# hwo_1e

August 18, 2018

```
In [64]: import numpy as np
         import matplotlib.pyplot as plt
```

## 1 Parameters

```
In [65]: N = 10                  # training samples
         poly_order = 12          # polynomial order
         M = 100                 # testing samples
         variance_y = 1e-6       # y guassian variance
         variance_w = 8e-3           # w guassian variance
```

```
In [66]: # 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))
```

## 2 adding the bias and higher order terms to x

```
In [72]: 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, 12)
```

## 3 finding the optimum weights

```
In [68]: w = (x.T*x +  (variance_y/variance_w)*np.eye(poly_order)).I*x.T*y_train
         print(w)
```

```
[[ 6.72485729e-01]
 [ 4.01922430e-01]
 [-1.53537450e-01]
 [-1.29081553e-01]
 [-2.35503068e-02]
 [ 6.93587612e-02]
 [-2.46160170e-02]
 [ 2.19864568e-03]
 [ 4.84498749e-04]
 [-1.25305610e-04]
 [ 9.62986321e-06]
 [-2.17271822e-07]]
```

## 4 generating test samples

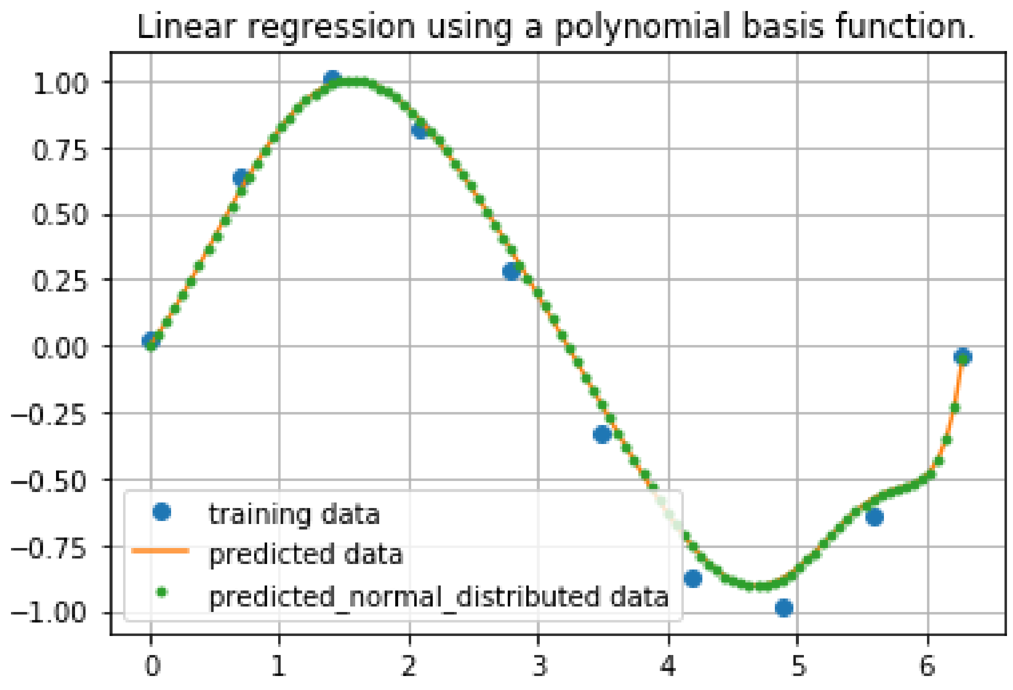
```
In [69]: x_test = np.linspace(0, 2*np.pi, M)
         x = x_test.reshape(M,1)
         for i in range(0,poly_order-1):
                 x = np.append(x,(x_test.reshape((M,1)))**(i+2),axis = 1)
         x = np.asmatrix(x)
```

## 5 predicting the outputs for the test sample

```
In [70]: y_test = x*w
         y_test_normal = y_test + np.random.normal(0,np.sqrt(variance_y),(M,1))
```

## 6 ploting the results

```
In [71]: 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

- labels follow a Gaussian distribution
- weights themselves follow a Gaussian distribution
- Weights are estimated same as l2 regression with legrangian as (variance_y/variance_w)
- Both the variances are idependent and can be varied accaordingly