CSE 375/381 Lab 4: Bayesian Decision Surfaces

Part 1: You are provided a dataset in the file `binclass.txt`. In this file, the first two numbers on each line denote the two features of the input $\boldsymbol{x}_n$, and the third number is the binary label $y_n \in \{-1, +1\}$.

Implement a generative classification model for this data assuming Gaussian class-conditional distributions of the positive and negative class examples to be $\mathcal{N}(\boldsymbol{x}|\boldsymbol{\mu}_+, \sigma_+^2\mathbf{I}_2)$ and $\mathcal{N}(\boldsymbol{x}|\boldsymbol{\mu}_-, \sigma_-^2\mathbf{I}_2)$, respectively. Note that here $\mathbf{I}_2$ denotes a 2×2 identity matrix. Assume the class-marginal to be $p(y_n = 1) = 0.5$, and use MLE estimates for the unknown parameters. Your implementation need not be specific to two-dimensional inputs and it should be almost equally easy to implement it such that it works for any number of features (but it is okay if your implementation is specific to two-dimensional inputs only).

On a two-dimensional plane, plot the examples from both the classes (use red color for positives and blue color for negatives) and the **learned decision boundary** for this model. Note that we are not providing any separate test data. Your task is only to learn the decision boundary using the provided training data and visualize it.

Next, repeat the same exercise but assuming the Gaussian class-conditional distributions of the positive and negative class examples to be $\mathcal{N}(\boldsymbol{x}|\boldsymbol{\mu}_+, \sigma^2\mathbf{I}_2)$ and $\mathcal{N}(\boldsymbol{x}|\boldsymbol{\mu}_-, \sigma^2\mathbf{I}_2)$, respectively.

Part 2: Repeat the same experiments as you did for part 1 but now using a different dataset `binclassv2.txt`.

Looking at the results of both the parts, comments on the produced results with your own findings. Include your plots (use a separate, appropriately labeled plot, for each case) and experimental findings in the main writeup PDF. Please comment the code so that it is easy to read and also provide a README that briefly explains how to run the code.