EE 527: Machine Learning Laboratory

Assignment 4

Due date: 6 Feb 2023

1. Consider the multi-modal function given by

𝑧 = 1.7 ∗ exp [− {

(𝑥 − 3)2

+

10

(𝑦 − 3)2

10 }] + exp [− {

(𝑥 + 5)2

+

8

(𝑦 + 5)2

8 }] +

𝑥2 𝑦2

(𝑥 − 4)2

(𝑦 + 4)2

2 ∗ exp [− { 4 + 5 }] + 1.5 ∗ exp [− {

(𝑥 + 4)2

+

18

(𝑦 − 4)2

16 }] +

1.2 ∗ exp [− { 18 + 16 }]

Display the surface plot and contour plot of the above function in the search space given

by 𝑆

𝑇

= [𝑥 𝑦 = [−10, −10]𝑇 and 𝑆

= [𝑥

𝑦 𝑇 = [10,10]𝑇.

𝑚𝑖𝑛

𝑚𝑖𝑛, 𝑚𝑖𝑛]

𝑚𝑎𝑥

𝑚𝑎𝑥,

𝑚𝑎𝑥]

Find the maxima 𝑧∗ = 𝑓(𝑥∗, 𝑦∗) using Gradient Ascent. Experiment with multiple initial values (𝑥(𝑜), 𝑦(𝑜)) ∈ [−10,10] × [−10,10], and different number of iterations. Visualize the trajectories of ascent solutions across iterations on the contour plot of 𝑧 = 𝑓(𝑥, 𝑦).

1. Write the following function in python to generate 𝑛 number of points around the line

𝑦 = 𝑎𝑥 + 𝑏 .

[𝑦𝑜𝑢𝑡𝑙𝑖𝑒𝑟, 𝑦𝑛𝑜𝑖𝑠𝑦, 𝑦𝑎𝑐𝑡𝑢𝑎𝑙] = 𝑔𝑒𝑛𝑒𝑟𝑎𝑡𝑒𝐷𝑎𝑡𝑎𝑆𝑒𝑡 (𝑎, 𝑏, 𝑥𝑚𝑖𝑛, 𝑥𝑚𝑎𝑥, 𝑛, 𝛼, 𝜎)

where 𝑥 ∈ [𝑥𝑚𝑖𝑛, 𝑥𝑚𝑎𝑥], 𝜎 is the standard deviation of additive white noise and 𝛼 is the fraction of outliers present in the data (𝛼 ∈ (0,0.49)) . The output of the function is obtained as follows

𝑦𝑎𝑐𝑡𝑢𝑎𝑙 (𝑖) = 𝑎𝑥(𝑖) + 𝑏

𝑦 𝑛𝑜𝑖𝑠𝑦(𝑖) = 𝑦𝑎𝑐𝑡𝑢𝑎𝑙(𝑖) + 𝜎𝒩(0,1)

𝑦𝑜𝑢𝑡𝑙𝑖𝑒𝑟 = 𝑜𝑢𝑡𝑙𝑖𝑒𝑟𝐶𝑜𝑟𝑟𝑢𝑝𝑡𝑖𝑜𝑛 (𝑦𝑛𝑜𝑖𝑠𝑦, 𝛼)

Display the scatter plot of the dataset. Plot the inliers in BLUE and outliers in RED.

1. Perform Regression Diagnostics and display the line obtained in each iteration. Please note that the outliers detected in each iteration should be marked in red color. Experiment with different values of 𝛼 .
2. Perform RANSAC on the above set of points and plot the output of each trial. Identify and plot the final line.