How to use LBFGSB code?

Introduction

This short example demostrates how to use L-BFGS-B software

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Add MLIB library

```
clear; close all; clc;
mlibfolder = '/home/ivan/Desktop/MLIB';
path(path, mlibfolder);
add_mlib_path;
```

L-BFGS-B

L-BFGS-B is a limited-memory quasi-Newton code for bound-constrained optimization, i.e., for problems where the only constraints are of the form l<= x <= u.

Authors of the original fortran code: Ciyou Zhu, Richard Byrd, Jorge Nocedal and Jose Luis Morales

MEX wrapper was created by *Stephen Becker.*

L-BFGS-B is commonly used in full waveform inversion and tomorgaphy.

Example: test the "lbfgs" on the Hock & Schittkowski test problem #38 (Hock, W. and Schittkowski, K. [1981] Test Examples for Nonlinear Programming Codes. Lecture Notes in Economics and Mathematical Systems Vol. 187, Springer-Verlag.):

Find minimum of function:

$$f = 100(x_2 - x_1^2)^2 + (1 - x_1)^2 + 90(x_4 - x_3^2)^2 + (1 - x_3)^2 + 10.1(x_2 - 1)^2 + 10.1(x_4 - 1)^2 + 19.8(x_2 - 1)(x_4 - 1);$$

The gradient of function is equal:

$$\frac{\partial f}{\partial x_1} = -400\, x_1 \left(x_2 - x_1^2 \right) - 2\left(1 - x_1 \right);$$

$$\frac{\partial f}{\partial x_2} = 200\left(x_2 - x_1^2\right) + 20.2\left(x_2 - 1\right) + 19.8\left(x_4 - 1\right);$$

$$\frac{\partial f}{\partial x_3} = -360\, x_3\left(x_4 - x_3^2\right) - 2\left(1 - x_3\right);$$

$$\frac{\partial f}{\partial x_4} = -400\, x_1\left(x_2 - x_1^2\right) - 2\left(1 - x_1\right);$$

Solution: f reaches minimum ($f = 0$) at point $x = [1, 1, 1, 1]$.

```
x0  = [-3  -1  -3  -1];   % The starting point.
lb  = [-10 -10 -10 -10];  % Lower bound on the variables.
ub  = [+10 +10 +10 +10];  % Upper bound on the variables.

x = lbfgsb(x0,lb,ub,'ExamplecomputeObjective','ExamplecomputeGradient',...
               [],'genericcallback','maxiter',80,'m',4,'factr',1e-12,...
               'pgtol',1e-5);
```

```
  1  573
  2  393
  3  132
  4  11.5
  5  1.48
  6  1.12
  7  0.984
  8  0.305
  9  0.0847
 10  0.0101
 11  0.000123
 12  0.000113
 13  0.000113
 14  0.000112
 15  0.000109
 16  9.75e-05
 17  7.93e-05
 18  7.17e-05
 19  3.55e-05
 20  1.46e-05
 21  1.71e-06
 22  1.94e-07
 23  1.47e-07
 24  8.84e-10
 25  2e-11
 26  2.21e-12
 27  7.16e-14
```

```
disp(x)
```

```
    1.0000    1.0000    1.0000    1.0000
```