Optimal Design with Composite Materials Problem

25 Conjugate Gradient Algorithms
Comparison between conjugate gradient algorithms and their accelerated variants

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1. Conjugate Gradient Algorithms

```
   *-----------------------------------------------------
   | Fastest Conjugate Gradient Algorithm Project
   |                                        April 1, 2009
   | stoptest =     1
   | maxiter  = 10000
   | Conjugate Gradient with Powell restart.
   *-----------------------------------------------------

     1    CG-HS Algorithm. Function:Optimal Design with Composite Materials
          Hestenes and Stiefel.  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   3399  1167   5175  1774     10924 -.1138112193034E-01  .1478498736859E-04
-------------------------------------------------------------------------------
TOTAL    3399  1167   5175  1774    109.24 (seconds)    proc=  34.33%


     2    CG-FR Algorithm. Function:Optimal Design with Composite Materials
          Fletcher and Reeves.  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   3670  1270   5682  2011     11901 -.1138116696265E-01  .1275659718157E-04
-------------------------------------------------------------------------------
TOTAL    3670  1270   5682  2011    119.01 (seconds)    proc=  34.60%


     3    CG-PRP Algorithm. Function:Optimal Design with Composite Materials
          Polak-Ribiere and Polyak.  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   3751  1350   5878  2124     12385 -.1138119488821E-01  .1049417594137E-04
-------------------------------------------------------------------------------
TOTAL    3751  1350   5878  2124    123.85 (seconds)    proc=  35.99%


     4    CG-PRP+ Algorithm. Function:Optimal Design with Composite Materials
          Polak-Ribiere and Polyak plus.  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
```

```
 40000   3751  1350   5878  2124     12386 -.1138119488821E-01  .1049417594137E-04
-----------------------------------------------------------------------------------
TOTAL    3751  1350   5878  2124    123.86 (seconds)    proc=  35.99%


     5    CG-CD Algorithm. Function:Optimal Design with Composite Materials
          Conjugate Descent - Fletcher. stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-----------------------------------------------------------------------------------
 40000   4448  1582   6899  2450     14463 -.1138118761476E-01  .1133773509089E-04
-----------------------------------------------------------------------------------
TOTAL    4448  1582   6899  2450    144.63 (seconds)    proc=  35.57%


     6    CG-LS Algorithm. Function:Optimal Design with Composite Materials
          Liu and Storey.  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-----------------------------------------------------------------------------------
 40000   3893  1379   6085  2189     12824 -.1138120334446E-01  .1067576885851E-04
-----------------------------------------------------------------------------------
TOTAL    3893  1379   6085  2189    128.24 (seconds)    proc=  35.42%


     7    CG-DY Algorithm. Function:Optimal Design with Composite Materials
          Dai and Yuan.  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-----------------------------------------------------------------------------------
 40000   3785  1297   5759  1973     12174 -.1138110522217E-01  .1485671669635E-04
-----------------------------------------------------------------------------------
TOTAL    3785  1297   5759  1973    121.74 (seconds)    proc=  34.27%


     8    CG-DL Algorithm. Function:Optimal Design with Composite Materials
          Dai and Liao (t=1).  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-----------------------------------------------------------------------------------
 40000   3266  1100   5006  1739     10580 -.1138122531925E-01  .9564194679520E-05
-----------------------------------------------------------------------------------
TOTAL    3266  1100   5006  1739    105.80 (seconds)    proc=  33.68%


     9    CG-DL+ Algorithm. Function:Optimal Design with Composite Materials
          Dai and Liao plus (t=1).  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-----------------------------------------------------------------------------------
 40000   4121  1390   6283  2159     13260 -.1138112306826E-01  .1646050938993E-04
-----------------------------------------------------------------------------------
TOTAL    4121  1390   6283  2159    132.60 (seconds)    proc=  33.73%


    10    CG-SDC Algorithm. Function:Optimal Design with Composite Materials
          Andrei - Sufficient Descent Condition.  stoptest= 1
    aCGSD: beta = gtg/yts - ytg*stg/(yts*yts)
     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-----------------------------------------------------------------------------------
 40000  10001  9843  10122   121     22712 -.5157475221677E-02  .1305463592173E-01
-----------------------------------------------------------------------------------
TOTAL   10001  9843  10122   121    227.12 (seconds)    proc=  98.42%


    11    CG-hDY Algorithm. Function:Optimal Design with Composite Materials
          hDY:Hybrid Dai and Yuan. max(c*DY,min(HS,DY)). stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-----------------------------------------------------------------------------------
 40000   3771  1315   5769  1997     12175 -.1138118590146E-01  .9907337558051E-05
-----------------------------------------------------------------------------------
TOTAL    3771  1315   5769  1997    121.75 (seconds)    proc=  34.87%


    12    CG-hDYz Algorithm. Function:Optimal Design with Composite Materials
          hDYz: Hybrid Dai and Yuan zero. max(0,min(HS,DY)). stoptest= 1
```

```
     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
--------------------------------------------------------------------------------
 40000   3771  1315   5769  1997     12175 -.1138118590146E-01  .9907337558051E-05
--------------------------------------------------------------------------------
TOTAL    3771  1315   5769  1997    121.75 (seconds)    proc=  34.87%


    13    CG-GN Algorithm. Function:Optimal Design with Composite Materials
          Gilbert and Nocedal.  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
--------------------------------------------------------------------------------
 40000   3875  1332   6030  2154     12701 -.1138119931942E-01  .1107137398193E-04
--------------------------------------------------------------------------------
TOTAL    3875  1332   6030  2154    127.01 (seconds)    proc=  34.37%


    14    CG-HuS Algorithm. Function:Optimal Design with Composite Materials
          PRP-FR: Hu and Storey. max(0,min(PRP,FR)). stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
--------------------------------------------------------------------------------
 40000   3875  1332   6030  2154     12695 -.1138119931942E-01  .1107137398193E-04
--------------------------------------------------------------------------------
TOTAL    3875  1332   6030  2154    126.95 (seconds)    proc=  34.37%


    15    CG-TAS Algorithm. Function:Optimal Design with Composite Materials
          Touat-Ahmed and Storey. (PRP <= FR). stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
--------------------------------------------------------------------------------
 40000   3875  1332   6030  2154     12696 -.1138119931942E-01  .1107137398193E-04
--------------------------------------------------------------------------------
TOTAL    3875  1332   6030  2154    126.96 (seconds)    proc=  34.37%


    16    LS-CD Algorithm. Function:Optimal Design with Composite Materials
          Hybrid Liu&Storey-Conjugate Descent. max(0,min(LS,CD)) stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
--------------------------------------------------------------------------------
 40000   4768  1641   7457  2686     15724 -.1138121698963E-01  .8595798881165E-05
--------------------------------------------------------------------------------
TOTAL    4768  1641   7457  2686    157.24 (seconds)    proc=  34.42%


    17    CG-BM Algorithm. Function:Optimal Design with Composite Materials
          Birgin and Martinez (scaled Perry). Theta spectral. stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
--------------------------------------------------------------------------------
 40000   3953  1309   6003  2049     12720 -.1138120666335E-01  .1365328291415E-04
--------------------------------------------------------------------------------
TOTAL    3953  1309   6003  2049    127.20 (seconds)    proc=  33.11%


    18    CG-BM+ Algorithm. Function:Optimal Design with Composite Materials
          Birgin and Martinez plus (scaled Perry). Theta spectral. stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
--------------------------------------------------------------------------------
 40000   4434  1482   6748  2311     14282 -.1138123160612E-01  .9242933187852E-05
--------------------------------------------------------------------------------
TOTAL    4434  1482   6748  2311    142.82 (seconds)    proc=  33.42%


    19    CG-sPRP Algorithm. Function:Optimal Design with Composite Materials
          Scaled Polak-Ribiere and Polyak. Theta spectral. stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
--------------------------------------------------------------------------------
 40000   3732  1373   5855  2120     12374 -.1138125139285E-01  .8702537668332E-05
--------------------------------------------------------------------------------
TOTAL    3732  1373   5855  2120    123.74 (seconds)    proc=  36.79%
```

```
    20    CG-sFR Algorithm. Function:Optimal Design with Composite Materials
          Scaled Fletcher and Revees. Theta spectral. stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
--------------------------------------------------------------------------------
 40000   4339  1506   6708  2367     14144 -.1138106878895E-01  .2014374522020E-04
--------------------------------------------------------------------------------
TOTAL    4339  1506   6708  2367    141.44 (seconds)    proc=  34.71%


    21    New CG Algorithm. Function:Optimal Design with Composite Materials
          Andrei New Sufficient Descent from PRP. stoptest= 1
    PRP-SDC: beta = (ytg-yty*stg/gtgprev)/yts
     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
--------------------------------------------------------------------------------
 40000  10001  8335  10850   846     23591 -.1096340516478E-01  .3536720945398E-01
--------------------------------------------------------------------------------
TOTAL   10001  8335  10850   846    235.91 (seconds)    proc=  83.34%


    22    New CG Algorithm. Function:Optimal Design with Composite Materials
          Andrei New Sufficient Descent from DY. stoptest= 1
          ACGSD: beta=ytg/yts-ytg*stg/(yts**2)

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
--------------------------------------------------------------------------------
 40000   4345  1462   6580  2234     13897 -.1138117883943E-01  .1032550321539E-04
--------------------------------------------------------------------------------
TOTAL    4345  1462   6580  2234    138.97 (seconds)    proc=  33.65%


    23    New CG Algorithm. Function:Optimal Design with Composite Materials
          Andrei Sufficient Descent from DY (max). stoptest= 1
          ACGSDz: beta=max(0,ytg/yts)*(1-stg/yts)

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
--------------------------------------------------------------------------------
 40000   4783  1621   7305  2516     15430 -.1138127272863E-01  .8700217587006E-05
--------------------------------------------------------------------------------
TOTAL    4783  1621   7305  2516    154.30 (seconds)    proc=  33.89%


    24    New CG Algorithm. Function:Optimal Design with Composite Materials
          PRP - DY with Newton direction. (NDOMB) stoptest= 1
     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
--------------------------------------------------------------------------------
 40000   3775  1238   5673  1895     12116 -.1138102175837E-01  .1807798149920E-04
--------------------------------------------------------------------------------
TOTAL    3775  1238   5673  1895    121.16 (seconds)    proc=  32.79%


    25    New CG Algorithm. Function:Optimal Design with Composite Materials
          PRP - DY with Conjugacy Condition. (CCOMB) stoptest= 1
     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
--------------------------------------------------------------------------------
 40000   3643  1222   5552  1908     11722 -.1138116038851E-01  .1669468135956E-04
--------------------------------------------------------------------------------
TOTAL    3643  1222   5552  1908    117.22 (seconds)    proc=  33.54%
```

2. Accelerated Conjugate Gradient Algorithms

```
*-----------------------------------------------------
| Fastest Conjugate Gradient Algorithm Project
|                                        April 1, 2009
| stoptest =     1
| maxiter  = 10000
| Accelerated Conjugate Gradient with Powell restart.
*-----------------------------------------------------

     1    CG-HS Algorithm. Function:Optimal Design with Composite Materials
          Hestenes and Stiefel.  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   1043     0   2118    31      4488 -.1138128902809E-01  .3920987288949E-04
-------------------------------------------------------------------------------
TOTAL    1043     0   2118    31     44.88 (seconds)    proc=    .00%


     2    CG-FR Algorithm. Function:Optimal Design with Composite Materials
          Fletcher and Reeves.  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   1733    53   3669   202      7690 -.1138128971667E-01  .3343405422109E-04
-------------------------------------------------------------------------------
TOTAL    1733    53   3669   202     76.90 (seconds)    proc=   3.06%


     3    CG-PRP Algorithm. Function:Optimal Design with Composite Materials
          Polak-Ribiere and Polyak.  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   1030     0   2089    28      4385 -.1138128879576E-01  .3823444227648E-04
-------------------------------------------------------------------------------
TOTAL    1030     0   2089    28     43.85 (seconds)    proc=    .00%


     4    CG-PRP+ Algorithm. Function:Optimal Design with Composite Materials
          Polak-Ribiere and Polyak plus.  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   1030     0   2089    28      4387 -.1138128879576E-01  .3823444227648E-04
-------------------------------------------------------------------------------
TOTAL    1030     0   2089    28     43.87 (seconds)    proc=    .00%


     5    CG-CD Algorithm. Function:Optimal Design with Composite Materials
          Conjugate Descent - Fletcher. stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   1811    57   3841   218      8046 -.1138128989067E-01  .3829576090555E-04
-------------------------------------------------------------------------------
TOTAL    1811    57   3841   218     80.46 (seconds)    proc=   3.15%


     6    CG-LS Algorithm. Function:Optimal Design with Composite Materials
          Liu and Storey.  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000    984     1   1996    27      4185 -.1138128965305E-01  .3777677967624E-04
-------------------------------------------------------------------------------
TOTAL     984     1   1996    27     41.85 (seconds)    proc=    .10%


     7    CG-DY Algorithm. Function:Optimal Design with Composite Materials
          Dai and Yuan.  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
```

```
 40000   1602    53   3411   206      7187 -.1138128979258E-01  .3865276508853E-04
-------------------------------------------------------------------------------------
TOTAL    1602    53   3411   206     71.87 (seconds)    proc=   3.31%


     8    CG-DL Algorithm. Function:Optimal Design with Composite Materials
          Dai and Liao (t=1).  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------------
 40000   1035     0   2098    27      4415 -.1138128911341E-01  .3683749727840E-04
-------------------------------------------------------------------------------------
TOTAL    1035     0   2098    27     44.15 (seconds)    proc=    .00%


     9    CG-DL+ Algorithm. Function:Optimal Design with Composite Materials
          Dai and Liao plus (t=1).  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------------
 40000   1034     0   2096    27      4406 -.1138128870415E-01  .3754379474696E-04
-------------------------------------------------------------------------------------
TOTAL    1034     0   2096    27     44.06 (seconds)    proc=    .00%


    10    CG-SDC Algorithm. Function:Optimal Design with Composite Materials
          Andrei - Sufficient Descent Condition.  stoptest= 1
    aCGSD: beta = gtg/yts - ytg*stg/(yts*yts)
     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------------
 40000   1041     0   2112    29      4450 -.1138128967513E-01  .3702931388322E-04
-------------------------------------------------------------------------------------
TOTAL    1041     0   2112    29     44.50 (seconds)    proc=    .00%


    11    CG-hDY Algorithm. Function:Optimal Design with Composite Materials
          hDY:Hybrid Dai and Yuan. max(c*DY,min(HS,DY)). stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------------
 40000   3239   652   8048  1568     16806 -.1138123773180E-01  .9499280235084E-05
-------------------------------------------------------------------------------------
TOTAL    3239   652   8048  1568    168.06 (seconds)    proc=  20.13%


    12    CG-hDYz Algorithm. Function:Optimal Design with Composite Materials
          hDYz: Hybrid Dai and Yuan zero. max(0,min(HS,DY)). stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------------
 40000   3239   652   8048  1568     16803 -.1138123773180E-01  .9499280235084E-05
-------------------------------------------------------------------------------------
TOTAL    3239   652   8048  1568    168.03 (seconds)    proc=  20.13%


    13    CG-GN Algorithm. Function:Optimal Design with Composite Materials
          Gilbert and Nocedal.  stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------------
 40000   1031     0   2089    26      4382 -.1138128871999E-01  .3918256100878E-04
-------------------------------------------------------------------------------------
TOTAL    1031     0   2089    26     43.82 (seconds)    proc=    .00%


    14    CG-HuS Algorithm. Function:Optimal Design with Composite Materials
          PRP-FR: Hu and Storey. max(0,min(PRP,FR)). stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------------
 40000   1031     0   2089    26      4384 -.1138128871999E-01  .3918256100878E-04
-------------------------------------------------------------------------------------
TOTAL    1031     0   2089    26     43.84 (seconds)    proc=    .00%


    15    CG-TAS Algorithm. Function:Optimal Design with Composite Materials
          Touat-Ahmed and Storey. (PRP <= FR). stoptest= 1
```

```
     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   1031     0   2089    26      4384 -.1138128871999E-01  .3918256100878E-04
-------------------------------------------------------------------------------
TOTAL    1031     0   2089    26     43.84 (seconds)    proc=    .00%


    16    LS-CD Algorithm. Function:Optimal Design with Composite Materials
          Hybrid Liu&Storey-Conjugate Descent. max(0,min(LS,CD)) stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   1026     0   2077    24      4354 -.1138128938779E-01  .3745054187325E-04
-------------------------------------------------------------------------------
TOTAL    1026     0   2077    24     43.54 (seconds)    proc=    .00%


    17    CG-BM Algorithm. Function:Optimal Design with Composite Materials
          Birgin and Martinez (scaled Perry). Theta spectral. stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   1040     0   2105    24      4436 -.1138128922187E-01  .3793953653336E-04
-------------------------------------------------------------------------------
TOTAL    1040     0   2105    24     44.36 (seconds)    proc=    .00%


    18    CG-BM+ Algorithm. Function:Optimal Design with Composite Materials
          Birgin and Martinez plus (scaled Perry). Theta spectral. stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   1040     0   2105    24      4437 -.1138128922185E-01  .3793975048272E-04
-------------------------------------------------------------------------------
TOTAL    1040     0   2105    24     44.37 (seconds)    proc=    .00%


    19    CG-sPRP Algorithm. Function:Optimal Design with Composite Materials
          Scaled Polak-Ribiere and Polyak. Theta spectral. stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   3234   704   8032  1563     16795 -.1138128645147E-01  .1022308744457E-04
-------------------------------------------------------------------------------
TOTAL    3234   704   8032  1563    167.95 (seconds)    proc=  21.77%


    20    CG-sFR Algorithm. Function:Optimal Design with Composite Materials
          Scaled Fletcher and Revees. Theta spectral. stoptest= 1

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   3847   925   9682  1987     20249 -.1138110120495E-01  .2542551653166E-04
-------------------------------------------------------------------------------
TOTAL    3847   925   9682  1987    202.49 (seconds)    proc=  24.04%


    21    New CG Algorithm. Function:Optimal Design with Composite Materials
          Andrei New Sufficient Descent from PRP. stoptest= 1
    PRP-SDC: beta = (ytg-yty*stg/gtgprev)/yts
     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000  10001  7453  14791  1708     31832 -.1135854607196E-01  .1033476542326E-01
-------------------------------------------------------------------------------
TOTAL   10001  7453  14791  1708    318.32 (seconds)    proc=  74.52%


    22    New CG Algorithm. Function:Optimal Design with Composite Materials
          Andrei New Sufficient Descent from DY. stoptest= 1
          ACGSD: beta=ytg/yts-ytg*stg/(yts**2)

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   1023     0   2074    27      4365 -.1138128678412E-01  .3713643463454E-04
-------------------------------------------------------------------------------
TOTAL    1023     0   2074    27     43.65 (seconds)    proc=    .00%
```

```
    23    New CG Algorithm. Function:Optimal Design with Composite Materials
          Andrei Sufficient Descent from DY (max). stoptest= 1
          ACGSDz: beta=max(0,ytg/yts)*(1-stg/yts)

     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   1023     0   2074    27      4362 -.1138128677104E-01  .3690786943227E-04
-------------------------------------------------------------------------------
TOTAL    1023     0   2074    27     43.62 (seconds)    proc=    .00%


    24    New CG Algorithm. Function:Optimal Design with Composite Materials
          PRP - DY with Newton direction. (NDOMB) stoptest= 1
     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   1040     0   2113    32      4549 -.1138128869008E-01  .3574069283101E-04
-------------------------------------------------------------------------------
TOTAL    1040     0   2113    32     45.49 (seconds)    proc=    .00%


    25    New CG Algorithm. Function:Optimal Design with Composite Materials
          PRP - DY with Conjugacy Condition. (CCOMB) stoptest= 1
     n   iter   irs  fgcnt lscnt   time(c)        fxnew              gnorm
-------------------------------------------------------------------------------
 40000   1035     0   2103    32      4416 -.1138129078628E-01  .3570019581066E-04
-------------------------------------------------------------------------------
TOTAL    1035     0   2103    32     44.16 (seconds)    proc=    .00%
```

Remarks.

This problem belongs to the MINPACK2 collection.

These results have been obtained with APPL3.FOR package which implements 25 conjugate gradient algorithms in classical and accelerated versions. To use the accelerated version of these algorithms the value of the logical parameter accel must be set to .true.

Observe the differences between cpu time corresponding to the conjugate gradient algorithms and their accelerated versions.

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