25
    for i in range(0, num):
        ax=plt.subplot(5,5, 1+i)
        #顯示黑白圖片
        ax.imshow(images[start_id], cmap='binary')

        # 有 AI 預測結果資料, 才在標題顯示預測結果
        if( len(predictions) > 0 ) :
            title = 'ai = ' + str(predictions[i])
            # 預測正確顯示(o), 錯誤顯示(x)
            title += (' (o)' if predictions[i]==labels[i] else ' (x)')
            title += '\nlabel = ' + str(labels[i])
        # 沒有 AI 預測結果資料, 只在標題顯示真實數值
        else :
            title = 'label = ' + str(labels[i])

        # X, Y 軸不顯示刻度
        ax.set_title(title,fontsize=12)
        ax.set_xticks([]);ax.set_yticks([])
        start_id+=1
    plt.show()
```

In [3]:

```
#建立訓練資料和測試資料，包括訓練特徵集、訓練標籤和測試特徵集、測試標籤
(train_feature, train_label),\
(test_feature, test_label) = mnist.load_data()
```

In [7]:

```
print(train_feature[0])
```

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

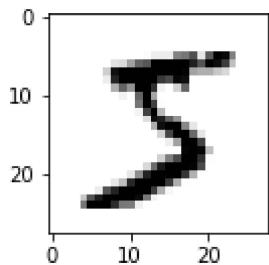
## Keras\_Mnist\_MLP

```
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 139 253 190  2  0  0  0
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0] ]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0  0 11 190 253 70  0  0  0
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0] ]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0  0 0  0 35 241 225 160 108  1
 [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0] ]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0  0 0  0 0  0 81 240 253 253 119
 25 0  0  0  0  0  0  0  0  0  0  0  0  0 0] ]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0  0 0  0 0  0 0  0 45 186 253 253
 150 27 0  0  0  0  0  0  0  0  0  0  0  0 0] ]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0  0 0  0 0  0 0  0 0  0 0  0 16 93 252
 253 187 0  0  0  0  0  0  0  0  0  0  0  0 0] ]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0  0 0  0 0  0 0  0 0  0 0  0 0  0 249
 253 249 64 0  0  0  0  0  0  0  0  0  0  0  0 0] ]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0  0 0  0 0  0 0  0 0  0 0  0 46 130 183 253
 253 207 2  0  0  0  0  0  0  0  0  0  0  0 0] ]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0  0 0  0 0  0 0  0 39 148 229 253 253 253
 250 182 0  0  0  0  0  0  0  0  0  0  0  0 0] ]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0  0 0  0 0  0 0  0 0  0 24 114 221 253 253 253 253 201
 78 0  0  0  0  0  0  0  0  0  0  0  0  0 0] ]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0  0 0  0 0  0 0  0 66 213 253 253 253 253 253 198 81  2
 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0] ]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0  0 0  0 0  0 0  0 18 171 219 253 253 253 253 195 80  9  0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0] ]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0  0 0  0 0  0 0  0 55 172 226 253 253 253 244 133 11  0  0  0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0] ]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0  0 0  0 0  0 0  0 136 253 253 253 212 135 132 16  0  0  0  0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0] ]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0  0 0  0 0  0 0  0 0  0 0  0 0  0 0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0] ]
[ 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0  0 0  0 0  0 0  0 0  0 0  0 0  0 0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0 0]]
```

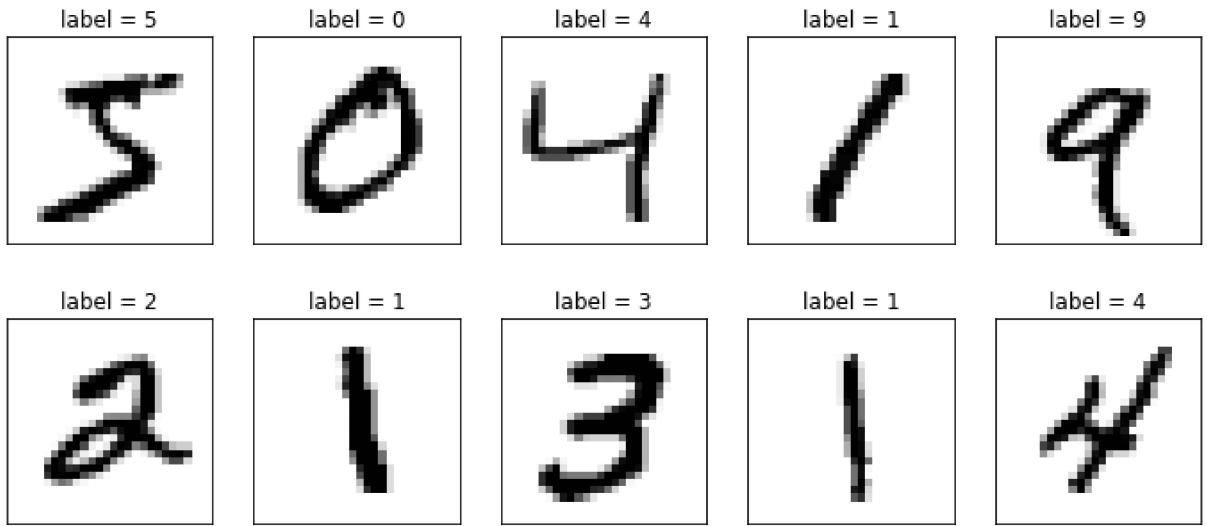
In [8]: `print(train_label[0])`

5

In [9]: `show_image(train_feature[0])`



In [10]: `show_images_labels_predictions(train_feature,train_label,[],0,10)`



In [11]:

#將 Features 特徵值換為 784個 float 數字的 1 維向量

```
train_feature_vector = train_feature.reshape(len(train_feature), 784).astype('float32')
test_feature_vector = test_feature.reshape(len(test_feature), 784).astype('float32')
```

In [12]:

```
print(train_feature_vector[0])
```

```
[ 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 18.  18.  126.  136.  175.  26.  166.  255.  247.  127.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  30.  36.  94.  154.  170.  253.
 253.  253.  253.  253.  225.  172.  253.  242.  195.  64.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  49.  238.  253.  253.  253.  253.  253.
 253.  253.  253.  251.  93.  82.  82.  56.  39.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  18.  219.  253.  253.  253.  253.  253.
 198.  182.  247.  241.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  80.  156.  107.  253.  253.  205.
 11.  0.  43.  154.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  14.  1.  154.  253.  90.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 2.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 70.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 225.  160.  108.  1.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 240.  253.  253.  119.  25.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 45.  186.  253.  253.  150.  27.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  16.  93.  252.  253.  187.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  249.  253.  249.  64.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 46.  130.  183.  253.  253.  207.  2.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
 229.  253.  253.  253.  250.  182.  0.  0.  0.  0.  0.  0.  0.  0.
 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
```

Keras\_Mnist\_MLP

In [13]:

#Features 特徵值標準化

```
train_feature_normalize = train_feature_vector/255  
test_feature_normalize = test_feature_vector/255
```

In [14]:

```
print(train_feature_normalize[0])
```

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.05490196	0.00392157	0.6039216	0.99215686	0.3529412
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.54509807	0.99215686	0.74509805	0.00784314	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.04313726
0.74509805	0.99215686	0.27450982	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.13725491	0.94509804
0.88235295	0.627451	0.42352942	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.	0.31764707	0.9411765	0.99215686
0.99215686	0.46666667	0.09803922	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.1764706	0.7294118	0.99215686	0.99215686
0.5882353	0.10588235	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.0627451	0.3647059	0.9882353	0.99215686	0.73333335
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.9764706	0.99215686	0.9764706	0.2509804	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.18039216	0.50980395	0.7176471	0.99215686
0.99215686	0.8117647	0.00784314	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.15294118	0.5803922
0.8980392	0.99215686	0.99215686	0.99215686	0.98039216	0.7137255
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.09411765	0.44705883	0.86666667	0.99215686	0.99215686	0.99215686
0.99215686	0.7882353	0.30588236	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.09019608	0.25882354	0.8352941	0.99215686
0.99215686	0.99215686	0.99215686	0.7764706	0.31764707	0.00784314
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.07058824	0.67058825
0.85882354	0.99215686	0.99215686	0.99215686	0.99215686	0.7647059
0.3137255	0.03529412	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.21568628	0.6745098	0.8862745	0.99215686	0.99215686	0.99215686
0.99215686	0.95686275	0.52156866	0.04313726	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.53333336	0.99215686
0.99215686	0.99215686	0.83137256	0.5294118	0.5176471	0.0627451

```
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
0.      0.      0.      0.      0.      0.
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 [15]:

```
#Label 轉換為 One-Hot Encoding 編碼
train_label_onehot = np_utils.to_categorical(train_label)
test_label_onehot = np_utils.to_categorical(test_label)
```

In [18]:

```
print(train_label_onehot[0:5])
```

```
[[0. 0. 0. 0. 0. 1. 0. 0. 0. 0.]
 [1. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 1. 0. 0. 0. 0. 0.]
 [0. 1. 0. 0. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. 1.]]
```

In [19]:

```
#建立模型
model = Sequential()
```

In [21]:

```
print(model)
```

```
<keras.engine.sequential.Sequential object at 0x000001BA68673408>
```

In [22]:

```
#輸入層：784, 隱藏層：256，輸出層：10
model.add(Dense(units=256,
                 input_dim=784,
                 kernel_initializer='normal',
                 activation='relu'))
model.add(Dense(units=10,
                 kernel_initializer='normal',
                 activation='softmax'))
```

In [23]:

```
#定義訓練方式
model.compile(loss='categorical_crossentropy',
               optimizer='adam', metrics=['accuracy'])
```

In [24]:

```
#以(train_feature_normalize,train_label_onehot)資料訓練。
#訓練資料保留 20% 作驗證，訓練10次、每批次讀取200筆資料，顯示簡易訓練過程
train_history = model.fit(x=train_feature_normalize,
                           y=train_label_onehot, validation_split=0.2,
                           epochs=10, batch_size=200, verbose=2)
```

WARNING:tensorflow:From C:\Users\User\anaconda3\envs\tensorflow\lib\site-packages\keras\backend\tensorflow\_backend.py:422: The name tf.global\_variables is deprecated. Please use tf.compat.v1.global\_variables instead.

```
Train on 48000 samples, validate on 12000 samples
Epoch 1/10
- 1s - loss: 0.4381 - accuracy: 0.8828 - val_loss: 0.2182 - val_accuracy: 0.9408
Epoch 2/10
- 1s - loss: 0.1908 - accuracy: 0.9454 - val_loss: 0.1555 - val_accuracy: 0.9555
Epoch 3/10
- 1s - loss: 0.1353 - accuracy: 0.9619 - val_loss: 0.1260 - val_accuracy: 0.9649
Epoch 4/10
- 1s - loss: 0.1026 - accuracy: 0.9701 - val_loss: 0.1117 - val_accuracy: 0.9681
Epoch 5/10
- 1s - loss: 0.0809 - accuracy: 0.9775 - val_loss: 0.0980 - val_accuracy: 0.9717
Epoch 6/10
- 1s - loss: 0.0660 - accuracy: 0.9818 - val_loss: 0.0932 - val_accuracy: 0.9726
Epoch 7/10
- 1s - loss: 0.0544 - accuracy: 0.9849 - val_loss: 0.0913 - val_accuracy: 0.9736
Epoch 8/10
- 1s - loss: 0.0458 - accuracy: 0.9878 - val_loss: 0.0824 - val_accuracy: 0.9760
Epoch 9/10
- 1s - loss: 0.0381 - accuracy: 0.9902 - val_loss: 0.0820 - val_accuracy: 0.9762
Epoch 10/10
- 1s - loss: 0.0316 - accuracy: 0.9919 - val_loss: 0.0807 - val_accuracy: 0.9762
```

In [25]:

```
#評估準確率
scores = model.evaluate(test_feature_normalize, test_label_onehot)
print('\n準確率=', scores[1])
```

```
10000/10000 [=====] - 0s 19us/step
```

準確率= 0.9757000207901001

In [26]:

```
#預測
prediction=model.predict_classes(test_feature_normalize)
```

In [27]:

```
#顯示圖像、預測值、真實值
show_images_labels_predictions(test_feature,test_label,prediction,0)
```

