Computational Experience with Conjugate Gradient Algorithms: CONMIN, CG_DESCENT, SCALCG, ASCALCG, ACGMSEC, ACGHES, AHYBRIDM, ACGSYS for solving MINPACK2 Applications (40000 variables)

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CONMIN (Shanno & Phua)

```
         CONGRAD Unconstrained Optimization Experiments
         ============================== January 9, 2009

 Tolerances:
     eps   =  .1000000000000E-05    ;    epsf  =  .1000000000000E-19
 Stopping Criterion:
     if(ginf .le. eps) return

 nexp=   1  CONMIN Algorithm. Function: ELASTIC-PLASTIC TORSION

      n     iter  irstart   fgcnt     time          fxnew                gnorm2
-------------------------------------------------------------------------------------
  40000      242        6     486      742   -.4392678185569E+00    .2889253660611E-04
-------------------------------------------------------------------------------------
TOTAL        242        6     486     7.42(seconds) ;    proc= 2.48%
```

```
         CONGRAD Unconstrained Optimization Experiments
         ============================== January 9, 2009

 Tolerances:
     eps   =  .1000000000000E-05    ;    epsf  =  .1000000000000E-19
 Stopping Criterion:
     if(ginf .le. eps) return

 nexp=   1  CONMIN Algorithm. Function: Pressure Distribution in a Journal

      n     iter  irstart   fgcnt     time          fxnew                gnorm2
-------------------------------------------------------------------------------------
  40000      736       30    1489     2396   -.2828929424780E+00    .1901677834931E-04
-------------------------------------------------------------------------------------
TOTAL        736       30    1489    23.96(seconds) ;    proc= 4.08%
```

```
         CONGRAD Unconstrained Optimization Experiments
         ============================== January 9, 2009

 Tolerances:
     eps   =  .1000000000000E-05    ;    epsf  =  .1000000000000E-19
 Stopping Criterion:
     if(ginf .le. eps) return

 nexp=   1  CONMIN Algorithm. Function: Optimal Design with Composite Materials

      n     iter  irstart   fgcnt     time          fxnew                gnorm2
```

```
-------------------------------------------------------------------------------------
  40000      890       61    1809     4381   -.1138127846192E-01    .2787026771770E-04
-------------------------------------------------------------------------------------
TOTAL        890       61    1809    43.81(seconds) ;    proc= 6.85%

         CONGRAD Unconstrained Optimization Experiments
         ============================== January 9, 2009

 Tolerances:
     eps   =  .1000000000000E-05    ;    epsf  =  .1000000000000E-19
 Stopping Criterion:
     if(ginf .le. eps) return

 nexp=   1  CONMIN Algorithm. Function: Ginzburg-Landau (1-dimensional) applicat

      n     iter  irstart   fgcnt     time          fxnew                gnorm2
-------------------------------------------------------------------------------------
   1000     7411      335   15001      262   -.4861007230865E+04    .4921809218147E+02
-------------------------------------------------------------------------------------
TOTAL       7411      335   15001     2.62(seconds) ;    proc= 4.52%

         CONGRAD Unconstrained Optimization Experiments
         ============================== January 9, 2009

 Tolerances:
     eps   =  .1000000000000E-05    ;    epsf  =  .1000000000000E-19
 Stopping Criterion:
     if(ginf .le. eps) return

 nexp=   1  CONMIN Algorithm. Function: Steady State Combustion Problem

      n     iter  irstart   fgcnt     time          fxnew                gnorm2
-------------------------------------------------------------------------------------
  40000      580       25    1174     3947   -.5611448502376E+01    .4364559915281E-04
-------------------------------------------------------------------------------------
TOTAL        580       25    1174    39.47(seconds) ;    proc= 4.31%

         CONGRAD Unconstrained Optimization Experiments
         ============================== January 9, 2009

 Tolerances:
     eps   =  .1000000000000E-05    ;    epsf  =  .1000000000000E-19
 Stopping Criterion:
 dabs(alpha*dg) .le. epsf*dabs(f)) return

 nexp=   1  CONMIN Algorithm. Function: Jones Clusters (Molecular Conformation)

      n     iter  irstart   fgcnt     time          fxnew                gnorm2
-------------------------------------------------------------------------------------
   3000     1103      103    2271     7963   -.6600828806492E+04    .4038922952854E-03
-------------------------------------------------------------------------------------
TOTAL       1103      103    2271    79.63(seconds) ;    proc= 9.34%

         CONGRAD Unconstrained Optimization Experiments
         ============================== January 9, 2009

 Tolerances:
     eps   =  .1000000000000E-05    ;    epsf  =  .1000000000000E-19
 Stopping Criterion:
     if(ginf .le. eps) return

 nexp=   1  CONMIN Algorithm. Function: Minimal Surface Area Problem

      n     iter  irstart   fgcnt     time          fxnew                gnorm2
-------------------------------------------------------------------------------------
  40000      406       29     828     1848    .1421353227332E+01    .2490617072775E-04
-------------------------------------------------------------------------------------
TOTAL        406       29     828    18.48(seconds) ;    proc= 7.14%
```

CG_DESCENT (Hager & Zhang)

```
CG-DESCENT, standard Wolfe line search, January 8, 2009

      1    CG_DESCENT Algorithm:    Elastic-Plastic Torsion            Function

        n     iter    nfunc    ngrad  time(c)               f                   gnorm
-----------------------------------------------------------------------------------------
    40000      323      647      324     1078      -.4392678100609E+00
.9290457449790E-06 0
-----------------------------------------------------------------------------------------
TOTAL          323      647      324    10.78(seconds)


CG-DESCENT, standard Wolfe line search, January 8, 2009

      1    CG_DESCENT Algorithm:    Pressure Distribution in a Journal Function

        n     iter    nfunc    ngrad  time(c)               f                   gnorm
-----------------------------------------------------------------------------------------
    40000      790     1581      791     2707      -.2828929480380E+00
.9303399476025E-06 0
-----------------------------------------------------------------------------------------
TOTAL          790     1581      791    27.07(seconds)


CG-DESCENT, standard Wolfe line search,January 8, 2009

      1    CG_DESCENT Algorithm:    Optimal Design with Composite Mater Function

        n     iter    nfunc    ngrad  time(c)               f                   gnorm
-----------------------------------------------------------------------------------------
    40000     1041     2084     1043     6374      -.1138128902727E-01
.9658994815568E-06 0
-----------------------------------------------------------------------------------------
TOTAL         1041     2084     1043    63.74(seconds)


CG-DESCENT, standard Wolfe line search, January 8, 2009

      1    CG_DESCENT Algorithm:    Ginzburg-Landau (1-dimensional)    Function

        n     iter    nfunc    ngrad  time(c)               f                   gnorm
-----------------------------------------------------------------------------------------
     1000        4       72       73        1      -.1661960345603E-03
.3189950752137E-01 4
-----------------------------------------------------------------------------------------
TOTAL            4       72       73      .01(seconds)


CG-DESCENT, standard Wolfe line search, January 8, 2009

      1    CG_DESCENT Algorithm:    Steady State Combustion            Function

        n     iter    nfunc    ngrad  time(c)               f                   gnorm
-----------------------------------------------------------------------------------------
    40000      435      871      436     3862      -.5611448491013E+01
.8436658044501E-06 0
-----------------------------------------------------------------------------------------
TOTAL          435      871      436    38.62(seconds)


CG-DESCENT, standard Wolfe line search, January 8, 2009

      1    CG_DESCENT Algorithm:    Jones Clusters (Molecular ConformatFunction

        n     iter    nfunc    ngrad  time(c)               f                   gnorm
-----------------------------------------------------------------------------------------
     3000     1200     2445     1406    12518      -.6628239421937E+04
.5585777475364E-04 4
-----------------------------------------------------------------------------------------
TOTAL         1200     2445     1406   125.18(seconds)
```

```
CG-DESCENT, standard Wolfe line search, January 8, 2009

      1    CG_DESCENT Algorithm:    Minimal Surface Area              Function

        n     iter    nfunc    ngrad  time(c)              f                  gnorm
-------------------------------------------------------------------------------------
    40000      288      577      289     1537       .1000000006196E+01
.9394579975403E-06 0
-------------------------------------------------------------------------------------
TOTAL          288      577      289    15.37(seconds)
```

SCALCG (Andrei)

```
 January 8, 2009   *** SCALCG ***
 *** SCALCG Algorithm ***. Function: ELASTIC-PLASTIC TORSION

      Powell criterion for restart.   Stoptest = 1  (theta spectral)

     n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
-------------------------------------------------------------------------------------
 40000    423    199     552    127     817  -.4392676796394E+00   .4724273657350E-04


 January 8, 2009   *** SCALCG ***
 *** SCALCG Algorithm ***. Function: PRESSURE DISTRIBUTION IN JOURNAL BEARING

      Powell criterion for restart.   Stoptest = 1  (theta spectral)

     n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
-------------------------------------------------------------------------------------
 40000   1008    477    1302    292    1959  -.2828929293146E+00   .3066630663384E-04


 January 8, 2009   *** SCALCG ***
 *** SCALCG Algorithm ***. Function: OPTIMAL DESIGN WITH COMPOSITE MATERIALS

      Powell criterion for restart.   Stoptest = 1  (theta spectral)

     n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
-------------------------------------------------------------------------------------
 40000   1448    671    1834    384    4316  -.1138129659686E-01   .9259258060562E-05


 January 8, 2009   *** SCALCG ***
 *** SCALCG Algorithm ***. Function: INHOMOGENEOUS SUPERCONDUCTORS 1 DIM

Powell criterion for restart.   Stoptest = 1
     n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
-------------------------------------------------------------------------------------
theta spectral
  1000  10001   4410   13118   3116     168  -.2047659243786E-03   .3491875081720E-01


 January 8, 2009   *** SCALCG ***
  *** SCALCG Algorithm ***. Function: STEADY-STATE COMBUSTION
      Powell criterion for restart.   Stoptest = 1  (theta spectral)

     n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
-------------------------------------------------------------------------------------
 40000    771    388     994    221    3285  -.5611448398892E+01   .3485751766729E-04


 January 8, 2009   *** SCALCG ***
 *** SCALCG Algorithm ***. Function: Jones Clusters (Molecular Conformation)

Powell criterion for restart.   Stoptest = 1
     n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
-------------------------------------------------------------------------------------
theta spectral
  3000   3001   1924   32846   1463  113225  -.6630318425576E+04   .3433996708697E-03
```

```
 January 8, 2009   *** 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
 40000    474    194     627    151    1335   .1421353257442E+01   .2126598131310E-04
```

ASCALCG (Andrei)

```
 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
-------------------------------------------------------------------------------
 40000    240      0     269     27     708  -.4392678184465E+00   .3175768233619E-04
-------------------------------------------------------------------------------
TOTAL     240      0     269     27    7.08(seconds)     proc=   .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
-------------------------------------------------------------------------------
 40000    630      0     666     34    1787  -.2828929484741E+00   .2447493166311E-04
-------------------------------------------------------------------------------
TOTAL     630      0     666     34   17.87(seconds)     proc=   .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
-------------------------------------------------------------------------------
 40000   1010      0    1036     24    4733  -.1138128448898E-01   .4098355699595E-04
-------------------------------------------------------------------------------
TOTAL    1010      0    1036     24   47.33(seconds)     proc=   .00%


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

   1  *** ASCALCG Algorithm ***. Function: Ginzburg-Landau (1-dimensional)
      Powell criterion for restart.   Stoptest = 1  (theta spectral)

     n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
-------------------------------------------------------------------------------
  1000   8586   1587  137757   5643     960  -.8456191975306E+04   .6879077836659E-05
-------------------------------------------------------------------------------
TOTAL    8586   1587  137757   5643    9.60(seconds)     proc= 18.48%


 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
 ---------------------------------------------------------------------------------
  40000    298      0     333     33    2035  -.5611448493559E+01   .2372278328169E-04
 ---------------------------------------------------------------------------------
 TOTAL     298      0     333     33   20.35(seconds)     proc=   .00%


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

    1  *** ASCALCG Algorithm ***. Function: Jones Clusters - Molecular
       Powell criterion for restart.   Stoptest = 1  (theta spectral)

     n   iter    irs   fgcnt  lscnt   time(c)       fxnew                gnorm
 ---------------------------------------------------------------------------------
   3000   1160     58    4107    170   18198  -.6638306140250E+04   .6635891864351E-05
 ---------------------------------------------------------------------------------
 TOTAL    1160     58    4107    170  181.98(seconds)     proc=  5.00%


  Accelerated SCALCG Algorithm.    Neculai Andrei
  BFGS preconditioned conjugate gradient algorthm
  January 8, 2009                *** 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
 ---------------------------------------------------------------------------------
  40000    274      1     296     20    1163   .1000000005584E+01   .3544751549824E-04
 ---------------------------------------------------------------------------------
 TOTAL     274      1     296     20   11.63(seconds)     proc=   .36%
```

ACGMSEC (Andrei)

```
**** ACGMESC ****              Neculai Andrei
    Accelerated CG with Modified Secant Condition
    Powell restart.               January 9, 2009
    Accelerated CG with Modified Secant Condition

      1    ACGMSEC Algorithm. Function:Elastic - Plastic Torsion Problem
           stoptest= 1     tau=  .0000000000000E+00

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm         delta
 ---------------------------------------------------------------------------------
 40000    241     0    269    27       600 -.4392678188056E+00  .3175756050107E-04     0
 ---------------------------------------------------------------------------------
 TOTAL    241     0    269    27      6.00 (seconds)    proc=    .00%

    **** ACGMESC ****              Neculai Andrei
    Accelerated CG with Modified Secant Condition
    Powell restart.               January 9, 2009
    Accelerated CG with Modified Secant Condition

      1    ACGMSEC Algorithm. Function:Pressure Distribution Problem
           stoptest= 1     tau=  .0000000000000E+00

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm         delta
 ---------------------------------------------------------------------------------
 40000    634     0    669    34      1582 -.2828929487195E+00  .2267181374741E-04     0
 ---------------------------------------------------------------------------------
 TOTAL    634     0    669    34     15.82 (seconds)    proc=    .00%


    **** ACGMESC ****              Neculai Andrei
    Accelerated CG with Modified Secant Condition
    Powell restart.               January 9, 2009
    Accelerated CG with Modified Secant Condition

      1    ACGMSEC Algorithm. Function:Optimal Design with Composite Materials
           stoptest= 1     tau=  .0000000000000E+00
```

```
    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm         delta
-------------------------------------------------------------------------------------------
40000   1034     0   1062    27      4423 -.1138128869389E-01  .3754320396487E-04     0
-------------------------------------------------------------------------------------------
TOTAL   1034     0   1062    27     44.23 (seconds)    proc=    .00%


   **** ACGMESC ****              Neculai Andrei
   Accelerated CG with Modified Secant Condition
   Powell restart.               January 9, 2009
   Accelerated CG with Modified Secant Condition

     1    ACGMSEC Algorithm. Function:Ginzburg-Landau (1-dimensional)
          stoptest= 1     tau=  .0000000000000E+00

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm         delta
-------------------------------------------------------------------------------------------
 1000   3294    48   7832   443       103 -.8456191975306E+04  .1028123281775E-04     9
-------------------------------------------------------------------------------------------
TOTAL   3294    48   7832   443      1.03 (seconds)    proc=   1.46%


   **** ACGMESC ****              Neculai Andrei
   Accelerated CG with Modified Secant Condition
   Powell restart.               January 9, 2009
   Accelerated CG with Modified Secant Condition

     1    ACGMSEC Algorithm. Function: Steady State Combustion Problem
          stoptest= 1     tau=  .0000000000000E+00

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm         delta
-------------------------------------------------------------------------------------------
40000    299     0    333    33      1910 -.5611448493595E+01  .2374436684536E-04     0
-------------------------------------------------------------------------------------------
TOTAL    299     0    333    33     19.10 (seconds)    proc=    .00%

   **** ACGMESC ****              Neculai Andrei
   Accelerated CG with Modified Secant Condition
   Powell restart.               January 9, 2009
   Accelerated CG with Modified Secant Condition

     1    ACGMSEC Algorithm. Function:  Molecular Conformation
          stoptest= 1     tau=  .0000000000000E+00

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm         delta
-------------------------------------------------------------------------------------------
 3000   1086    36   4838   222     20310 -.6631964147459E+04  .6898304840377E-05     0
-------------------------------------------------------------------------------------------
TOTAL   1086    36   4838   222    203.10 (seconds)    proc=   3.31%

   **** ACGMESC ****              Neculai Andrei
   Accelerated CG with Modified Secant Condition
   Powell restart.               January 9, 2009
   Accelerated CG with Modified Secant Condition

     1    ACGMSEC Algorithm. Function: Minimal Surface Area Problem
          stoptest= 1     tau=  .0000000000000E+00

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm         delta
-------------------------------------------------------------------------------------------
40000    281     1    301    19      1099  .1000000004679E+01  .3595009221651E-04     0
-------------------------------------------------------------------------------------------
TOTAL    281     1    301    19     10.99 (seconds)    proc=    .36%
```

ACGHES (Andrei)

```
   # ACGHES Algorithm.           FCG Algorithms Project
   # Forward difference approximation of Hessian-vector
   # product in combination with an acceleration scheme
   # ACGHES with Powell restart.    January 8, 2009

     1    ACGHES Algorithm. Function:Elastic-plastic torsion problem
          Hessian*vector product approximation by finite difference.  stoptest= 1

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
40000  10001  9998  10039     4     14445 -.3327960357264E+00  .4176561670138E+00
-------------------------------------------------------------------------------
TOTAL  10001  9998  10039     4    144.45 (seconds)    proc=  99.97%


   # ACGHES Algorithm.           FCG Algorithms Project
   # Forward difference approximation of Hessian-vector
   # product in combination with an acceleration scheme
   # ACGHES with Powell restart.    January  8, 2009

     1    ACGHES Algorithm. Function:Pressure Distribution Problem
          Hessian*vector product approximation by finite difference.  stoptest= 1

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
40000    634     0    669    34      2334 -.2828929487202E+00  .2266645519577E-04
-------------------------------------------------------------------------------
TOTAL    634     0    669    34     23.34 (seconds)    proc=    .00%


   # ACGHES Algorithm.           FCG Algorithms Project
   # Forward difference approximation of Hessian-vector
   # product in combination with an acceleration scheme
   # ACGHES with Powell restart.    January  8, 2009

     1    ACGHES Algorithm. Function:Optimal Design with Composite Materials
          Hessian*vector product approximation by finite difference.  stoptest= 1

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
40000   1022     2   1057    34      6103 -.1138129039912E-01  .3514848555591E-04
-------------------------------------------------------------------------------
TOTAL   1022     2   1057    34     61.03 (seconds)    proc=    .20%


   # ACGHES Algorithm.           FCG Algorithms Project
   # Forward difference approximation of Hessian-vector
   # product in combination with an acceleration scheme
   # ACGHES with Powell restart.    January 8, 2009

     1    ACGHES Algorithm. Function:Ginzburg-Landau (1-dimensional)
          Hessian*vector product approximation by finite difference.  stoptest= 1

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 1000   4180   164  17705   909       187 -.8456191975306E+04  .8675772300078E-05
-------------------------------------------------------------------------------
TOTAL   4180   164  17705   909      1.87 (seconds)    proc=   3.92%


  # ACGHES Algorithm.           FCG Algorithms Project
   # Forward difference approximation of Hessian-vector
   # product in combination with an acceleration scheme
   # ACGHES with Powell restart.    January 8, 2009

     1    ACGHES Algorithm. Function: Steady State Combustion Problem
          Hessian*vector product approximation by finite difference.  stoptest= 1

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
40000    299     0    333    33      2815 -.5611448493610E+01  .2374331095272E-04
-------------------------------------------------------------------------------
TOTAL    299     0    333    33     28.15 (seconds)    proc=    .00%
```

```
   # ACGHES Algorithm.           FCG Algorithms Project
   # Forward difference approximation of Hessian-vector
   # product in combination with an acceleration scheme
   # ACGHES with Powell restart.    January 8, 2009

     1    ACGHES Algorithm. Function:Molecular Conformation
          Hessian*vector product approximation by finite difference.  stoptest= 1

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
 -------------------------------------------------------------------------------
  3000   5001  4999   5002     1     17481 -.4494653725848E+04  .1107711749162E+03
 -------------------------------------------------------------------------------
 TOTAL   5001  4999   5002     1    174.81 (seconds)    proc=  99.96%

   # ACGHES Algorithm.           FCG Algorithms Project
   # Forward difference approximation of Hessian-vector
   # product in combination with an acceleration scheme
   # ACGHES with Powell restart.    January 8, 2009

     1    ACGHES Algorithm. Function:Minimal Surface Area Problem
          Hessian*vector product approximation by finite difference.  stoptest= 1

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
 -------------------------------------------------------------------------------
 40000    281     1    308    26      1622  .1000000005255E+01  .3569140372954E-04
 -------------------------------------------------------------------------------
 TOTAL    281     1    308    26     16.22 (seconds)    proc=    .36%
```

AHYBRIDM (Andrei)

```
   *** Conjugate Gradient Algorithms Project ***
   AHYBRIDM Conjugate Gradient Algorithm
   Accelerated convex combination of HS,DY:
   from Newton direction with modified  secant condition
   Powell restart.  January 9, 2009

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

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm           DY
HS   CC
 -------------------------------------------------------------------------------------
-------
 40000    241     0    269    27       604 -.4392678188056E+00  .3175756676210E-04  106
135    0
 -------------------------------------------------------------------------------------
-------
 TOTAL    241     0    269    27      6.04 (seconds)    proc=    .00%

 Total # iter for DY=   106   i.e.   43.98%
 Total # iter for HS=   135   i.e.   56.02%
 Total # iter for CC=     0   i.e.     .00%


   *** Conjugate Gradient Algorithms Project ***
   AHYBRIDM Conjugate Gradient Algorithm
   Accelerated convex combination of HS,DY:
   from Newton direction with modified  secant condition
   Powell restart.  January 9, 2009

     1    AHYBRIDM Algorithm. Function Pressure Distribution Problem
          stoptest= 1

    n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm           DY
HS   CC
 -------------------------------------------------------------------------------------
-------
 40000    634     0    669    34      1563 -.2828929487236E+00  .2262124595643E-04  263
371    0
 -------------------------------------------------------------------------------------
-------
 TOTAL    634     0    669    34     15.63 (seconds)    proc=    .00%
```

```
 Total # iter for DY=   263   i.e.   41.48
 Total # iter for HS=   371   i.e.   58.52
 Total # iter for CC=     0   i.e.     .00


    *** Conjugate Gradient Algorithms Project ***
    AHYBRIDM Conjugate Gradient Algorithm
    Accelerated convex combination of HS,DY:
    from Newton direction with modified  secant condition
    Powell restart.  January 9, 2009

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

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm           DY
HS   CC
 ---------------------------------------------------------------------------------------
-------
 40000   1025     0   1053    27      4367 -.1138128917301E-01  .3791821681957E-04  143
703  179
 ---------------------------------------------------------------------------------------
-------
 TOTAL   1025     0   1053    27     43.67 (seconds)    proc=    .00%

 Total # iter for DY=   143   i.e.   13.95
 Total # iter for HS=   703   i.e.   68.59
 Total # iter for CC=   179   i.e.   17.46


    *** Conjugate Gradient Algorithms Project ***
    AHYBRIDM Conjugate Gradient Algorithm
    Accelerated convex combination of HS,DY:
    from Newton direction with modified  secant condition
    Powell restart.  January 9, 2009

      1    AHYBRIDM Algorithm. Function Ginzburg-Landau (1-dimensional)
           stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm           DY
HS   CC
 ---------------------------------------------------------------------------------------
-------
  1000   5408    21   7695   651       117 -.8456191975306E+04  .6535630159993E-05 2060
3229  119
 ---------------------------------------------------------------------------------------
-------
 TOTAL   5408    21   7695   651      1.17 (seconds)    proc=    .39%

 Total # iter for DY=  2060   i.e.   38.09
 Total # iter for HS=  3229   i.e.   59.71
 Total # iter for CC=   119   i.e.    2.20


    *** Conjugate Gradient Algorithms Project ***
    AHYBRIDM Conjugate Gradient Algorithm
    Accelerated convex combination of HS,DY:
    from Newton direction with modified  secant condition
    Powell restart.  January 9, 2009

      1    AHYBRIDM Algorithm. Function Steady State Combustion
           stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm           DY
HS   CC
 ---------------------------------------------------------------------------------------
-------
 40000    299     0    333    33      1924 -.5611448493596E+01  .2374434222296E-04   29
267    3
 ---------------------------------------------------------------------------------------
-------
 TOTAL    299     0    333    33     19.24 (seconds)    proc=    .00%

 Total # iter for DY=    29   i.e.    9.70
 Total # iter for HS=   267   i.e.   89.30
 Total # iter for CC=     3   i.e.    1.00
```

```
    *** Conjugate Gradient Algorithms Project ***
    AHYBRIDM Conjugate Gradient Algorithm
    Accelerated convex combination of HS,DY:
    from Newton direction with modified  secant condition
    Powell restart.  January 9, 2009

      1    AHYBRIDM Algorithm. Function Jones Clusters (Molecular Conformation)
           stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm           DY
HS   CC
 ---------------------------------------------------------------------------------------
-------
  3000   5001  7257   8716   226     34716 -.6597837550222E+04  .5933410007762E-03  195
4732   73
 ---------------------------------------------------------------------------------------
-------
 TOTAL   5001  7257   8716   226    347.16 (seconds)    proc= 145.11%

 Total # iter for DY=   195   i.e.    3.90
 Total # iter for HS=  4732   i.e.   94.62
 Total # iter for CC=    73   i.e.    1.46

    *** Conjugate Gradient Algorithms Project ***
    AHYBRIDM Conjugate Gradient Algorithm
    Accelerated convex combination of HS,DY:
    from Newton direction with modified  secant condition
    Powell restart.  January 9, 2009

      1    AHYBRIDM Algorithm. Function Minimal Surface Area
           stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm           DY
HS   CC
 ---------------------------------------------------------------------------------------
-------
 40000    288     3    315    26      1135  .1000000004110E+01  .3601390204558E-04   48
236    4
 ---------------------------------------------------------------------------------------
-------
 TOTAL    288     3    315    26     11.35 (seconds)    proc=   1.04%

 Total # iter for DY=    48   i.e.   16.67
 Total # iter for HS=   236   i.e.   81.94
 Total # iter for CC=     4   i.e.    1.39
```

ACGSYS (Andrei)

```
   **** CGSYS ****                   Neculai Andrei *
    * Accelerated Conjugate Gradient with Guaranteed *
    * Descent and Conjugacy conditions               *
    ***************************************************

    CGSYS Algorithm.    Elastic-Plastic Torsion Problem

    Parameters: t=  .8750000000000E+00    u=  .1000000000000E-01
    CGSYS. Powell restart.           January 9, 2009
 ------------------------------------------------------------------------------
       n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
 ------------------------------------------------------------------------------
   40000    241     0    510    27       601 -.4392678188056E+00  .3175760230075E-04
 ------------------------------------------------------------------------------
 TOTAL    241     0    510    27      6.01 (seconds)    proc=    .00%


    **** CGSYS ****                   Neculai Andrei *
    * Accelerated Conjugate Gradient with Guaranteed *
    * Descent and Conjugacy conditions               *
    ***************************************************

    CGSYS Algorithm.    Pressure Distribution Problem

    CGSYS. Parameters: t=  .8750000000000E+00    u=  .1000000000000E-01
    CGSYS. Powell restart.           January 9, 2009
```

```
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
  40000    631     0   1297    34      1547 -.2828929485422E+00  .2454633793774E-04
-------------------------------------------------------------------------------
TOTAL    631     0   1297    34     15.47 (seconds)    proc=    .00%


   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   CGSYS Algorithm.    Optimal Design with Composite Materials

   Parameters: t=  .8750000000000E+00    u=  .1000000000000E-01
   CGSYS. Powell restart.           January 9, 2009
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
  40000   1022     0   2072    27      4463 -.1138128643088E-01  .3751235966340E-04
-------------------------------------------------------------------------------
TOTAL   1022     0   2072    27     44.63 (seconds)    proc=    .00%


   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   CGSYS Algorithm.    Ginzburg-Landau (1-dimensional)

   Parameters: t=  .8750000000000E+00    u=  .1000000000000E-01
   CGSYS. Powell restart.           January 9, 2009
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
   1000  10001  1722  35994  2772       246 -.8456191975306E+04  .3985625277706E-02
-------------------------------------------------------------------------------
TOTAL  10001  1722  35994  2772      2.46 (seconds)    proc=  17.22%


   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   CGSYS Algorithm.     Steady State Combustion Problem

   Parameters: t=  .8750000000000E+00    u=  .1000000000000E-01
   CGSYS. Powell restart.           January 9, 2009
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
  40000    299     0    632    33      1913 -.5611448493596E+01  .2374434247984E-04
-------------------------------------------------------------------------------
TOTAL    299     0    632    33     19.13 (seconds)    proc=    .00%


   **** CGSYS ****                   Neculai Andrei *
   * Accelerated Conjugate Gradient with Guaranteed *
   * Descent and Conjugacy conditions               *
   ***************************************************

   CGSYS Algorithm.    Molecular Conformation

   Parameters: t=  .8750000000000E+00    u=  .1000000000000E-01
   CGSYS. Powell restart.           January 9, 2009
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
   3000   1418    30   5732   200     19589 -.6606920834714E+04  .4928508148204E-05
-------------------------------------------------------------------------------
TOTAL   1418    30   5732   200    195.89 (seconds)    proc=   2.12%
```

```
**** CGSYS ****                    Neculai Andrei *
* Accelerated Conjugate Gradient with Guaranteed *
* Descent and Conjugacy conditions               *
**************************************************

CGSYS Algorithm.    Minimal Surface Area Problem

Parameters: t=  .8750000000000E+00    u=  .1000000000000E-01
CGSYS. Powell restart.           January 9, 2009
-------------------------------------------------------------------------------
      n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
  40000    281     1    582    19      1083  .1000000005259E+01  .3677889822123E-04
-------------------------------------------------------------------------------
TOTAL    281     1    582    19     10.83 (seconds)    proc=    .36%
```

January 9, 2009