EE 527: Machine Learning Laboratory

Assignment 4

Due date: 6 Feb 2023

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1. Consider the multi-modal function given by

$$z = 1.7 * \exp\left[-\left\{\frac{(x-3)^2}{10} + \frac{(y-3)^2}{10}\right\}\right] + \exp\left[-\left\{\frac{(x+5)^2}{8} + \frac{(y+5)^2}{8}\right\}\right] +$$
$$2 * \exp\left[-\left\{\frac{x^2}{4} + \frac{y^2}{5}\right\}\right] + 1.5 * \exp\left[-\left\{\frac{(x-4)^2}{18} + \frac{(y+4)^2}{16}\right\}\right] +$$
$$1.2 * \exp\left[-\left\{\frac{(x+4)^2}{18} + \frac{(y-4)^2}{16}\right\}\right]$$

Display the surface plot and contour plot of the above function in the search space given by $S_{min} = [x_{min}, y_{min}]^T = [-10, -10]^T$ and $S_{max} = [x_{max}, y_{max}]^T = [10,10]^T$.

Find the maxima $z^* = f(x^*, y^*)$ using Gradient Ascent. Experiment with multiple initial values $(x^{(o)}, y^{(o)}) \in [-10,10] \times [-10,10]$, and different number of iterations. Visualize the trajectories of ascent solutions across iterations on the contour plot of $z = f(x, y)$.

2. Write the following function in python to generate n number of points around the line $y = ax + b$.

$$[y_{outlier}, y_{noisy}, y_{actual}] = generateDataSet\,(a,\ b,\ x_{min},\ x_{max},\ n,\ \alpha,\ \sigma)$$

where $x \in [x_{min}, x_{max}]$, σ is the standard deviation of additive white noise and α is the fraction of outliers present in the data $(\alpha \in (0,0.49))$. The output of the function is obtained as follows

$$y_{actual}(i) = ax(i) + b$$
$$y_{noisy}(i) = y_{actual}(i) + \sigma\mathcal{N}(0,1)$$
$$y_{outlier} = outlierCorruption\,(y_{noisy}, \alpha)$$

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

3. 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.

4. Perform RANSAC on the above set of points and plot the output of each trial. Identify and plot the final line.