

STANFORD UNIVERSITY  
DEPARTMENT OF STATISTICS  
DEPARTMENTAL SEMINAR

Time of talk, Weekday, Date of talk  
4:15 p.m., Tuesday, March 11, 2008  
Sequoia Hall Room 200  
(Cookies at 3:45 in 1st Floor Lounge)

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Google

**Efficient Projections Algorithms onto the  $\ell_1$  Ball for Learning Sparse  
Representations from High Dimension Data**

We describe efficient algorithms for projecting a vector onto the  $\ell_1$ -ball. We present two projection methods. The first method performs exact projection in  $O(n)$  time, where  $n$  is the dimension of the space. The second method works on vectors  $k$  of whose elements are perturbed outside the  $\ell_1$ -ball, projecting in  $O(k \log(n))$  time. This setting is especially useful for online learning in sparse feature spaces, such as text categorization applications. We demonstrate the merits and effectiveness of our algorithms in numerous batch and online statistical learning tasks. We show that variants of gradient projection methods augmented with our efficient projection procedures outperform interior point methods, which are considered state-of-the-art optimization techniques. For least squares problems we show that the algorithm is competitive with a coordinate descent algorithm that was tailored to the problem. We also show that in online settings gradient updates with  $\ell_1$  projections outperform the entropic descent and exponentiated gradient algorithms while obtaining models with high degrees of sparsity. To conclude, we present general analysis for online convex programming with strongly convex functions and show that all algorithms we discuss attain logarithmic regret.