In [1]:

```
import keras
from keras.datasets import mnist
```

```
Using TensorFlow backend.
```

In [2]:

```
((train_X, train_Y), (test_X, test_Y)) = mnist.load_data()
```

In [3]:

```
print(train_X.shape)
```

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

In [4]:

```
print(test_X.shape)
```

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

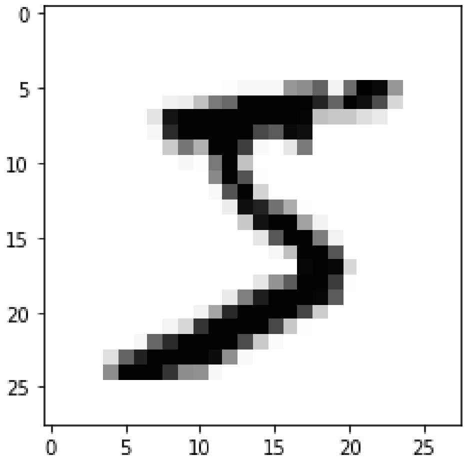
In [5]:

```
import tensorflow as tf
import matplotlib.pyplot as plt
```

In [6]:

```
print(train_Y[0])
plt.imshow(tf.squeeze(train_X[0]), cmap = 'Greys')
plt.show()
```

```
5
```



In [7]:

```
train_X = train_X.reshape(-1, 28, 28, 1)
test_X = test_X.reshape(-1, 28, 28, 1)
train_X = train_X.astype('float32')
test_X = test_X.astype('float32')
train_X = train_X / 255
test_X = test_X / 255
```

In [8]:

```
from keras.utils import to_categorical
```

In [9]:

```
train_Y_one_hot = to_categorical(train_Y)
test_Y_one_hot = to_categorical(test_Y)
```

In [10]:

```
from keras.models import Sequential
from keras.layers import Dense, Activation, Flatten, Conv2D, MaxPooling2D
```

In [11]:

```
model = Sequential()
model.add(Conv2D(64, (3, 3), input_shape = (28, 28, 1)))
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size = (2, 2)))
model.add(Conv2D(64, (3, 3)))
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size = (2, 2)))
model.add(Flatten())
model.add(Dense(64))
model.add(Dense(10))
model.add(Activation('softmax'))
```

In [12]:

```
model.compile(loss = keras.losses.categorical_crossentropy, optimizer = keras.optimizers.Adam(), metrics = ['accuracy'])
```

In [13]:
```
model.fit(train_X, train_Y_one_hot, batch_size = 64, epochs = 10)
```

```
Epoch 1/10
60000/60000 [==============================] - 63s 1ms/step - loss: 0.1468 - accuracy: 0.9567
Epoch 2/10
60000/60000 [==============================] - 65s 1ms/step - loss: 0.0464 - accuracy: 0.9856
Epoch 3/10
60000/60000 [==============================] - 68s 1ms/step - loss: 0.0333 - accuracy: 0.9894
Epoch 4/10
60000/60000 [==============================] - 71s 1ms/step - loss: 0.0259 - accuracy: 0.9918
Epoch 5/10
60000/60000 [==============================] - 67s 1ms/step - loss: 0.0203 - accuracy: 0.9939
Epoch 6/10
60000/60000 [==============================] - 64s 1ms/step - loss: 0.0176 - accuracy: 0.9941
Epoch 7/10
60000/60000 [==============================] - 64s 1ms/step - loss: 0.0138 - accuracy: 0.9953
Epoch 8/10
60000/60000 [==============================] - 65s 1ms/step - loss: 0.0119 - accuracy: 0.9960
Epoch 9/10
60000/60000 [==============================] - 66s 1ms/step - loss: 0.0098 - accuracy: 0.9968
Epoch 10/10
60000/60000 [==============================] - 66s 1ms/step - loss: 0.0083 - accuracy: 0.9968
```

Out[13]:
```
<keras.callbacks.callbacks.History at 0x1fd0215a908>
```

In [14]:
```
model.save('model.h5')
```

In [15]:
```
test_loss, test_acc = model.evaluate(test_X, test_Y_one_hot)
```

```
10000/10000 [==============================] - 3s 274us/step
```

In [16]:
```
print('Test loss:', test_loss)
```

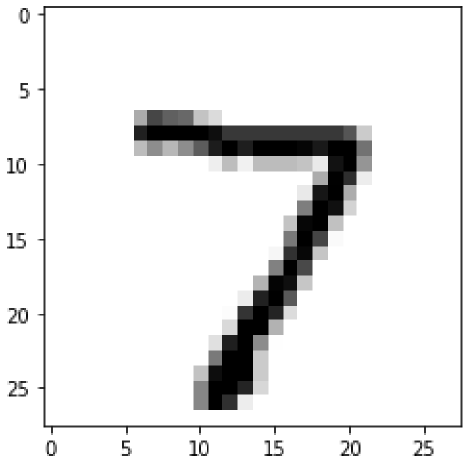
```
Test loss: 0.04015183128897649
```

In [17]:
```
print('Test accuracy:', test_acc)
```

```
Test accuracy: 0.9909999966621399
```

In [18]:

```
plt.imshow(test_X[0].reshape(28, 28), cmap = plt.cm.binary)
plt.show()
```



In [19]:

```
predictions = model.predict(test_X)
```

In [20]:

```
import numpy as np
```

In [21]:

```
print('Predicted value:', np.argmax(np.round(predictions[0])))
```

```
Predicted value: 7
```

In [ ]: