Project Report

1. Task 2- Energy Minimization with Regulation

$$E(\mathbf{w}) = \left(\frac{1}{2}\right) \sum (y(\mathbf{x_n}) - \mathbf{t_n})^2 + \left(\frac{\lambda}{2}\right) \mathbf{w}^2.$$

   Differentiating with respect to w, we get

$$\frac{d}{dw}(E(w)) = \left(\frac{1}{2}\right)(2X^T X - 2X^T t) + w\lambda$$

$$\frac{d}{dw}(E(w)) = X^T X w - X^T t + w\lambda$$

   equate this to 0:

$$w* = (X^T X + \lambda)^{-1} - X^T t$$

   In this task, add an extra term for Regularization. This technique is often used to control the over-fitting phenomenon. Regularization involves adding a penalty term to the error function in order to discourage the coefficients from reaching large values.

   For fixed Number of sample points: N =50 and ln (λ) = -18 various plots have been created Also, We will see, for N= 15 and N=100 the curve has improved. Thats why we need more test set data.

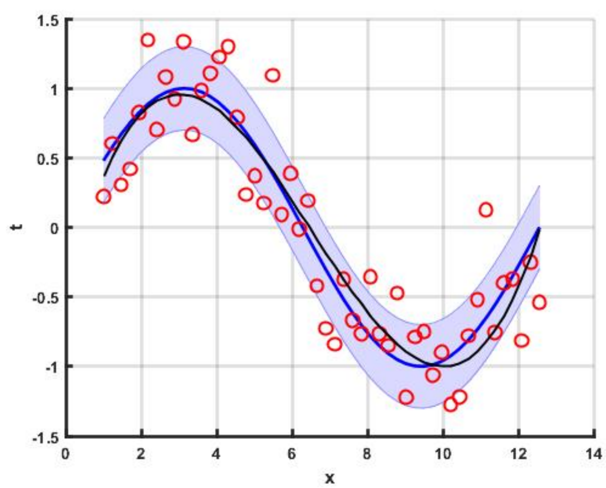

Figure 1: Case 1: (M = 0) w* = [-0.0022]

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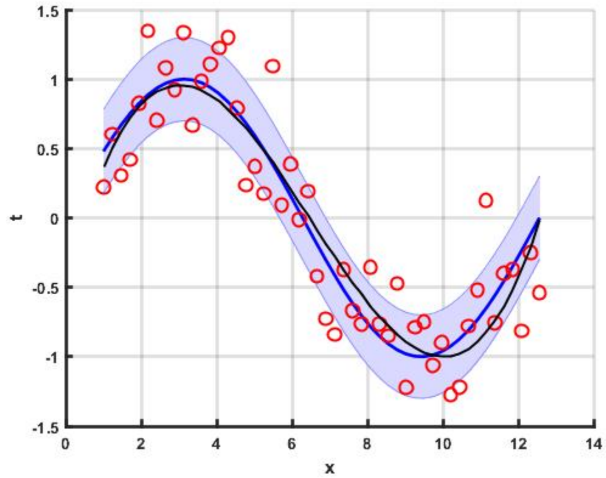

Figure 2: Case 2: (M = 1) w* = [1.5182,-0.2241]

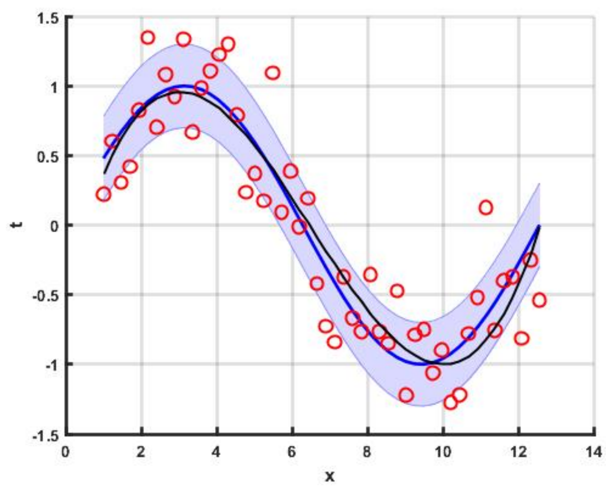

Figure 3: Case 3: (M = 3) w* = [-0.8306,1.2747,-0.2677,0.0137]

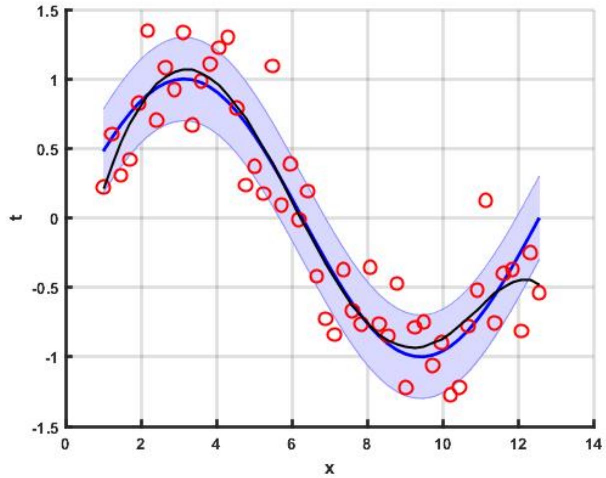

Figure 4: Case 4: (M = 6) w* = [2.2676,-4.1447, 2.9201,-0.8385, 0.1135,-0.0073, 0.0002]

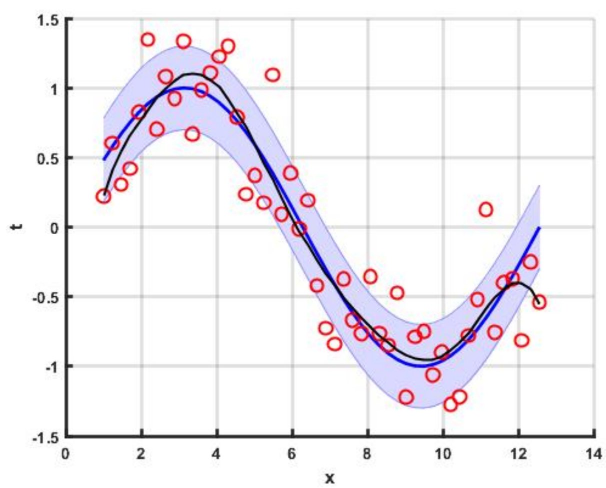

Figure 5: Case 5: (M = 9) w* =[17.5579,,-20.3416,12.0873,-4.0460, 0.8078,-0.0983, 0.0072,-0.0003,0.0000]

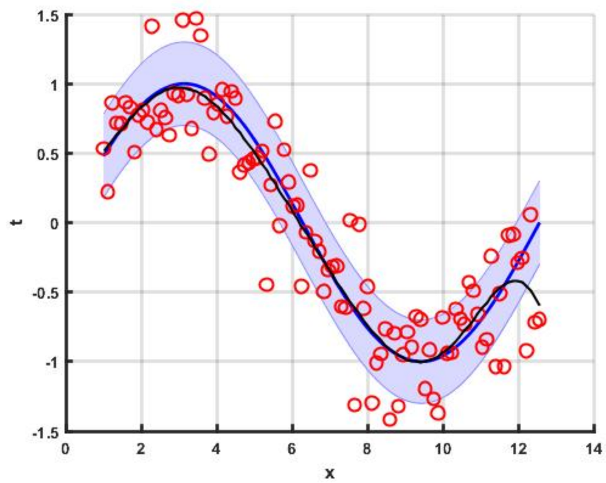

Figure 6: Case 6: (M = 9) N is 100

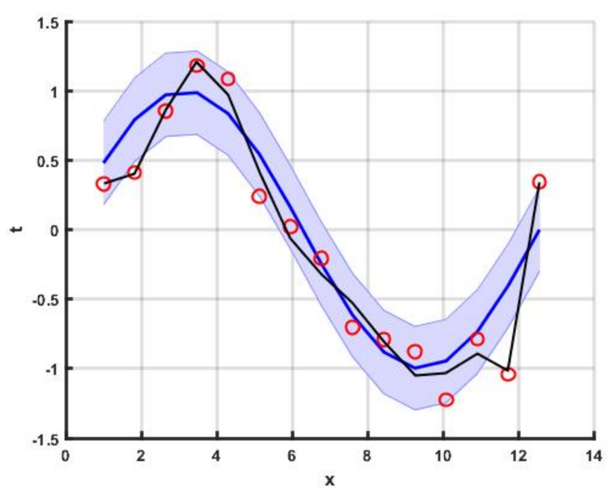

Figure 7: Case 7: (M = 9) N is 15