ADAPTIVE CONSTRAINT REDUCTION FOR TRAINING SUPPORT VECTOR MACHINES*

JIN HYUK JUNG1, DIANNE P. O’LEARY1, AND ANDRÉ L. TITS2

Abstract. A support vector machine (SVM) determines whether a given observed pattern lies in a particular class. The decision is based on prior training of the SVM on a set of patterns with known classification, and training is achieved by solving a convex quadratic programming problem. Since there are typically a large number of training patterns, this can be expensive. In this work, we propose an adaptive constraint reduction primal-dual interior-point method for training a linear SVM with $\ell_1$ penalty (hinge loss) for misclassification. We reduce the computational effort by assembling the normal equation matrix using only a well-chosen subset of patterns. Starting with a large portion of the patterns, our algorithm excludes more and more unnecessary patterns as the iteration proceeds. We extend our approach to training nonlinear SVMs through Gram matrix approximation methods. We demonstrate the effectiveness of the algorithm on a variety of standard test problems.

Key words. Constraint reduction, column generation, primal-dual interior-point method, support vector machine.

AMS subject classifications. 90C20, 90C51, 90C59, 68W01.

* Received November 29, 2007. Accepted September 26, 2008. Published online on February 23, 2009. Recommended by Martin H. Gutknecht. This work was supported by the US Department of Energy under Grant DEFG0204ER25655.

1Department of Computer Science, University of Maryland, College Park, MD 20742 (jjung@cs.umd.edu).

2Department of Computer Science and Institute for Advanced Computer Studies, University of Maryland, College Park, MD 20742 (oleary@cs.umd.edu).

3Department of Electrical and Computer Engineering and the Institute for Systems Research, University of Maryland, College Park, MD 20742 (andre@umd.edu).

156