hwo_1d

August 18, 2018

```
In [166]: import numpy as np
          import matplotlib.pyplot as plt
```

```
In [167]: N = 20                 # training samples
          poly_order = 10         # polynomial order
          M = 100                # testing samples
```

```
In [168]: # 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))
```

1 adding the bias and higher order terms to x

```
In [175]: x = np.append(np.ones((N,1)),x_train.reshape((N,1)),axis = 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)
```

```
(20, 11)
```

2 finding the optimum weights

```
In [170]: w = (x.T*x).I*x.T*y_train
          print(w)
```

```
[[-6.38080034e-02]
 [ 2.61354820e+00]
 [-6.85966457e+00]
 [ 1.17597977e+01]
 [-1.08833485e+01]
 [ 5.83551909e+00]
 [-1.93037154e+00]
 [ 4.00929121e-01]
 [-5.09489913e-02]
 [ 3.62070155e-03]
 [-1.10241772e-04]]
```

3 finding the 1/beta(variance)

```
In [171]: y_train_predict = x*w
          variance = (np.linalg.norm(y_train - y_train_predict)**2)/N
          print(variance)
```

```
0.0004200252733318746
```

4 generating test samples

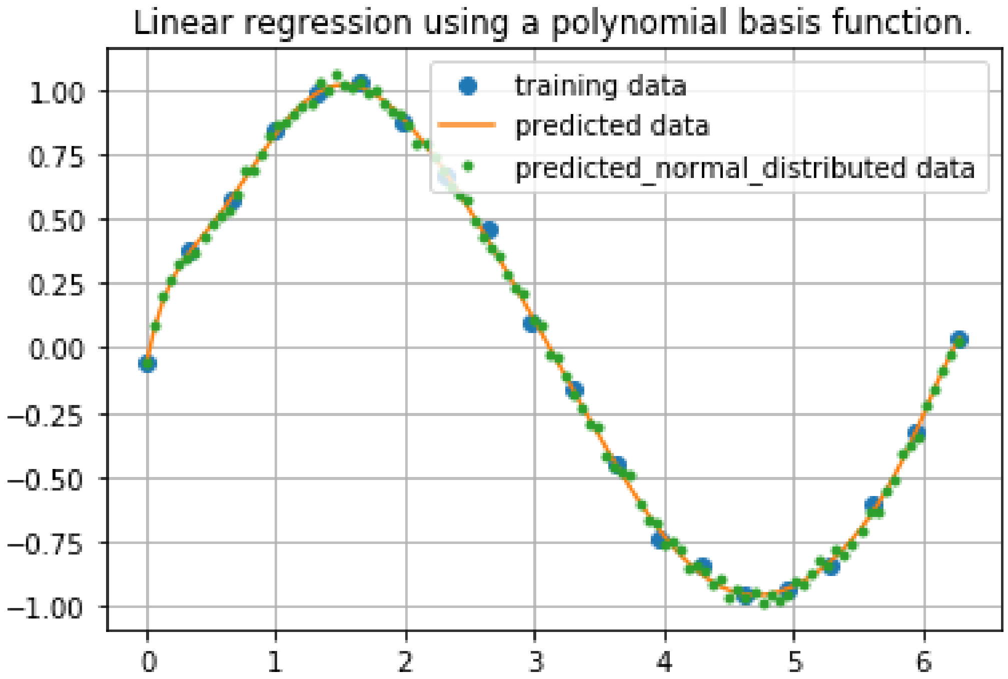
```
In [172]: M = 100
          x_test = np.linspace(0, 2*np.pi, M)
          x_testing = np.asmatrix(np.append(np.ones((M,1)),x_test.reshape(M,1),axis = 1))
          for i in range(0,poly_order-1):
                  x_testing = np.append(x_testing,(x_test.reshape((M,1)))**(i+2),axis = 1)
          x_testing = np.asmatrix(x_testing)
```

5 predicting the outputs for the test sample

```
In [173]: y_test = x_testing*w
          y_test_normal = y_test + np.random.normal(0,np.sqrt(variance),(M,1))
```

6 ploting the results

```
In [174]: plt.plot(x_train,y_train,'o',label = 'training data')
          plt.plot(x_test,y_test,label = 'predicted data')
          plt.plot(x_test,y_test_normal,'.',label = 'predicted_normal_distributed data')
          plt.legend()
          plt.grid()
          plt.title("Linear regression using a polynomial basis function.")
          plt.show()
```



7 Observations

- The label following a distribution is taken into account and the model is trained accordingly
- Weights are estimated by maximum likelyhood of Y
- variance of the labels is minimized and Normal distribution has been fit to the predicted lables, which gave pretty good fit