Chapter_4_Section_3_Softmax_Regression

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1 Ch 04: Concept 04

1.1 Softmax classification

Import the usual libraries:

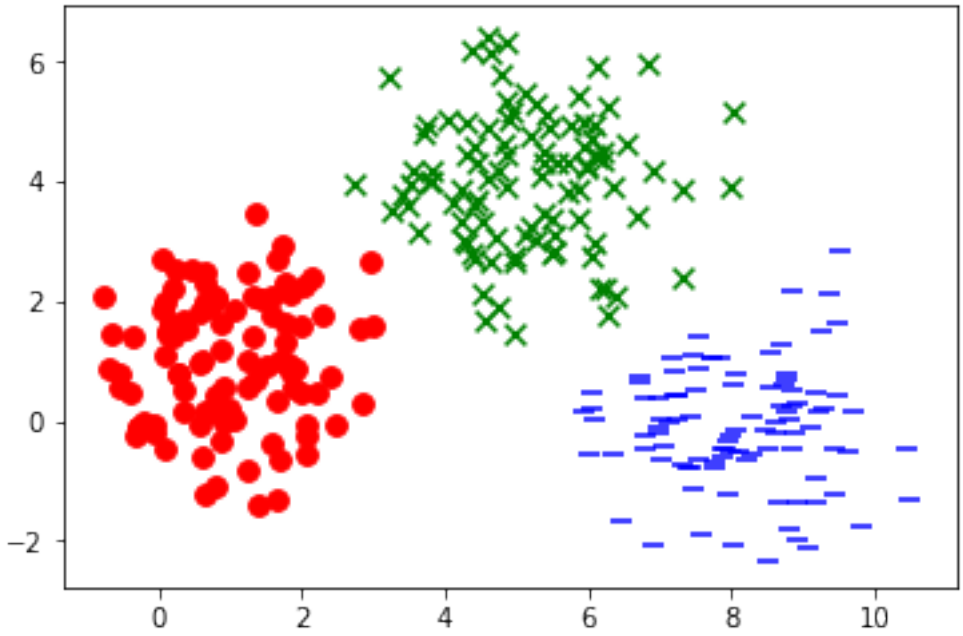
```
In [1]: %matplotlib inline
        import numpy as np
        import tensorflow as tf
        import matplotlib.pyplot as plt
```

Generated some initial 2D data:

```
In [2]: learning_rate = 0.01
        training_epochs = 1000
        num_labels = 3
        batch_size = 100

        x1_label0 = np.random.normal(1, 1, (100, 1))
        x2_label0 = np.random.normal(1, 1, (100, 1))
        x1_label1 = np.random.normal(5, 1, (100, 1))
        x2_label1 = np.random.normal(4, 1, (100, 1))
        x1_label2 = np.random.normal(8, 1, (100, 1))
        x2_label2 = np.random.normal(0, 1, (100, 1))

        plt.scatter(x1_label0, x2_label0, c='r', marker='o', s=60)
        plt.scatter(x1_label1, x2_label1, c='g', marker='x', s=60)
        plt.scatter(x1_label2, x2_label2, c='b', marker='_', s=60)
        plt.show()
```



Define the labels and shuffle the data:

```
In [3]: xs_label0 = np.hstack((x1_label0, x2_label0))
        xs_label1 = np.hstack((x1_label1, x2_label1))
        xs_label2 = np.hstack((x1_label2, x2_label2))

        xs = np.vstack((xs_label0, xs_label1, xs_label2))
        labels = np.matrix([[1., 0., 0.]] * len(x1_label0) + [[0., 1., 0.]] * len(x1_label1) +

        arr = np.arange(xs.shape[0])
        np.random.shuffle(arr)
        xs = xs[arr, :]
        labels = labels[arr, :]
```

We'll get back to this later, but the following are test inputs that we'll use to evaluate the model:

```
In [4]: test_x1_label0 = np.random.normal(1, 1, (10, 1))
        test_x2_label0 = np.random.normal(1, 1, (10, 1))
        test_x1_label1 = np.random.normal(5, 1, (10, 1))
        test_x2_label1 = np.random.normal(4, 1, (10, 1))
        test_x1_label2 = np.random.normal(8, 1, (10, 1))
        test_x2_label2 = np.random.normal(0, 1, (10, 1))
        test_xs_label0 = np.hstack((test_x1_label0, test_x2_label0))
        test_xs_label1 = np.hstack((test_x1_label1, test_x2_label1))
        test_xs_label2 = np.hstack((test_x1_label2, test_x2_label2))

        test_xs = np.vstack((test_xs_label0, test_xs_label1, test_xs_label2))
        test_labels = np.matrix([[1., 0., 0.]] * 10 + [[0., 1., 0.]] * 10 + [[0., 0., 1.]] * 1
```

Again, define the placeholders, variables, model, and cost function:

```
In [5]: train_size, num_features = xs.shape

        X = tf.placeholder("float", shape=[None, num_features])
        Y = tf.placeholder("float", shape=[None, num_labels])

        W = tf.Variable(tf.zeros([num_features, num_labels]))
        b = tf.Variable(tf.zeros([num_labels]))
        y_model = tf.nn.softmax(tf.matmul(X, W) + b)

        cost = -tf.reduce_sum(Y * tf.log(y_model))
        train_op = tf.train.GradientDescentOptimizer(learning_rate).minimize(cost)

        correct_prediction = tf.equal(tf.argmax(y_model, 1), tf.argmax(Y, 1))
        accuracy = tf.reduce_mean(tf.cast(correct_prediction, "float"))
```

Train the softmax classification model:

```
In [6]: sess = tf.Session()
        init = tf.global_variables_initializer()
        sess.run(init)

        for step in range(training_epochs * train_size // batch_size):
            offset = (step * batch_size) % train_size
            batch_xs = xs[offset:(offset + batch_size), :]
            batch_labels = labels[offset:(offset + batch_size)]
            err, _ = sess.run([cost, train_op], feed_dict={X: batch_xs, Y: batch_labels})
            if step % 500 == 0:
                print (step, err)

        W_val = sess.run(W)
        print('w', W_val)
        b_val = sess.run(b)
        print('b', b_val)
        print("accuracy", accuracy.eval(session=sess, feed_dict={X: test_xs, Y: test_labels}))
```

```
0 109.86121
500 1.0744843
1000 2.401994
1500 2.7906587
2000 0.33025676
2500 1.5249108
w [[-2.7173483   0.25687253  2.460474  ]
 [ 0.55276555  2.5527036  -3.105484  ]]
b [10.937231  -3.1458795 -7.7913513]
accuracy 1.0
```