```
cd ../../../../pqnl1
addpath(genpath(pwd))
cd ../experiments/help_spgl1/modifying/task17mmv/
clear;

m = 50; n = 128;                        % Measurement matrix is m x n
k = 14;                                 % Set sparsity level x0
A = randn(m,n);                         % Random encoding matrix
[Q,R] = qr(A',0);  A = Q';


% group sparse X0
p = 2; nn = n/2;
X0 = zeros(nn,p);
pp = randperm(nn); pp = pp(1:k);
X0(pp,:) = 1e-3*randn(k,p);
B = A * vec(X0);% + 0.005 * randn(m,1);
b = B(:);

groups = p;


options.project     = @(x,weight,tau) NormL12_project(groups,x,weight,tau);
options.primal_norm = @(x,weight    ) NormL12_primal(groups,x,weight);
options.dual_norm   = @(x,weight    ) NormL12_dual(groups,x,weight);

% cd ../task7
% addpath(genpath(pwd))
% cd ../task8
% tau = mixNorm(X0,1,2);

tau = 0;
%sigma = 1e-3;
sigma = 0;
[x_spg,r_spg,g_spg,info_spg] = spgl1(A,B(:),tau,sigma,zeros(size(A,2),1),options);
[x_pqn1,r_pqn1,g_pqn1,info_pqn1] = pqnl1_2(A,B(:),tau,sigma,zeros(size(A,2),1),opt

figure;
subplot(3,1,1); plot(vec(X0));title('X0')
subplot(3,1,2); plot(vec(x_spg)); title('x_spg')
subplot(3,1,3); plot(vec(x_pqn1)); title('x_pqn')
title('Multiple Measurement Vector Basis Pursuit');
info_spg
info_pqn1
```

```
================================================================================
SPGL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
================================================================================
No. rows              :       50      No. columns           :      128
Initial tau           : 0.00e+00      Two-norm of b         : 3.27e-03
Optimality tol        : 1.00e-04      Target objective      : 0.00e+00
```

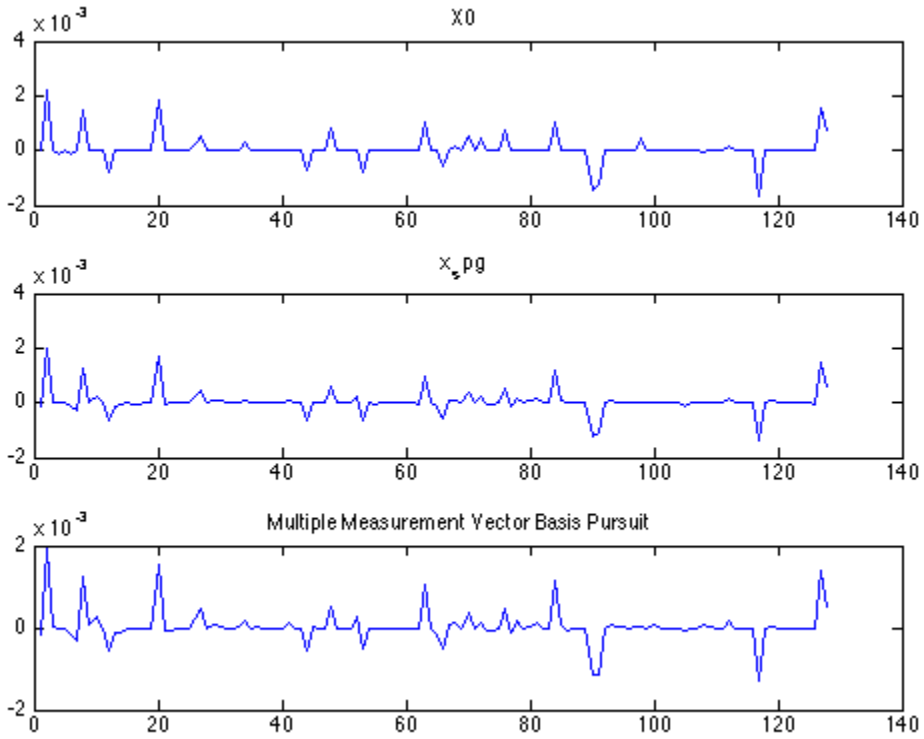
Basis pursuit tol : 1.00e-06 Maximum iterations : 500

Iter	Objective	Relative Gap	Rel Error	gNorm	stepG	nnzX
0	3.2722461e-03	0.0000000e+00	3.27e-03	1.027e-03	0.0	0
1	2.8844048e-03	9.0474168e-06	2.88e-03	8.403e-04	-0.3	2
2	1.2846925e-03	1.7225185e-06	1.28e-03	3.385e-04	0.0	3
3	1.1489742e-03	4.3876574e-07	1.15e-03	2.323e-04	0.0	3
4	1.1131523e-03	3.3177933e-07	1.11e-03	2.186e-04	0.0	3
5	1.0676105e-03	3.8298416e-07	1.07e-03	2.168e-04	0.0	5
6	1.0782715e-03	7.3583675e-07	1.08e-03	2.556e-04	0.0	4
7	1.0854393e-03	1.3382518e-06	1.09e-03	2.918e-04	0.0	4
8	1.0402680e-03	7.4461407e-08	1.04e-03	1.872e-04	0.0	5
9	1.0387735e-03	5.5290799e-08	1.04e-03	1.857e-04	0.0	6
10	1.0378834e-03	4.2721939e-08	1.04e-03	1.846e-04	0.0	6
11	1.0372591e-03	1.1677787e-07	1.04e-03	1.894e-04	0.0	5
12	1.0372757e-03	1.0457073e-07	1.04e-03	1.910e-04	-0.3	5
13	2.3226185e-04	5.1509904e-07	2.32e-04	5.398e-05	0.0	9
14	2.0225401e-04	1.1810539e-07	2.02e-04	3.712e-05	0.0	9
15	1.9408727e-04	1.2504745e-07	1.94e-04	3.611e-05	0.0	9
16	1.7567201e-04	2.0564929e-07	1.76e-04	3.756e-05	0.0	9
17	1.9760337e-04	4.0337298e-07	1.98e-04	4.669e-05	-0.3	9
18	1.6274726e-04	1.4646406e-07	1.63e-04	3.294e-05	0.0	9
19	1.5501895e-04	7.4198366e-08	1.55e-04	2.777e-05	0.0	9
20	1.5350836e-04	6.0948796e-08	1.54e-04	2.687e-05	0.0	9
21	1.4733059e-04	4.1297953e-08	1.47e-04	2.458e-05	0.0	9
22	1.4519535e-04	2.2333522e-07	1.45e-04	3.459e-05	-0.3	9
23	1.3815473e-04	3.6357218e-08	1.38e-04	2.330e-05	-0.3	9
24	1.3653341e-04	3.7628548e-08	1.37e-04	2.304e-05	0.0	9
25	1.3596637e-04	1.9359035e-08	1.36e-04	2.182e-05	0.0	9
26	1.3478333e-04	3.0420847e-08	1.35e-04	2.219e-05	0.0	9
27	1.3619740e-04	1.0128464e-07	1.36e-04	2.658e-05	-0.3	8
28	1.3566097e-04	8.8481798e-08	1.36e-04	2.554e-05	0.0	8
29	1.3288199e-04	1.0576499e-08	1.33e-04	2.083e-05	0.0	8
30	1.3272240e-04	1.0800349e-08	1.33e-04	2.079e-05	0.0	8
31	1.3153915e-04	1.2975383e-08	1.32e-04	2.057e-05	0.0	8
32	1.3133006e-04	3.2077354e-08	1.31e-04	2.183e-05	-0.3	8
33	1.3143470e-04	6.9677172e-08	1.31e-04	2.400e-05	0.0	8
34	1.3082253e-04	3.4106682e-08	1.31e-04	2.188e-05	0.0	8
35	1.3053279e-04	7.5210900e-09	1.31e-04	2.021e-05	0.0	8
36	1.3043823e-04	9.2781545e-09	1.30e-04	2.028e-05	0.0	8
37	1.2963278e-04	1.5906114e-08	1.30e-04	2.031e-05	0.0	8
38	1.2967806e-04	4.2095237e-08	1.30e-04	2.221e-05	-0.3	8
39	1.2939055e-04	2.4043783e-08	1.29e-04	2.088e-05	0.0	8
40	1.2923457e-04	1.2728896e-08	1.29e-04	2.023e-05	0.0	8
41	1.2916840e-04	8.3379887e-09	1.29e-04	1.995e-05	0.0	8
42	1.2893117e-04	9.4424514e-09	1.29e-04	1.994e-05	0.0	8
43	1.2884096e-04	2.1392050e-08	1.29e-04	2.064e-05	-0.3	8
44	1.2875955e-04	2.2832142e-08	1.29e-04	2.075e-05	-0.3	8
45	1.2863095e-04	8.8222892e-09	1.29e-04	1.989e-05	0.0	8
46	1.2858284e-04	8.2969939e-09	1.29e-04	1.983e-05	0.0	8
47	1.2848098e-04	5.9229707e-09	1.28e-04	1.966e-05	0.0	8
48	1.2839146e-04	3.8373249e-08	1.28e-04	2.126e-05	-0.3	8
49	1.2794427e-04	1.1794438e-08	1.28e-04	1.981e-05	-0.3	8
50	1.2783861e-04	7.6504556e-09	1.28e-04	1.957e-05	0.0	8

```
   51  1.2780421e-04  6.5239624e-09   1.28e-04  1.952e-05     0.0       8
   52  1.2753848e-04  1.0744087e-08   1.28e-04  1.964e-05     0.0       8
   53  1.2774333e-04  3.4339417e-08   1.28e-04  2.130e-05    -0.3       8
   54  1.2757437e-04  2.1838869e-08   1.28e-04  2.028e-05     0.0       8
   55  1.2738923e-04  3.8461405e-09   1.27e-04  1.927e-05     0.0       8
   56  1.2737178e-04  5.7482976e-09   1.27e-04  1.938e-05     0.0       8
   57  1.2729833e-04  3.7915472e-09   1.27e-04  1.923e-05     0.0       8
   58  1.2730150e-04  4.4870048e-08   1.27e-04  2.149e-05    -0.3       8
   59  8.3539597e-05  4.3971577e-07   8.35e-05  2.645e-05    -0.3       8

 EXIT -- Found a root

 Products with A     :      82        Total time   (secs) :     0.6
 Products with A'    :      60        Project time (secs) :     0.1
 Newton iterations   :       3        Mat-vec time (secs) :     0.2
 Line search its     :      27        Subspace iterations :       0


 ================================================================================
 PQNL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
 ================================================================================
 No. rows              :       50      No. columns           :      128
 Initial tau           : 0.00e+00      Two-norm of b         : 3.27e-03
 Optimality tol        : 1.00e-04      Target objective      : 0.00e+00
 Basis pursuit tol     : 1.00e-06      Maximum iterations    :      500

     0  3.2722461e-03  0.0000000e+00   3.27e-03  1.027e-03     0.0       0

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
         1          1           4     1.00000e+00     1.39147e-03     2.672
         2          1          10     1.00000e+00     1.25964e-03     1.702
         3          1          19     1.00000e+00     1.15903e-03     8.968
         4          1          28     1.00000e+00     1.12229e-03     7.301
         5          1          37     1.00000e+00     1.08727e-03     5.099
         6          1          48     1.00000e+00     1.06912e-03     3.984
         7          1          64     1.00000e+00     1.05631e-03     3.850
         8          1          77     1.00000e+00     1.04778e-03     3.106
         9          1          88     1.00000e+00     1.04027e-03     1.588
        10          1         100     1.00000e+00     1.03796e-03     1.043
        11          1         112     1.00000e+00     1.03737e-03     7.199
        12          1         121     1.00000e+00     1.03695e-03     3.785
break of testUpdateTau, exit minConf_PQN
    12  1.0369517e-03  3.1459615e-08   1.04e-03  1.827e-04     0.0       6

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
        13          1           4     1.00000e+00     2.15489e-04     5.157
        14          1          10     1.00000e+00     1.98623e-04     4.200
        15          1          18     1.00000e+00     1.65810e-04     2.553
        16          1          29     1.00000e+00     1.54803e-04     2.158
        17          1          38     1.00000e+00     1.42846e-04     1.683
        18          1          54     1.00000e+00     1.35172e-04     1.572
        19          1          69     1.00000e+00     1.27800e-04     1.387
```

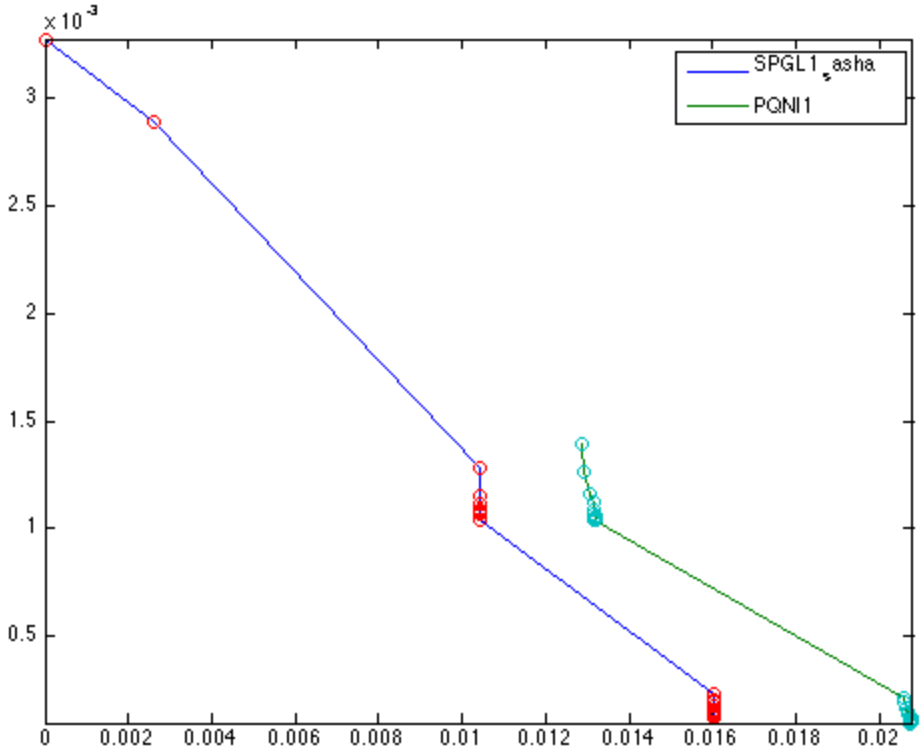
```
        20          1          90     1.00000e+00     1.19861e-04     1.330
        21          1         110     1.00000e+00     1.15506e-04     1.270
        22          1         130     1.00000e+00     1.10453e-04     1.167
        23          1         154     1.00000e+00     1.05201e-04     1.060
        24          1         169     1.00000e+00     1.02293e-04     8.042
        25          1         183     1.00000e+00     9.95981e-05     6.582
find BP solution

 EXIT -- Found a root

 Products with A     :      28        Total time   (secs) :     1.2
 Products with A'    :      28        Project time (secs) :     1.0
 Newton iterations   :       2        Mat-vec time (secs) :     0.1


info_spg =

           tau: 0.0168
          rNorm: 8.3540e-05
           rGap: 4.3972e-07
          gNorm: 2.6447e-05
           stat: 1
           iter: 59
         nProdA: 82
        nProdAt: 60
        nNewton: 3
    timeProject: 0.0702
    timeMatProd: 0.1657
        itnLSQR: 0
        options: [1x1 struct]
      timeTotal: 0.5606
          xNorm1: [59x1 double]
          rNorm2: [59x1 double]
          lambda: [59x1 double]


info_pqn1 =

           tau: 0.0163
          rNorm: 9.9598e-05
           rGap: 3.5332e-08
          gNorm: 1.6659e-05
           stat: 1
           iter: 25
         nProdA: 28
        nProdAt: 28
        nNewton: 2
    timeProject: 1.0130
    timeMatProd: 0.0766
        itnLSQR: 0
        options: [1x1 struct]
      timeTotal: 1.1783
          xNorm1: [25x1 double]
          rNorm2: [25x1 double]
```

lambda: [25x1 double]



show result

```
figure('Name','Solution paths')
plot(info_spg.xNorm1,info_spg.rNorm2,info_pqn1.xNorm1,info_pqn1.rNorm2);hold on
scatter(info_spg.xNorm1,info_spg.rNorm2);
scatter(info_pqn1.xNorm1,info_pqn1.rNorm2);hold off
legend('SPGL1_sasha','PQNl1')
axis tight
```



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