Deep Learning
Homework 3 – Logistic Regression

In this assignment you will implement a probabilistic classifier, namely Logistic Regression. While in some of the previous homework you were analysing real data (USPS data), this time you will generate the data yourself.

1. Data Generation
   Write a function `make_data(mus,S,N)` that generates two classes of data from a two dimensional gaussian distribution $\mathcal{N}(\boldsymbol{\mu}, \mathbf{S})$ with means

$$\boldsymbol{\mu}_1 = \begin{bmatrix} 0 \\ 3 \end{bmatrix} \qquad \boldsymbol{\mu}_2 = \begin{bmatrix} 0 \\ -3 \end{bmatrix} \tag{1}$$

   and covariance matrix

$$\mathbf{S}_1 = \mathbf{S}_2 = \begin{bmatrix} 5 & 4 \\ 4 & 5 \end{bmatrix} \tag{2}$$

   The function should return the data points as a matrix and the labels as a vector. Generate 50 data points for each class. Plot the training data as a scatter plot (x-axis is first dimension, y-axis the second dimension) as in fig. 1.

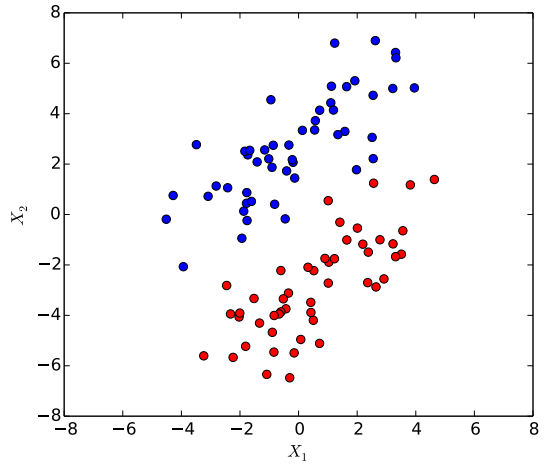

Figure 1: Toy data for a two class problem, data for each class was generated from gaussian distribution with means given in eq. 1 and covariance given in eq. 2.

2. Probabilistic Classification with Logistic Regression
   Use a Logistic Regression Classifier to compute the probability that a data point is of the second class.

$$p(y = 2|\mathbf{x}, \mathbf{w}_1, \mathbf{w}_2) = \frac{e^{\mathbf{w}_2^\top \mathbf{x}}}{e^{\mathbf{w}_1^\top \mathbf{x}} + e^{\mathbf{w}_2^\top \mathbf{x}}}$$

   Plot the data on top of a fine grid that shows the $p(y = 2|\mathbf{x})$ for each point in the grid as shown in figure 2, right.

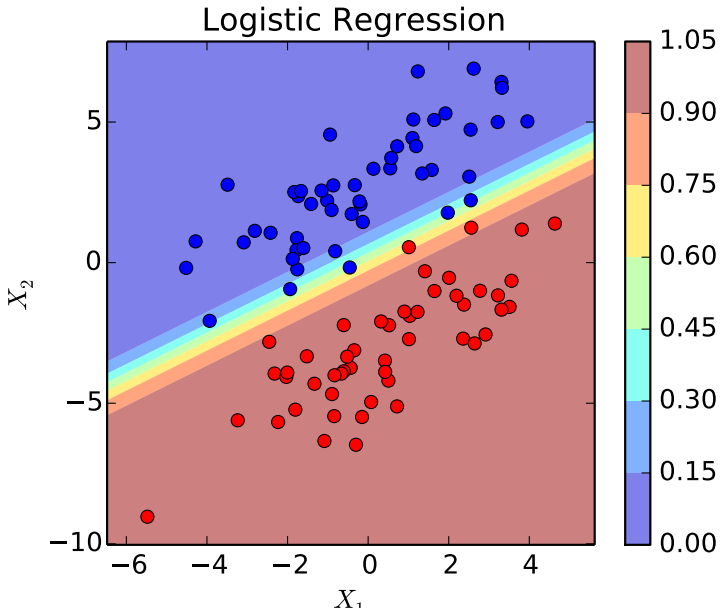

Figure 2: $p(y = 2|\mathbf{x})$ for Logistic Regression.