

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

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In this work I present the numerical comparisons of LBFGS-B versus SPG (quadratic 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. 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  $i=1,\dots,730$ , respectively. We say that, in the particular problem  $i$ , the performance of ALG1 was better than the performance of ALG2 if:

$$|f_i^{ALG1} - f_i^{ALG2}| < 10^{-3}$$

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.

**Performance Profile: August 31, 2010**

Results lbfgsb versus mspgl , valeps= 0.10000000000000E-02

nexptot= 730 nexpe= 546

Total Number of iterations for lbfgsb = 34431

Total Number of iterations for mspgl = 100524

Total Number of function evaluations for lbfgsb = 39449

Total Number of function evaluations for mspgl = 178325

Total Time (centeseconds) for lbfgsb = 12627

Total Time (centeseconds) for mspgl = 20657

lbfgsb achieved minimum # of iter in 459 problems

mspgl achieved minimum # of iter in 54 problems

lbfgsb and mspgl achieved the same # of iter in 33 problems

Iterations Performance Profile for lbfgsb

lbfgsb

= [0.90, 0.93, 0.95, 0.96, 0.96, 0.96, 0.96, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00];

Iterations Performance Profile for mspgl

mspgl

= [0.16, 0.54, 0.73, 0.83, 0.86, 0.88, 0.89, 0.90, 0.91, 0.92, 0.93, 0.94, 0.95, 0.96, 0.97, 0.97];

lbfgsb achieved minimum # of fg in 410 problems

mspgl achieved minimum # of fg in 85 problems

lbfgsb and mspgl achieved the same # of fg in 51 problems

Function Evaluations Performance Profile for lbfgsb

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lbfgsb
=[0.84,0.93,0.95,0.99,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00];

Function Evaluations Performance Profile for mspgl

mspgl
=[0.25,0.54,0.64,0.76,0.82,0.84,0.87,0.89,0.89,0.89,0.89,0.90,0.90,0.91,0.91,0.92];

lbfgsb achieved minimum time in 85 problems
mspgl achieved minimum time in 310 problems
lbfgsb and mspgl achieved the same time in 151 problems

Time Performance Profile for lbfgsb

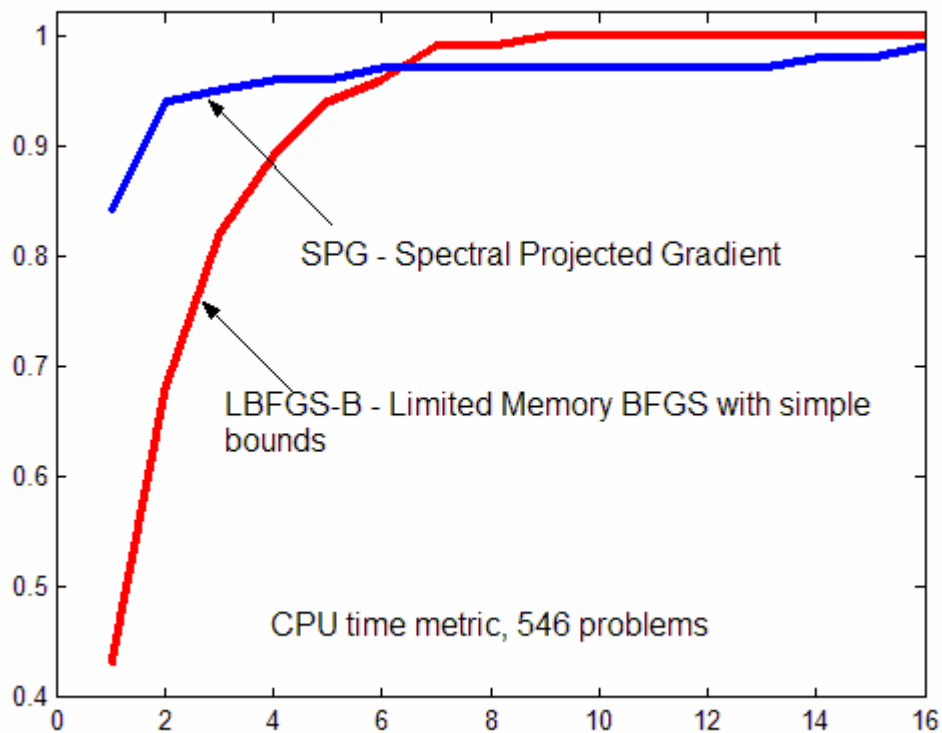
lbfgsb
=[0.43,0.68,0.82,0.89,0.94,0.96,0.99,0.99,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00];

Time Performance Profile for mspgl

mspgl
=[0.84,0.94,0.95,0.96,0.96,0.97,0.97,0.97,0.97,0.97,0.97,0.97,0.97,0.98,0.98,0.99];

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The performance profile is illustrated in Figure 1.



**Fig.1.** SPG (quadratic) versus LBFGS-B

## References

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