Ain Shams University, Faculty of Engineering,
Computer & Systems Engineering Department
CSE463: Neural Networks
Sheet #02: Bipolar Perceptron Learning & Optimization

1- Given a data set of gray levels, {50, 55, 70, 80, 130, 150, 155, and 160} and their corresponding labels {O, O, O, O, B, B, B, and B}, find and visualize a classification boundary assuming the use of a bipolar perceptron with bias. The symbol O stands for object while B stands for background.
2- For the problem description in (1), write a computer program to generate the weighting coefficients randomly and counts the misclassified points in each case. The random numbers generated should be between -1 and 1. Use a loop which stops when you reach zero error. How many trials do you get? Comment on the results.
3- Given a data set of 2D points, {(-1, -1), (+1, -1), (-1, +1), (+1, +1)} and their corresponding labels {+1, +1, +1, -1}, find and visualize a classification boundary assuming the use of a bipolar perceptron with bias.
4- Given a data set of RGB colors, {(0, 0, 0), (255, 0, 0), (0, 255, 0), (0, 0, 255), (255, 255, 0), (0, 255, 255), (255, 0, 255), (255, 255, 255)} and their corresponding labels {+1, +1, +1, -1, +1, -1, -1, +1}, find and visualize a classification boundary assuming the use of a bipolar perceptron with bias.
5- What is the constraint on the learning rate for minimizing $f(x) = x^2$ using the gradient descent optimization? Use visualization to verify your answer by showing different results for different learning rates w.r.t the optimal learning rate.
6- Given the following objective function:-

$$F(x, y) = 3x^4 + 3x^2y^2 + x^2 + 2y^4$$

   a- Use the gradient descent to find a local minimum.
   b- Use the steepest descent to find a local minimum.
   c- Use the NR gradient descent to find a local minimum.
   d- For the all of the above cases, use the same initial position and compare your results.
   e- Verify your solution by visualizing the function surface using your favorite programming language.
7- Use the gradient descent to solve problems (1), (3), (4).
8- Show that the bipolar perceptron will fail in solving the XOR problem.
