Comparison between LBFGS-B and SPG with cubic interpolation in line search

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In this work I present the numerical comparisons of LBFGS-B versus SPG (cubic interpolation) on a collection of 730 simple bounded optimization test problems.

Spectral Projected Gradient is implemented by Birgin, Martinez and Raydan in MSPG.FOR package. The variant with cubic interpolation in line search is implemented by Neculai Andrei. Both these variants of the algorithm are included in the package MSPG.FOR.

Limited memory BFGS with simple bounds is implemented by Ciyou Zhu in collaboration with Byrd, Lu and Nocedal in MLBFGSB.FOR package

The comparison is considered in the following format. Let f_i^{ALG1} and f_i^{ALG2} be the optimal value found by ALG1 and ALG2, for problem i = 1, ..., 730, respectively. We say that, in the particular problem *i*, the performance of ALG1 was better than the performance of ALG2 if:

$$\left|f_{i}^{ALG1}-f_{i}^{ALG2}\right| < 10^{-3}$$

and the number of iterations, or the number of function-gradient evaluations, or the CPU time of ALG1 was less than the number of iterations, or the number of function-gradient evaluations, or the CPU time corresponding to ALG2, respectively. Out of 730 test simple bounded optimization problems only 546 problems satisfies the above comparison criteria.

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Performance Profile:
                     September 1, 2010
 Results lbfgsb versus mspgc (cubic) , valeps= 0.10000000000E-02
              nexp= 546
 nexptot= 730
 Total Number of iterations for lbfgsb =
                                         34351
 Total Number of iterations for mspgc = 103335
 Total Number of function evaluations for lbfgsb =
                                                  39375
 Total Number of function evaluations for mspgc = 147032
 Total Time (centeseconds) for lbfgsb =
                                         12447
 Total Time (centeseconds) for mspgc =
                                         21948
                                               454 problems
59 problems
          lbfgsb achieved minimum # of iter in
                  achieved minimum # of iter in
          mspqc
          lbfgsb and mspgc
                            achieved the same # of iter in 33 problems
  Iterations Performance Profile for lbfgsb
  lbfqsb
Iterations Performance Profile for mspgc
  mspac
=[0.17,0.55,0.73,0.83,0.87,0.89,0.90,0.90,0.91,0.92,0.93,0.94,0.94,0.95,0.95,0.95];
                                              399
          lbfgsb achieved minimum # of fg in
                                                    problems
                                              86 problems
          mspgc achieved minimum # of fg in 86 problems
lbfgsb and mspgc achieved the same # of fg in
                                                            61 problems
```

```
Function Evaluations Performance Profile for lbfgsb
  lbfgsb
Function Evaluations Performance Profile for mspgc
  mspqc
=[0.27,0.58,0.71,0.81,0.86,0.87,0.88,0.90,0.91,0.91,0.92,0.92,0.92,0.92,0.93,0.93];
         lbfqsb
                achieved minimum time in
                                       75
                                           problems
         mspgc
                achieved minimum time in
                                      321
                                           problems
         lbfqsb
                          achieved the same time in
                                                 150
                                                      problems
                and mspgc
  Time Performance Profile for lbfgsb
  lbfgsb
= [0.41, 0.66, 0.81, 0.89, 0.93, 0.97, 0.99, 0.99, 0.99, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00];
  Time Performance Profile for mspgc
  mspgc
```

The performance profile is illustrated in Figure 1.



Fig.1. SPG (cubic) versus LBFGS-B

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