Ain Shams University, Faculty of Engineering,
Computer & Systems Engineering Department
CSE463: Neural Networks
Sheet #04: Regression

1- For the linear regression problem, derive the Hessian matrix of the loss function. Comment on the convexity of such a function.
2- Derive the classification boundary equation for the logistic regression problem.
3- Carry out five Gradient Descent iterations for the following linear regression problem:-

X	0	1	2	3	4	5	6	7	8
Y	0	0.81	0.95	0.31	-0.59	-1	-0.59	0.31	0.95

Use a learning rate of 0.01.
4- For the regression problem in (3), find the Hessian matrix after 5 iterations. Is this learning process convex? Hint (Find the Eigen values. Also, you may visualize the loss function vs the weighing coefficients.)
5- Use the closed form solution technique to find the linear model parameters of problem (3).
6- Fit the following model, $(y = \sum_{i=0}^{M} a_i x^i)$ on the data given in problem (3) for M=10. Comment on the results. Use the gradient descent optimization with a suitable learning rate. Comment on the results.
7- Show that the weighing coefficients can be estimated in a closed form solution linear regression problem as follows: $\mathbf{W} = (\mathbf{D}^T\mathbf{D} + \lambda\mathbf{I})^{-1}\mathbf{D}^T\mathbf{Y}$ adopting a regularization term in the loss function.
8- The following data set of 2D points, {(-1, -1), (+1, -1), (-1, +1), (+1, +1)} and their corresponding labels {+1, +1, +1, -1} is trained with a logistic regression model. Assume a suitable learning rate, find and visualize the classification boundary.
9- 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}, train a logistic regression model using gradient descent with a suitable learning rate. Visualize the classification boundary. You may need to normalize the input feature vectors.
10- Consider using an identity activation function with the logistic regression problem. Recommend a loss function and derive the learning equation adopting a regularization term.