Performance of AHYBRIDM, ASCALCG, CG-DESCENT, DESCON and THREECG for solving 5 applications from MINPACK-2

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AHYBRIDM

```
   *** Conjugate Gradient Algorithms Project ***
   *** Dr. Neculai Andrei

   AHYBRIDM Conjugate Gradient Algorithm
   Accelerated convex combination of HS,DY:
   from Newton direction with modified  secant condition
   Powell restart.  April 1, 2013

     1    AHYBRIDM Algorithm. Function Elastic-Plastic Torsion Problem
          stoptest= 1

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm            DY   HS   CC
-----------------------------------------------------------------------------------------------------
1000000   1113     0   1144    30     37814-0.4393016862064E+00 0.6317808491284E-04  502  611    0
-----------------------------------------------------------------------------------------------------
  TOTAL   1113     0   1144    30     378.14 (seconds)    proc=   0.00%

Total # iter for DY=   502   i.e.   45.10%
Total # iter for HS=   611   i.e.   54.90%
Total # iter for CC=     0   i.e.    0.00%


   *** Conjugate Gradient Algorithms Project ***
   *** Dr. Neculai Andrei

   AHYBRIDM Conjugate Gradient Algorithm
   Accelerated convex combination of HS,DY:
   from Newton direction with modified  secant condition
   Powell restart.  April 1, 2013

     1    AHYBRIDM Algorithm. Function Pressure Distribution Problem
          stoptest= 1

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm           DY   HS   CC
-----------------------------------------------------------------------------------------------------
1000000   2845     0   2873    27    120913-0.2829101200583E+00 0.7903314962057E-04 1289 1556    0
-----------------------------------------------------------------------------------------------------
  TOTAL   2845     0   2873    27    1209.13 (seconds)    proc=   0.00%

Total # iter for DY=  1289   i.e.   45.31%
Total # iter for HS=  1556   i.e.   54.69%
Total # iter for CC=     0   i.e.    0.00%


   *** Conjugate Gradient Algorithms Project ***
   *** Dr. Neculai Andrei

   AHYBRIDM Conjugate Gradient Algorithm
   Accelerated convex combination of HS,DY:
   from Newton direction with modified  secant condition
   Powell restart.  April 1, 2013

     1    AHYBRIDM Algorithm. Function Optimal Design with Composite Materials
          stoptest= 1

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm            DY   HS   CC
-----------------------------------------------------------------------------------------------------
1000000   4701     0   4738    36    287692-0.1138217907140E-01 0.1313666426220E-03  291 3279 1131
-----------------------------------------------------------------------------------------------------
  TOTAL   4701     0   4738    36    2876.92 (seconds)    proc=   0.00%

Total # iter for DY=   291   i.e.    6.19%
Total # iter for HS=  3279   i.e.   69.75%
Total # iter for CC=  1131   i.e.   24.06%
```

```
   *** Conjugate Gradient Algorithms Project ***
   *** Dr. Neculai Andrei

   AHYBRIDM Conjugate Gradient Algorithm
   Accelerated convex combination of HS,DY:
   from Newton direction with modified  secant condition
   Powell restart.  April 1, 2013

     1    AHYBRIDM Algorithm. Function Steady State Combustion
          stoptest= 1

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm            DY   HS   CC
-----------------------------------------------------------------------------------------------------
1000000   1413     0   1451    37    205096-0.5611488188408E+01 0.4244605297429E-04  333  981   99
-----------------------------------------------------------------------------------------------------
  TOTAL   1413     0   1451    37    2050.96 (seconds)    proc=   0.00%

Total # iter for DY=   333   i.e.   23.57%
Total # iter for HS=   981   i.e.   69.43%
Total # iter for CC=    99   i.e.    7.01%


   *** Conjugate Gradient Algorithms Project ***
   *** Dr. Neculai Andrei

   AHYBRIDM Conjugate Gradient Algorithm
   Accelerated convex combination of HS,DY:
   from Newton direction with modified  secant condition
   Powell restart.  April 1, 2013

     1    AHYBRIDM Algorithm. Function Minimal Surface Area
          stoptest= 1

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm            DY   HS   CC
-----------------------------------------------------------------------------------------------------
1000000   1265     4   1293    27     60054 0.1000000261551E+01 0.1394516598787E-03  131 1079   55
-----------------------------------------------------------------------------------------------------
  TOTAL   1265     4   1293    27     600.54 (seconds)    proc=   0.32%

Total # iter for DY=   131   i.e.   10.36%
Total # iter for HS=  1079   i.e.   85.30%
Total # iter for CC=    55   i.e.    4.35%
```

ASCALCG

```
 Accelerated SCALCG Algorithm.    Neculai Andrei
 BFGS preconditioned conjugate gradient algorthm
 January 8, 2009                 *** ASCALCG ***

   1  *** ASCALCG Algorithm ***. Function: ELASTIC-PLASTIC TORSION
      Powell criterion for restart.   Stoptest = 1  (theta spectral)

     n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
-------------------------------------------------------------------------------------
1000000  1110      0    1142     30   48526 -0.4393016828721E+00  0.6698893276483E-04
-------------------------------------------------------------------------------------
TOTAL    1110      0    1142     30   485.26(seconds)     proc=  0.00%


 Accelerated SCALCG Algorithm.    Neculai Andrei
 BFGS preconditioned conjugate gradient algorthm
 January 8, 2009                 *** ASCALCG ***

   1  *** ASCALCG Algorithm ***. Function: PRESSURE DISTRIBUTION
      Powell criterion for restart.   Stoptest = 1  (theta spectral)

     n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
-------------------------------------------------------------------------------------
1000000  2842      0    2871     27  147358 -0.2829101180254E+00  0.7908650227680E-04
-------------------------------------------------------------------------------------
TOTAL    2842      0    2871     27  1473.58(seconds)     proc=  0.00%
```

```
 Accelerated SCALCG Algorithm.    Neculai Andrei
 BFGS preconditioned conjugate gradient algorthm
 January 8, 2009                 *** ASCALCG ***

   1  *** ASCALCG Algorithm ***. Function: OPTIMAL DESIGN WITH COMPOSITE MATERIALS
      Powell criterion for restart.   Stoptest = 1  (theta spectral)

     n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
-------------------------------------------------------------------------------------
1000000  4701      0    4854    151  336216 -0.1138198271655E-01  0.1343898661645E-03
-------------------------------------------------------------------------------------
TOTAL    4701      0    4854    151  3362.16(seconds)     proc=  0.00%


 Accelerated SCALCG Algorithm.    Neculai Andrei
 BFGS preconditioned conjugate gradient algorthm
 January 8, 2009                 *** ASCALCG ***

   1  *** ASCALCG Algorithm ***. Function: STEADY STATE COMBUSTION PROBLEM
      Powell criterion for restart.   Stoptest = 1  (theta spectral)

     n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
-------------------------------------------------------------------------------------
1000000  1412      0    1451     37  219264 -0.5611488187956E+01  0.4244246165743E-04
-------------------------------------------------------------------------------------
TOTAL    1412      0    1451     37  2192.64(seconds)     proc=  0.00%


 Accelerated SCALCG Algorithm.    Neculai Andrei
 BFGS preconditioned conjugate gradient algorthm
 April 2, 2013                 *** ASCALCG ***

   1  *** ASCALCG Algorithm ***. Function: MINIMAL SURFACE AREA
      Powell criterion for restart.   Stoptest = 1  (theta spectral)

     n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
-------------------------------------------------------------------------------------
1000000  1280      0    1323     41   72997  0.1000000210656E+01  0.1129029789953E-03
-------------------------------------------------------------------------------------
TOTAL    1280      0    1323     41   729.97(seconds)     proc=  0.00%
```

CG-DESCENT

```
 CG-DESCENT, standard Wolfe line search.
    Date: ---  Month: 4  Day: 1  Year: 2013

      1    CG_DESCENT Algorithm:    Elastic-Plastic Torsion            Function

        n     iter    nfunc    ngrad  time(c)               f                   gnorm         s
-------------------------------------------------------------------------------------
   1000000     1145     2291     1147    47612     -0.4393012993297E+00   0.9734489421375E-06 0
-------------------------------------------------------------------------------------
 TOTAL         1145     2291     1147    476.12(seconds)


CG-DESCENT, standard Wolfe line search

      1    CG_DESCENT Algorithm:    Pressure Distribution in a Journal Function

        n     iter    nfunc    ngrad  time(c)               f                   gnorm         s
-------------------------------------------------------------------------------------
   1000000     3370     6741     3371   183977     -0.2829101428571E+00   0.9839601515413E-06 0
-------------------------------------------------------------------------------------
 TOTAL         3370     6741     3371   1839.77(seconds)
```

```
CG-DESCENT, standard Wolfe line search

      1    CG_DESCENT Algorithm:    Optimal Design with Composite MaterFunction

        n     iter    nfunc    ngrad  time(c)               f                   gnorm         s
-------------------------------------------------------------------------------------------------
   1000000     4814     9630     4816   396059     -0.1138216915970E-01   0.9989891981388E-06 0
 -------------------------------------------------------------------------------------------------
TOTAL         4814     9630     4816    3960.59(seconds)

CG-DESCENT, standard Wolfe line search

      1    CG_DESCENT Algorithm:    Steady State Combustion            Function

        n     iter    nfunc    ngrad  time(c)               f                   gnorm         s
-------------------------------------------------------------------------------------------------
   1000000     1802     3605     1803   379639     -0.5611488032463E+01   0.9904901474582E-06 0
-------------------------------------------------------------------------------------------------
 TOTAL         1802     3605     1803   3796.39(seconds)

CG-DESCENT, standard Wolfe line search

      1    CG_DESCENT Algorithm:    Minimal Surface Area              Function

        n     iter    nfunc    ngrad  time(c)               f                   gnorm         s
-------------------------------------------------------------------------------------------------
   1000000     1225     2451     1226    75621      0.1000000263791E+01   0.9929727386683E-06 0
-------------------------------------------------------------------------------------------------
 TOTAL         1225     2451     1226    756.21(seconds)
```

DESCON

```
   ***************************************************
   * DESCON                        Neculai Andrei ***
   * Another Accelerated Conjugate Gradient with   ***
   * Guaranteed Descent and Conjugacy conditions.  ***
   * --------------------------------------------- ***
   * Project: FCGA                                 ***
   * The Fastest Conjugate Gradient Algorithm      ***
   ***************************************************

   Parameters: Descent= 0.8750000000000E+00    Conjugacy= 0.5000000000000E-01

   Date: ---  Month: 4  Day: 2  Year: 2013

   DESCON. Powell restart.
-----------------------------------------------------------------------------------------------

     1    DESCON Algorithm. Function:Elastic-Plastic Torsion Problem
          stoptest= 1

      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm         ib   it
-----------------------------------------------------------------------------------------------
1000000   1113     0   2257    30     34725-0.4393016862073E+00 0.6317448022065E-04  0    0
-----------------------------------------------------------------------------------------------
  TOTAL   1113     0   2257    30     347.25 (seconds)    proc=   0.00%



   ***************************************************
   * DESCON                        Neculai Andrei ***
   * Another Accelerated Conjugate Gradient with   ***
   * Guaranteed Descent and Conjugacy conditions.  ***
   * --------------------------------------------- ***
   * Project: FCGA                                 ***
   * The Fastest Conjugate Gradient Algorithm      ***
   ***************************************************

   Parameters: Descent= 0.8750000000000E+00    Conjugacy= 0.5000000000000E-01

   Date: ---  Month: 4  Day: 2  Year: 2013

   DESCON. Powell restart.
-----------------------------------------------------------------------------------------------

     1    DESCON Algorithm. Function:Pressure Distribution in a Journal Beari
          stoptest= 1
```

```
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm         ib   it
-----------------------------------------------------------------------------------------------
1000000   2845     0   5718    27    112264-0.2829101200564E+00 0.7903242603368E-04  0    0
-----------------------------------------------------------------------------------------------
  TOTAL   2845     0   5718    27    1122.64 (seconds)    proc=   0.00%


   ***************************************************
   * DESCON                        Neculai Andrei ***
   * Another Accelerated Conjugate Gradient with   ***
   * Guaranteed Descent and Conjugacy conditions.  ***
   * --------------------------------------------- ***
   * Project: FCGA                                 ***
   * The Fastest Conjugate Gradient Algorithm      ***
   ***************************************************

   Parameters: Descent= 0.8750000000000E+00    Conjugacy= 0.5000000000000E-01

   Date: ---  Month: 4  Day: 2  Year: 2013

   DESCON. Powell restart.
-----------------------------------------------------------------------------------------------

     1    DESCON Algorithm. Function:Optimal Design with Composite Materials
          stoptest= 1

      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm         ib   it
-----------------------------------------------------------------------------------------------
1000000   4693     0   9425    38    271507-0.1138213169267E-01 0.1340134143262E-03  0    0
-----------------------------------------------------------------------------------------------
  TOTAL   4693     0   9425    38    2715.07 (seconds)    proc=   0.00%


   ***************************************************
   * DESCON                        Neculai Andrei ***
   * Another Accelerated Conjugate Gradient with   ***
   * Guaranteed Descent and Conjugacy conditions.  ***
   * --------------------------------------------- ***
   * Project: FCGA                                 ***
   * The Fastest Conjugate Gradient Algorithm      ***
   ***************************************************

   Parameters: Descent= 0.8750000000000E+00    Conjugacy= 0.5000000000000E-01

   Date: ---  Month: 4  Day: 2  Year: 2013

   DESCON. Powell restart.
-----------------------------------------------------------------------------------------------

     1    DESCON Algorithm. Function:Steady State Combustion
          stoptest= 1

      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm         ib   it
-----------------------------------------------------------------------------------------------
1000000   1413     0   2864    37    200378-0.5611488188408E+01 0.4244605574158E-04  0    0
-----------------------------------------------------------------------------------------------
  TOTAL   1413     0   2864    37    2003.78 (seconds)    proc=   0.00%


   ***************************************************
   * DESCON                        Neculai Andrei ***
   * Another Accelerated Conjugate Gradient with   ***
   * Guaranteed Descent and Conjugacy conditions.  ***
   * --------------------------------------------- ***
   * Project: FCGA                                 ***
   * The Fastest Conjugate Gradient Algorithm      ***
   ***************************************************

   Parameters: Descent= 0.8750000000000E+00    Conjugacy= 0.5000000000000E-01

   Date: ---  Month: 4  Day: 2  Year: 2013

   DESCON. Powell restart.
-----------------------------------------------------------------------------------------------

     1    DESCON Algorithm. Function:Minimal Surface Area
          stoptest= 1

      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm         ib   it
-----------------------------------------------------------------------------------------------
1000000   1277     2   2576    21     56806 0.1000000219581E+01 0.1269188594941E-03  0    0
-----------------------------------------------------------------------------------------------
  TOTAL   1277     2   2576    21     568.06 (seconds)    proc=   0.16%
```

THREECG

```
   ***************************************************
   * THREECG                                         ***
   * A simple three-term conjugate gradient          ***
   * algorithm with Guaranteed Descent and           ***
   * Conjugacy conditions                            ***
   * ------------------------------------------- ***
   * Project: FCGA                                   ***
   * The Fastest Conjugate Gradient Algorithm        ***
   *                                                 ***
   * Dr. Neculai Andrei                              ***
   * Research Institute for Informatics              ***
   * Bucharest - Romania                             ***
   ***************************************************

   Date: ---  Month: 4  Day: 1  Year: 2013

   THREECG. Powell restart.
-------------------------------------------------------------------------------------------

     0    THREECG Algorithm. Function:Elastic-Plastic Torsion
          stoptest= 1

      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------------------
1000000   1111     0   2253    30     35260-0.4393016840057E+00 0.6699053824829E-04
-------------------------------------------------------------------------------------------
  TOTAL   1111     0   2253    30     352.60 (seconds)    proc=   0.00%


   ***************************************************
   * THREECG                                         ***
   * A simple three-term conjugate gradient          ***
   * algorithm with Guaranteed Descent and           ***
   * Conjugacy conditions                            ***
   * ------------------------------------------- ***
   * Project: FCGA                                   ***
   * The Fastest Conjugate Gradient Algorithm        ***
   *                                                 ***
   * Dr. Neculai Andrei                              ***
   * Research Institute for Informatics              ***
   * Bucharest - Romania                             ***
   ***************************************************

   Date: ---  Month: 4  Day: 1  Year: 2013

   THREECG. Powell restart.
-------------------------------------------------------------------------------------------

     0    THREECG Algorithm. Function:Pressure Distribution in a Journal Bearing
          stoptest= 1

      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------------------
1000000   2845     0   5718    27    114019-0.2829101200576E+00 0.7903245817571E-04
-------------------------------------------------------------------------------------------
  TOTAL   2845     0   5718    27    1140.19 (seconds)    proc=   0.00%


   ***************************************************
   * THREECG                                         ***
   * A simple three-term conjugate gradient          ***
   * algorithm with Guaranteed Descent and           ***
   * Conjugacy conditions                            ***
   * ------------------------------------------- ***
   * Project: FCGA                                   ***
   * The Fastest Conjugate Gradient Algorithm        ***
   *                                                 ***
   * Dr. Neculai Andrei                              ***
   * Research Institute for Informatics              ***
   * Bucharest - Romania                             ***
   ***************************************************

   Date: ---  Month: 4  Day: 2  Year: 2013

   THREECG. Powell restart.
-------------------------------------------------------------------------------------------

     0    THREECG Algorithm. Function:Optimal Design with Composite Materials
          stoptest= 1
```

```
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-----------------------------------------------------------------------------------------
1000000   4478    15   9045    88    264122-0.1138198767702E-01 0.1392280312323E-03
-----------------------------------------------------------------------------------------
  TOTAL   4478    15   9045    88    2641.22 (seconds)    proc=   0.33%


   ***************************************************
   * THREECG                                         ***
   * A simple three-term conjugate gradient          ***
   * algorithm with Guaranteed Descent and           ***
   * Conjugacy conditions                            ***
   * ----------------------------------------------- ***
   * Project: FCGA                                   ***
   * The Fastest Conjugate Gradient Algorithm        ***
   *                                                 ***
   * Dr. Neculai Andrei                              ***
   * Research Institute for Informatics              ***
   * Bucharest - Romania                             ***
   ***************************************************

   Date: ---  Month: 4  Day: 2  Year: 2013

   THREECG. Powell restart.
-----------------------------------------------------------------------------------------

     0    THREECG Algorithm. Function:Steady State Combustion
          stoptest= 1

      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-----------------------------------------------------------------------------------------
1000000   1413     0   2864    37    205980-0.5611488188379E+01 0.4244552590341E-04
-----------------------------------------------------------------------------------------
  TOTAL   1413     0   2864    37    2059.80 (seconds)    proc=   0.00%


   ***************************************************
   * THREECG                                         ***
   * A simple three-term conjugate gradient          ***
   * algorithm with Guaranteed Descent and           ***
   * Conjugacy conditions                            ***
   * ----------------------------------------------- ***
   * Project: FCGA                                   ***
   * The Fastest Conjugate Gradient Algorithm        ***
   *                                                 ***
   * Dr. Neculai Andrei                              ***
   * Research Institute for Informatics              ***
   * Bucharest - Romania                             ***
   ***************************************************

   Date: ---  Month: 4  Day: 2  Year: 2013

   THREECG. Powell restart.
-----------------------------------------------------------------------------------------

     0    THREECG Algorithm. Function:Minimal Surface Area
          stoptest= 1

      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-----------------------------------------------------------------------------------------
1000000   1298     2   2619    22     58229 0.1000000285870E+01 0.1439850665919E-03
-----------------------------------------------------------------------------------------
  TOTAL   1298     2   2619    22     582.29 (seconds)    proc=   0.15%
```

References for the software:

AHYBRIDM:
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April 3, 2013