MNIST Multi-Layer Perceptron

June 10, 2018

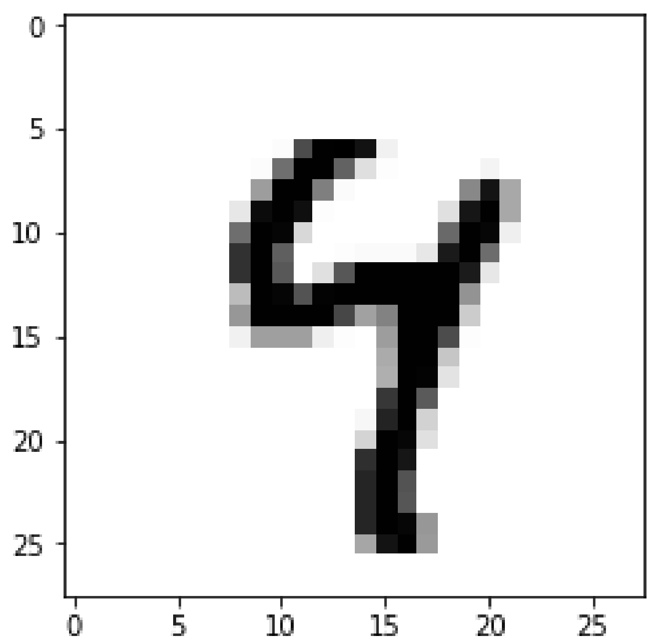
```
In [9]: import tensorflow as tf
        import matplotlib.pyplot as plt

        # Import MINST data
        from tensorflow.examples.tutorials.mnist import input_data
        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 [10]: %matplotlib inline
```

```
In [12]: # visualize what the data looks like
         sample = mnist.train.images[2].reshape(28,28)
         plt.imshow(sample, cmap='Greys')
```

```
Out[12]: <matplotlib.image.AxesImage at 0x1c2b813710>
```



In [13]:
```python
# Define parameters for training
# learning rate (how quickly the cost function is adjusted)
learning_rate = 0.001
# training epochs (how many training cycle to go through)
training_epochs = 15
# size of the batches of training data
batch_size = 100
```

In [14]:
```python
# 10 possible outputs from 0 - 9
n_classes = 10
# Num of samples in data
n_samples = mnist.train.num_examples
```

In [15]:
```python
# what we expect the input to look like
n_input = 784
```

In [16]:
```python
# number of neurons in first hidden layer
n_hidden_1 = 256
# number of neurons in second hidden layer
n_hidden_2 = 256
```

In [17]:
```python
def multilayer_perceptron(x,weights,biases):
    '''
    x: Placeholder for Data Input
    weights: Dict of weights
    biases: dict of bias values
    '''

    # First Hidden Layer with RELU Activation
    # X * W + B
    layer_1 = tf.add(tf.matmul(x,weights['h1']), biases['b1'])
    # RELU(X * W + B) = RELU ->  f(x) = max(0,x)
    layer_1 = tf.nn.relu(layer_1)

    #Second Hidden Layer
    layer_2 = tf.add(tf.matmul(layer_1,weights['h2']),biases['b2'])
    layer_2 = tf.nn.relu(layer_2)

    #Last Output Layer
    out_layer = tf.matmul(layer_2,weights['out']) + biases['out']

    return out_layer
```

In [18]:
```python
# make weight dictionary
```

```
weights = {
    'h1':tf.Variable(tf.random_normal([n_input,n_hidden_1])),
    'h2':tf.Variable(tf.random_normal([n_hidden_1,n_hidden_2])),
    'out':tf.Variable(tf.random_normal([n_hidden_2,n_classes]))
}
```

In [19]:
```
# make biases dictionary
biases = {
    'b1':tf.Variable(tf.random_normal([n_hidden_1])),
    'b2':tf.Variable(tf.random_normal([n_hidden_2])),
    'out':tf.Variable(tf.random_normal([n_classes]))
}
```

In [20]:
```
x = tf.placeholder('float',[None,n_input])
```

In [21]:
```
y = tf.placeholder('float',[None,n_classes])
```

In [22]:
```
# Construct model
pred = multilayer_perceptron(x, weights, biases)
```

In [25]:
```
# Define loss and optimizer
cost = tf.reduce_mean(tf.nn.softmax_cross_entropy_with_logits(logits=pred, labels=y))
optimizer = tf.train.AdamOptimizer(learning_rate=learning_rate).minimize(cost)
```

In [26]:
```
# Run session

sess = tf.InteractiveSession()
```

In [28]:
```
# Initializing the variables
init = tf.global_variables_initializer()
```

In [31]:
```
# 15 loops
# training_epochs = 15

sess.run(init)

for epoch in range(training_epochs):

    # Cost
    avg_cost = 0.0

    total_batch = int(n_samples/batch_size)

    for i in range(total_batch):

        batch_x,batch_y = mnist.train.next_batch(batch_size)

        _,c = sess.run([optimizer,cost],feed_dict={x:batch_x,y:batch_y})
```

```
            # Average Loss
            avg_cost += c/total_batch

        print("Epoch: {} cost={:.4f}".format(epoch+1,avg_cost))

    print("Model has completed {} Epochs of training".format(training_epochs))
```

```
Epoch: 1 cost=156.2893
Epoch: 2 cost=38.3124
Epoch: 3 cost=24.2077
Epoch: 4 cost=16.6557
Epoch: 5 cost=12.2072
Epoch: 6 cost=9.0535
Epoch: 7 cost=6.7135
Epoch: 8 cost=5.0896
Epoch: 9 cost=3.7315
Epoch: 10 cost=2.8349
Epoch: 11 cost=2.2116
Epoch: 12 cost=1.6116
Epoch: 13 cost=1.1371
Epoch: 14 cost=0.9615
Epoch: 15 cost=0.8236
Model has completed 15 Epochs of training
```

In [32]:
```
# Evaluating the model

correct_predictions = tf.equal(tf.argmax(pred,1),tf.argmax(y,1))
```

In [38]:
```
# change from bool to float
correct_predictions = tf.cast(correct_predictions,'float')
```

In [39]:
```
print(correct_predictions[1])
```

```
Tensor("strided_slice_3:0", shape=(), dtype=float32)
```

In [40]:
```
accuracy = tf.reduce_mean(correct_predictions)
```

In [44]:
```
accuracy.eval({x:mnist.test.images,y:mnist.test.labels})
```

Out[44]:
```
0.94919997
```