

Notes: ‘n’ represents the dimension of the corresponding problem. ‘NI’ represents the total number of iterations. ‘NF’ represents the number of the function evaluation. ‘T’ represents the running time of the algorithm. ‘ $\|g^*\|$ ’ represents the gradient value for the solution. The values of ‘NI’, ‘NF’, ‘T’ and ‘ $\|g^*\|$ ’ are set as ‘NaN’ if and only if the number of iterations is greater than 3000.

Table 1: Numerical results for Test 3					
Problem/n	SHCG-V3 NI/NF/T/ $\ g^*\ $	CG-Descent NI/NF/T/ $\ g^*\ $	FhDY NI/NF/T/ $\ g^*\ $	FHTTCGM-N NI/NF/T/ $\ g^*\ $	MP+ NI/NF/T/ $\ g^*\ $
dixmaana/3000	18/81/0.077/3.31e-07	24/77/0.054/6.47e-07	19/83/0.057/7.02e-08	24/88/0.060/6.83e-08	25/80/0.056/2.43e-07
dixmaana/30000	18/85/0.468/3.32e-07	31/88/0.469/8.56e-07	19/86/0.462/3.86e-07	20/86/0.467/6.58e-07	28/87/0.467/3.87e-07
dixmaana/600000	18/89/9.628/8.43e-07	24/92/9.951/2.34e-07	17/90/9.744/6.14e-07	17/91/9.869/7.71e-07	22/86/9.346/9.81e-07
dixmaanb/6000	20/80/0.123/6.54e-07	27/83/0.103/5.87e-07	16/82/0.102/2.89e-07	18/84/0.104/1.28e-07	22/78/0.097/6.67e-07
dixmaanb/15000	17/83/0.252/3.80e-07	27/79/0.233/9.37e-07	22/90/0.263/4.55e-09	20/88/0.259/7.29e-08	23/73/0.213/3.05e-07
dixmaanb/60000	19/88/0.886/2.81e-07	27/90/0.908/3.75e-07	23/98/1.015/9.52e-07	19/88/0.883/6.63e-07	25/80/0.807/9.71e-07
dixmaanc/3000	17/80/0.081/3.06e-07	26/82/0.054/3.01e-07	19/84/0.052/5.05e-07	18/83/0.052/6.29e-07	19/75/0.048/5.81e-08
dixmaanc/150000	24/93/2.558/3.22e-07	21/85/2.323/4.33e-07	20/95/2.600/6.35e-07	21/94/2.566/7.80e-07	26/91/2.505/9.73e-07
dixmaand/300000	18/92/4.964/3.90e-07	27/93/4.986/9.15e-07	17/80/4.309/8.83e-07	22/96/5.218/4.28e-07	28/93/5.056/1.66e-07
dixmaane/1500	314/410/0.155/7.47e-07	565/661/0.219/8.38e-07	338/649/0.248/6.50e-07	282/528/0.186/8.03e-07	632/704/0.230/8.56e-07
dixmaane/3000	387/495/0.313/7.90e-07	793/911/0.589/9.52e-07	423/798/0.516/9.58e-07	473/878/0.566/7.49e-07	933/1025/0.672/9.74e-07
dixmaane/15000	945/1167/3.532/9.58e-07	1907/2192/6.482/8.86e-07	880/1701/5.045/9.31e-07	810/1451/4.339/8.93e-07	NaN/NaN/NaN/NaN
dixmaanf/1500	284/385/0.174/8.66e-07	433/486/0.204/9.08e-07	266/535/0.221/9.65e-07	257/478/0.163/7.36e-07	521/583/0.184/9.97e-07
dixmaanf/3000	308/408/0.252/8.90e-07	534/608/0.377/9.03e-07	276/542/0.337/4.42e-07	338/621/0.385/7.47e-07	706/830/0.514/9.74e-07
dixmaanf/30000	724/906/4.978/8.85e-07	1804/1950/10.698/9.93e-07	912/1713/9.272/9.43e-07	947/1681/9.161/9.07e-07	NaN/NaN/NaN/NaN
dixmaang/300	137/202/0.034/8.91e-07	196/248/0.024/7.09e-07	124/254/0.023/6.19e-07	118/222/0.020/9.89e-07	177/233/0.020/7.87e-07
dixmaang/1500	270/357/0.142/6.57e-07	370/430/0.148/9.74e-07	272/521/0.163/6.91e-07	293/553/0.174/6.93e-07	512/573/0.185/9.51e-07
dixmaang/15000	1669/2109/6.397/7.24e-07	1221/1314/3.886/8.31e-07	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN	1865/1960/5.990/8.91e-07
dixmaanh/15000	841/1063/3.303/8.34e-07	1040/1167/3.505/9.25e-07	630/1218/3.616/7.63e-07	723/1336/3.999/8.39e-07	1654/1724/5.278/9.90e-07
dixmaanh/21000	772/966/3.906/9.45e-07	1436/1573/6.305/9.79e-07	912/1745/6.956/9.35e-07	754/1451/5.752/6.72e-07	NaN/NaN/NaN/NaN
dixmaanh/30000	1031/1282/7.106/7.48e-07	1432/1542/8.546/9.78e-07	1001/1912/10.434/9.86e-07	912/1692/9.228/8.92e-07	NaN/NaN/NaN/NaN
dixmaani/30	200/276/0.023/8.95e-07	421/508/0.012/7.93e-07	222/425/0.012/6.03e-07	202/363/0.010/9.82e-07	474/535/0.014/9.98e-07
dixmaani/90	580/740/0.035/9.24e-07	839/913/0.045/7.41e-07	513/943/0.045/9.64e-07	570/1002/0.045/7.07e-07	1574/1663/0.072/8.58e-07
dixmaani/210	1419/1749/0.112/9.14e-07	NaN/NaN/NaN/NaN	1416/2727/0.160/8.63e-07	1403/2551/0.150/7.56e-07	NaN/NaN/NaN/NaN
dixmaanj/6000	754/965/1.246/9.68e-07	1481/1670/2.128/7.11e-07	694/1307/1.608/7.85e-07	685/1223/1.540/7.44e-07	NaN/NaN/NaN/NaN
dixmaank/1500	277/375/0.172/8.31e-07	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN	1085/1914/0.606/7.35e-07	NaN/NaN/NaN/NaN
dixmaanl/300	848/1068/0.128/7.34e-07	NaN/NaN/NaN/NaN	1004/1896/0.156/9.47e-07	1142/2035/0.163/7.21e-07	NaN/NaN/NaN/NaN
dixmaanl/21000	1120/1422/5.735/9.47e-07	1282/1467/5.875/8.08e-07	1440/2796/11.100/9.16e-07	NaN/NaN/NaN/NaN	1865/1949/7.893/7.55e-07
dixmaanl/30000	989/1234/6.803/9.37e-07	1410/1570/8.598/8.03e-07	859/1635/8.829/8.41e-07	766/1394/7.563/6.61e-07	NaN/NaN/NaN/NaN
dixon3dq/50	345/450/0.022/8.31e-07	776/862/0.008/7.99e-07	616/1166/0.012/8.84e-07	584/1050/0.012/7.86e-07	1782/2074/0.022/9.81e-07
dixon3dq/100	999/1269/0.014/9.66e-07	NaN/NaN/NaN/NaN	821/1576/0.016/9.16e-07	1015/1810/0.016/8.60e-07	NaN/NaN/NaN/NaN
dixon3dq/150	1474/1817/0.019/7.25e-07	NaN/NaN/NaN/NaN	1363/2582/0.026/6.46e-07	1426/2507/0.024/6.75e-07	NaN/NaN/NaN/NaN
dqdrtic/10000	74/223/0.028/8.25e-07	152/258/0.019/3.02e-07	72/223/0.019/2.69e-07	96/250/0.024/3.08e-07	317/474/0.046/9.80e-07
dqdrtic/50000	68/204/0.067/6.92e-07	150/265/0.090/8.12e-07	62/210/0.065/5.14e-07	96/276/0.091/6.43e-07	294/447/0.170/8.98e-07
dqdrtic/150000	76/214/0.293/9.05e-07	149/263/0.338/3.43e-07	72/225/0.263/2.59e-07	120/325/0.438/9.01e-07	267/423/0.668/7.80e-07
dqrtic/5000	47/154/0.174/9.37e-07	62/157/0.158/4.63e-07	41/156/0.156/4.19e-07	39/147/0.170/4.61e-07	189/1248/1.254/9.25e-07
edensch/500	41/108/0.024/8.46e-07	74/399/0.040/9.74e-07	68/474/0.047/3.98e-07	31/95/0.011/4.45e-07	31/84/0.009/9.85e-07
edensch/20000	51/220/0.855/9.77e-07	120/849/3.255/9.79e-07	51/269/1.035/5.85e-07	72/429/1.657/7.25e-07	45/213/0.831/5.72e-07
edensch/120000	67/214/4.614/9.54e-07	111/827/17.787/8.11e-07	125/965/20.582/2.12e-07	49/235/5.059/4.99e-07	58/308/6.606/9.15e-07
eg2/100	289/970/0.032/4.42e-07	1057/6524/0.088/9.94e-07	538/1585/0.022/4.46e-07	476/1401/0.019/7.55e-07	NaN/NaN/NaN/NaN
eg2/200	356/2160/0.044/7.27e-07	NaN/NaN/NaN/NaN	1122/5148/0.101/8.30e-07	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN
eg2/500	1592/14367/0.551/4.70e-07	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN
fletcher/7000	168/1533/0.122/7.41e-07	179/1292/0.070/9.69e-07	391/3583/0.191/9.27e-07	380/3726/0.203/6.75e-07	255/2295/0.124/7.59e-07
freuroth/50	295/1518/0.036/6.01e-07	383/2205/0.026/8.64e-07	236/1585/0.018/9.83e-07	169/505/0.006/9.28e-07	NaN/NaN/NaN/NaN
freuroth/500	501/4097/0.065/4.33e-07	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN
freuroth/5000	1286/13047/0.926/7.78e-07	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN
genrose/10000	259/389/0.066/8.43e-07	302/418/0.052/8.30e-07	225/473/0.059/7.75e-07	218/433/0.045/9.95e-07	845/1051/0.115/8.56e-07
himmelbg/1000	2/13/0.017/7.55e-30	6/24/0.001/2.61e-08	2/13/0.001/7.57e-30	2/13/0.001/6.48e-30	9/17/0.001/1.49e-18
himmelbg/70000	2/15/0.033/8.37e-43	6/26/0.036/5.05e-200	2/15/0.029/8.41e-43	2/15/0.029/6.76e-43	11/42/0.062/0.00e+00
himmelbg/600000	3/16/0.266/1.31e-26	6/37/0.478/1.76e-30	3/16/0.254/8.54e-27	3/16/0.257/8.40e-27	5/17/0.287/4.37e-12
liarwhd/10000	128/522/0.053/7.65e-07	411/823/0.073/3.49e-07	176/628/0.033/5.48e-07	275/833/0.056/9.17e-07	1794/9193/0.551/9.26e-07
liarwhd/30000	107/465/0.088/8.59e-07	459/951/0.211/5.53e-08	201/732/0.136/2.54e-07	177/566/0.114/4.56e-07	NaN/NaN/NaN/NaN
liarwhd/120000	144/529/0.336/6.06e-07	391/836/0.525/5.75e-07	262/966/0.534/1.31e-07	278/824/0.490/7.49e-07	NaN/NaN/NaN/NaN
penalty1/100	19/109/0.018/9.20e-07	14/66/0.001/6.61e-07	18/107/0.002/2.82e-07	20/111/0.003/1.92e-07	14/66/0.001/6.62e-07
penalty1/10000	20/92/3.141/4.52e-07	65/281/9.639/4.56e-07	20/91/3.155/8.17e-07	20/91/3.169/1.61e-07	50/250/8.454/7.08e-07
quartc/5000	47/154/0.162/9.37e-07	62/157/0.154/4.63e-07	41/156/0.154/4.19e-07	39/147/0.154/4.61e-07	189/1248/1.235/9.25e-07
tridia/100	283/375/0.010/9.39e-07	809/940/0.010/9.75e-07	357/664/0.007/8.43e-07	384/689/0.008/7.67e-07	1195/1385/0.015/8.35e-07
tridia/300	497/626/0.008/7.81e-07	1702/1959/0.021/9.71e-07	564/1068/0.011/7.99e-07	543/1000/0.011/6.30e-07	NaN/NaN/NaN/NaN
tridia/1500	1572/1924/0.035/8.29e-07	NaN/NaN/NaN/NaN	1516/2941/0.048/7.80e-07	1575/2844/0.046/6.71e-07	NaN/NaN/NaN/NaN
woods/5000	168/407/0.039/6.03e-07	347/476/0.020/6.25e-07	263/640/0.025/7.03e-07	235/572/0.027/3.04e-07	711/1739/0.084/9.18e-07
woods/300000	196/519/1.441/4.89e-07	461/613/1.758/6.53e-07	376/910/2.352/8.20e-07	292/743/2.023/9.96e-07	932/2508/6.892/9.29e-07
woods/1000000	175/471/4.281/9.24e-07	341/493/4.411/9.18e-07	191/543/4.413/8.42e-07	277/778/7.002/4.65e-07	914/2429/21.798/8.70e-07
bdexp/1000	2/11/0.019/2.99e-133	6/25/0.002/1.76e-16	2/11/0.001/3.25e-133	2/11/0.001/2.09e-136	NaN/NaN/NaN/NaN
bdexp/10000	2/17/0.010/2.62e-61	7/21/0.011/7.59e-161	2/17/0.010/2.63e-61	2/17/0.010/1.36e-62	NaN/NaN/NaN/NaN
bdexp/100000	2/12/0.084/4.57e-106	6/22/0.108/5.22e-44	2/12/0.080/4.57e-106	2/12/0.082/4.51e-106	6/22/0.114/8.46e-38
exdenschnf/10000	32/105/0.033/6.59e-07	25/94/0.008/7.73e-07	25/99/0.011/4.94e-08	37/112/0.012/3.96e-07	27/95/0.009/8.85e-07
exdenschnb/3000	24/81/0.010/8.95e-07	28/82/0.004/6.56e-07	19/84/0.004/8.43e-09	26/89/0.004/4.60e-07	25/76/0.003/2.42e-07
exdenschnb/5000000	26/104/3.894/4.74e-07	34/106/3.501/3.53e-07	32/108/3.581/1.75e-07	31/108/3.680/2.72e-07	22/91/3.056/2.64e-07
genquartic/50000	22/93/0.060/4.56e-07	27/89/0.035/1.78e-08	24/116/0.043/3.82e-07	23/93/0.034/9.08e-07	23/85/0.031/5.06e-07
genquartic/100000	18/87/0.073/4.32e-07	32/95/0.074/9.65e-07	19/96/0.070/3.50e-07	24/92/0.058/5.18e-07	30/96/0.074/5.54e-07
biggsb1/250	1174/1444/0.034/8.00e-07	1912/2019/0.022/7.25e-07	1376/2566/0.026/9.56e-07	1322/2400/0.026/6.72e-07	NaN/NaN/NaN/NaN
biggsb1/500	1810/2189/0.028/1.00e-06	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN
fletcherb3/100	1277/3059/0.121/9.88e-07	1037/1324/0.047/5.49e-07	1931/3749/0.119/7.50e-07	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN
nonscomp/10000	177/359/0.055/7.39e-07	56/122/0.010/8.83e-07	NaN/NaN/NaN/NaN	192/410/0.035/3.32e-07	50/116/0.009/9.56e-07
nonscomp/70000	1586/2514/1.484/9.80e-07	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN
nonscomp/100000	1895/2914/2.344/8.57e-07	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN	NaN/NaN/NaN/NaN
power1/100	1322/1640/0.033/8.18e-07	NaN/NaN/NaN/NaN	1428/2671/0.030/8.23e-07	1185/2113/0.022/9.42e-07	NaN/NaN/NaN/NaN
raydan1/300	159/232/0.010/7.28e-07	299/370/0.006/4.73e-07	149/273/0.005/6.21e-07	147/276/0.005/9.58e-07	172/224/0.005/6.61e-07
raydan2/2000	14/67/0.008/5.34e-07	14/65/0.003/9.35e-07	14/71/0.005/7.00e-07	14/71/0.007/6.99e-07	14/64/0.006/2.58e-07
raydan2/70000	20/100/0.311/3.56e-08	21/75/0.236/1.28e-07	22/130/0.405/6.99e-07	17/105/0.332/6.01e-07	47/103/0.327/3.02e-07
diagonal1/250	350/2530/0.074/8.27e-07	789/6148/0.134/9.14e-07	449/3517/0.076/9.72e-07	275/1713/0.037/9.16e-07	896/8103/0.176/9.42e-07
diagonal2/500	160/275/0.013/9.54e-07	310/372/0.014/9.53e-07	159/311/0.012/9.06e-07	176/346/0.015/5.28e-07	653/2726/0.099/8.61e-07
diagonal2/5000	482/747/0.233/7.91e-07	1106/1235/0.374/8.59e-07	535/1012/0.302/9.26e-07	518/948/0.285/8.68e-07	NaN/NaN/NaN/NaN
diagonal2/10000	732/1121/0.707/9.88e-07	1750/2011/1.254/9.94e-07	752/1427/0.870/9.87e-07	718/1341/0.846/9.49e-07	NaN/NaN/NaN/NaN
singx/300	173/445/0.055/4.75e-07	725/1059/0.121/8.92e-07	286/671/0.062/5.32e-07	329/764/0.079/7.74e-07	NaN/NaN/NaN/NaN
singx/1000	412/1004/1.922/6.36e-07	895/1307/2.539/7.18e-07	633/1489/2.894/4.88e-07	565/1257/2.444/6.29e-07	NaN/NaN/NaN/NaN
singx/3000	175/4				