hwo_1c

August 18, 2018

```
In [92]: import numpy as np
         import matplotlib.pyplot as plt
```

1 Parameters

```
In [93]: N = 10              # training samples
         poly_order = 11      # polynomial order
         M = 100             # testing samples
         lagrangian = 0.1   # lambda, regularization parameter
```

2 Generating training samples

```
In [94]: # Generate equispaced floats in the interval [0, 2*pi]
         x_train = np.linspace(0, 2*np.pi, N)
         # Generate noise
         mean = 0
         std = 0.05
         # Generate some numbers from the sine function
         y = np.sin(x_train)
         # Add noise
         y += np.random.normal(mean, std, N)
         #defining it as a matrix
         y_train = np.asmatrix(y.reshape(N,1))
```

3 adding the bias and higher order terms to x

```
In [95]: x = x_train.reshape((N,1))
         for i in range(0,poly_order-1):
                 x = np.append(x,(x_train.reshape((N,1)))**(i+2),axis = 1)
         x = np.asmatrix(x)
         print(x.shape)
         # print(x)
```

```
(10, 11)
```

4 finding the optimum weights

```
In [96]: w = (x.T*x + lagrangian * np.eye(poly_order)).I*x.T*y_train
         print(w)
```

```
[[ 6.83742250e-01]
 [ 2.60885020e-01]
 [-2.50352775e-02]
 [-1.26902835e-01]
 [-4.02642829e-02]
 [ 6.85613670e-02]
 [-2.62641572e-02]
 [ 4.84170450e-03]
 [-4.50640788e-04]
 [ 1.71990544e-05]
 [-2.22612517e-08]]
```

5 generating test samples

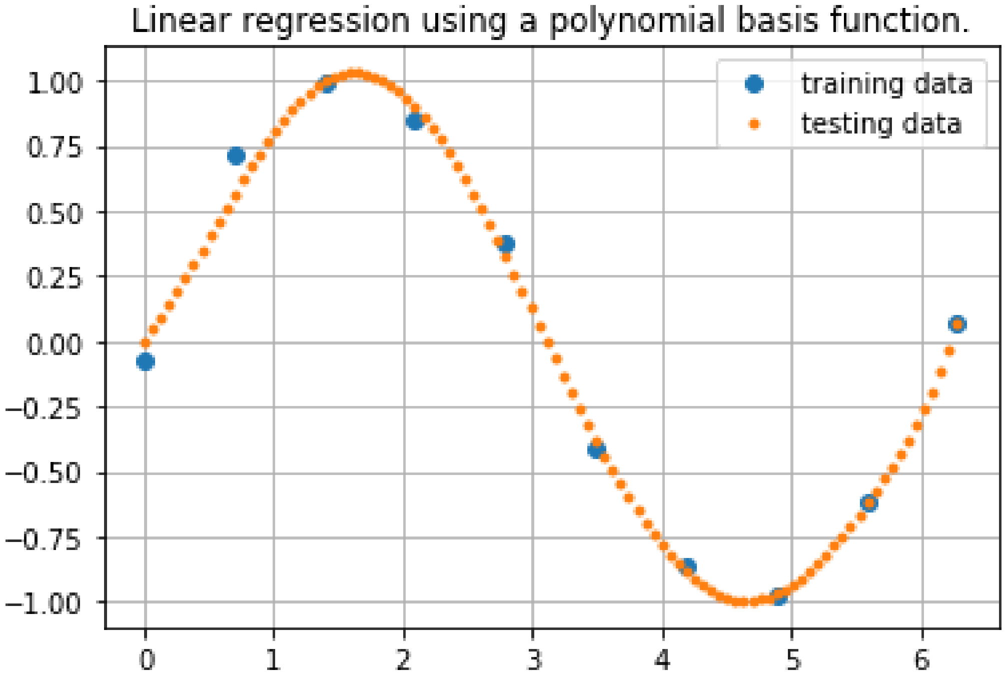
```
In [97]: x_test = np.linspace(0, 2*np.pi, M)
         x = x_test.reshape(M,1)
         for i in range(0,poly_order-1):
                 x = np.append(x,(x_test.reshape((M,1)))**(i+2),axis = 1)
         x = np.asmatrix(x)
```

6 predicting the outputs for the test sample

```
In [98]: y_test = x*w
```

7 ploting the results

```
In [99]: plt.plot(x_train,y_train,'o',label = 'training data')
         plt.plot(x_test,y_test,'.',label = 'testing data')
         plt.legend()
         plt.grid()
         plt.title("Linear regression using a polynomial basis function.")
         plt.show()
```



8 Observations

- Regularisation has been implemented (legrangian multiplier =)
- Noise is added to the training data labels
- Unlike the normal polynomial basis,by adding the regularisation even for the polynomial order of 11, the model is still performance of the model is still good
- when the legrangian = 0 , same curve as the Q2, observed
- Its observed that the problem of overfit is almost solved for linear regression