LARGE-SCALE UNCONSTRAINED OPTIMIZATION MINPACK-2 APPLICATIONS SOLVED WITH „SCALCG”

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In this work we present the results given by SCALCG package for solving five applications from MINPACK-2 collection.

The applications solved are as follows:
1) Elastic-Plastic torsion problem (A1),
2) Pressure distribution in a journal bearing (A2),
3) Optimal design with composite materials (A3),
4) Steady-state combustion (A5),
5) Minimal surface area problem (A7).

The parameters in SCALCG package have the following values:
1) Scaling parameter θ is assigned to spectral value θ^s. (testas=.true.)
2) The stopping criterion is $\|\nabla f(x_k)\|_\infty \le 10^{-6}$. (stoptest=1)
3) The maximum number of iterations is limited to 6000.
4) The restart criterion is given by Powell.

For each application I have considered three numerical experiments, corresponding to three discretization steps: $nx = ny = 400$, ($n = 160000$ variables), $nx = ny = 500$, ($n = 250000$ variables) and $nx = ny = 1000$, ($n = 1000000$ variables).

The results of optimization are as follows.

Application A1

```
  September 4, 2007   *** SCALCG ***

  *** SCALCG Algorithm ***. Function: ELASTIC-PLASTIC TORSION

 Powell criterion for restart.   Stoptest = 1
      n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
 ---------------------------------------------------------------------------------
 theta spectral
 160000    645    283     831    184    5819  -.4392908148586E+00   .9551165354504E-04


  September 4, 2007   *** SCALCG ***

  *** SCALCG Algorithm ***. Function: ELASTIC-PLASTIC TORSION

 Powell criterion for restart.   Stoptest = 1
      n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
```

```
 ---------------------------------------------------------------------------------
 theta spectral
 250000    710    324     909    197    9788  -.4392926611563E+00   .1194332905281E-03


  September 4, 2007   *** SCALCG ***

  *** SCALCG Algorithm ***. Function: ELASTIC-PLASTIC TORSION

 Powell criterion for restart.   Stoptest = 1
      n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
 ---------------------------------------------------------------------------------
 theta spectral
1000000   1257    557    1630    371   74411  -.4392784425689E+00   .2027676412762E-03
```

Application A2

```
  September 4, 2007   *** SCALCG ***

  *** SCALCG Algorithm ***. Function: PRESSURE DISTRIBUTION IN JOURNAL BEARING

 Powell criterion for restart.   Stoptest = 1
      n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
 ---------------------------------------------------------------------------------
 theta spectral
 160000   2034    906    2675    639   19714  -.2829061237653E+00   .4672702151729E-04


  September 4, 2007   *** SCALCG ***

  *** SCALCG Algorithm ***. Function: PRESSURE DISTRIBUTION IN JOURNAL BEARING

 Powell criterion for restart.   Stoptest = 1
      n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
 ---------------------------------------------------------------------------------
 theta spectral
 250000   2349   1060    3057    706   36160  -.2829069564984E+00   .8169642179602E-04


  September 4, 2007   *** SCALCG ***

  *** SCALCG Algorithm ***. Function: PRESSURE DISTRIBUTION IN JOURNAL BEARING

 Powell criterion for restart.   Stoptest = 1
      n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
 ---------------------------------------------------------------------------------
 theta spectral
1000000   4646   2071    6055   1407  293801  -.2829045513703E+00   .6684890149914E-04
```

APPLICATION A3

```
  September 4, 2007   *** SCALCG ***

  *** SCALCG Algorithm ***. Function: OPTIMAL DESIGN WITH COMPOSITE MATERIALS

 Powell criterion for restart.   Stoptest = 1
      n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
 ---------------------------------------------------------------------------------
 theta spectral
 160000   4042   1853    5006    962   53225  -.1138243312539E-01   .5499470478814E-05


  September 4, 2007   *** SCALCG ***

  *** SCALCG Algorithm ***. Function: OPTIMAL DESIGN WITH COMPOSITE MATERIALS

 Powell criterion for restart.   Stoptest = 1
      n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
 ---------------------------------------------------------------------------------
 theta spectral
 250000   4379   2012    5445   1064   92944  -.1138251608760E-01   .1797270817790E-04

  September 4, 2007   *** SCALCG ***
```

```
  *** SCALCG Algorithm ***. Function: OPTIMAL DESIGN WITH COMPOSITE MATERIALS

 Powell criterion for restart.   Stoptest = 1
      n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
 -------------------------------------------------------------------------------
 theta spectral
1000000   6001   2715    7468   1466  516971  -.1125754278733E-01   .6471283912188E-03
```

APPLICATION A5

```
  September 4, 2007   *** SCALCG ***

  *** SCALCG Algorithm ***. Function: STEADY-STATE COMBUSTION

 Powell criterion for restart.   Stoptest = 1
      n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
 -------------------------------------------------------------------------------
 theta spectral
 160000   1319    608    1722    401   24695  -.5611477475820E+01   .6505433456790E-04


  September 4, 2007   *** SCALCG ***

  *** SCALCG Algorithm ***. Function: STEADY-STATE COMBUSTION

 Powell criterion for restart.   Stoptest = 1
      n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
 -------------------------------------------------------------------------------
 theta spectral
 250000   1275    653    1644    367   37085  -.5611461270399E+01   .8322293255443E-04


  September 4, 2007   *** SCALCG ***

  *** SCALCG Algorithm ***. Function: STEADY-STATE COMBUSTION

 Powell criterion for restart.   Stoptest = 1
      n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
 -------------------------------------------------------------------------------
 theta spectral
1000000   2587   1198    3355    766  302708  -.5611376243089E+01   .1188052994298E-03
```

APPLICATION A7

```
  September 4, 2007   *** SCALCG ***

  *** SCALCG Algorithm ***. Function: Minimal Surface Area Problem

 Powell criterion for restart.   Stoptest = 1
      n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
 -------------------------------------------------------------------------------
 theta spectral
 160000    922    407    1180    256   11377   .1421360076323E+01   .5759902173840E-04


  September 4, 2007   *** SCALCG ***

  *** SCALCG Algorithm ***. Function: Minimal Surface Area Problem

 Powell criterion for restart.   Stoptest = 1
      n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
 -------------------------------------------------------------------------------
 theta spectral
 250000   1279    550    1641    360   25043   .1421360746575E+01   .3984151789400E-04


  September 4, 2007   *** SCALCG ***

  *** SCALCG Algorithm ***. Function: Minimal Surface Area Problem

 Powell criterion for restart.   Stoptest = 1
      n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
 -------------------------------------------------------------------------------
 theta spectral
1000000   2308   1073    2951    641  183183   .1421365409373E+01   .6890302861548E-04
```

Table 1 contains the CPU time (seconds) needed by SCALCG to solve these 5 applications.

Table 1. cpu time

	Time				
n	A1	A2	A3	A5	A7
160000	58.19	197.14	532.25	246.95	113.77
250000	97.88	361.60	929.44	370.85	250.43
1000000	744.11	2938.01	5169.71	3027.08	1831.83

The Figures 1 and 2 present the evolution of CPU time subject to the number of variables for each application.

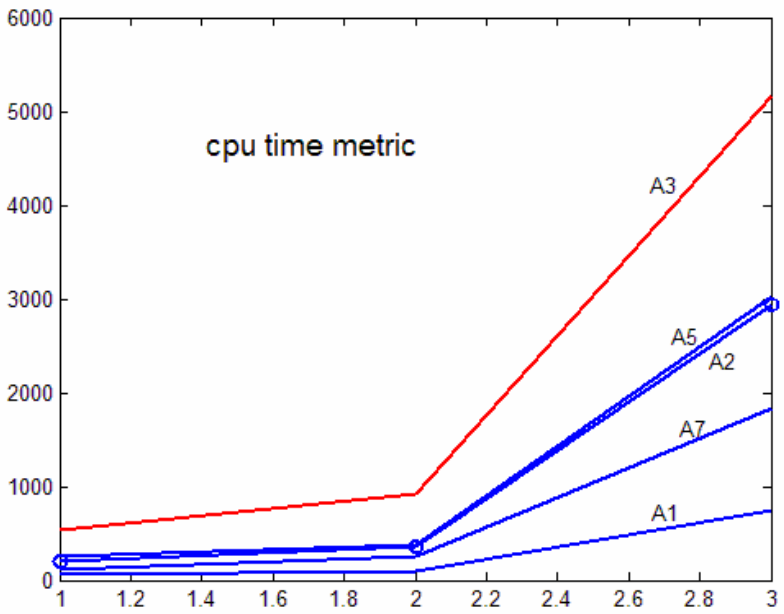

Fig.1. cpu time evolution.

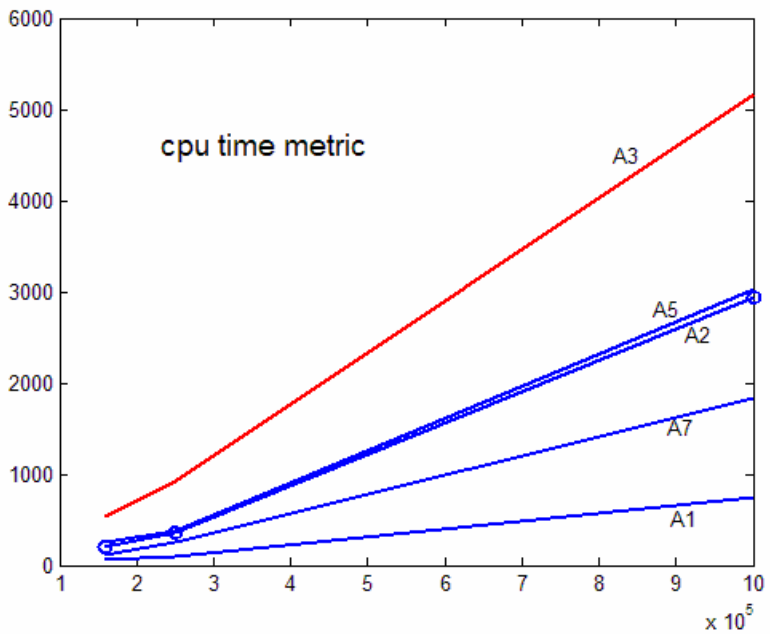

Fig. 2. cpu time metric.

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