Modern Optimization Techniques - Exercise Sheet 8

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Solutions need to be handed in until **Tuesday, January 5th, 2016 at 10:15**

Exercise 1: Linear Regression with Coordinate Descent (12P)

Let us revisit our toy linear regression example from last time with data given by design matrix X and labels y:

$$X = \begin{pmatrix} 1 & 1 & 2 \\ 1 & 2 & 1 \\ 1 & 1 & 1 \end{pmatrix} \qquad y = \begin{pmatrix} 11 \\ 10 \\ 8 \end{pmatrix}$$

We want to find the parameter vector $\beta = (\beta_0, \beta_1, \beta_2)$ that minimizes the loss over all instances x_i:

$$\mathcal{L}(X, \beta, y) = \sum_{i=1}^{3} (\beta^\top x_i - y_i)^2$$

a) Explain in your own words, what is the difference of Coordinate Descent compared to a normal Gradient Descent!

b) Do two epochs using Coordinate Descent! Report the errors and the overall Loss after each epoch and start with an initial $\beta = (1, 1, 1)^\top$.

Exercise 2: Coordinate Descent (8P)

a) Show that coordinate descent fails for the function

$$g(x) = |x_1 - x_2| + 0.1(x_1 + x_2)$$

Hint: Verify that the algorithm temrinates after one step while $\inf_x g(x) = -\infty$

b) Let

$$\mathcal{L}(x) = f(x) + \lambda \|x\|_1$$

be l_1-regularized minimization with $f(x)$ convex and differential and $\lambda \geq 0$. Assume we converge in a fixed point x^*. Show that x^* is optimal, i.e. it minimizes $\mathcal{L}$.

Hint: Use the subdifferential you have seen in the previous lecture and exercise sheet. $\|x\|_1 = |x|$