Homework #4: Machine Learning

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March 25, 2018

Problem #1

Exercise 8.5
Show that the matrix Q described in the linear hard-margin SVM algorithm above is positive semi-definite (that is $\boldsymbol{u}^T Q \boldsymbol{u} \geq 0$ for any $\boldsymbol{u}$).

Problem #2

Exercise 8.11
(a) Show that the problem in (8.21) is a standard QP-problem:

$$\begin{array}{ll} \underset{\alpha \in R^N}{\text{minimize}} & \frac{1}{2}\alpha^T Q_D \alpha - 1_N^T \alpha \\ \text{subject to} & A_D \alpha \geq 0_{N+2} \end{array}$$

where Q_D and A_D (D for the dual) are given by:

$$Q_D = \begin{bmatrix} y_1 y_1 x_1^T x_1 & \dots & y_1 y_N x_1^T x_N \\ y_2 y_1 x_2^T x_1 & \dots & y_2 y_N x_2^T x_N \\ \vdots & \vdots & \vdots \\ y_N y_1 x_N^T x_1 & \dots & y_N y_N x_N^T x_N \end{bmatrix} \text{ and } A_D = \begin{bmatrix} y^T \\ -y^T \\ I_{NxN} \end{bmatrix}$$

(b) The matrix Q_d of quadratic coefficients is $[Q_d]_{mn} = y_m y_n x_m^T x_n$. Show that $Q_d = X_s X_s^T$, where X_s is the 'signed data matrix',

$$X_s = \begin{bmatrix} y_1 x_x^T \\ -y^T \\ I_{NxN} \end{bmatrix}$$

Problem #3

Exercise 8.13

Problem #4

Problem 8.1

Problem #5

Problem 8.2

Problem #6

Problem 8.4