

CPU time metric comparisons: DESCON, TTS, CG-DESCENT

Neculai Andrei

*Research Institute for Informatics,
Center for Advanced Modeling and Optimization,
8-10, Averescu Avenue, Bucharest 1, Romania,
Academy of Romanian Scientists
54, Splaiul Independenței, Bucharest 5, Romania*

In this technical report we compare the following conjugate gradient algorithms (and software) for solving large-scale unconstrained optimization problems:

- 1) DESCON (Andrei),
- 2) TTS (Andrei),
- 3) CG-DESCENT (Hager & Zhang).

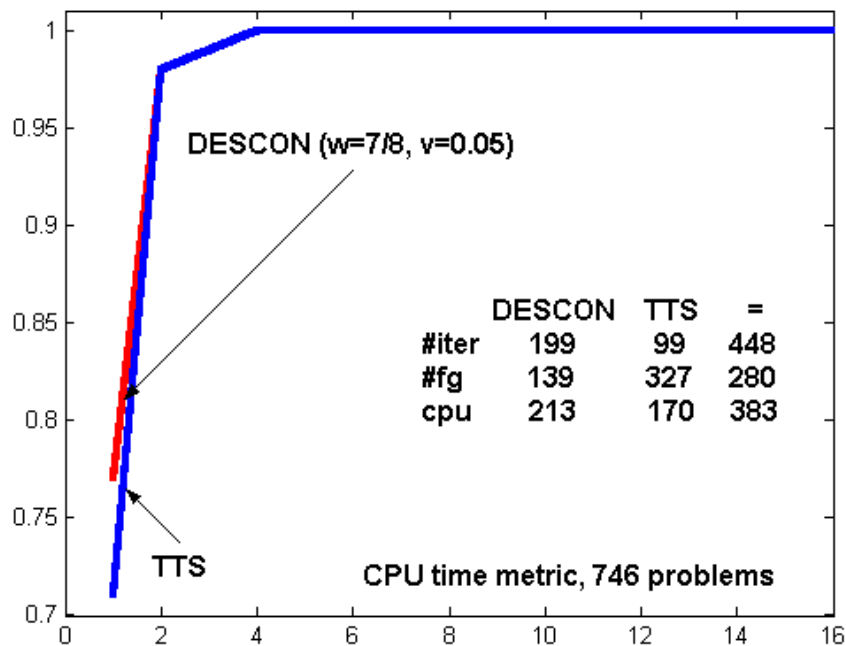


Fig.1. DESCON versus TTS

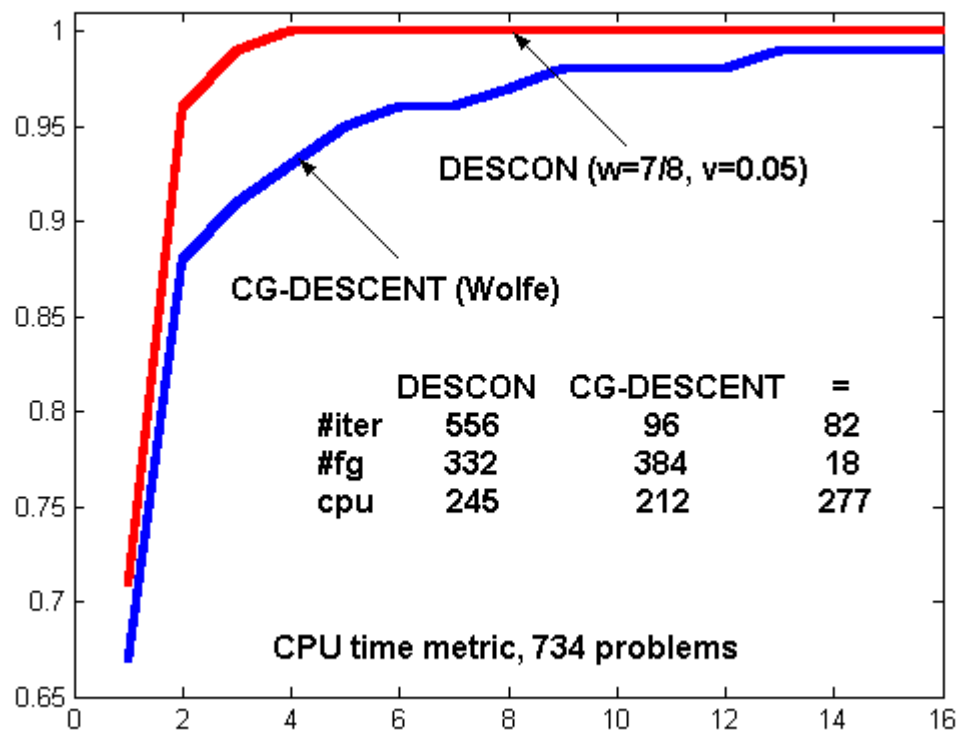


Fig.2. DESCON versus CG-DESCENT (Wolfe)

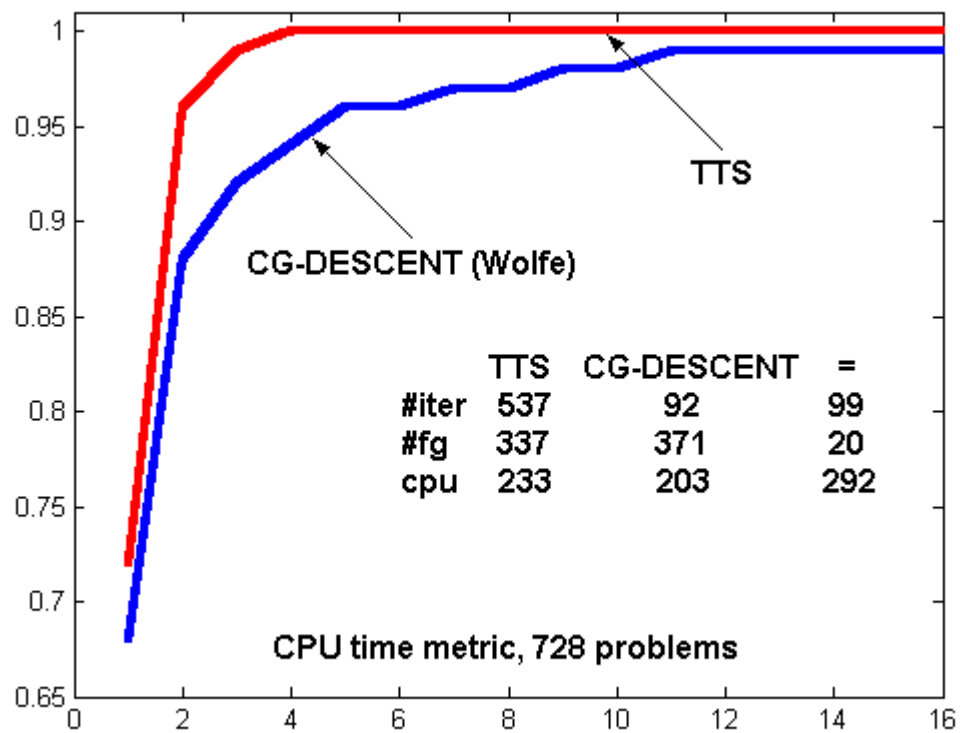


Fig.3. TTS versus CG-DESCENT (Wolfe)

Performance Profile: July 18, 2012.

Results descon versus tts , valeps= 0.100000000000E-02

nexptot= 750 nexp= 746
Total Number of iterations for descon = 247899
Total Number of iterations for tts = 262736

Total Number of function evaluations for descon = 584808
Total Number of function evaluations for tts = 608404

Total Time (centeseconds) for descon = 23553
Total Time (centeseconds) for tts = 24296

descon achieved minimum # of iter in 199 problems
tts achieved minimum # of iter in 99 problems
descon and tts achieved the same # of iter in 448 problems

Iterations Performance Profile for descon

descon=[0.87,0.99,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00];

Iterations Performance Profile for tts

tts=[0.73,0.99,0.99,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00];

descon achieved minimum # of fg in 139 problems
tts achieved minimum # of fg in 327 problems
descon and tts achieved the same # of fg in 280 problems

Function Evaluations Performance Profile for descon

descon=[0.56,0.99,0.99,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00];

Function Evaluations Performance Profile for tts

tts=[0.81,0.99,0.99,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00];

descon achieved minimum time in 213 problems
tts achieved minimum time in 170 problems
descon and tts achieved the same time in 363 problems

Time Performance Profile for descon

descon=[0.77,0.98,0.99,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00];

Time Performance Profile for tts

tts=[0.71,0.98,0.99,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00];

Performance Profile: July 18, 2012.

Results descon versus hzw , valeps= 0.100000000000E-02

nexptot= 750 nexp= 734
Total Number of iterations for descon = 245507
Total Number of iterations for hzw = 424687

Total Number of function evaluations for descon = 577028
Total Number of function evaluations for hzw = 866878

Total Time (centeseconds) for descon = 22906
Total Time (centeseconds) for hzw = 30835

descon achieved minimum # of iter in 556 problems
hzw achieved minimum # of iter in 96 problems
descon and hzw achieved the same # of iter in 82 problems

Iterations Performance Profile for descon

descon=[0.87,0.98,0.98,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00];

Iterations Performance Profile for hzw

hzw=[0.24,0.80,0.88,0.92,0.94,0.95,0.95,0.96,0.96,0.97,0.97,0.98,0.98,0.98,0.99,0.99];

descon	achieved minimum # of fg in	332	problems
hzw	achieved minimum # of fg in	384	problems
descon	and hzw	achieved the same # of fg in	18 problems

Function Evaluations Performance Profile for descon

```
descon=[0.48,0.96,0.99,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00];
```

Function Evaluations Performance Profile for hzw

```
hzw=[0.55,0.82,0.88,0.90,0.92,0.95,0.95,0.96,0.96,0.98,0.98,0.98,0.98,0.98,0.98,0.98,0.99];
```

descon	achieved minimum time in	245	problems
hzw	achieved minimum time in	212	problems
descon	and hzw	achieved the same time in	277 problems

Time Performance Profile for descon

```
descon=[0.71,0.96,0.99,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00];
```

Time Performance Profile for hzw

```
hzw=[0.67,0.88,0.91,0.93,0.95,0.96,0.96,0.97,0.98,0.98,0.98,0.98,0.99,0.99,0.99,0.99,0.99];
```

Performance Profile: July 18, 2012.

Results tts versus hzw , valeps= 0.10000000000000E-02

```
nexptot= 750 nexp= 728
Total Number of iterations for tts = 261023
Total Number of iterations for hzw = 424668

Total Number of function evaluations for tts = 602649
Total Number of function evaluations for hzw = 866204

Total Time (centeseconds) for tts = 23725
Total Time (centeseconds) for hzw = 30700
```

tts	achieved minimum # of iter in	537	problems
hzw	achieved minimum # of iter in	92	problems
tts	and hzw	achieved the same # of iter in	99 problems

Iterations Performance Profile for tts

```
tts=[0.87,0.99,0.99,0.99,0.99,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00];
```

Iterations Performance Profile for hzw

```
hzw=[0.26,0.81,0.90,0.93,0.94,0.95,0.95,0.95,0.96,0.96,0.97,0.98,0.98,0.98,0.98,0.98,0.98];
```

tts	achieved minimum # of fg in	337	problems
hzw	achieved minimum # of fg in	371	problems
tts	and hzw	achieved the same # of fg in	20 problems

Function Evaluations Performance Profile for tts

```
tts=[0.49,0.98,0.99,0.99,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00];
```

Function Evaluations Performance Profile for hzw

```
hzw=[0.54,0.82,0.88,0.90,0.92,0.93,0.94,0.96,0.97,0.97,0.97,0.98,0.98,0.98,0.98,0.98,0.98];
```

tts	achieved minimum time in	233	problems
hzw	achieved minimum time in	203	problems
tts	and hzw	achieved the same time in	292 problems

Time Performance Profile for tts

```
tts=[0.72,0.96,0.99,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00];
```

Time Performance Profile for hzw

```
hzw=[0.68,0.88,0.92,0.94,0.96,0.96,0.97,0.97,0.98,0.98,0.99,0.99,0.99,0.99,0.99,0.99,0.99];
```

References

- [1] Andrei, N., *An accelerated conjugate gradient algorithm with guaranteed descent and conjugacy conditions for unconstrained optimization*. Optimization Methods & Software, Vol. 27, issue 4-5, (2012), pp. 583-604
- [2] Andrei, N., *An accelerated subspace minimization three-term conjugate gradient algorithm for unconstrained optimization*. ICI Technical Report, July 12, 2012 (for TTS)
- [3] Andrei, N., *A simple three-term conjugate gradient algorithm for unconstrained optimization*. ICI Technical Report, March 5, 2012
- [4] Andrei, N., *Another conjugate gradient algorithm with guaranteed descent and conjugacy conditions for large-scale unconstrained optimization*. ICI Technical Report, April 12, 2012 (for DESCN)
- [5] Andrei, N., *On three-term conjugate gradient algorithms for unconstrained optimization*. ICI Technical Report, March 9, 2012
- [6] Andrei, N., *A modified Polak-Ribiere-Polyak conjugate gradient algorithm for unconstrained optimization*. Optimization. A Journal of Mathematical Programming and Operations Research, Vol. 60, Issue 12 (2011), pp. 1457-1471.
- [7] Hager, W., Zhang, H., *A new conjugate gradient method with guaranteed descent and an efficient line search*. SIAM J. Optim. vol. 16, (2005), pp.170-192 (for CG-DESCENT)

July 18, 2012