

Exercise 1

Research what method is better: the gradient method or the Newton method.

Write a program implementing both methods for the minimization of the following function:

$$f(x) = -\sum_{i=1}^m \ln(b_i - (a_i, x)) + \frac{1}{2} \|x\|^2, \quad x \in R^n.$$

Here $a_i \in R^n, i = 1, 2, \dots, m$, are given vectors, $b_i \in R^1, \|x\|^2 = \sum_{j=1}^n x_j^2$.

1. Is the function convex (strictly convex, self-concordant)?
2. Choose the most appropriate algorithm for the methods.
3. Stop iterations when $\|grad(f(x^k))\| < 10^{-8}$.
4. Input data. The input file should be named 'input.txt'. It contains the following data:
 - m – the number of vectors a_i (integer);
 - n – the dimension of vectors a_i and x (integer);
 - vectors $a_1, a_2, \dots, a_m$ (real numbers).

The numbers b_i should be calculated as $b_i = 1 + \sum_{j=1}^n a_{ij}$ to guarantee that the

domain of f is not empty.

5. Output data. The program should produce output file named 'output.txt'. The file should contain (for both methods):
 - x – optimal vector;
 - $f(x)$ – minimal value of the target function;
 - number of iterations;
 - processing time.
6. Run the program for different input data. Write conclusion: how the number of iterations and the processing time depend on the problem size and what method is more preferable.
7. Submit source files and the typed report by e-mail to:
Bregman@bgu.ac.il
The subject should be NLP_Assignment 1.
Write your name and ID in the mail text, not only in the attachments.
The report should contain all necessary explanations, results of the program runs and conclusion.
Deadline for the exercise submission is 25/06/2009.

Good luck!