Homework Assignment 3

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1. Suppose we are given a set of input-output pairs $D = \{(\mathbf{x}_1, y_1^*), \ldots, (\mathbf{x}_N, y_N^*)\}$, and we want to find the best classifier among the following hypothesis sets:

1. $H_{\text{perceptron}}$: Perceptron classifier
2. H_{logreg}: Logistic regression
3. $H_{\text{svm},C}$: Support vector machine with a regularization coefficient C

where C is one of $\{c_0, \ldots, c_M\}$. The dataset D is split into 80% training set and 20% test set. Our goal is two folds; (1) choose the best classifier, and (2) report its generalization performance (or its estimate). Describe in words how these two goals are met using the principles of K-fold cross validation.

2. The distance function of multi-class logistic regression was defined as

$$\begin{aligned} D(y^*, M, \mathbf{x}) &= -\log p_{M^*(\mathbf{x})} \\ &= -a_{y^*} + \log \sum_{k=1}^{K} \exp(a_k), \end{aligned}$$

where

$$\mathbf{a} = \mathbf{W}\tilde{\mathbf{x}}.$$

Derive a learning rule step-by-step for each column vector $\mathbf{w}_c$ of the weight matrix $\mathbf{W}$.

3. PROGRAMMING ASSIGNMENT