

AI1001: Introduction to Modern AI
Homework Assignment 3
Due Date: 11:59 PM, 12 December 2020

1. This problem involves logistic regression.

- Use logistic regression to find the classifier that maximizes the log-likelihood ratio for the following data set. (The matrix consists of the 2×1 vectors, and the column vector consists of the corresponding labels.)

$$X = \begin{bmatrix} -1 & -0.2 \\ 3.5 & 1.8 \\ 5.3 & 1.2 \\ 2.2 & 1.1 \\ 7.5 & 1.4 \\ 2.3 & -0.3 \\ 4.4 & 1.1 \\ 7.0 & 0.5 \end{bmatrix}, y = \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}.$$

- Compute the probability of assigning the label 1 to each training vector.
 - Plot the vectors \mathbf{x}_i and the optimal separating straight line, and show the probabilities assigned to each training vector.
 - Now suppose we have two test inputs, namely $\mathbf{v}_1 = [0.7 \ 0.2]$ and $\mathbf{v}_2 = [4.7 \ -0.2]$. Compute the probability with which the logistic regressor assigns the probability of 1 to each test sample.
2. Suppose we have a set of training inputs $(\mathbf{x}_1, y_1), \dots, (\mathbf{x}_m, y_m)$, and we train an optimal logistic regression classifier. Now suppose we simply flip the labels on all training inputs, that is, we change y_i to $1 - y_i$ for all i . What happens to the optimal logistic regression classifier? What happens to the probability associated with each training sample?
3. This problem has to do with multi-class classification. Suppose there are three classes. Write down the code matrix for each of the three approaches described in the notes.
4. Find three applications of conventional neural networks from the Internet, and write a brief one-paragraph description of each.
5. Find three applications of deep neural networks from the Internet, and write a brief one-paragraph description of each.