EE 527: Machine Learning Laboratory

Assignment 3

Due date: 30 Jan 2023

1. Generate a set of points around a line *y* = *ax* + *b*
   1. Choose *a* = 2 and *b* = 3
   2. Select the range for *x* as [−10*,*10] and generate *n* = 100 values for *x* in that interval.
   3. Compute the values of *y* for each *x* as *yi* = 2*xi* + 3.
   4. Plot the line *y* = 2*x* + 3 in black color.
   5. Generate a set of *n* points around the line using the equation

*yi* = 2*xi* + 3 + *σ*N(0*,*1) (1)

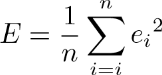
where *σ* is the standard deviation and N(0*,*1) is the zero-mean unity variance normal distribution

* 1. Show the scatter plot of these noisy points (in red color) on the same graph generated in step (d).

1. Plot the average error surface *E* for different values of *a* and *b* in the interval of

[−10 : 0*.*1 : 10].

* 1. Vary both *a* and *b* in steps of 0*.*1 in the interval [−10*,*10]
  2. Compute the element-wise error as *ei* = *yi* − ŷ𝑖 where ŷ𝑖 = *axi* + *b* and *yi* is computed using equation (1).
  3. Compute the average error as

(2)

* 1. Compute the average error values for all combinations of *a* and *b*.
  2. Plot the error surface with the values of *a* along *x*-axis, that of *b* along *y*-axis and *E* along *z*-axis.

1. Generate a set of 200 data points {𝑥𝑖, 𝑦𝑖} following equation (1). Split this data into train and test subsets of 100 points each, using the *train\_test\_split* method available in the *sklearn* library. Estimate the values of 𝑎 and 𝑏 using the pseudo- inverse approach on the train set. Use these estimated values to make predictions for the test set. Compute the MSE and the 𝑅−𝑠𝑞𝑢𝑎𝑟𝑒𝑑 measure. Experiment with different values of standard deviation (𝜎 ) and observe the impact on the values of MSE and 𝑅2 .
2. Taking the points generated in Q.1 (e) as the dataset, solve for *a* and *b* using the Gradient Descent approach where the values of **p** = (*a,b*)*T* in the (*k* + 1)*th* iteration is updated as

**p***k*+1 = **p***k* − *η*∇**p***E*|**p**=**p***k* (3)

Vary the update rate *η* and the initial values (*a*0*,b*0) and note the final solution after 100 iterations. Plot the trajectory of the solutions (*ak,bk*) for varying (*a*0*,b*0*,η*) on the contour plot of *E* on (*a,b*) plane.