Software Implementation Project for "Convex Optimization"

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Consider the composite optimization problem

$$\min_x f(x) + g(x) \tag{1}$$

where $f(x)$ is differentiable and $g(x)$ is a function whose proximal operator is easily available. Let $g(x)$ be a proper and close function, and $\inf_{x \in \mathrm{dom}_g} g(x) > -\infty$. The proximal operator of $g(x)$ is defined as

$$\mathrm{prox}_g(x) = \arg\min_u g(u) + \frac{1}{2}\|u - x\|^2.$$

1 Proximal Gradient Method for Composite Programming

The proximal gradient method to solve (1) is performed as

$$x^{k+1} = \mathrm{prox}_{\alpha^k g}(x^k - \alpha^k \nabla f(x^k)),$$

where α^k is a chosen step-size. Your tasks are listed as follows:

1. Consider the LASSO problem

$$\min_x \frac{1}{2}\|Ax - b\|_2^2 + \lambda\|x\|_1.$$

Perform numerical experiments on the binary classification problems of the LIBSVM dataset. See https://www.csie.ntu.edu.tw/~cjlin/libsvmtools/datasets/

2. Consider the logistic regression problem

$$\min_x \frac{1}{m}\sum_{i=1}^{m} \log(1 + \exp(-b_i a_i^\top x)) + \lambda\|x\|$$

where $\|.\|$ can be either $\|.\|_1$ or $\|.\|_2$. Perform numerical experiments on the binary classification problem of the LIBSVM dataset. See https://www.csie.ntu.edu.tw/~cjlin/libsvmtools/datasets/

2 Requirements

1. Your algorithms should be coded in Matlab or Python.
2. Prepare a report including
- detailed description of the design of each module (self-implemented functions, solvers, etc)
- detailed answers to each question
- tables of numerical results (including the total number of iterations, the optimality measures, the CPU time, etc) and their interpretation

3. Pack the report and all of your codes in one file named as "学号-姓名-日期.zip" and send it to yanxu.su@ahu.edu.cn before Nov. 15th, 2023.
4. If you get significant help from others on one routine, write down the source of references at the beginning of this routine.