

# Homework Set 4, CPSC 8420, Fall 2024

Last Name, First Name

**Due 11/19/2024, 11:59PM EST**

## Problem 1

Considering soft margin SVM, where we have the objective and constraints as follows:

$$\begin{aligned} \min \quad & \frac{1}{2} \|w\|_2^2 + C \sum_{i=1}^m \xi_i \\ \text{s.t.} \quad & y_i(w^T x_i + b) \geq 1 - \xi_i \quad (i = 1, 2, \dots, m) \\ & \xi_i \geq 0 \quad (i = 1, 2, \dots, m) \end{aligned} \tag{1}$$

Now we formulate another formulation as:

$$\begin{aligned} \min \quad & \frac{1}{2} \|w\|_2^2 + \frac{C}{2} \sum_{i=1}^m \xi_i^2 \\ \text{s.t.} \quad & y_i(w^T x_i + b) \geq 1 - \xi_i \quad (i = 1, 2, \dots, m) \end{aligned} \tag{2}$$

1. Different from Eq. (1), we now drop the non-negative constraint for  $\xi_i$ , please show that optimal value of the objective will be the same when  $\xi_i$  constraint is removed.
2. What's the generalized Lagrangian of the new soft margin SVM optimization problem?
3. Now please minimize the Lagrangian with respect to  $w, b$ , and  $\xi$ .
4. What is the dual of this version soft margin SVM optimization problem? (should be similar to Eq. (10) in the slides)