Homework 5 for "Convex Optimization"

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1 Algorithms for ℓ_1 minimization

Consider the ℓ_1-regularized problem

$$(1.1) \qquad \min_x \quad \frac{1}{2}\|Ax - b\|_2^2 + \mu\|x\|_1,$$

where $A \in \mathbb{R}^{m \times n}$, $b \in \mathbb{R}^m$ and $\mu > 0$ are given. Test matrices:

```
n = 1024;
m = 512;
A = randn(m,n);
u = sprandn(n,1,0.1);
b = A*u;
mu = 1e-3;
```
See http://bicmr.pku.edu.cn/~wenzw/courses/Test_l1_regularized_problems.m

1. Solve (1.1) using CVX by calling different solvers mosek and gurobi.

2. Solve (1.1) by calling mosek and gurobi directly.

3. Write down and implement three of the following algorithms in Matlab:

   (a) Projection gradient method by reformulating the primal problem as a quadratic program with box constraints

   (b) Subgradient method for the primal problem

   (c) Gradient method for the smoothed primal problem

   (d) Fast gradient method for the smoothed primal problem

   (e) Proximal gradient method for the primal problem

   (f) Fast proximal gradient method for the primal problem

   (g) Augmented Lagrangian method for the dual problem

   (h) Alternating direction method of multipliers for the dual problem

   (i) Alternating direction method of multipliers with linearization for the primal problem

4. Requirement:

    (a) The interface of each method should be written in the following format

```
[x, out] = method_name(x0, A, b, mu, opts);
```

        Here, x0 is a given input initial solution, A, b and mu are given data, opts is a struct which stores the options of the algorithm, out is a struct which saves all other output information.

    (b) Compare the efficiency (cpu time) and accuracy (checking optimality condition) in the format as
`http://bicmr.pku.edu.cn/~wenzw/courses/Test_l1_regularized_problems.m`

    (c) Pack all of your codes in one file named as "l1-hw-name-ID.zip" and send it to both me and TA:
wendouble@gmail.com
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    (d) If you get significant help from others on one routine, write down the source of references at the beginning of this routine.