In [155]:

```
# Code kindly shared by Juba Nait Saada

# Imports
import numpy as np
import tensorflow as tf
from tensorflow.examples.tutorials.mnist import input_data
import matplotlib.pyplot as plt
```

In [156]:

```
# Import MNIST dataset
mnist = input_data.read_data_sets("MNIST_data/", one_hot=True)
```

```
Extracting MNIST_data/train-images-idx3-ubyte.gz
Extracting MNIST_data/train-labels-idx1-ubyte.gz
Extracting MNIST_data/t10k-images-idx3-ubyte.gz
Extracting MNIST_data/t10k-labels-idx1-ubyte.gz
```

In [157]:

```
print("Number of images in training dataset : ", len(mnist.train.images))
print("Number of labels in training dataset : ", len(mnist.train.labels))
print("Number of images in test dataset : ", len(mnist.test.images))
print("Number of labels in test dataset : ", len(mnist.test.labels))
```

```
Number of images in training dataset :  55000
Number of labels in training dataset :  55000
Number of images in test dataset :  10000
Number of labels in test dataset :  10000
```

In [158]:

```
#Some useful functions
def reshape(x):
    return x.reshape(28,28,1)

def visualize_image(x):
    return x.reshape(28,28)
```

In [159]:

```
images_train = np.apply_along_axis(reshape, 1, mnist.train.images)
images_train_visualize = np.apply_along_axis(visualize_image, 1, mnist.train.ima
ges)
images_test = np.apply_along_axis(reshape, 1, mnist.test.images)
images_test_visualize = np.apply_along_axis(visualize_image, 1, mnist.test.image
s)
```

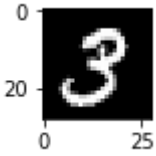
In [166]:

```
#print("Example of one image : ", images_train[0])
```

In [161]:

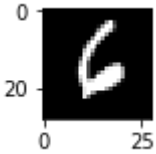
```
# Visualizing some images
for i in range(10):
    plt.figure(figsize=(1,1))
    first_array=images_train_visualize[i]
    plt.imshow(first_array, cmap="gray")
    plt.show()
    print("label : ", np.argmax(mnist.train.labels[i]))
```

label : 7

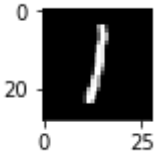


label : 3

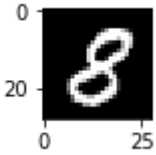
label : 4



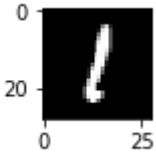
label : 6



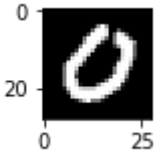
label : 1



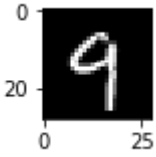
label : 8



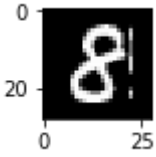
label : 1




```
label :  0
```




```
label :  9
```




```
label :  8
```

In [162]:

```
# Inputs
x = tf.placeholder(tf.float32, [None, 28, 28, 1])
y = tf.placeholder(tf.int32, [None, 10])

# Convolutional Layer #1
conv1 = tf.layers.conv2d(inputs= x,
                         filters=32,
                         kernel_size=[5, 5],
                         padding="same",
                         activation=tf.nn.relu)

# Pooling Layer #1
pool1 = tf.layers.max_pooling2d(inputs=conv1, pool_size=[2, 2], strides=2)

# Convolutional Layer #2
conv2 = tf.layers.conv2d(
      inputs=pool1,
      filters=64,
      kernel_size=[5, 5],
      padding="same",
      activation=tf.nn.relu)

# Pooling Layer #2
pool2 = tf.layers.max_pooling2d(inputs=conv2, pool_size=[2, 2], strides=2)

# Dense Layer
pool2_flat = tf.reshape(pool2, [-1, 7 * 7 * 64])
dense = tf.layers.dense(inputs=pool2_flat, units=1024, activation=tf.nn.relu)

# Logits Layer
logits = tf.layers.dense(inputs=dense, units=10)
predictions_probabilities = tf.nn.softmax(logits)
predictions_class = tf.argmax(predictions_probabilities, 1)

# Error + Training
error = tf.nn.softmax_cross_entropy_with_logits(labels=y, logits=predictions_pro
babilities)
train = tf.train.GradientDescentOptimizer(learning_rate=0.001).minimize(error)

# Accuracy
correct_prediction = tf.equal(tf.argmax(predictions_probabilities, 1), tf.argmax
(y, 1))
accuracy = tf.reduce_mean(tf.cast(correct_prediction, tf.float32))
```

In [164]:

```
with tf.Session() as sess:
    sess.run(tf.global_variables_initializer())

    epochs = 1000
    for e in range(epochs):
        p = np.random.permutation(len(mnist.train.labels))
        temp_x = images_train[p]
        temp_y = mnist.train.labels[p]
        batch_images = temp_x[:100]
        batch_labels = temp_y[:100]
        sess.run(train, feed_dict = {
            x : batch_images,
            y : batch_labels
        })
        print("Accuracy ", sess.run(accuracy, feed_dict = {
            x : batch_images,
            y : batch_labels
        }))

    print('------------------------------------------------------------')
    batch_images = images_test[:100]
    batch_labels = mnist.test.labels[:100]
    print("Accuracy on test dataset", sess.run(accuracy, feed_dict = {
            x : batch_images,
            y : batch_labels
        }))
    results_predictions = sess.run(predictions_class, feed_dict = {
            x : batch_images,
            y : batch_labels
        })
```

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Accuracy  0.98
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Accuracy  0.97
Accuracy  1.0
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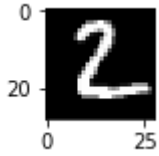
Accuracy  0.98
Accuracy  0.94
Accuracy  0.97
Accuracy  0.97
Accuracy  0.97
Accuracy  0.97
------------------------------------------------------------
Accuracy on test dataset 0.98
```

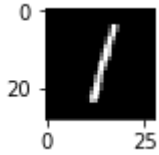
In [171]:

```
# Visualizing some results
for i in range(20):
    plt.figure(figsize=(1,1))
    first_array=images_test_visualize[i]
    plt.imshow(first_array, cmap="gray")
    plt.show()
    print("Predicted label : ", results_predictions[i])
    print("True label : ", np.argmax(mnist.test.labels[i]))
```

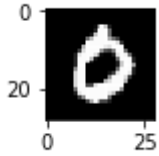

```
Predicted label :  7
True label :  7
```



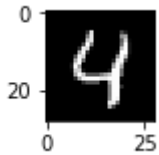

```
Predicted label :  2
True label :  2
```



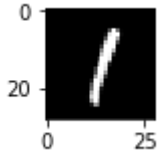

```
Predicted label :  1
True label :  1
```




```
Predicted label :  0
True label :  0
```

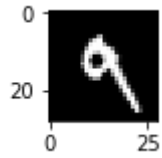



```
Predicted label :  4
True label :  4
```

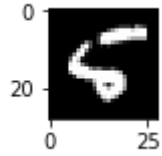



```
Predicted label :  1
True label :  1
```

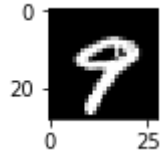

```
Predicted label :  4
True label :  4
```



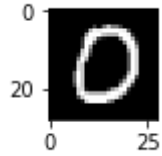

```
Predicted label :  9
True label :  9
```



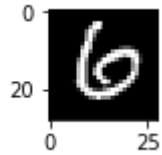

```
Predicted label :  5
True label :  5
```



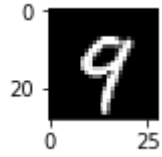

```
Predicted label :  9
True label :  9
```



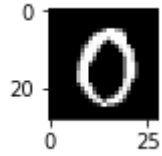

```
Predicted label :  0
True label :  0
```



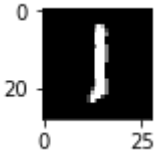

```
Predicted label :  6
True label :  6
```




```
Predicted label :  9
True label :  9
```

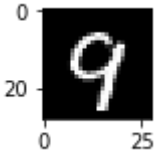



```
Predicted label :  0
True label :  0
```




```
Predicted label :  1
True label :  1
```

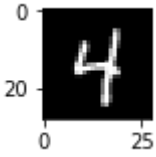

```
Predicted label :  5
True label :  5
```




```
Predicted label :  9
True label :  9
```


```
Predicted label :  7
True label :  7
```


```
Predicted label :  8
True label :  3
```




```
Predicted label :  4
True label :  4
```