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add working path of tools and functions

```
%addpath(genpath('e:\research\Tools\spot-slim'))
% addpath(genpath('e:\research\Tools\pSPOT'))
cd ../../../../../pqnl1;
addpath(genpath(pwd))
rmpath(genpath('./minConF'))
cd ../experiments/help_spgl1/modifying/task12illconditioned
addpath(genpath(pwd))
cd ./convolution
rmpath('/Volumes/Users/linamiao/Dropbox/PQN/pqnl1/minConF/')
```

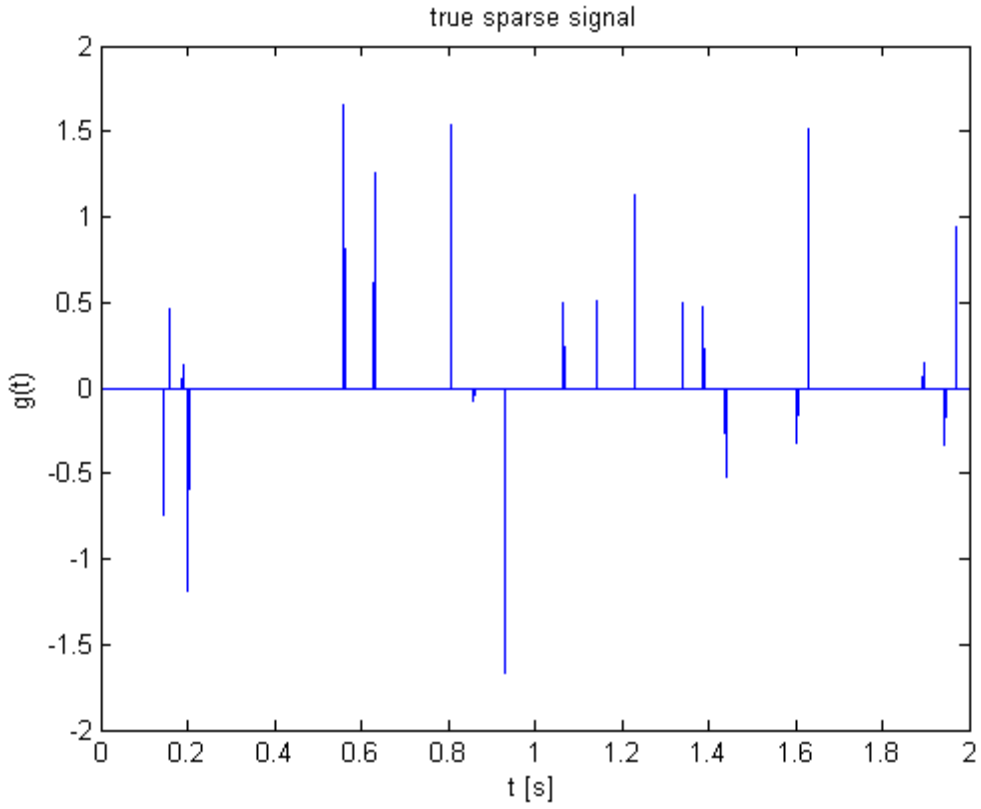
```
Warning: ".\minConF" not found in path.
Warning: ".\minConF\html" not found in path.
Warning:
"\Volumes\Users\linamiao\Dropbox\PQN\pqnl1\minConF" not
found in path.
```

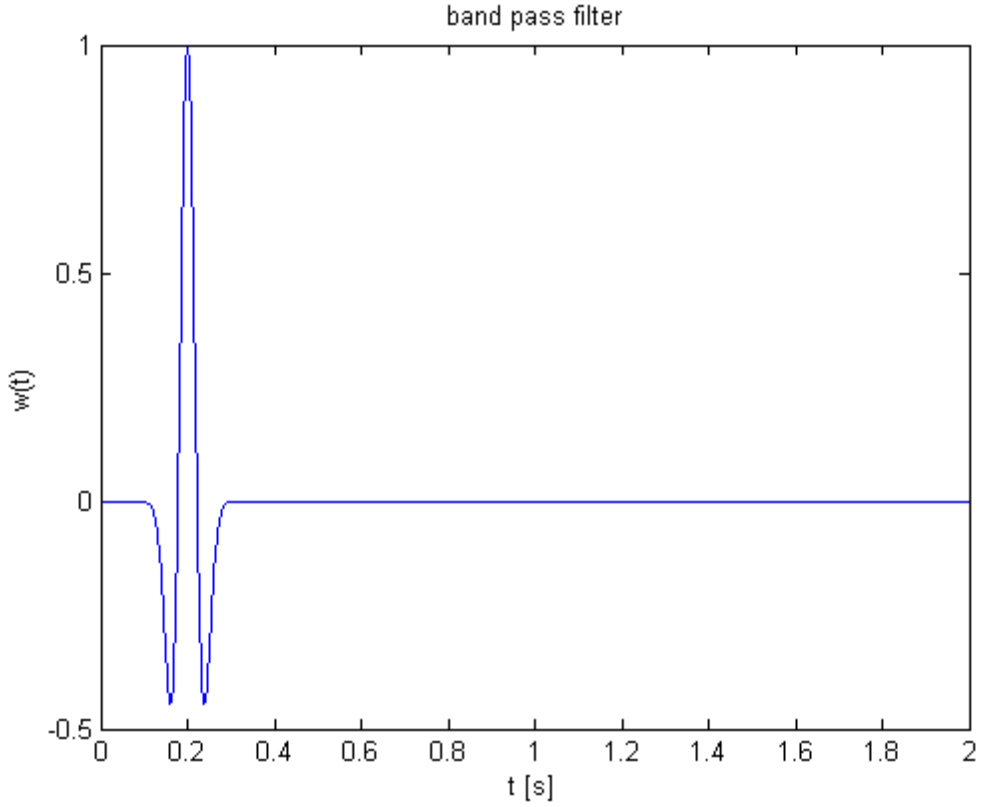
problem setting

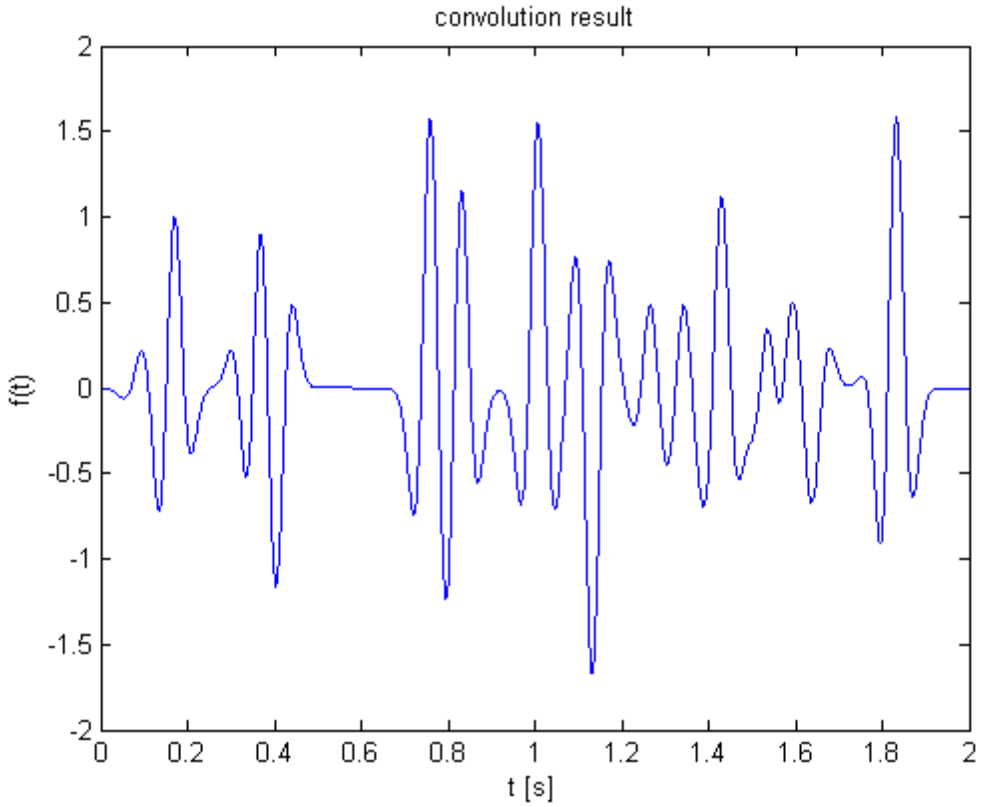
time axis

```
t = [0:.001:2]';
N = length(t);

% true signal g has approx k spikes with random amplitudes
k = 20;
g = zeros(N,1);
g(randi(N,k,1)) = randn(k,1);

% filter
w = (1-2*1e3*(t-.2).^2).*exp(-1e3*(t-.2).^2);

% plot
figure;
plot(t,g);
xlabel('t [s]');ylabel('g(t)');
title('true sparse signal')

figure;
plot(t,w);
xlabel('t [s]');ylabel('w(t)');
title('band pass filter')


% fourier transform of w
```

```
wf = fft(w);

% SPOT operator to perform convolution.
C = opDFT(N)'*opDiag(wf)*opDFT(N);
f = C*g;

% plot
figure;
plot(t,f);
xlabel('t [s]');ylabel('f(t)');
title('convolution result')
```




band pass filter
w(t)
t [s]
1
0.5
0
-0.5
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2


convolution result
f(t)
t [s]
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2

spgl1 and pqnl1

lasso

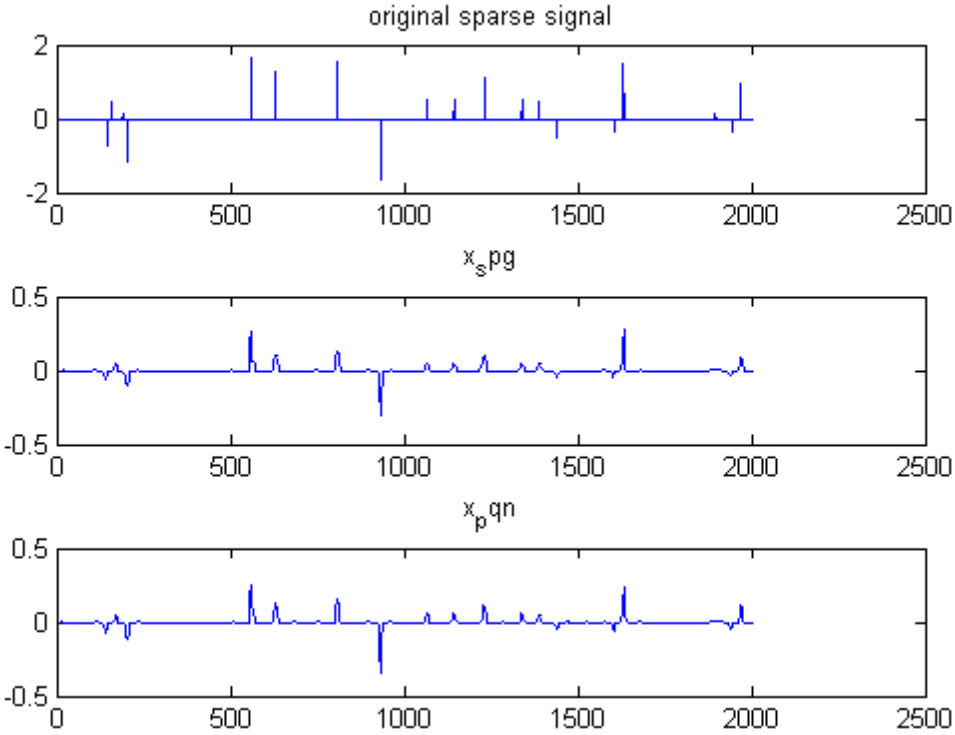
```
opts.iterations = 100;
tau = norm(g,1);

[x_spg,r_spg,g_spg,info_spg] = spgl1(C, f, tau, [], zeros(size(g)), opts);
[x_pqn,r_pqn,g_pqn,info_pqn] = pqnl1_2(C, f, tau, [], zeros(size(g)), opts);

figure;
subplot(3,1,1); plot(g); title('original sparse signal')
subplot(3,1,2); plot(x_spg);title('x_spg')
subplot(3,1,3); plot(x_pqn);title('x_pqn')
```

```
================================================================================
SPGL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
================================================================================
No. rows              :     2001      No. columns           :     2001
Initial tau           : 1.56e+001      Two-norm of b         : 2.26e+001
Optimality tol        : 1.00e-004      Target one-norm of x  : 1.56e+001
Basis pursuit tol     : 1.00e-006      Maximum iterations    :      100

 Iter      Objective   Relative Gap      gNorm   stepG    nnzX    nnzG
    0  2.2645313e+001  2.9494325e+000  4.85e+001     0.0       0       0
    1  1.8776891e+001  4.8799941e+000  4.75e+001    -0.3      23       0
    2  1.9394462e+001  7.5596761e+000  7.46e+001     0.0     368       0
    3  1.6045261e+001  7.7725249e+000  5.35e+001     0.0     762       0
    4  4.8711421e+000  1.2167068e+001  1.18e+001     0.0    1119       0
    5  3.4119268e+000  4.7277531e+000  4.11e+000     0.0    1063       0
    6  3.0042147e+000  4.4646305e+000  3.34e+000     0.0    1007       0
    7  1.9739365e+000  7.9157751e+000  2.18e+000     0.0     842       0
    8  2.0682892e+000  1.9952064e+001  3.48e+000     0.0     817       0
    9  2.9419648e+000  2.9664084e+001  9.59e+000     0.0     859       0
   10  1.4781236e+000  1.3299536e+001  1.85e+000     0.0     796       0
   11  1.3754619e+000  7.1049805e+000  1.37e+000     0.0     780       0
   12  1.3322292e+000  7.1134280e+000  1.33e+000     0.0     765       0
   13  1.1398846e+000  7.4482398e+000  1.24e+000     0.0     688       0
   14  1.0949871e+000  8.6926827e+000  1.30e+000    -0.3     683       0
   15  1.0661115e+000  1.1982020e+001  1.48e+000     0.0     674       0
   16  1.0388838e+000  5.1162391e+000  1.04e+000     0.0     669       0
   17  1.0186312e+000  5.0139361e+000  1.02e+000     0.0     664       0
   18  9.9566608e-001  4.2332343e+000  9.53e-001     0.0     661       0
   19  9.6585026e-001  1.2631348e+001  1.44e+000     0.0     641       0
   20  9.7409335e-001  1.7845686e+001  1.77e+000    -0.3     632       0
   21  9.1725308e-001  5.5867550e+000  9.83e-001     0.0     631       0
   22  9.0648131e-001  2.1543128e+000  7.53e-001     0.0     626       0
   23  8.8945943e-001  2.1672139e+000  7.40e-001     0.0     620       0
   24  6.7476980e-001  1.6708661e+001  1.36e+000     0.0     502       0
   25  7.7400512e-001  1.9226471e+001  1.64e+000    -0.3     510       0
   26  6.4892431e-001  1.3641303e+001  1.26e+000     0.0     509       0
   27  6.0569619e-001  1.9946960e+000  4.89e-001     0.0     507       0
   28  6.0059862e-001  1.2714380e+000  4.37e-001     0.0     507       0
   29  5.8910641e-001  1.6548856e+000  4.58e-001     0.0     503       0
   30  5.8539016e-001  1.1248513e+001  1.05e+000     0.0     516       0
   31  5.5261977e-001  3.3893330e+000  5.54e-001    -0.3     511       0
   32  5.4636270e-001  1.7998161e+000  4.45e-001     0.0     506       0
   33  5.4326357e-001  1.1057386e+000  3.97e-001     0.0     503       0
   34  5.3322303e-001  1.9913246e+000  4.45e-001     0.0     500       0
   35  5.2914537e-001  3.9012734e+000  5.65e-001    -0.3     499       0
```

36	5.4120367e-001	1.1657952e+001	1.05e+000	0.0	501	0
37	5.2307154e-001	4.1205431e+000	5.76e-001	0.0	497	0
38	5.1723605e-001	1.0250733e+000	3.72e-001	0.0	498	0
39	5.1536067e-001	8.9308973e-001	3.61e-001	0.0	498	0
40	4.8601558e-001	1.0126047e+000	3.55e-001	0.0	494	0
41	4.9172175e-001	9.1044765e+000	8.30e-001	-0.3	498	0
42	4.8010762e-001	3.5303543e+000	5.01e-001	-0.3	493	0
43	4.7517898e-001	1.5423907e+000	3.69e-001	0.0	494	0
44	4.7350303e-001	9.2211230e-001	3.29e-001	0.0	493	0
45	4.6954363e-001	6.9186986e-001	3.13e-001	0.0	492	0
46	4.5332590e-001	1.2906648e+001	1.03e+000	0.0	474	0
47	4.7046384e-001	1.2852216e+001	1.08e+000	-0.3	481	0
48	4.2454221e-001	3.0273691e+000	4.32e-001	0.0	477	0
49	4.1997155e-001	6.2320463e-001	2.72e-001	0.0	476	0
50	4.1858119e-001	6.7045367e-001	2.72e-001	0.0	476	0
51	4.0626870e-001	2.0445869e+000	3.52e-001	0.0	469	0
52	4.1611190e-001	6.4343625e+000	6.01e-001	-0.3	471	0
53	4.0271255e-001	3.1572940e+000	4.28e-001	0.0	467	0
54	3.9520887e-001	1.3209422e+000	2.92e-001	0.0	468	0
55	3.9392899e-001	7.6808916e-001	2.57e-001	0.0	469	0
56	3.9236141e-001	4.8433808e-001	2.37e-001	0.0	469	0
57	3.7428314e-001	2.3546791e+000	3.50e-001	0.0	455	0
58	3.7443408e-001	3.3572585e+000	3.99e-001	-0.3	458	0
59	3.6954026e-001	1.0533078e+000	2.61e-001	0.0	455	0
60	3.6850003e-001	4.7552958e-001	2.19e-001	0.0	455	0
61	3.6755264e-001	4.9816460e-001	2.20e-001	0.0	455	0
62	3.5445822e-001	2.2623903e+000	3.19e-001	0.0	445	0
63	3.6794970e-001	5.9901184e+000	5.74e-001	-0.3	449	0
64	3.5450448e-001	3.5407053e+000	4.05e-001	0.0	447	0
65	3.5006704e-001	6.8403235e-001	2.20e-001	0.0	448	0
66	3.4945448e-001	4.7928156e-001	2.05e-001	0.0	448	0
67	3.4623251e-001	4.8693773e-001	2.03e-001	0.0	447	0
68	3.4469985e-001	1.9790504e+000	2.94e-001	-0.3	448	0
69	3.4515734e-001	1.7423995e+000	2.84e-001	-0.3	444	0
70	3.4202089e-001	1.1578532e+000	2.43e-001	0.0	445	0
71	3.4125379e-001	4.1466166e-001	1.95e-001	0.0	445	0
72	3.4051593e-001	3.9603100e-001	1.93e-001	0.0	445	0
73	3.0491475e-001	3.2767023e+000	3.52e-001	0.0	425	0
74	3.0562183e-001	3.2170111e+000	3.43e-001	-0.3	434	0
75	2.9545390e-001	1.3513436e+000	2.31e-001	0.0	427	0
76	2.9343348e-001	5.9842678e-001	1.75e-001	0.0	429	0
77	2.9290749e-001	4.8922161e-001	1.67e-001	0.0	428	0
78	2.9015425e-001	4.2245474e-001	1.54e-001	0.0	429	0
79	2.9062132e-001	1.8774976e+000	2.65e-001	-0.3	427	0
80	2.9267023e-001	2.9798518e+000	3.04e-001	-0.3	429	0
81	2.8679601e-001	7.4835815e-001	1.80e-001	0.0	426	0
82	2.8610950e-001	3.4169368e-001	1.49e-001	0.0	427	0
83	2.8572767e-001	2.9149238e-001	1.46e-001	0.0	426	0
84	2.7892935e-001	6.3525255e-001	1.61e-001	0.0	424	0
85	2.8069205e-001	2.1761998e+000	2.64e-001	-0.3	422	0
86	2.7732659e-001	7.0767514e-001	1.72e-001	-0.3	421	0
87	2.7623102e-001	5.4451913e-001	1.56e-001	0.0	421	0
88	2.7585576e-001	2.4821454e-001	1.38e-001	0.0	421	0
89	2.7526080e-001	2.6860777e-001	1.38e-001	0.0	421	0
90	2.7338176e-001	1.6736696e+000	2.33e-001	0.0	417	0
91	2.6830446e-001	1.0641051e+000	1.82e-001	-0.3	418	0
92	2.6745271e-001	3.7933332e-001	1.40e-001	0.0	418	0
93	2.6718283e-001	3.0577791e-001	1.34e-001	0.0	418	0
94	2.6651313e-001	3.5359478e-001	1.37e-001	0.0	417	0
95	2.6590882e-001	1.8026232e+000	2.21e-001	-0.3	417	0
96	2.6344037e-001	6.2650185e-001	1.58e-001	-0.3	416	0
97	2.6296169e-001	3.3103893e-001	1.34e-001	0.0	416	0
98	2.6270367e-001	3.1316992e-001	1.33e-001	0.0	416	0
99	2.6141106e-001	4.1182473e-001	1.36e-001	0.0	415	0

```
  100  2.6121201e-001  1.1436003e+000  1.89e-001    -0.3     413       0

 ERROR EXIT -- Too many iterations

 Products with A     :     140        Total time   (secs) :     0.7
 Products with A'    :     101        Project time (secs) :     0.1
 Newton iterations   :       0        Mat-vec time (secs) :     0.5
 Line search its     :      71        Subspace iterations :       0


 ================================================================================
 PQNL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
 ================================================================================
 No. rows              :     2001      No. columns           :     2001
 Initial tau           : 1.56e+001      Two-norm of b         : 2.26e+001
 Optimality tol        : 1.00e-004      Target one-norm of x  : 1.56e+001
 Basis pursuit tol     : 1.00e-006      Maximum iterations    :      100

  Iter      Objective   Relative Gap      gNorm   stepG    nnzX    nnzG
     0  2.2645313e+001  2.9494325e+000  4.85e+001     0.0       0       0
Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        Opt Cond
         1          1           4    2.50000e-001    1.88963e+001    1.94800e+001
         2          1          54    1.00000e+000    6.43914e+000    3.08723e+001
         3          1          93    1.00000e+000    4.95773e+000    2.91748e+001
         4          1         134    1.00000e+000    3.74552e+000    2.92408e+001
         5          1         161    1.00000e+000    2.90773e+000    2.66553e+001
         6          1         200    1.00000e+000    2.23657e+000    2.57576e+001
         7          1         235    1.00000e+000    1.91208e+000    2.44644e+001
         8          1         272    1.00000e+000    1.66764e+000    2.32200e+001
         9          1         315    1.00000e+000    1.44081e+000    2.25119e+001
        10          1         352    1.00000e+000    1.21722e+000    1.99309e+001
        11          1         394    1.00000e+000    1.08479e+000    1.72984e+001
        12          1         436    1.00000e+000    9.89065e-001    1.53690e+001
        13          1         469    1.00000e+000    8.90853e-001    1.41033e+001
        14          1         504    1.00000e+000    8.13831e-001    1.37043e+001
        15          1         543    1.00000e+000    7.62573e-001    1.22500e+001
        16          1         594    1.00000e+000    6.99145e-001    1.23110e+001
        17          1         645    1.00000e+000    6.56325e-001    1.15205e+001
        18          1         698    1.00000e+000    6.05557e-001    1.13585e+001
        19          1         760    1.00000e+000    5.65197e-001    1.03104e+001
        20          1         812    1.00000e+000    5.25313e-001    9.24461e+000
        21          1         849    1.00000e+000    5.01150e-001    8.49573e+000
        22          1         905    1.00000e+000    4.78754e-001    1.11613e+001
        23          1         938    1.00000e+000    4.56491e-001    1.25151e+001
        24          1         984    1.00000e+000    4.32863e-001    9.10706e+000
        25          1        1033    1.00000e+000    4.14822e-001    9.20458e+000
        26          1        1081    1.00000e+000    4.03798e-001    9.35979e+000
        27          1        1154    1.00000e+000    3.87043e-001    8.74426e+000
        28          1        1214    1.00000e+000    3.74406e-001    8.50772e+000
        29          1        1276    1.00000e+000    3.64840e-001    7.60408e+000
        30          1        1328    1.00000e+000    3.57169e-001    9.30376e+000
        31          1        1416    1.00000e+000    3.47370e-001    1.22706e+001
        32          1        1565    1.00000e+000    3.33640e-001    1.35564e+001
        33          1        1662    1.00000e+000    3.22727e-001    1.03813e+001
        34          1        1738    1.00000e+000    3.12505e-001    5.84699e+000
        35          1        1829    1.00000e+000    3.06153e-001    6.31949e+000
        36          1        1925    1.00000e+000    2.96649e-001    5.84227e+000
        37          1        2013    1.00000e+000    2.89638e-001    5.52742e+000
        38          1        2069    1.00000e+000    2.81169e-001    6.02468e+000
        39          1        2136    1.00000e+000    2.74149e-001    6.14528e+000
        40          1        2231    1.00000e+000    2.67506e-001    5.52781e+000
        41          1        2318    1.00000e+000    2.62973e-001    4.87220e+000
        42          1        2419    1.00000e+000    2.57505e-001    4.67060e+000
```

```
      43          1       2482    1.00000e+000    2.53572e-001    4.11459e+000
      44          1       2540    1.00000e+000    2.50129e-001    3.52126e+000
      45          1       2603    1.00000e+000    2.46388e-001    5.36360e+000
      46          1       2670    1.00000e+000    2.42207e-001    6.89069e+000
      47          1       2749    1.00000e+000    2.38209e-001    6.20254e+000
      48          1       2876    1.00000e+000    2.31407e-001    5.70848e+000
      49          1       2987    1.00000e+000    2.24343e-001    6.27225e+000
      50          1       3084    1.00000e+000    2.17897e-001    5.15739e+000
      51          1       3215    1.00000e+000    2.09360e-001    3.89798e+000
      52          1       3279    1.00000e+000    2.06051e-001    4.01823e+000
      53          1       3358    1.00000e+000    2.02382e-001    4.24092e+000
      54          1       3431    1.00000e+000    1.99498e-001    3.57918e+000
      55          1       3484    1.00000e+000    1.96936e-001    3.17061e+000
      56          1       3569    1.00000e+000    1.93877e-001    3.79097e+000
      57          1       3603    1.00000e+000    1.92137e-001    3.41969e+000
      58          1       3696    1.00000e+000    1.88206e-001    3.01527e+000
      59          1       3793    1.00000e+000    1.84486e-001    3.17005e+000
      60          1       3813    1.00000e+000    1.83013e-001    2.73076e+000
      61          1       3871    1.00000e+000    1.81119e-001    3.25828e+000
      62          1       3940    1.00000e+000    1.79604e-001    3.53079e+000
      63          1       4009    1.00000e+000    1.77164e-001    3.26749e+000
      64          1       4066    1.00000e+000    1.75353e-001    3.08693e+000
      65          1       4130    1.00000e+000    1.73632e-001    3.22444e+000
      66          1       4197    1.00000e+000    1.71655e-001    3.33909e+000
      67          1       4263    1.00000e+000    1.70256e-001    2.72990e+000
      68          1       4317    1.00000e+000    1.69089e-001    2.13853e+000
      69          1       4369    1.00000e+000    1.68266e-001    2.72189e+000
      70          1       4413    1.00000e+000    1.67154e-001    3.83586e+000
      71          1       4455    1.00000e+000    1.66239e-001    3.82867e+000
      72          1       4523    1.00000e+000    1.64247e-001    2.56957e+000
      73          1       4564    1.00000e+000    1.62921e-001    2.35973e+000
      74          1       4630    1.00000e+000    1.61320e-001    1.91743e+000
      75          1       4680    1.00000e+000    1.59438e-001    1.83681e+000
      76          1       4719    1.00000e+000    1.58639e-001    1.93105e+000
      77          1       4776    1.00000e+000    1.57796e-001    2.14427e+000
      78          1       4820    1.00000e+000    1.57024e-001    1.79408e+000
      79          1       4900    1.00000e+000    1.55538e-001    1.67845e+000
      80          1       4997    1.00000e+000    1.52174e-001    2.09069e+000
      81          1       5170    1.00000e+000    1.46937e-001    2.66195e+000
      82          1       5323    1.00000e+000    1.41216e-001    2.70069e+000
      83          1       5366    1.00000e+000    1.39591e-001    2.00095e+000
      84          1       5425    1.00000e+000    1.38485e-001    1.60459e+000
      85          1       5452    1.00000e+000    1.38079e-001    1.46284e+000
      86          1       5524    1.00000e+000    1.36615e-001    3.35872e+000
      87          1       5531    1.00000e+000    1.36332e-001    1.88522e+000
      88          1       5574    1.00000e+000    1.35495e-001    1.33698e+000
      89          1       5618    1.00000e+000    1.34990e-001    1.45858e+000
      90          1       5692    1.00000e+000    1.33691e-001    1.65416e+000
      91          1       5724    1.00000e+000    1.33109e-001    1.67949e+000
      92          1       5785    1.00000e+000    1.32199e-001    1.54889e+000
      93          1       5828    1.00000e+000    1.30856e-001    1.51711e+000
      94          1       5839    1.00000e+000    1.30611e-001    1.14289e+000
      95          1       5883    1.00000e+000    1.29657e-001    1.58833e+000
      96          1       5899    1.00000e+000    1.29396e-001    1.10613e+000
      97          1       5972    1.00000e+000    1.27827e-001    1.40269e+000
      98          1       6115    1.00000e+000    1.25013e-001    1.60522e+000
      99          1       6143    1.00000e+000    1.24412e-001    1.19403e+000
     100          1       6185    1.00000e+000    1.23720e-001    1.17072e+000
  100  1.2372032e-001  1.3654918e-001  4.32e-002     0.0     362       0
ERROR EXIT -- Too many iterations

Products with A     :     104        Total time   (secs) :    16.3
Products with A'    :     104        Project time (secs) :    14.7
Newton iterations   :       0        Mat-vec time (secs) :     0.5
```



BPDN

noisy signal

```
f = C*g+ 1e-2*randn(N,1);

% plot
figure;
plot(t,f);
xlabel('t [s]');ylabel('f(t)');
title('convolution result')

opts.iterations = 100;


[x_spg,r_spg,g_spg,info_spg] = spgl1(C, f, 0, 1e-2, zeros(size(g)), opts);
[x_pqn,r_pqn,g_pqn,info_pqn] = pqnl1_2(C, f, 0, 1-2, zeros(size(g)), opts);

figure;
subplot(3,1,1); plot(g); title('original sparse signal')
subplot(3,1,2); plot(x_spg);title('x_spg')
subplot(3,1,3); plot(x_pqn);title('x_pqn')

figure('Name','Solution paths')
plot(info_spg.xNorm1,info_spg.rNorm2,info_pqn.xNorm1,info_pqn.rNorm2);hold on
scatter(info_spg.xNorm1,info_spg.rNorm2);
scatter(info_pqn.xNorm1,info_pqn.rNorm2);hold off
```

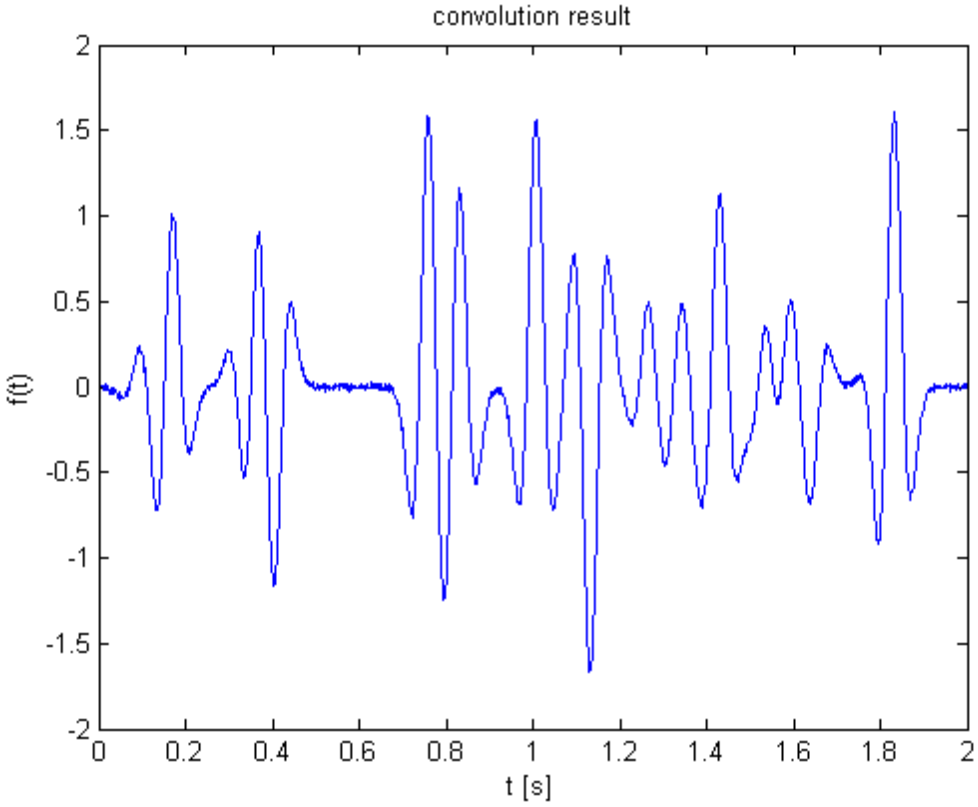
```
legend('spg','pqn')
axis tight
```

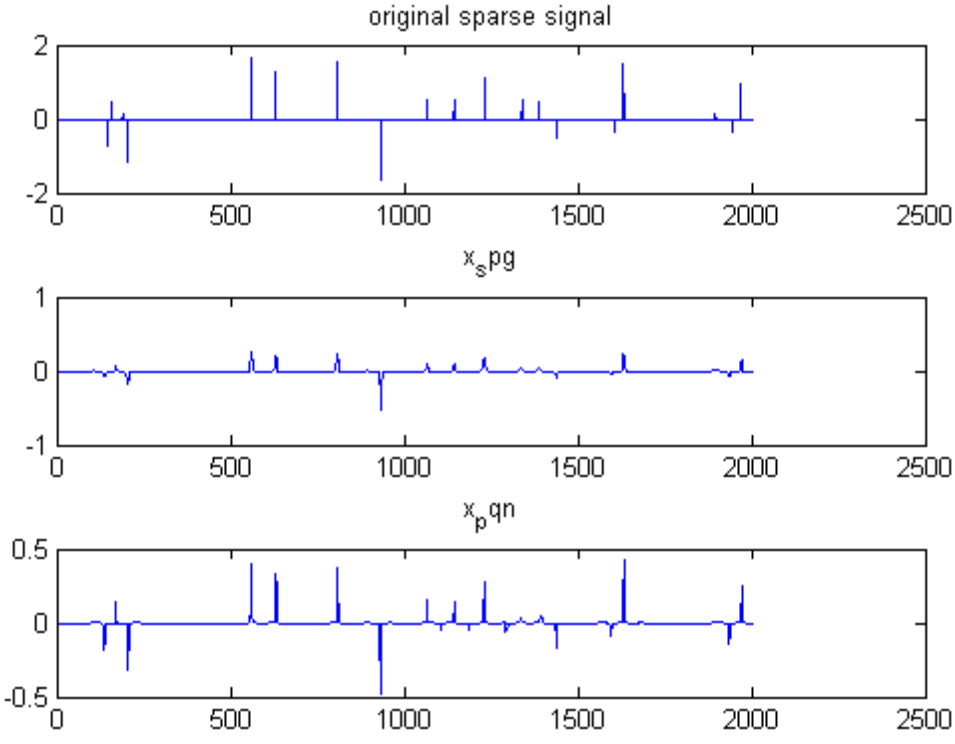
```
================================================================================
SPGL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
================================================================================
No. rows              :     2001      No. columns           :     2001
Initial tau           : 0.00e+000      Two-norm of b         : 2.27e+001
Optimality tol        : 1.00e-004      Target objective      : 1.00e-002
Basis pursuit tol     : 1.00e-006      Maximum iterations    :      100

 Iter      Objective   Relative Gap  Rel Error      gNorm   stepG    nnzX    nnzG
    0  2.2653829e+001  0.0000000e+000  1.00e+000  4.857e+001     0.0       0
    1  2.1539742e+001  2.5053147e+000  1.00e+000  4.755e+001    -0.3       1
    2  2.1945525e+001  4.5039507e+000  1.00e+000  6.067e+001     0.0      64
    3  1.3015228e+001  2.7336742e+000  9.99e-001  2.707e+001    -0.3     238
    4  8.9481166e+000  3.4466186e+000  9.99e-001  1.756e+001     0.0     453
    5  7.6772763e+000  1.8196608e+000  9.99e-001  1.320e+001     0.0     444
    6  7.0711798e+000  2.0411517e+000  9.99e-001  1.214e+001     0.0     413
    7  6.5625362e+000  1.3708150e+000  9.98e-001  1.075e+001     0.0     378
    8  6.4224922e+000  3.7827647e+000  9.98e-001  1.470e+001     0.0     351
    9  6.3378483e+000  2.9081220e+000  9.98e-001  1.336e+001     0.0     320
   10  6.1671065e+000  1.5393709e+000  9.98e-001  1.054e+001     0.0     329
   11  6.1283601e+000  8.1179270e-001  9.98e-001  9.217e+000     0.0     318
   12  6.0684023e+000  7.4350472e-001  9.98e-001  9.046e+000     0.0     299
   13  5.8955071e+000  1.3759245e+000  9.98e-001  9.948e+000     0.0     196
   14  5.7943583e+000  9.0793147e-001  9.98e-001  9.048e+000    -0.3     212
   15  5.7510872e+000  4.5987525e-001  9.98e-001  8.490e+000     0.0     207
   16  5.7390312e+000  2.9508745e-001  9.98e-001  8.170e+000     0.0     203
   17  5.7232635e+000  3.0532273e-001  9.98e-001  8.178e+000     0.0     201
   18  5.7213778e+000  2.0532600e+000  9.98e-001  1.068e+001     0.0     183
   19  5.6866066e+000  2.3590914e-001  9.98e-001  7.995e+000    -0.3     211
   20  5.6793217e+000  3.5216926e-001  9.98e-001  8.158e+000     0.0     198
   21  5.6712292e+000  2.7335622e-001  9.98e-001  8.045e+000     0.0     192
   22  5.6556886e+000  7.0342383e-001  9.98e-001  8.602e+000     0.0     172
   23  5.6485594e+000  2.0366325e-001  9.98e-001  7.911e+000    -0.3     177
   24  5.6442907e+000  2.1630401e-001  9.98e-001  7.908e+000     0.0     172
   25  5.6397189e+000  1.9905938e-001  9.98e-001  7.890e+000     0.0     171
   26  5.6229640e+000  6.7155804e-001  9.98e-001  8.541e+000     0.0     162
   27  5.6252771e+000  2.9233220e-001  9.98e-001  8.037e+000    -0.3     169
   28  5.6140753e+000  2.8217972e-001  9.98e-001  7.975e+000     0.0     161
   29  5.6114538e+000  1.6027372e-001  9.98e-001  7.803e+000     0.0     159
   30  5.6053517e+000  1.4196301e-001  9.98e-001  7.768e+000     0.0     155
   31  5.5722997e+000  1.2453964e+000  9.98e-001  9.242e+000    -0.3     125
   32  5.5613695e+000  5.8866510e-001  9.98e-001  8.294e+000    -0.3     138
   33  5.5406642e+000  3.5814175e-001  9.98e-001  8.025e+000     0.0     131
   34  5.5379695e+000  1.2432341e-001  9.98e-001  7.663e+000     0.0     126
   35  5.5366953e+000  9.6422682e-002  9.98e-001  7.626e+000     0.0     128
   36  5.5301037e+000  2.7880167e-001  9.98e-001  7.875e+000     0.0     124
   37  5.5300422e+000  2.0436936e-001  9.98e-001  7.800e+000    -0.3     127
   38  2.5030243e+000  2.0874012e+001  9.96e-001  4.164e+000     0.0     538
   39  1.9900975e+000  9.3735668e+000  9.95e-001  3.045e+000     0.0     838
   40  1.7084173e+000  1.1276363e+001  9.94e-001  2.108e+000     0.0     740
   41  1.6419438e+000  9.4318367e+000  9.94e-001  1.914e+000     0.0     736
   42  1.5324760e+000  9.0884197e+000  9.93e-001  1.812e+000     0.0     689
   43  1.4105912e+000  3.4845627e+001  9.93e-001  3.355e+000     0.0     547
   44  1.3293368e+000  6.5315443e+000  9.92e-001  1.477e+000    -0.3     554
   45  1.3095864e+000  4.5738073e+000  9.92e-001  1.328e+000     0.0     542
   46  1.2950123e+000  2.8765273e+000  9.92e-001  1.201e+000     0.0     540
   47  1.2378355e+000  8.7045155e+000  9.92e-001  1.556e+000     0.0     496
   48  1.3007029e+000  3.0844659e+001  9.92e-001  3.087e+000    -0.3     490
   49  1.2577326e+000  2.3570587e+001  9.92e-001  2.568e+000     0.0     482
   50  1.2033508e+000  4.6429863e+000  9.92e-001  1.264e+000     0.0     475
```

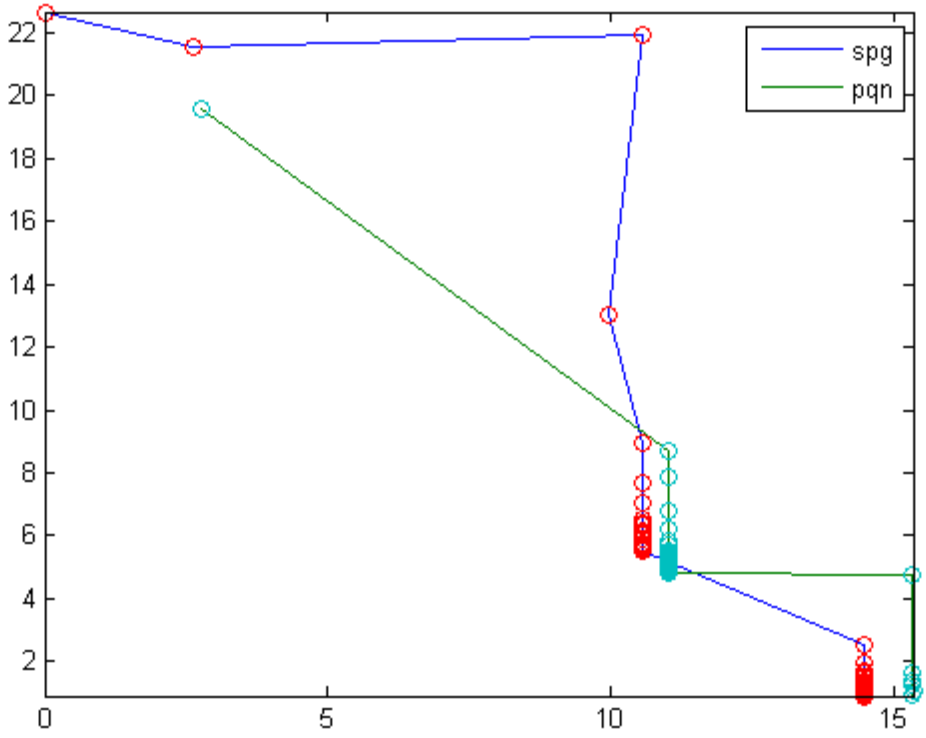
```
  51  1.1973516e+000  2.7606393e+000  9.92e-001  1.125e+000     0.0     474
  52  1.1872620e+000  2.6206209e+000  9.92e-001  1.107e+000     0.0     462
  53  1.1307990e+000  1.5887124e+001  9.91e-001  1.971e+000     0.0     337
  54  1.1066290e+000  7.0454559e+000  9.91e-001  1.405e+000    -0.3     346
  55  1.0895973e+000  4.1964280e+000  9.91e-001  1.173e+000     0.0     336
  56  1.0851709e+000  1.2213389e+000  9.91e-001  9.650e-001     0.0     334
  57  1.0828656e+000  1.1972088e+000  9.91e-001  9.578e-001     0.0     331
  58  1.0669274e+000  5.5060804e+000  9.91e-001  1.226e+000     0.0     328
  59  1.0662451e+000  6.1906129e+000  9.91e-001  1.277e+000    -0.3     326
  60  1.0620657e+000  3.7805691e+000  9.91e-001  1.111e+000     0.0     328
  61  1.0596490e+000  1.5376901e+000  9.91e-001  9.525e-001     0.0     321
  62  1.0582505e+000  1.0966667e+000  9.91e-001  9.220e-001     0.0     320
  63  1.0437502e+000  2.5248775e+000  9.90e-001  1.011e+000     0.0     312
  64  1.0494401e+000  1.0341956e+001  9.90e-001  1.559e+000    -0.3     313
  65  1.0529689e+000  1.1102447e+001  9.91e-001  1.605e+000     0.0     303
  66  1.0378969e+000  2.6053913e+000  9.90e-001  1.021e+000     0.0     308
  67  1.0358707e+000  1.1113317e+000  9.90e-001  9.123e-001     0.0     308
  68  1.0345859e+000  1.0803532e+000  9.90e-001  9.090e-001     0.0     307
  69  1.0100182e+000  5.4351502e+000  9.90e-001  1.254e+000     0.0     266
  70  9.9294631e-001  3.6824102e+000  9.83e-001  1.091e+000    -0.3     268
  71  9.8296626e-001  3.3244990e+000  9.73e-001  1.043e+000     0.0     265
  72  9.7967681e-001  1.4402224e+000  9.70e-001  9.147e-001     0.0     265
  73  9.7833766e-001  7.5514084e-001  9.68e-001  8.627e-001     0.0     265
  74  9.7576340e-001  8.1060745e-001  9.66e-001  8.628e-001     0.0     263
  75  9.7519971e-001  7.5291769e+000  9.65e-001  1.316e+000     0.0     259
  76  9.6835172e-001  9.4105252e-001  9.58e-001  8.739e-001    -0.3     257
  77  9.6695920e-001  1.2534387e+000  9.57e-001  8.862e-001     0.0     257
  78  9.6585036e-001  6.9930414e-001  9.56e-001  8.475e-001     0.0     256
  79  9.6125114e-001  1.0795349e+000  9.51e-001  8.642e-001     0.0     253
  80  9.5991242e-001  2.0840159e+000  9.50e-001  9.464e-001    -0.3     252
  81  9.6194278e-001  7.3780610e+000  9.52e-001  1.296e+000    -0.3     253
  82  9.5759164e-001  2.2120235e+000  9.48e-001  9.529e-001     0.0     251
  83  9.5445143e-001  1.3222274e+000  9.44e-001  8.805e-001     0.0     251
  84  9.5381269e-001  6.6290617e-001  9.44e-001  8.345e-001     0.0     251
  85  9.5156471e-001  8.3952199e-001  9.42e-001  8.468e-001     0.0     249
  86  9.4991006e-001  3.5507123e+000  9.40e-001  1.026e+000    -0.3     248
  87  9.4801263e-001  1.1268133e+000  9.38e-001  8.646e-001    -0.3     248
  88  9.4735026e-001  7.9674917e-001  9.37e-001  8.396e-001     0.0     248
  89  9.4643154e-001  6.7615153e-001  9.36e-001  8.318e-001     0.0     247
  90  9.4329576e-001  5.7559944e+000  9.33e-001  1.173e+000     0.0     238
  91  9.4405378e-001  5.6211564e+000  9.34e-001  1.176e+000    -0.3     239
  92  9.3939482e-001  1.7954881e+000  9.29e-001  9.035e-001     0.0     238
  93  9.3860944e-001  5.8425965e-001  9.29e-001  8.186e-001     0.0     237
  94  9.3809984e-001  5.8439282e-001  9.28e-001  8.184e-001     0.0     237
  95  9.2655311e-001  3.8033969e+000  9.17e-001  1.066e+000     0.0     223
  96  9.3008758e-001  8.9404482e+000  9.20e-001  1.375e+000    -0.3     225
  97  9.2712345e-001  6.4216582e+000  9.17e-001  1.219e+000     0.0     228
  98  9.1414281e-001  3.5761182e+000  9.04e-001  1.015e+000     0.0     223
  99  9.1182405e-001  6.8432291e-001  9.02e-001  8.090e-001     0.0     224
 100  9.1133996e-001  5.2656535e-001  9.01e-001  7.969e-001     0.0     224

ERROR EXIT -- Too many iterations

Products with A     :     143        Total time   (secs) :     0.8
Products with A'    :     101        Project time (secs) :     0.1
Newton iterations   :       2        Mat-vec time (secs) :     0.5
Line search its     :      72        Subspace iterations :       0


================================================================================
PQNL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
================================================================================
No. rows              :     2001      No. columns           :     2001
Initial tau           : 0.00e+000      Two-norm of b         : 2.27e+001
```

```
 Optimality tol        : 1.00e-004      Target objective      : -1.00e+000
 Basis pursuit tol     : 1.00e-006      Maximum iterations    :      100

     0  2.2653829e+001  0.0000000e+000  1.04e+000  4.857e+001     0.0       0

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2         Opt Cond
         1          1           4    2.50000e-001    1.95410e+001    1.37914e+001
         2          1          37    1.00000e+000    8.72147e+000    2.01963e+001
         3          1          60    1.00000e+000    7.87001e+000    2.04149e+001
         4          1          89    1.00000e+000    6.80721e+000    1.99116e+001
         5          1         116    1.00000e+000    6.18932e+000    1.73701e+001
         6          1         143    1.00000e+000    5.86912e+000    1.69641e+001
         7          1         170    1.00000e+000    5.68653e+000    1.73610e+001
         8          1         195    1.00000e+000    5.54593e+000    1.64133e+001
         9          1         216    1.00000e+000    5.43221e+000    1.39788e+001
        10          1         240    1.00000e+000    5.36403e+000    1.36777e+001
        11          1         266    1.00000e+000    5.30710e+000    1.31236e+001
        12          1         290    1.00000e+000    5.25375e+000    1.24564e+001
        13          1         316    1.00000e+000    5.21921e+000    1.17837e+001
        14          1         348    1.00000e+000    5.17607e+000    1.04996e+001
        15          1         372    1.00000e+000    5.15471e+000    1.06717e+001
        16          1         408    1.00000e+000    5.12554e+000    1.06730e+001
        17          1         436    1.00000e+000    5.09687e+000    9.80724e+000
        18          1         462    1.00000e+000    5.07937e+000    9.03638e+000
        19          1         496    1.00000e+000    5.06779e+000    8.83850e+000
        20          1         522    1.00000e+000    5.05410e+000    8.28314e+000
        21          1         560    1.00000e+000    5.02884e+000    8.88169e+000
        22          1         594    1.00000e+000    5.01403e+000    8.85173e+000
        23          1         628    1.00000e+000    5.00301e+000    8.27836e+000
        24          1         656    1.00000e+000    4.99622e+000    7.39837e+000
        25          1         696    1.00000e+000    4.98468e+000    8.74229e+000
        26          1         734    1.00000e+000    4.97695e+000    8.96922e+000
        27          1         779    1.00000e+000    4.96448e+000    8.11239e+000
        28          1         817    1.00000e+000    4.95806e+000    7.50045e+000
        29          1         865    1.00000e+000    4.94659e+000    7.20714e+000
        30          1         906    1.00000e+000    4.94183e+000    7.56886e+000
        31          1         961    1.00000e+000    4.93514e+000    7.64929e+000
        32          1         993    1.00000e+000    4.93137e+000    7.23914e+000
        33          1        1027    1.00000e+000    4.92590e+000    7.21247e+000
        34          1        1065    1.00000e+000    4.92302e+000    6.80827e+000
        35          1        1146    1.00000e+000    4.91488e+000    7.66149e+000
        36          1        1187    1.00000e+000    4.91063e+000    8.24783e+000
        37          1        1240    1.00000e+000    4.90279e+000    9.36629e+000
        38          1        1284    1.00000e+000    4.89884e+000    9.22215e+000
        39          1        1327    1.00000e+000    4.89451e+000    8.25664e+000
        40          1        1379    1.00000e+000    4.89004e+000    6.42364e+000
        41          1        1420    1.00000e+000    4.88460e+000    7.25058e+000
        42          1        1475    1.00000e+000    4.87941e+000    9.09805e+000
        43          1        1515    1.00000e+000    4.87753e+000    8.73137e+000
        44          1        1565    1.00000e+000    4.87412e+000    8.24319e+000
        45          1        1594    1.00000e+000    4.87288e+000    7.72510e+000
        46          1        1637    1.00000e+000    4.87004e+000    5.80899e+000
        47          1        1713    1.00000e+000    4.86608e+000    7.17227e+000
        48          1        1753    1.00000e+000    4.86492e+000    7.64816e+000
        49          1        1846    1.00000e+000    4.86087e+000    8.91781e+000
        50          1        1912    1.00000e+000    4.85840e+000    8.53143e+000
        51          1        1977    1.00000e+000    4.85398e+000    6.75271e+000
        52          1        2129    1.00000e+000    4.84570e+000    8.19297e+000
        53          1        2162    1.00000e+000    4.84411e+000    7.29876e+000
        54          1        2214    1.00000e+000    4.84219e+000    6.00265e+000
        55          1        2257    1.00000e+000    4.84069e+000    5.56476e+000
        56          1        2308    1.00000e+000    4.83869e+000    5.96414e+000
        57          1        2369    1.00000e+000    4.83679e+000    7.11867e+000
```

```
        58           1        2431    1.00000e+000    4.83533e+000    7.89737e+000
        59           1        2528    1.00000e+000    4.83319e+000    9.43801e+000
        60           1        2601    1.00000e+000    4.83154e+000    8.94404e+000
        61           1        2633    1.00000e+000    4.83037e+000    7.37479e+000
        62           1        2687    1.00000e+000    4.82843e+000    5.42102e+000
        63           1        2728    1.00000e+000    4.82754e+000    4.93113e+000
        64           1        2780    1.00000e+000    4.82652e+000    6.36848e+000
        65           1        2874    1.00000e+000    4.82497e+000    9.03994e+000
        66           1        2905    1.00000e+000    4.82420e+000    8.57085e+000
        67           1        2965    1.00000e+000    4.82199e+000    5.13524e+000
        68           1        3032    1.00000e+000    4.82064e+000    6.01275e+000
        69           1        3070    1.00000e+000    4.82005e+000    5.68687e+000
        70           1        3097    1.00000e+000    4.81958e+000    4.21729e+000
        71           1        3125    1.00000e+000    4.81914e+000    3.66839e+000
        72           1        3162    1.00000e+000    4.81880e+000    3.28373e+000
        73           1        3188    1.00000e+000    4.81852e+000    3.04400e+000
        74           1        3234    1.00000e+000    4.81767e+000    5.05706e+000
        75           1        3290    1.00000e+000    4.81714e+000    7.01630e+000
        76           1        3356    1.00000e+000    4.81646e+000    7.66806e+000
        77           1        3520    1.00000e+000    4.81411e+000    8.34056e+000
        78           1        3590    1.00000e+000    4.81191e+000    6.89912e+000
        79           1        3628    1.00000e+000    4.81094e+000    5.25305e+000
        80           1        3668    1.00000e+000    4.81044e+000    4.80736e+000
        81           1        3708    1.00000e+000    4.80970e+000    4.98176e+000
        82           1        3795    1.00000e+000    4.80876e+000    6.01965e+000
        83           1        3835    1.00000e+000    4.80835e+000    5.28667e+000
        84           1        3898    1.00000e+000    4.80725e+000    5.59141e+000
        85           1        3933    1.00000e+000    4.80677e+000    6.04866e+000
        86           1        4066    1.00000e+000    4.80408e+000    6.59174e+000
        87           1        4145    1.00000e+000    4.80304e+000    5.87872e+000
        88           1        4213    1.00000e+000    4.80152e+000    4.70528e+000
        89           1        4254    1.00000e+000    4.80048e+000    4.49987e+000
        90           1        4298    1.00000e+000    4.80012e+000    4.43804e+000
        91           1        4360    1.00000e+000    4.79928e+000    4.74935e+000
        92           1        4421    1.00000e+000    4.79872e+000    4.35972e+000
        93           1        4460    1.00000e+000    4.79825e+000    2.95317e+000
        94           1        4497    1.00000e+000    4.79803e+000    2.50413e+000
    94  4.7980302e+000  8.5020529e-002  1.21e+000  6.462e+000     0.0      76

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        Opt Cond
        95           1           4    1.00000e+000    4.77164e+000    3.06768e+001
        96           1          65    1.00000e+000    1.67227e+000    3.03111e+001
        97           1         104    1.00000e+000    1.41041e+000    2.76955e+001
        98           1         143    1.00000e+000    1.23687e+000    2.35533e+001
        99           1         203    1.00000e+000    1.05619e+000    1.65658e+001
       100           1         255    1.00000e+000    9.38798e-001    1.87036e+001


 ERROR EXIT -- Too many iterations

 Products with A     :     105        Total time   (secs) :    12.8
 Products with A'    :     105        Project time (secs) :    11.6
 Newton iterations   :       2        Mat-vec time (secs) :     0.5
```


convolution result
f(t)
t [s]


original sparse signal
x_s pg
x_p qn



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