Chapter_3_Section_3_Regularization

February 2, 2019

1 Ch 03: Concept 03

1.1 Regularization

Import the relevant libraries and initialize the hyper-parameters

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

        np.random.seed(100)

        learning_rate = 0.001
        training_epochs = 1000
        reg_lambda = 0.
```

create a helper method to split the dataset

```
In [2]: def split_dataset(x_dataset, y_dataset, ratio):
            arr = np.arange(x_dataset.size)
            np.random.shuffle(arr)
            num_train = int(ratio * x_dataset.size)
            x_train = x_dataset[arr[0:num_train]]
            y_train = y_dataset[arr[0:num_train]]
            x_test = x_dataset[arr[num_train:x_dataset.size]]
            y_test = y_dataset[arr[num_train:x_dataset.size]]
            return x_train, x_test, y_train, y_test
```

Create a fake dataset. y = x^2

```
In [3]: x_dataset = np.linspace(-1, 1, 100)

        num_coeffs = 9
        y_dataset_params = [0.] * num_coeffs
        y_dataset_params[2] = 1
        y_dataset = 0
        for i in range(num_coeffs):
            y_dataset += y_dataset_params[i] * np.power(x_dataset, i)
        y_dataset += np.random.randn(*x_dataset.shape) * 0.3
```

Split the dataset into 70% training and testing 30%

```
In [4]: (x_train, x_test, y_train, y_test) = split_dataset(x_dataset, y_dataset, 0.7)
```

Set up the input/output placeholders

```
In [5]: X = tf.placeholder("float")
        Y = tf.placeholder("float")
```

Define our model

```
In [6]: def model(X, w):
            terms = []
            for i in range(num_coeffs):
                term = tf.multiply(w[i], tf.pow(X, i))
                terms.append(term)
            return tf.add_n(terms)
```

Define the regularized cost function

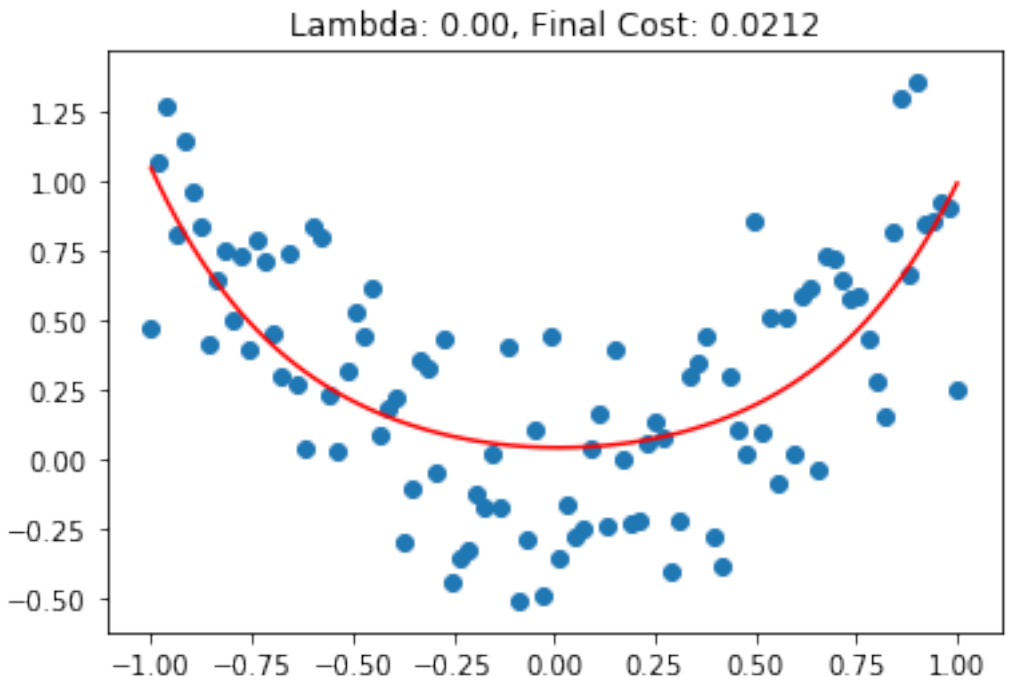
```
In [7]: w = tf.Variable([0.] * num_coeffs, name="parameters")
        y_model = model(X, w)
        cost = tf.div(tf.add(tf.reduce_sum(tf.square(Y-y_model)),
                             tf.multiply(reg_lambda, tf.reduce_sum(tf.square(w)))),
                      2*x_train.size)
        train_op = tf.train.GradientDescentOptimizer(learning_rate).minimize(cost)
```

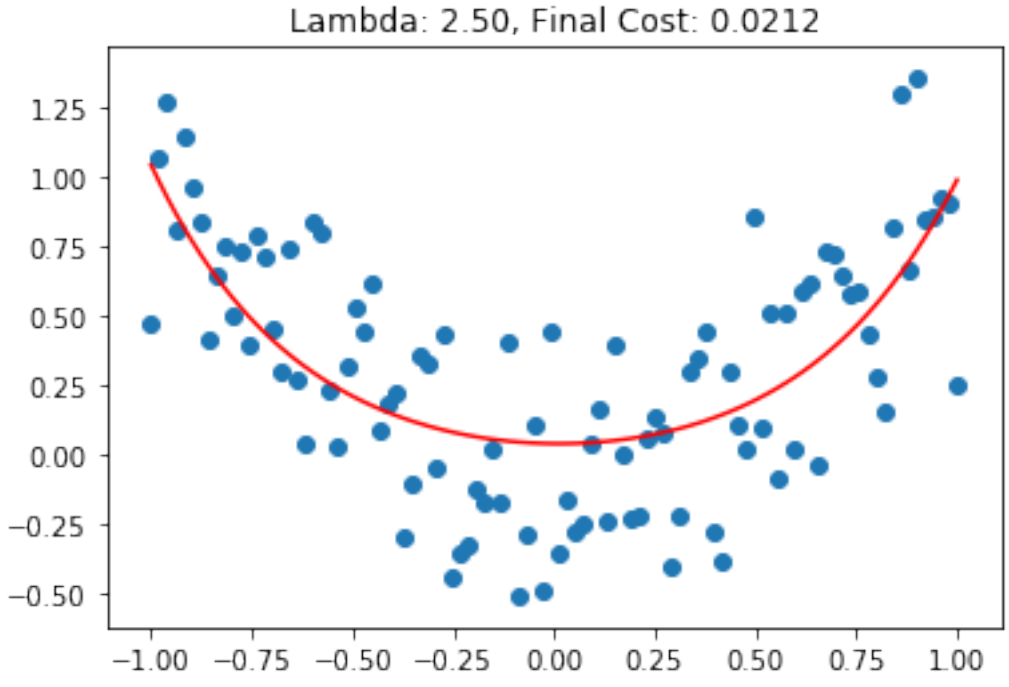
Set up the session

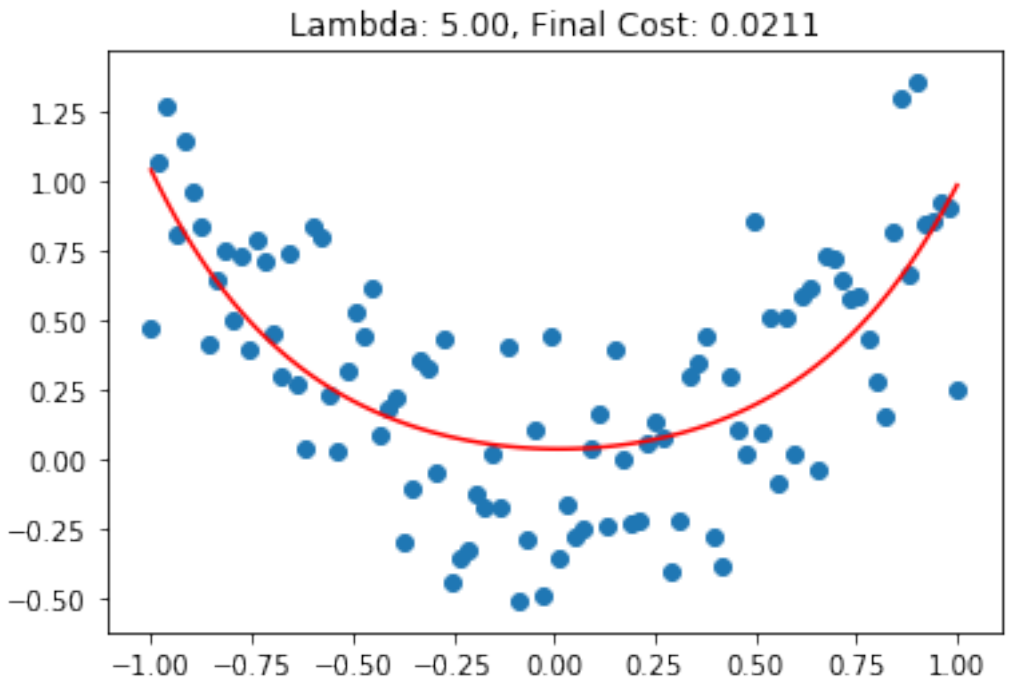
```
In [8]: sess = tf.Session()
        init = tf.global_variables_initializer()
        sess.run(init)
```

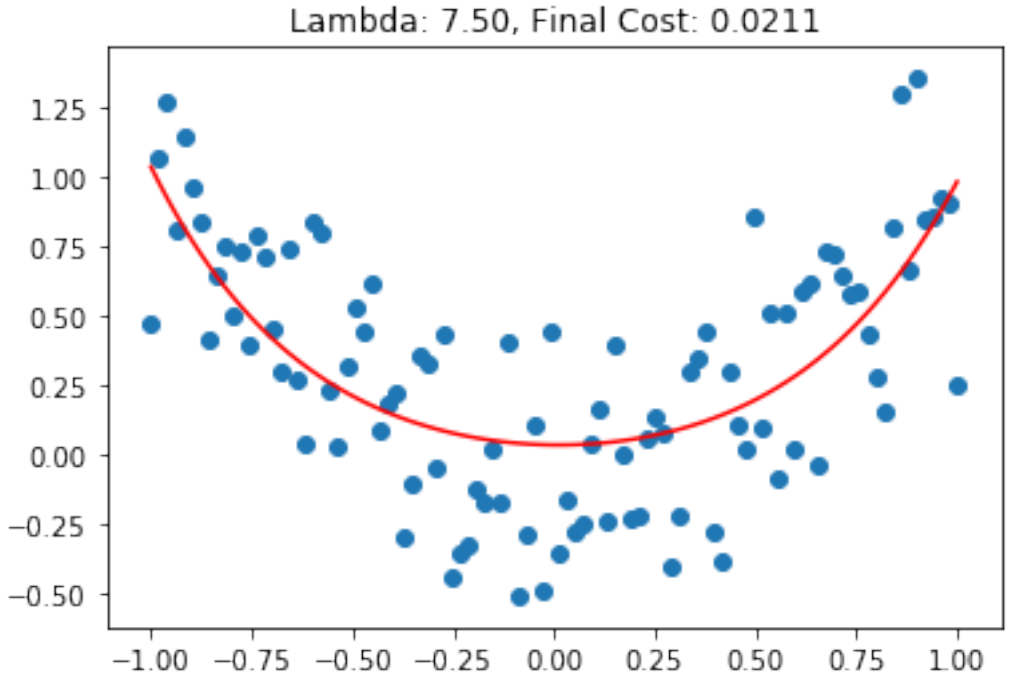
Try out various regularization parameters

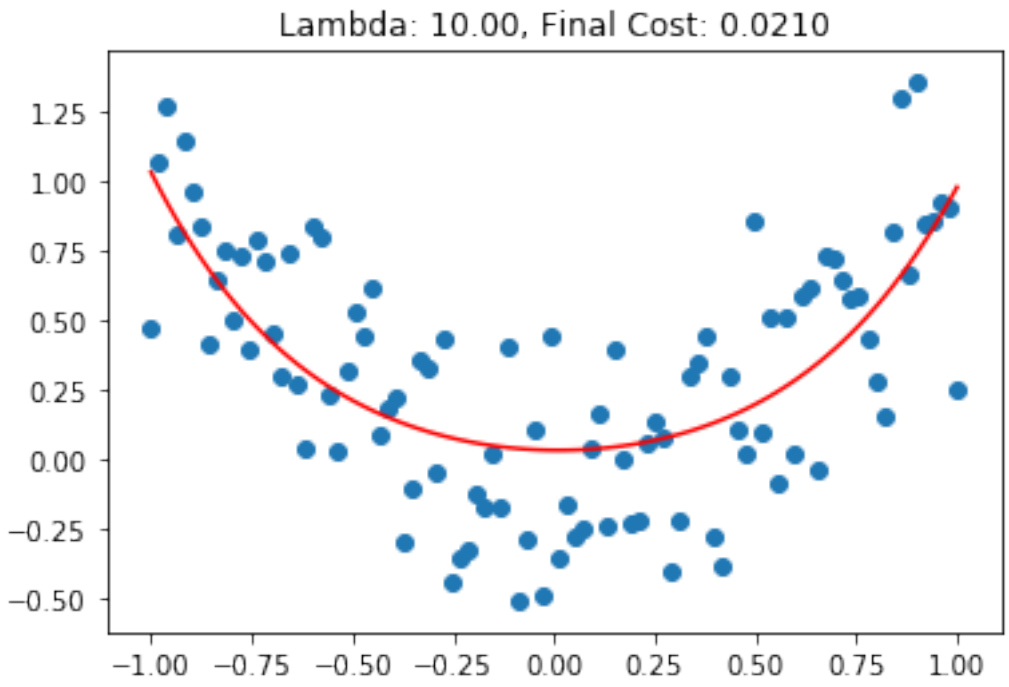
```
In [10]: for reg_lambda in np.linspace(0,10,5):
             for epoch in range(training_epochs):
                 sess.run(train_op, feed_dict={X: x_train, Y: y_train})
             final_cost = sess.run(cost, feed_dict={X: x_test, Y:y_test})

             plt.figure()
             plt.scatter(x_dataset, y_dataset)
             w_val = sess.run(w)
             trY2 = 0
             for i in range(num_coeffs):
                 trY2 += w_val[i] * np.power(x_dataset, i)
             plt.plot(x_dataset, trY2, 'r')
             plt.title('Lambda: {0:.2f}, Final Cost: {1:.4f}'.format(reg_lambda,final_cost))
             plt.show()
```


Lambda: 0.00, Final Cost: 0.0212
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00


Lambda: 2.50, Final Cost: 0.0212
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00


Lambda: 5.00, Final Cost: 0.0211
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00


Lambda: 7.50, Final Cost: 0.0211
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00



Close the session

```
In [11]: sess.close()
```