# Table of Contents

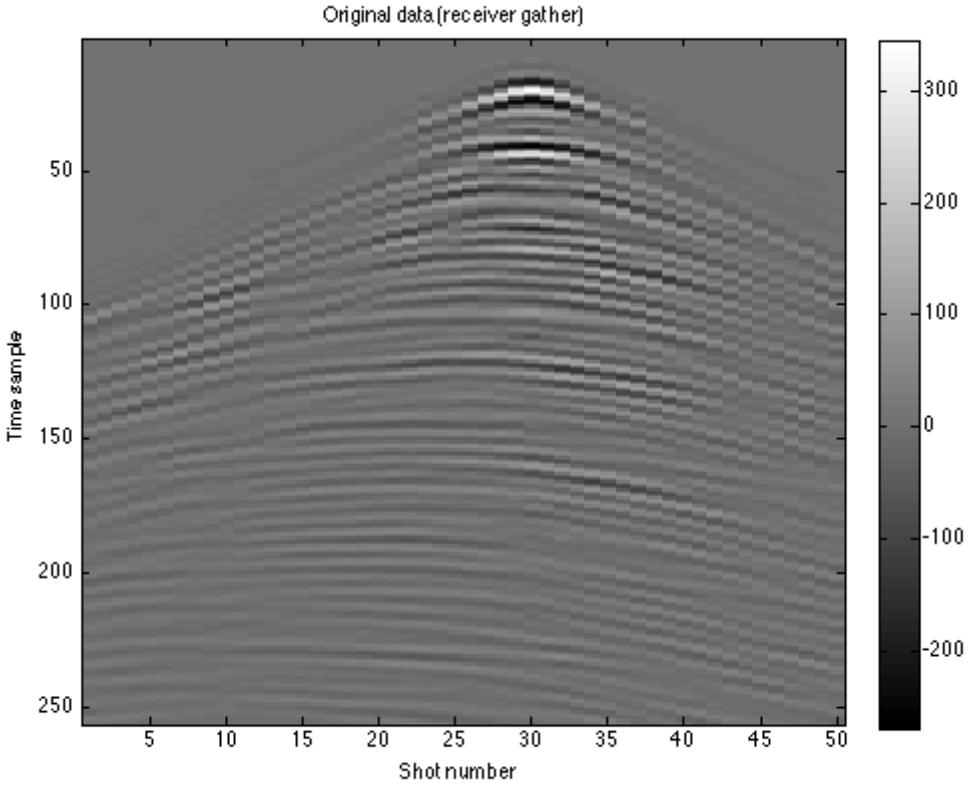


```
%Sequential-source data reconstruction (acquistion with randomly jittered missing
clear; close all;
cd ./simu_functions/
addpath(genpath(pwd))
cd ../../..
addpath(genpath(pwd))
cd ../../../../pqnl1;
addpath(genpath(pwd))

cd ../experiments/help_spgl1/modifying/task16bpdn/seismic/simushots
rmpath('/Volumes/Users/linamiao/Dropbox/PQN/pqnl1/minConF/')
```

# original data

Number of time samples

```
nt = 1024;
% Number of sources
ns = 178;
% Number of receivers
nr = 178;

% Read data
D = ReadSuFast('GulfOfSuez178.su');
D = reshape(D,nt,nr,ns);

% Select small subset
D = D(1:256,30,1:50);

% Define new data sizes
[nt,nr,ns] = size(D);

% Vectorize D
D = D(:);

% Display
figure
imagesc(reshape(D,nt,ns)); colormap(gray); colorbar;
title('Original data (receiver gather)');
xlabel('Shot number'); ylabel('Time sample')
```

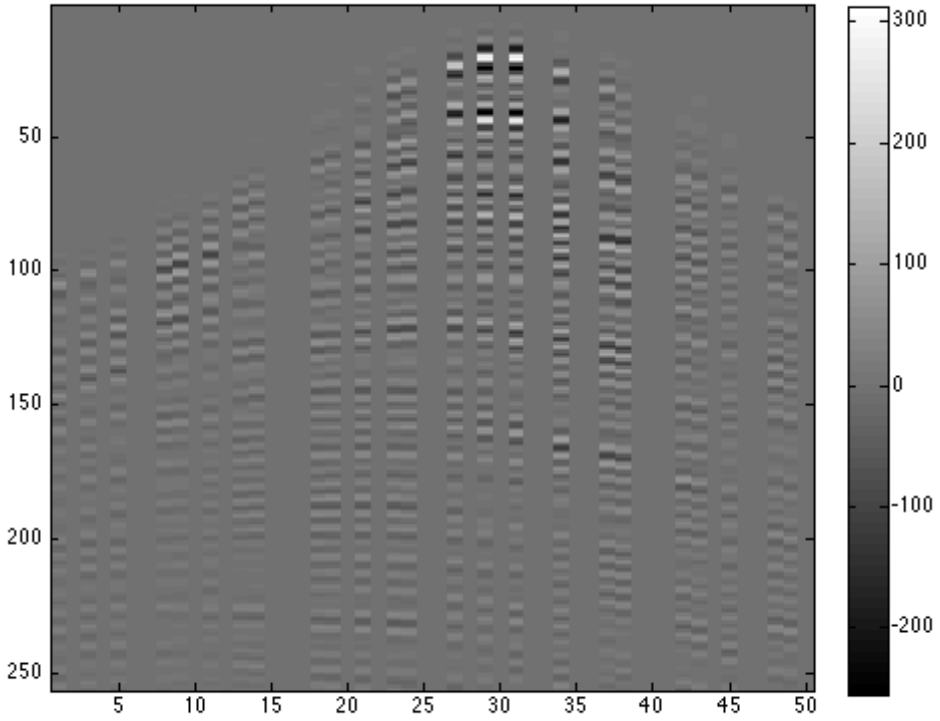



# random jittering missing shots

random jittering missing shots

```
n = ns;
p = .5;
I_jitter = jitter1d(n,p*n);
S_jitter = zeros(n,1); S_jitter(I_jitter) = 1;
Js = opDiag(S_jitter);
Dt = opDirac(nt);
Dr = opDirac(nr);
RM = opKron(Js,Dr,Dt);


x_test = rand(size(RM,2),1);
y_test = rand(size(RM,1),1);
left = y_test'*(RM*x_test);
right = (RM'*y_test)'*x_test;
error = norm(left-right);
fprintf('In dottest error:%5.5e\n',error);


simD1 = RM*D;
figure;
imagesc(reshape(simD1,nt,ns)); colormap(gray); colorbar;
```

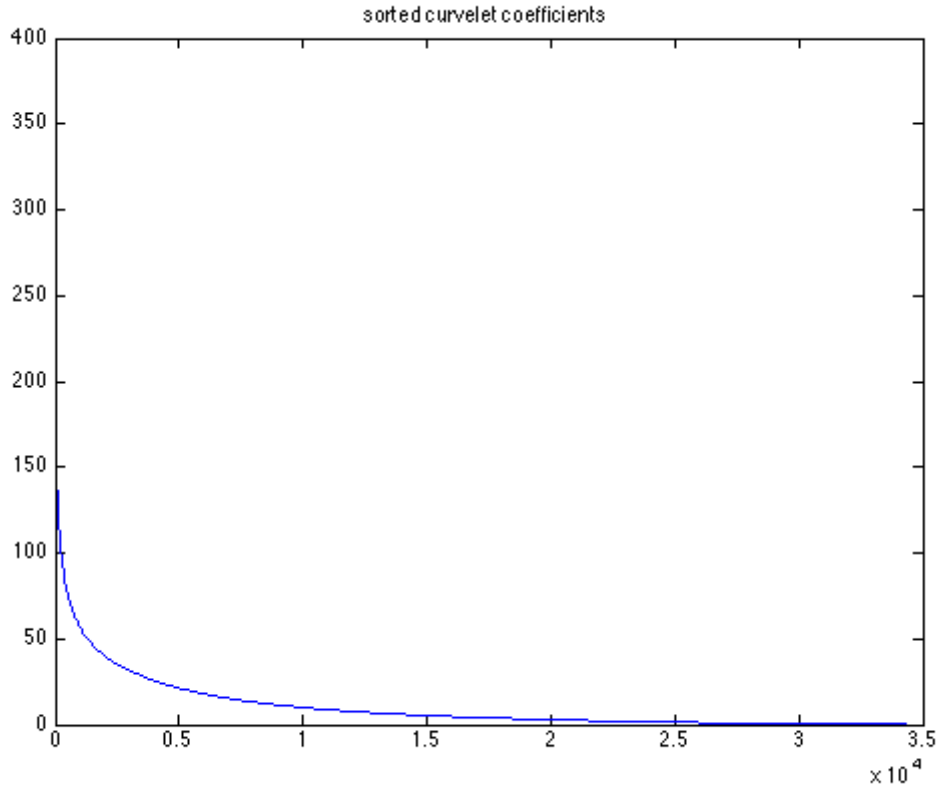
```
In dottest error:0.00000e+00
```




# sparsifying transform

Use this to create a Curvelet SPOT operator:

```
C = opCurvelet(nt, ns);

% Transform the data into the Curvelet domain and plot the sorted coefficients
C_D = C*D;
sort_CD = sort(abs(C_D),'descend');
figure;plot(sort_CD);title('sorted curvelet coefficients')
```




# reconstruct

```
options = spgSetParms('optTol', 1e-4, 'iterations', 200);%, 'fid', fid);
A = RM*C';

% options = spgSetParms('optTol', 1e-4, 'iterations', 1000);%, 'fid', fid);
% xestspg = spgl1(A,simD1,0,1e-3,[],options);
% tau = norm(xestspg,1);
tau = 1.8203121e+05;

options = spgSetParms('optTol', 1e-4, 'iterations', 200);%, 'fid', fid);
xinit = zeros(size(A,2),1);

which spgl1
%keyboard;
xestspg = spgl1(A,simD1,tau,[],xinit,options);
%options.iterations = 100;
xestpqn = pqnl1_2(A,simD1,tau,[],xinit,options);
fspg = C'*xestspg;
snrspg = SNR(D,fspg);
fpqn = C'*xestpqn;
snrpqn = SNR(D,fpqn);


figure;
```

```
subplot(1,2,1);imagesc(reshape(fspg,nt,ns)); colormap(gray);
title(strcat(['p = .5, SNR=' num2str(snrspg) 'dB']))
subplot(1,2,2);imagesc(reshape(fspg-D,nt,ns)); colormap(gray);
title('difference')


figure;
subplot(1,2,1);imagesc(reshape(fpqn,nt,ns)); colormap(gray);
title(strcat(['p = .5, SNR=' num2str(snrpqn) 'dB']))
subplot(1,2,2);imagesc(reshape(fpqn-D,nt,ns)); colormap(gray);
title('difference')

% BPDN
[x_spg,r_spg,g_spg,info_spg] = spgl1(A, simD1, 0, 0, zeros(size(A,2),1), options);

[x_pqn1,r_pqn1,g_pqn1,info_pqn1] = pqnl1_2(A, simD1, 0, 0, zeros(size(A,2),1), opt

figure; subplot(2,1,1);plot(x_spg);subplot(2,1,2);plot(x_pqn1);
info_spg
info_pqn1

% 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','PQNl1')
axis tight
```

```
        /Tools/mat_toolbox/spgl1-slim/spgl1.m

         ================================================================================
         SPGL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
         ================================================================================
         No. rows              :    12800      No. columns           :    34341
         Initial tau           : 1.82e+05      Two-norm of b         : 2.62e+03
         Optimality tol        : 1.00e-04      Target one-norm of x  : 1.82e+05
         Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

          Iter      Objective   Relative Gap      gNorm   stepG    nnzX    nnzG
             0  2.6212440e+03  1.0333980e+01   1.95e+02     0.0       0       0
             1  2.6074782e+03  1.0377978e+01   1.94e+02     0.0   32325       0
             2  5.8878361e+02  1.0277097e+01   1.50e+01     0.0   17416       0
             3  4.9473660e+02  1.0841397e+01   1.18e+01     0.0   14653       0
             4  3.1887350e+02  1.8734436e+01   7.87e+00     0.0    9976       0
             5  3.9058442e+02  4.6431962e+01   2.20e+01     0.0    9186       0
             6  3.2796772e+02  6.8711816e+01   2.18e+01     0.0   10389       0
             7  2.1521246e+02  2.3789416e+01   5.11e+00     0.0   10172       0
             8  2.0640751e+02  1.5820804e+01   3.83e+00     0.0    9548       0
             9  1.9525970e+02  1.6849757e+01   3.64e+00     0.0    8992       0
            10  1.5843747e+02  9.2214568e+01   7.49e+00     0.0    7562       0
            11  1.8256649e+02  1.3967434e+02   1.43e+01    -0.3    8370       0
            12  1.3882115e+02  8.5246215e+01   5.74e+00     0.0    9131       0
            13  1.3338906e+02  2.1303577e+01   2.30e+00     0.0    8557       0
```

| | | | | | | |
|---|---|---|---|---|---|---|
| 14 | 1.3143050e+02 | 2.2497225e+01 | 2.30e+00 | 0.0 | 8355 | 0 |
| 15 | 1.1525454e+02 | 3.2951358e+01 | 2.25e+00 | 0.0 | 7685 | 0 |
| 16 | 1.2135094e+02 | 1.4742706e+02 | 7.03e+00 | -0.3 | 7991 | 0 |
| 17 | 1.1709965e+02 | 1.0636457e+02 | 5.00e+00 | 0.0 | 8262 | 0 |
| 18 | 1.0648105e+02 | 2.6094237e+01 | 1.81e+00 | 0.0 | 8180 | 0 |
| 19 | 1.0535847e+02 | 2.7606761e+01 | 1.83e+00 | 0.0 | 8006 | 0 |
| 20 | 1.0329408e+02 | 2.8766839e+01 | 1.81e+00 | 0.0 | 7866 | 0 |
| 21 | 9.4703502e+01 | 1.8825341e+02 | 5.29e+00 | 0.0 | 7021 | 0 |
| 22 | 8.3514350e+01 | 1.6246399e+02 | 3.85e+00 | -0.3 | 7588 | 0 |
| 23 | 7.6566026e+01 | 4.7022709e+01 | 1.46e+00 | 0.0 | 8039 | 0 |
| 24 | 7.5690968e+01 | 3.6100240e+01 | 1.26e+00 | 0.0 | 7853 | 0 |
| 25 | 7.4547543e+01 | 3.6866391e+01 | 1.25e+00 | 0.0 | 7706 | 0 |
| 26 | 7.1557565e+01 | 8.7591944e+01 | 1.88e+00 | 0.0 | 7505 | 0 |
| 27 | 7.1239619e+01 | 1.3112399e+02 | 2.48e+00 | -0.3 | 7634 | 0 |
| 28 | 6.9489486e+01 | 3.7853379e+01 | 1.14e+00 | 0.0 | 7634 | 0 |
| 29 | 6.9094647e+01 | 3.8003653e+01 | 1.14e+00 | 0.0 | 7607 | 0 |
| 30 | 6.8220879e+01 | 3.8507682e+01 | 1.12e+00 | 0.0 | 7553 | 0 |
| 31 | 6.4689606e+01 | 2.3179035e+02 | 3.22e+00 | -0.3 | 7285 | 0 |
| 32 | 6.8229934e+01 | 2.3420752e+02 | 3.55e+00 | -0.3 | 7432 | 0 |
| 33 | 5.9991349e+01 | 4.2548400e+01 | 9.76e-01 | 0.0 | 7481 | 0 |
| 34 | 5.9725864e+01 | 4.2263247e+01 | 9.66e-01 | 0.0 | 7470 | 0 |
| 35 | 5.8899900e+01 | 4.2382899e+01 | 9.47e-01 | 0.0 | 7421 | 0 |
| 36 | 5.5083586e+01 | 2.2967785e+02 | 2.39e+00 | 0.0 | 7169 | 0 |
| 37 | 5.3082386e+01 | 1.7256822e+02 | 1.82e+00 | -0.3 | 7755 | 0 |
| 38 | 5.0759802e+01 | 6.6397753e+01 | 9.31e-01 | 0.0 | 7732 | 0 |
| 39 | 5.0344978e+01 | 4.7175418e+01 | 7.91e-01 | 0.0 | 7604 | 0 |
| 40 | 5.0098482e+01 | 4.6825156e+01 | 7.82e-01 | 0.0 | 7543 | 0 |
| 41 | 4.8523329e+01 | 6.0243725e+01 | 8.34e-01 | 0.0 | 7338 | 0 |
| 42 | 4.9153873e+01 | 1.7905689e+02 | 1.62e+00 | -0.3 | 7422 | 0 |
| 43 | 4.8107956e+01 | 1.2546516e+02 | 1.24e+00 | 0.0 | 7437 | 0 |
| 44 | 4.7430053e+01 | 5.0580328e+01 | 7.48e-01 | 0.0 | 7431 | 0 |
| 45 | 4.7288241e+01 | 5.0983162e+01 | 7.47e-01 | 0.0 | 7413 | 0 |
| 46 | 4.4685511e+01 | 5.4248950e+01 | 7.02e-01 | 0.0 | 7252 | 0 |
| 47 | 4.5356310e+01 | 1.8083630e+02 | 1.44e+00 | -0.3 | 7328 | 0 |
| 48 | 4.3923039e+01 | 1.0252817e+02 | 9.42e-01 | -0.3 | 7578 | 0 |
| 49 | 4.3500676e+01 | 5.3670760e+01 | 6.79e-01 | 0.0 | 7464 | 0 |
| 50 | 4.3356084e+01 | 5.4192305e+01 | 6.78e-01 | 0.0 | 7409 | 0 |
| 51 | 4.2254267e+01 | 5.8570273e+01 | 6.72e-01 | 0.0 | 7294 | 0 |
| 52 | 4.2408386e+01 | 1.7388692e+02 | 1.24e+00 | -0.3 | 7342 | 0 |
| 53 | 4.1594739e+01 | 7.3856977e+01 | 7.32e-01 | -0.3 | 7433 | 0 |
| 54 | 4.1314319e+01 | 5.6773265e+01 | 6.45e-01 | 0.0 | 7389 | 0 |
| 55 | 4.1180482e+01 | 5.7423871e+01 | 6.45e-01 | 0.0 | 7364 | 0 |
| 56 | 3.9765512e+01 | 8.8674863e+01 | 7.45e-01 | 0.0 | 7257 | 0 |
| 57 | 4.0168441e+01 | 1.7988229e+02 | 1.16e+00 | -0.3 | 7308 | 0 |
| 58 | 3.9679194e+01 | 1.9258713e+02 | 1.19e+00 | 0.0 | 7378 | 0 |
| 59 | 3.8985832e+01 | 6.0321970e+01 | 6.09e-01 | 0.0 | 7337 | 0 |
| 60 | 3.8889562e+01 | 6.0313860e+01 | 6.07e-01 | 0.0 | 7324 | 0 |
| 61 | 3.7794388e+01 | 6.8655382e+01 | 6.14e-01 | 0.0 | 7256 | 0 |
| 62 | 3.7682921e+01 | 2.7305777e+02 | 1.40e+00 | -0.3 | 7287 | 0 |
| 63 | 3.8431281e+01 | 4.6155406e+02 | 2.21e+00 | -0.3 | 7369 | 0 |
| 64 | 3.6729855e+01 | 9.1733854e+01 | 6.75e-01 | 0.0 | 7366 | 0 |
| 65 | 3.6603003e+01 | 6.4073270e+01 | 5.70e-01 | 0.0 | 7330 | 0 |
| 66 | 3.6442532e+01 | 6.3876619e+01 | 5.66e-01 | 0.0 | 7315 | 0 |
| 67 | 3.4289490e+01 | 9.1558424e+02 | 3.22e+00 | 0.0 | 7097 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 68 | 3.2922603e+01 | 7.0834381e+02 | 2.40e+00 | -0.3 | 7390 | 0 |
| 69 | 3.0832870e+01 | 1.8778586e+02 | 7.69e-01 | 0.0 | 7560 | 0 |
| 70 | 3.0677616e+01 | 7.2866269e+01 | 4.66e-01 | 0.0 | 7467 | 0 |
| 71 | 3.0349469e+01 | 9.3215329e+01 | 5.10e-01 | 0.0 | 7363 | 0 |
| 72 | 3.0048472e+01 | 6.0215384e+02 | 1.76e+00 | 0.0 | 7289 | 0 |
| 73 | 2.9425704e+01 | 1.0297977e+02 | 5.12e-01 | -0.3 | 7433 | 0 |
| 74 | 2.9248854e+01 | 7.8052912e+01 | 4.49e-01 | 0.0 | 7386 | 0 |
| 75 | 2.9154360e+01 | 7.8235152e+01 | 4.47e-01 | 0.0 | 7362 | 0 |
| 76 | 2.8489540e+01 | 1.7978318e+02 | 6.57e-01 | 0.0 | 7288 | 0 |
| 77 | 2.8491830e+01 | 2.6612164e+02 | 8.50e-01 | -0.3 | 7340 | 0 |
| 78 | 2.8264676e+01 | 2.5172445e+02 | 8.08e-01 | 0.0 | 7317 | 0 |
| 79 | 2.8138303e+01 | 8.0727342e+01 | 4.30e-01 | 0.0 | 7319 | 0 |
| 80 | 2.8076258e+01 | 7.9882375e+01 | 4.27e-01 | 0.0 | 7316 | 0 |
| 81 | 2.7241783e+01 | 1.4623428e+02 | 5.44e-01 | 0.0 | 7276 | 0 |
| 82 | 2.7870771e+01 | 4.7520455e+02 | 1.26e+00 | -0.3 | 7302 | 0 |
| 83 | 2.7259921e+01 | 2.5356317e+02 | 7.61e-01 | 0.0 | 7326 | 0 |
| 84 | 2.6810762e+01 | 8.3201839e+01 | 4.07e-01 | 0.0 | 7319 | 0 |
| 85 | 2.6764600e+01 | 8.3217083e+01 | 4.06e-01 | 0.0 | 7308 | 0 |
| 86 | 2.5612718e+01 | 2.5916184e+02 | 6.97e-01 | 0.0 | 7258 | 0 |
| 87 | 2.6551925e+01 | 1.3217061e+03 | 2.79e+00 | -0.3 | 7322 | 0 |
| 88 | 2.6306534e+01 | 1.6174008e+03 | 3.30e+00 | 0.0 | 7494 | 0 |
| 89 | 2.5101084e+01 | 1.0641104e+02 | 4.11e-01 | 0.0 | 7442 | 0 |
| 90 | 2.5047374e+01 | 8.8204041e+01 | 3.78e-01 | 0.0 | 7392 | 0 |
| 91 | 2.4889931e+01 | 8.9599877e+01 | 3.77e-01 | 0.0 | 7336 | 0 |
| 92 | 2.3975206e+01 | 1.6335122e+03 | 2.78e+00 | 0.0 | 7240 | 0 |
| 93 | 2.4897492e+01 | 2.4054724e+03 | 4.30e+00 | -0.3 | 7501 | 0 |
| 94 | 2.2876438e+01 | 5.5505183e+02 | 1.00e+00 | 0.0 | 7640 | 0 |
| 95 | 2.2756385e+01 | 9.5243240e+01 | 3.41e-01 | 0.0 | 7490 | 0 |
| 96 | 2.2695580e+01 | 9.4340563e+01 | 3.38e-01 | 0.0 | 7422 | 0 |
| 97 | 2.2336404e+01 | 3.2954259e+02 | 6.51e-01 | 0.0 | 7305 | 0 |
| 98 | 2.2355881e+01 | 5.8324298e+02 | 1.00e+00 | -0.3 | 7358 | 0 |
| 99 | 2.2169543e+01 | 3.7198628e+02 | 7.01e-01 | 0.0 | 7369 | 0 |
| 100 | 2.2081113e+01 | 9.7732103e+01 | 3.30e-01 | 0.0 | 7357 | 0 |
| 101 | 2.2040310e+01 | 9.8296405e+01 | 3.29e-01 | 0.0 | 7347 | 0 |
| 102 | 2.1613246e+01 | 2.3470138e+02 | 4.95e-01 | 0.0 | 7308 | 0 |
| 103 | 2.1946713e+01 | 8.4956109e+02 | 1.32e+00 | -0.3 | 7330 | 0 |
| 104 | 2.1971710e+01 | 9.6146993e+02 | 1.47e+00 | 0.0 | 7345 | 0 |
| 105 | 2.1297871e+01 | 1.0158667e+02 | 3.18e-01 | 0.0 | 7347 | 0 |
| 106 | 2.1266138e+01 | 1.0191800e+02 | 3.18e-01 | 0.0 | 7337 | 0 |
| 107 | 2.1023215e+01 | 1.0342711e+02 | 3.15e-01 | 0.0 | 7315 | 0 |
| 108 | 2.0698005e+01 | 8.6128401e+02 | 1.20e+00 | -0.3 | 7325 | 0 |
| 109 | 2.0999675e+01 | 1.1413770e+03 | 1.57e+00 | -0.3 | 7453 | 0 |
| 110 | 2.0266015e+01 | 3.0465598e+02 | 5.26e-01 | 0.0 | 7480 | 0 |
| 111 | 2.0206888e+01 | 1.0709671e+02 | 3.02e-01 | 0.0 | 7419 | 0 |
| 112 | 2.0159605e+01 | 1.0723118e+02 | 3.01e-01 | 0.0 | 7386 | 0 |
| 113 | 1.9542251e+01 | 6.5384509e+02 | 8.59e-01 | 0.0 | 7292 | 0 |
| 114 | 1.9555013e+01 | 6.2110805e+02 | 8.27e-01 | -0.3 | 7345 | 0 |
| 115 | 1.9279798e+01 | 2.0664507e+02 | 3.84e-01 | 0.0 | 7375 | 0 |
| 116 | 1.9234428e+01 | 1.1166786e+02 | 2.86e-01 | 0.0 | 7354 | 0 |
| 117 | 1.9179967e+01 | 1.1219519e+02 | 2.86e-01 | 0.0 | 7346 | 0 |
| 118 | 1.8637504e+01 | 8.3950047e+02 | 9.66e-01 | 0.0 | 7310 | 0 |
| 119 | 1.8956213e+01 | 1.2940968e+03 | 1.44e+00 | -0.3 | 7355 | 0 |
| 120 | 1.8374234e+01 | 2.1866224e+02 | 3.68e-01 | 0.0 | 7375 | 0 |
| 121 | 1.8337569e+01 | 1.1723228e+02 | 2.73e-01 | 0.0 | 7361 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 122 | 1.8281458e+01 | 1.1718152e+02 | 2.72e-01 | 0.0 | 7352 | 0 |
| 123 | 1.7769949e+01 | 2.4474114e+03 | 2.27e+00 | 0.0 | 7275 | 0 |
| 124 | 1.7288809e+01 | 1.4778824e+03 | 1.37e+00 | -0.3 | 7447 | 0 |
| 125 | 1.6935187e+01 | 2.3317163e+02 | 3.35e-01 | 0.0 | 7480 | 0 |
| 126 | 1.6889136e+01 | 1.4217010e+02 | 2.62e-01 | 0.0 | 7444 | 0 |
| 127 | 1.6660882e+01 | 2.4715111e+02 | 3.38e-01 | 0.0 | 7382 | 0 |
| 128 | 1.6750470e+01 | 1.7198235e+03 | 1.47e+00 | -0.3 | 7358 | 0 |
| 129 | 1.6516591e+01 | 1.1212288e+03 | 9.87e-01 | -0.3 | 7411 | 0 |
| 130 | 1.6409220e+01 | 1.2721064e+02 | 2.41e-01 | 0.0 | 7386 | 0 |
| 131 | 1.6385066e+01 | 1.2805927e+02 | 2.41e-01 | 0.0 | 7379 | 0 |
| 132 | 1.6236937e+01 | 1.3162257e+02 | 2.41e-01 | 0.0 | 7357 | 0 |
| 133 | 1.6140309e+01 | 9.9207755e+02 | 8.54e-01 | -0.3 | 7365 | 0 |
| 134 | 1.6028086e+01 | 2.1170144e+02 | 2.93e-01 | -0.3 | 7389 | 0 |
| 135 | 1.5988191e+01 | 1.3046246e+02 | 2.35e-01 | 0.0 | 7367 | 0 |
| 136 | 1.5953257e+01 | 1.3184655e+02 | 2.35e-01 | 0.0 | 7359 | 0 |
| 137 | 1.5756487e+01 | 6.5019247e+02 | 5.84e-01 | 0.0 | 7330 | 0 |
| 138 | 1.5983687e+01 | 1.4615314e+03 | 1.17e+00 | -0.3 | 7355 | 0 |
| 139 | 1.5639401e+01 | 4.3352234e+02 | 4.31e-01 | 0.0 | 7353 | 0 |
| 140 | 1.5602876e+01 | 1.3440209e+02 | 2.30e-01 | 0.0 | 7349 | 0 |
| 141 | 1.5576726e+01 | 1.3469336e+02 | 2.29e-01 | 0.0 | 7346 | 0 |
| 142 | 1.3755062e+01 | 3.1428882e+03 | 1.74e+00 | 0.0 | 7234 | 0 |
| 143 | 1.5083149e+01 | 4.5390804e+03 | 2.96e+00 | -0.3 | 7550 | 0 |
| 144 | 1.2868294e+01 | 7.1421421e+02 | 4.39e-01 | 0.0 | 7950 | 0 |
| 145 | 1.2784046e+01 | 1.5426572e+02 | 1.83e-01 | 0.0 | 7710 | 0 |
| 146 | 1.2741890e+01 | 1.5982930e+02 | 1.85e-01 | 0.0 | 7612 | 0 |
| 147 | 1.2549686e+01 | 6.5179799e+02 | 3.93e-01 | 0.0 | 7468 | 0 |
| 148 | 1.2503857e+01 | 3.7341531e+02 | 2.72e-01 | -0.3 | 7537 | 0 |
| 149 | 1.2467848e+01 | 7.3393626e+02 | 4.24e-01 | 0.0 | 7499 | 0 |
| 150 | 1.2435953e+01 | 2.3807336e+02 | 2.12e-01 | 0.0 | 7496 | 0 |
| 151 | 1.2411109e+01 | 2.0460578e+02 | 1.97e-01 | 0.0 | 7488 | 0 |
| 152 | 1.2378148e+01 | 2.3696355e+02 | 2.10e-01 | 0.0 | 7478 | 0 |
| 153 | 1.2356326e+01 | 9.2166256e+02 | 4.96e-01 | 0.0 | 7450 | 0 |
| 154 | 1.2305408e+01 | 5.7985718e+02 | 3.51e-01 | -0.3 | 7470 | 0 |
| 155 | 1.2263760e+01 | 1.6454520e+02 | 1.77e-01 | 0.0 | 7463 | 0 |
| 156 | 1.2247571e+01 | 1.6483025e+02 | 1.77e-01 | 0.0 | 7460 | 0 |
| 157 | 1.2074124e+01 | 2.4385140e+02 | 2.05e-01 | 0.0 | 7432 | 0 |
| 158 | 1.2084642e+01 | 6.5189339e+02 | 3.69e-01 | -0.3 | 7447 | 0 |
| 159 | 1.2123652e+01 | 1.1970646e+03 | 5.90e-01 | 0.0 | 7428 | 0 |
| 160 | 1.1965612e+01 | 1.6921305e+02 | 1.73e-01 | 0.0 | 7446 | 0 |
| 161 | 1.1951847e+01 | 1.6925443e+02 | 1.73e-01 | 0.0 | 7444 | 0 |
| 162 | 1.1887516e+01 | 1.7007492e+02 | 1.72e-01 | 0.0 | 7437 | 0 |
| 163 | 1.1594658e+01 | 2.5333386e+03 | 1.03e+00 | -0.3 | 7438 | 0 |
| 164 | 1.1493018e+01 | 1.6921018e+03 | 7.15e-01 | -0.3 | 7507 | 0 |
| 165 | 1.1256103e+01 | 2.8593007e+02 | 2.00e-01 | 0.0 | 7504 | 0 |
| 166 | 1.1239194e+01 | 1.8106179e+02 | 1.63e-01 | 0.0 | 7482 | 0 |
| 167 | 1.1187815e+01 | 1.8044481e+02 | 1.62e-01 | 0.0 | 7451 | 0 |
| 168 | 1.1103370e+01 | 2.5421454e+03 | 9.59e-01 | 0.0 | 7433 | 0 |
| 169 | 1.1130563e+01 | 2.7140530e+03 | 1.02e+00 | -0.3 | 7538 | 0 |
| 170 | 1.0888226e+01 | 6.5562253e+02 | 3.10e-01 | 0.0 | 7487 | 0 |
| 171 | 1.0868530e+01 | 1.8819361e+02 | 1.58e-01 | 0.0 | 7465 | 0 |
| 172 | 1.0842480e+01 | 1.8667465e+02 | 1.57e-01 | 0.0 | 7450 | 0 |
| 173 | 1.0609254e+01 | 3.2705881e+03 | 1.10e+00 | 0.0 | 7398 | 0 |
| 174 | 1.0732001e+01 | 4.0385889e+03 | 1.37e+00 | -0.3 | 7464 | 0 |
| 175 | 1.0410937e+01 | 4.0371590e+02 | 2.13e-01 | 0.0 | 7470 | 0 |

```
  176  1.0392392e+01  1.9499593e+02   1.50e-01     0.0    7452       0
  177  1.0363286e+01  1.9624011e+02   1.50e-01     0.0    7431       0
  178  1.0102139e+01  1.7982109e+03   5.93e-01     0.0    7399       0
  179  1.0049390e+01  1.1972707e+03   4.21e-01    -0.3    7471       0
  180  9.9799831e+00  3.9535698e+02   1.97e-01     0.0    7453       0
  181  9.9638778e+00  2.0287659e+02   1.44e-01     0.0    7448       0
  182  9.9317079e+00  2.0379085e+02   1.44e-01     0.0    7437       0
  183  9.8735227e+00  1.7690239e+03   5.61e-01    -0.3    7420       0
  184  9.8092819e+00  3.0911082e+02   1.69e-01    -0.3    7426       0
  185  9.7840961e+00  2.0769915e+02   1.42e-01     0.0    7422       0
  186  9.7678106e+00  2.0788375e+02   1.41e-01     0.0    7414       0
  187  9.5397101e+00  5.9952634e+02   2.34e-01     0.0    7396       0
  188  9.5703845e+00  7.7457140e+02   2.79e-01    -0.3    7417       0
  189  9.4758562e+00  3.0907270e+02   1.61e-01     0.0    7410       0
  190  9.4611473e+00  2.1417049e+02   1.37e-01     0.0    7407       0
  191  9.4454292e+00  2.1472832e+02   1.37e-01     0.0    7405       0
  192  8.9712500e+00  9.1239519e+02   2.80e-01     0.0    7381       0
  193  8.9945319e+00  1.3071311e+03   3.69e-01    -0.3    7444       0
  194  8.8345887e+00  2.3301200e+02   1.29e-01     0.0    7441       0
  195  8.8227861e+00  2.3146070e+02   1.28e-01     0.0    7436       0
  196  8.7899532e+00  2.2963140e+02   1.27e-01     0.0    7428       0
  197  8.5949717e+00  9.2226315e+02   2.63e-01     0.0    7405       0
  198  8.6033564e+00  1.0047082e+03   2.80e-01    -0.3    7484       0
  199  8.4892219e+00  3.9378033e+02   1.53e-01     0.0    7447       0
  200  8.4743567e+00  2.3851146e+02   1.22e-01     0.0    7445       0

ERROR EXIT -- Too many iterations

Products with A     :     287        Total time   (secs) :   186.3
Products with A'    :     201        Project time (secs) :     1.1
Newton iterations   :       0        Mat-vec time (secs) :   183.8
Line search its     :     185        Subspace iterations :       0


================================================================================
PQNL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
================================================================================
No. rows              :    12800      No. columns           :    34341
Initial tau           : 1.82e+05      Two-norm of b         : 2.62e+03
Optimality tol        : 1.00e-04      Target one-norm of x  : 1.82e+05
Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

  Iter      Objective   Relative Gap      gNorm   stepG    nnzX    nnzG
     0  2.6212440e+03  1.0333980e+01   1.95e+02     0.0       0       0
Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
         1          1           4     1.00000e+00     5.88784e+02     2.309
         2          1          10     1.00000e+00     4.90169e+02     1.504
         3          1          19     1.00000e+00     3.72234e+02     8.353
         4          1          28     1.00000e+00     3.08969e+02     5.885
         5          1          38     1.00000e+00     2.63117e+02     4.399
         6          1          48     1.00000e+00     2.28226e+02     3.433
         7          1          58     1.00000e+00     2.01975e+02     2.754
         8          1          70     1.00000e+00     1.81371e+02     2.299
```

| | | | | | |
|---|---|---|---|---|---|
| 9 | 1 | 81 | 1.00000e+00 | 1.64064e+02 | 1.980 |
| 10 | 1 | 94 | 1.00000e+00 | 1.49721e+02 | 1.760 |
| 11 | 1 | 108 | 1.00000e+00 | 1.37599e+02 | 1.549 |
| 12 | 1 | 122 | 1.00000e+00 | 1.26675e+02 | 1.366 |
| 13 | 1 | 140 | 1.00000e+00 | 1.17148e+02 | 1.226 |
| 14 | 1 | 157 | 1.00000e+00 | 1.09807e+02 | 1.131 |
| 15 | 1 | 173 | 1.00000e+00 | 1.02693e+02 | 1.073 |
| 16 | 1 | 193 | 1.00000e+00 | 9.57634e+01 | 1.020 |
| 17 | 1 | 211 | 1.00000e+00 | 8.97698e+01 | 9.149 |
| 18 | 1 | 233 | 1.00000e+00 | 8.35725e+01 | 8.606 |
| 19 | 1 | 265 | 1.00000e+00 | 7.86231e+01 | 7.888 |
| 20 | 1 | 288 | 1.00000e+00 | 7.39468e+01 | 7.087 |
| 21 | 1 | 312 | 1.00000e+00 | 6.92394e+01 | 6.684 |
| 22 | 1 | 340 | 1.00000e+00 | 6.53083e+01 | 6.206 |
| 23 | 1 | 368 | 1.00000e+00 | 6.18647e+01 | 5.473 |
| 24 | 1 | 391 | 1.00000e+00 | 5.84188e+01 | 5.044 |
| 25 | 1 | 420 | 1.00000e+00 | 5.56540e+01 | 4.877 |
| 26 | 1 | 444 | 1.00000e+00 | 5.30546e+01 | 4.581 |
| 27 | 1 | 471 | 1.00000e+00 | 5.04552e+01 | 4.388 |
| 28 | 1 | 501 | 1.00000e+00 | 4.79605e+01 | 4.246 |
| 29 | 1 | 529 | 1.00000e+00 | 4.54741e+01 | 4.097 |
| 30 | 1 | 561 | 1.00000e+00 | 4.29855e+01 | 3.899 |
| 31 | 1 | 605 | 1.00000e+00 | 4.09758e+01 | 3.499 |
| 32 | 1 | 636 | 1.00000e+00 | 3.89115e+01 | 3.332 |
| 33 | 1 | 674 | 1.00000e+00 | 3.69775e+01 | 3.249 |
| 34 | 1 | 709 | 1.00000e+00 | 3.53199e+01 | 3.038 |
| 35 | 1 | 743 | 1.00000e+00 | 3.37260e+01 | 2.940 |
| 36 | 1 | 765 | 1.00000e+00 | 3.23582e+01 | 2.525 |
| 37 | 1 | 792 | 1.00000e+00 | 3.08089e+01 | 2.421 |
| 38 | 1 | 820 | 1.00000e+00 | 2.95983e+01 | 2.377 |
| 39 | 1 | 847 | 1.00000e+00 | 2.82436e+01 | 2.372 |
| 40 | 1 | 884 | 1.00000e+00 | 2.70857e+01 | 2.311 |
| 41 | 1 | 917 | 1.00000e+00 | 2.60267e+01 | 2.048 |
| 42 | 1 | 951 | 1.00000e+00 | 2.49546e+01 | 1.933 |
| 43 | 1 | 974 | 1.00000e+00 | 2.41263e+01 | 1.897 |
| 44 | 1 | 1002 | 1.00000e+00 | 2.32035e+01 | 1.747 |
| 45 | 1 | 1047 | 1.00000e+00 | 2.23125e+01 | 1.732 |
| 46 | 1 | 1074 | 1.00000e+00 | 2.14903e+01 | 1.723 |
| 47 | 1 | 1126 | 1.00000e+00 | 2.05915e+01 | 1.752 |
| 48 | 1 | 1157 | 1.00000e+00 | 1.97204e+01 | 1.740 |
| 49 | 1 | 1190 | 1.00000e+00 | 1.88642e+01 | 1.638 |
| 50 | 1 | 1222 | 1.00000e+00 | 1.80311e+01 | 1.560 |
| 51 | 1 | 1261 | 1.00000e+00 | 1.72893e+01 | 1.471 |
| 52 | 1 | 1295 | 1.00000e+00 | 1.64697e+01 | 1.408 |
| 53 | 1 | 1343 | 1.00000e+00 | 1.57575e+01 | 1.331 |
| 54 | 1 | 1380 | 1.00000e+00 | 1.50658e+01 | 1.234 |
| 55 | 1 | 1421 | 1.00000e+00 | 1.44263e+01 | 1.205 |
| 56 | 1 | 1457 | 1.00000e+00 | 1.38684e+01 | 1.189 |
| 57 | 1 | 1495 | 1.00000e+00 | 1.32966e+01 | 1.083 |
| 58 | 1 | 1511 | 1.00000e+00 | 1.28781e+01 | 8.761 |
| 59 | 1 | 1553 | 1.00000e+00 | 1.22588e+01 | 9.043 |
| 60 | 1 | 1589 | 1.00000e+00 | 1.17329e+01 | 9.612 |
| 61 | 1 | 1603 | 1.00000e+00 | 1.14287e+01 | 7.576 |
| 62 | 1 | 1643 | 1.00000e+00 | 1.08771e+01 | 7.627 |

| | | | | | |
|---|---|---|---|---|---|
| 63 | 1 | 1687 | 1.00000e+00 | 1.03608e+01 | 8.886 |
| 64 | 1 | 1696 | 1.00000e+00 | 1.01692e+01 | 7.958 |
| 65 | 1 | 1734 | 1.00000e+00 | 9.59444e+00 | 7.432 |
| 66 | 1 | 1773 | 1.00000e+00 | 9.28743e+00 | 6.750 |
| 67 | 1 | 1809 | 1.00000e+00 | 8.80577e+00 | 6.937 |
| 68 | 1 | 1856 | 1.00000e+00 | 8.33358e+00 | 7.647 |
| 69 | 1 | 1898 | 1.00000e+00 | 7.95630e+00 | 7.256 |
| 70 | 1 | 1959 | 1.00000e+00 | 7.53092e+00 | 6.548 |
| 71 | 1 | 1990 | 1.00000e+00 | 7.28853e+00 | 6.315 |
| 72 | 1 | 2033 | 1.00000e+00 | 6.98593e+00 | 6.325 |
| 73 | 1 | 2067 | 1.00000e+00 | 6.68224e+00 | 5.850 |
| 74 | 1 | 2104 | 1.00000e+00 | 6.43939e+00 | 5.134 |
| 75 | 1 | 2153 | 1.00000e+00 | 6.16913e+00 | 5.296 |
| 76 | 1 | 2167 | 1.00000e+00 | 6.01670e+00 | 4.568 |
| 77 | 1 | 2189 | 1.00000e+00 | 5.78528e+00 | 3.545 |
| 78 | 1 | 2234 | 1.00000e+00 | 5.52806e+00 | 3.996 |
| 79 | 1 | 2277 | 1.00000e+00 | 5.28621e+00 | 4.577 |
| 80 | 1 | 2333 | 1.00000e+00 | 5.01701e+00 | 4.343 |
| 81 | 1 | 2391 | 1.00000e+00 | 4.69825e+00 | 4.130 |
| 82 | 1 | 2451 | 1.00000e+00 | 4.44009e+00 | 4.091 |
| 83 | 1 | 2504 | 1.00000e+00 | 4.25171e+00 | 3.796 |
| 84 | 1 | 2528 | 1.00000e+00 | 4.08812e+00 | 3.127 |
| 85 | 1 | 2563 | 1.00000e+00 | 3.86638e+00 | 3.087 |
| 86 | 1 | 2612 | 1.00000e+00 | 3.61562e+00 | 3.400 |
| 87 | 1 | 2674 | 1.00000e+00 | 3.36605e+00 | 3.316 |
| 88 | 1 | 2714 | 1.00000e+00 | 3.20559e+00 | 2.714 |
| 89 | 1 | 2776 | 1.00000e+00 | 3.00510e+00 | 2.548 |
| 90 | 1 | 2828 | 1.00000e+00 | 2.84959e+00 | 2.529 |
| 91 | 1 | 2889 | 1.00000e+00 | 2.66038e+00 | 2.678 |
| 92 | 1 | 2943 | 1.00000e+00 | 2.49329e+00 | 2.539 |
| 93 | 1 | 2999 | 1.00000e+00 | 2.28961e+00 | 2.502 |
| 94 | 1 | 3071 | 1.00000e+00 | 2.14198e+00 | 2.373 |
| 95 | 1 | 3130 | 1.00000e+00 | 1.99590e+00 | 2.175 |
| 96 | 1 | 3169 | 1.00000e+00 | 1.88032e+00 | 2.109 |
| 97 | 1 | 3252 | 1.00000e+00 | 1.74146e+00 | 2.117 |
| 98 | 1 | 3270 | 1.00000e+00 | 1.66853e+00 | 1.690 |
| 99 | 1 | 3319 | 1.00000e+00 | 1.56975e+00 | 1.537 |
| 100 | 1 | 3347 | 1.00000e+00 | 1.51775e+00 | 1.365 |
| 101 | 1 | 3385 | 1.00000e+00 | 1.42903e+00 | 1.338 |
| 102 | 1 | 3449 | 1.00000e+00 | 1.34379e+00 | 1.243 |
| 103 | 1 | 3487 | 1.00000e+00 | 1.27634e+00 | 1.126 |
| 104 | 1 | 3571 | 1.00000e+00 | 1.18373e+00 | 1.157 |
| 105 | 1 | 3640 | 1.00000e+00 | 1.09591e+00 | 1.271 |
| 106 | 1 | 3674 | 1.00000e+00 | 1.03458e+00 | 1.078 |
| 107 | 1 | 3732 | 1.00000e+00 | 9.49003e-01 | 9.568 |
| 108 | 1 | 3758 | 1.00000e+00 | 9.01047e-01 | 8.750 |
| 109 | 1 | 3813 | 1.00000e+00 | 8.17092e-01 | 9.147 |
| 110 | 1 | 3867 | 1.00000e+00 | 7.46869e-01 | 8.703 |
| 111 | 1 | 3965 | 1.00000e+00 | 6.75398e-01 | 8.107 |
| 112 | 1 | 4024 | 1.00000e+00 | 6.25916e-01 | 7.540 |
| 113 | 1 | 4079 | 1.00000e+00 | 5.82505e-01 | 7.354 |
| 114 | 1 | 4141 | 1.00000e+00 | 5.37138e-01 | 6.779 |
| 115 | 1 | 4199 | 1.00000e+00 | 5.00736e-01 | 5.737 |
| 116 | 1 | 4282 | 1.00000e+00 | 4.58200e-01 | 5.976 |

```
      117          1       4371     1.00000e+00     4.18171e-01     5.813
      118          1       4448     1.00000e+00     3.77881e-01     4.976
      119          1       4527     1.00000e+00     3.37947e-01     4.500
      120          1       4559     1.00000e+00     3.13033e-01     3.815
      121          1       4660     1.00000e+00     2.73571e-01     3.580
      122          1       4741     1.00000e+00     2.35863e-01     3.425
      123          1       4824     1.00000e+00     2.07628e-01     2.945
      124          1       4875     1.00000e+00     1.84892e-01     2.514
      125          1       4913     1.00000e+00     1.68601e-01     2.333
      126          1       4971     1.00000e+00     1.49640e-01     2.319
      127          1       5017     1.00000e+00     1.29623e-01     2.143
      128          1       5099     1.00000e+00     1.15734e-01     1.731
      129          1       5166     1.00000e+00     1.02421e-01     1.640
      130          1       5247     1.00000e+00     8.94200e-02     1.575
      131          1       5307     1.00000e+00     7.45123e-02     1.385
      132          1       5354     1.00000e+00     6.66828e-02     1.096
      133          1       5418     1.00000e+00     5.58915e-02     9.700
      134          1       5494     1.00000e+00     4.73071e-02     9.002
      135          1       5585     1.00000e+00     3.86709e-02     7.468
      136          1       5666     1.00000e+00     3.28555e-02     5.914
      137          1       5729     1.00000e+00     2.70440e-02     4.951
      138          1       5765     1.00000e+00     2.40716e-02     4.235
      139          1       5834     1.00000e+00     1.95667e-02     3.791
      140          1       5896     1.00000e+00     1.63925e-02     3.187
      141          1       5975     1.00000e+00     1.31553e-02     2.593
      142          1       6016     1.00000e+00     1.09800e-02     2.180
      143          1       6103     1.00000e+00     8.53196e-03     1.883
      144          1       6152     1.00000e+00     7.16145e-03     1.577
      145          1       6207     1.00000e+00     5.74941e-03     1.248
      146          1       6259     1.00000e+00     4.44089e-03     1.081
      147          1       6324     1.00000e+00     3.19320e-03     9.077
      148          1       6394     1.00000e+00     2.31946e-03     6.842
      149          1       6424     1.00000e+00     1.78004e-03     4.270
      150          1       6481     1.00000e+00     1.20164e-03     3.467
      151          1       6544     1.00000e+00     7.98305e-04     2.504
      152          1       6606     1.00000e+00     5.42572e-04     1.511
      153          1       6682     1.00000e+00     2.38924e-04     9.777
      154          1       6732     1.00000e+00     1.61642e-04     5.895
      155          1       6769     1.00000e+00     9.37523e-05     3.118
 Optimal solution found
    155  9.3752294e-05  1.4376734e-01   1.52e-06     0.0   10489       0
  EXIT -- Optimal solution found

  Products with A     :     157        Total time   (secs) :   368.0
  Products with A'    :     157        Project time (secs) :   264.7
  Newton iterations   :       0        Mat-vec time (secs) :   117.8


  ================================================================================
  SPGL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
  ================================================================================
  No. rows              :    12800      No. columns           :    34341
  Initial tau           : 0.00e+00      Two-norm of b         : 2.62e+03
  Optimality tol        : 1.00e-04      Target objective      : 0.00e+00
```

```
Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

 Iter      Objective   Relative Gap  Rel Error      gNorm   stepG    nnzX
    0  2.6212440e+03  0.0000000e+00  1.00e+00  1.950e+02     0.0       0
    1  2.5961167e+03  1.9763651e+00  1.00e+00  1.867e+02    -0.3       1
    2  2.1768554e+03  4.2655397e+00  1.00e+00  2.625e+02     0.0     519
    3  1.8596081e+03  1.3295186e+00  1.00e+00  9.486e+01     0.0    1454
    4  1.8162749e+03  3.5359474e-01  1.00e+00  4.685e+01     0.0    1209
    5  1.8057458e+03  3.2053936e-01  1.00e+00  4.588e+01     0.0    1060
    6  1.7824737e+03  3.4159822e-01  1.00e+00  4.703e+01     0.0     728
    7  1.8129018e+03  1.5948061e+00  1.00e+00  1.006e+02     0.0     566
    8  1.7688092e+03  1.0125368e+00  1.00e+00  7.459e+01    -0.3     733
    9  1.7586793e+03  1.9779348e-01  1.00e+00  3.983e+01     0.0     678
   10  1.7573069e+03  2.0734789e-01  1.00e+00  4.030e+01     0.0     646
   11  1.7540112e+03  2.3004767e-01  1.00e+00  4.138e+01     0.0     597
   12  1.7520016e+03  1.3131654e+00  1.00e+00  8.652e+01     0.0     528
   13  1.7470971e+03  2.8726841e-01  1.00e+00  4.277e+01    -0.3     560
   14  1.7452165e+03  9.9510170e-02  1.00e+00  3.493e+01     0.0     571
   15  1.7446468e+03  8.7428065e-02  1.00e+00  3.453e+01     0.0     562
   16  1.7439778e+03  9.6991898e-02  1.00e+00  3.491e+01     0.0     536
   17  1.7438776e+03  2.4645276e-01  1.00e+00  4.133e+01    -0.3     529
   18  1.7438409e+03  3.0392528e-01  1.00e+00  4.363e+01     0.0     533
   19  9.3601536e+02  2.4996791e+00  1.00e+00  2.098e+01     0.0    8701
   20  8.8921818e+02  1.8413461e+00  1.00e+00  1.757e+01     0.0    6862
   21  8.2688236e+02  1.4950373e+00  1.00e+00  1.450e+01     0.0    3829
   22  8.9663193e+02  6.4832359e+00  1.00e+00  3.376e+01     0.0    3159
   23  8.2788810e+02  6.7694961e+00  1.00e+00  3.105e+01     0.0    3756
   24  7.9379402e+02  1.1146393e+00  1.00e+00  1.294e+01     0.0    3413
   25  7.9106216e+02  1.0039845e+00  1.00e+00  1.254e+01     0.0    3310
   26  7.8854888e+02  9.3373865e-01  1.00e+00  1.229e+01     0.0    3143
   27  7.8055288e+02  1.5272874e+00  1.00e+00  1.364e+01     0.0    2606
   28  7.7835663e+02  9.0964632e-01  1.00e+00  1.198e+01    -0.3    2707
   29  7.7712727e+02  6.8144556e-01  1.00e+00  1.127e+01     0.0    2739
   30  7.7640529e+02  6.5349442e-01  1.00e+00  1.121e+01     0.0    2724
   31  7.7511986e+02  6.3508278e-01  1.00e+00  1.112e+01     0.0    2684
   32  7.7531154e+02  1.8435420e+00  1.00e+00  1.461e+01    -0.3    2620
   33  7.7553991e+02  2.8381368e+00  1.00e+00  1.731e+01     0.0    2615
   34  7.7257666e+02  6.2074574e-01  1.00e+00  1.105e+01     0.0    2617
   35  7.7228950e+02  6.2090650e-01  1.00e+00  1.104e+01     0.0    2611
   36  7.7042020e+02  6.0847722e-01  1.00e+00  1.097e+01     0.0    2545
   37  7.7220438e+02  4.2930543e+00  1.00e+00  2.105e+01    -0.3    2230
   38  7.6911805e+02  3.8237891e+00  1.00e+00  1.992e+01    -0.3    2319
   39  7.6492853e+02  7.9155690e-01  1.00e+00  1.131e+01     0.0    2418
   40  7.6459504e+02  4.1562899e-01  1.00e+00  1.027e+01     0.0    2394
   41  7.6431943e+02  3.8247969e-01  1.00e+00  1.018e+01     0.0    2376
   42  7.6375020e+02  7.8588922e-01  1.00e+00  1.132e+01     0.0    2333
   43  7.6437953e+02  3.3295802e+00  1.00e+00  1.836e+01    -0.3    2327
   44  7.6328454e+02  4.5679989e-01  1.00e+00  1.040e+01    -0.3    2356
   45  7.6319652e+02  4.3402401e-01  1.00e+00  1.034e+01     0.0    2352
   46  7.6299892e+02  4.3093015e-01  1.00e+00  1.033e+01     0.0    2332
   47  7.6279031e+02  3.9060071e+00  1.00e+00  1.994e+01     0.0    2311
   48  7.6246104e+02  1.0534957e+00  1.00e+00  1.204e+01    -0.3    2332
   49  7.6231438e+02  7.4529042e-01  1.00e+00  1.118e+01     0.0    2327
   50  7.6224053e+02  2.8863177e-01  1.00e+00  9.922e+00     0.0    2319
```

| | | | | | | |
|---|---|---|---|---|---|---|
| 51 | 7.6205639e+02 | 8.7957787e-01 | 1.00e+00 | 1.155e+01 | 0.0 | 2306 |
| 52 | 7.6198258e+02 | 4.5978802e-01 | 1.00e+00 | 1.039e+01 | -0.3 | 2310 |
| 53 | 7.6192299e+02 | 1.1405743e+00 | 1.00e+00 | 1.227e+01 | 0.0 | 2304 |
| 54 | 7.6183103e+02 | 3.9330673e-01 | 1.00e+00 | 1.021e+01 | 0.0 | 2303 |
| 55 | 7.6177764e+02 | 2.8443346e-01 | 1.00e+00 | 9.903e+00 | 0.0 | 2303 |
| 56 | 7.6171338e+02 | 2.8339530e-01 | 1.00e+00 | 9.900e+00 | 0.0 | 2302 |
| 57 | 7.6152364e+02 | 1.7001038e+00 | 1.00e+00 | 1.379e+01 | 0.0 | 2275 |
| 58 | 7.6131396e+02 | 2.9955189e-01 | 1.00e+00 | 9.938e+00 | -0.3 | 2286 |
| 59 | 7.6126479e+02 | 2.7681553e-01 | 1.00e+00 | 9.872e+00 | 0.0 | 2286 |
| 60 | 7.6122455e+02 | 2.7519329e-01 | 1.00e+00 | 9.868e+00 | 0.0 | 2282 |
| 61 | 7.6063391e+02 | 7.5627732e-01 | 1.00e+00 | 1.117e+01 | 0.0 | 2235 |
| 62 | 7.6062175e+02 | 8.5608985e-01 | 1.00e+00 | 1.146e+01 | -0.3 | 2248 |
| 63 | 2.9950782e+02 | 7.9575353e+00 | 1.00e+00 | 5.104e+00 | 0.0 | 14622 |
| 64 | 2.7952935e+02 | 6.8072247e+00 | 1.00e+00 | 4.467e+00 | 0.0 | 12667 |
| 65 | 2.5089888e+02 | 7.0265565e+00 | 1.00e+00 | 3.842e+00 | 0.0 | 8697 |
| 66 | 2.7118149e+02 | 2.6789731e+01 | 1.00e+00 | 8.677e+00 | 0.0 | 6840 |
| 67 | 2.6285065e+02 | 3.4248893e+01 | 1.00e+00 | 9.693e+00 | 0.0 | 7177 |
| 68 | 2.3180251e+02 | 6.5128616e+00 | 1.00e+00 | 3.414e+00 | 0.0 | 6977 |
| 69 | 2.2993684e+02 | 3.2680285e+00 | 1.00e+00 | 2.809e+00 | 0.0 | 6798 |
| 70 | 2.2894315e+02 | 3.1125339e+00 | 1.00e+00 | 2.771e+00 | 0.0 | 6599 |
| 71 | 2.2432686e+02 | 6.2130110e+00 | 1.00e+00 | 3.162e+00 | 0.0 | 5701 |
| 72 | 2.2418186e+02 | 8.9300487e+00 | 1.00e+00 | 3.661e+00 | -0.3 | 5807 |
| 73 | 2.2258986e+02 | 4.7459975e+00 | 1.00e+00 | 2.919e+00 | 0.0 | 5839 |
| 74 | 2.2201944e+02 | 2.9860741e+00 | 1.00e+00 | 2.651e+00 | 0.0 | 5758 |
| 75 | 2.2170178e+02 | 2.9613519e+00 | 1.00e+00 | 2.640e+00 | 0.0 | 5722 |
| 76 | 2.1906992e+02 | 4.8664949e+00 | 1.00e+00 | 2.900e+00 | 0.0 | 5239 |
| 77 | 2.2032615e+02 | 1.2992147e+01 | 1.00e+00 | 4.164e+00 | -0.3 | 5293 |
| 78 | 2.1850141e+02 | 5.7096625e+00 | 1.00e+00 | 3.033e+00 | 0.0 | 5315 |
| 79 | 2.1800992e+02 | 2.6880787e+00 | 1.00e+00 | 2.553e+00 | 0.0 | 5284 |
| 80 | 2.1787962e+02 | 2.6979558e+00 | 1.00e+00 | 2.553e+00 | 0.0 | 5255 |
| 81 | 2.1653527e+02 | 2.9087041e+00 | 1.00e+00 | 2.549e+00 | 0.0 | 4978 |
| 82 | 2.1733355e+02 | 8.9613132e+00 | 1.00e+00 | 3.528e+00 | -0.3 | 5020 |
| 83 | 2.1747217e+02 | 1.4639744e+01 | 1.00e+00 | 4.317e+00 | 0.0 | 5124 |
| 84 | 2.1581311e+02 | 2.0951540e+00 | 1.00e+00 | 2.439e+00 | 0.0 | 5013 |
| 85 | 2.1571810e+02 | 2.0984809e+00 | 1.00e+00 | 2.436e+00 | 0.0 | 4998 |
| 86 | 2.1559454e+02 | 2.1041602e+00 | 1.00e+00 | 2.435e+00 | 0.0 | 4961 |
| 87 | 2.1451313e+02 | 7.4781892e+00 | 1.00e+00 | 3.190e+00 | 0.0 | 4478 |
| 88 | 2.1442595e+02 | 1.6333921e+01 | 1.00e+00 | 4.555e+00 | -0.3 | 4575 |
| 89 | 2.1336466e+02 | 7.1105493e+00 | 1.00e+00 | 3.141e+00 | 0.0 | 4720 |
| 90 | 2.1311325e+02 | 1.5305616e+00 | 1.00e+00 | 2.332e+00 | 0.0 | 4666 |
| 91 | 2.1306602e+02 | 1.5369883e+00 | 1.00e+00 | 2.331e+00 | 0.0 | 4648 |
| 92 | 2.1283456e+02 | 1.5736550e+00 | 1.00e+00 | 2.329e+00 | 0.0 | 4604 |
| 93 | 2.1302465e+02 | 1.2935438e+01 | 1.00e+00 | 3.988e+00 | 0.0 | 4562 |
| 94 | 2.1247673e+02 | 2.8777937e+00 | 1.00e+00 | 2.525e+00 | -0.3 | 4630 |
| 95 | 2.1238868e+02 | 1.4900628e+00 | 1.00e+00 | 2.316e+00 | 0.0 | 4606 |
| 96 | 2.1234468e+02 | 1.4876181e+00 | 1.00e+00 | 2.314e+00 | 0.0 | 4585 |
| 97 | 2.1223913e+02 | 1.5507842e+00 | 1.00e+00 | 2.318e+00 | 0.0 | 4548 |
| 98 | 2.1229883e+02 | 7.2084719e+00 | 1.00e+00 | 3.150e+00 | -0.3 | 4535 |
| 99 | 2.1218407e+02 | 7.3500658e+00 | 1.00e+00 | 3.154e+00 | -0.3 | 4543 |
| 100 | 2.1203368e+02 | 1.5325965e+00 | 1.00e+00 | 2.317e+00 | 0.0 | 4535 |
| 101 | 2.1201584e+02 | 1.5333430e+00 | 1.00e+00 | 2.316e+00 | 0.0 | 4529 |
| 102 | 2.1179633e+02 | 1.4612209e+00 | 1.00e+00 | 2.301e+00 | 0.0 | 4501 |
| 103 | 2.1189167e+02 | 1.0487792e+01 | 1.00e+00 | 3.615e+00 | -0.3 | 4511 |
| 104 | 2.1156394e+02 | 2.8970810e+00 | 1.00e+00 | 2.516e+00 | -0.3 | 4567 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 105 | 2.1148999e+02 | 1.4748197e+00 | 1.00e+00 | 2.306e+00 | 0.0 | 4538 |
| 106 | 2.1145553e+02 | 1.3346048e+00 | 1.00e+00 | 2.284e+00 | 0.0 | 4523 |
| 107 | 2.1139446e+02 | 1.3406950e+00 | 1.00e+00 | 2.281e+00 | 0.0 | 4490 |
| 108 | 2.1140967e+02 | 5.4586562e+00 | 1.00e+00 | 2.878e+00 | -0.3 | 4487 |
| 109 | 2.1130804e+02 | 2.1898516e+00 | 1.00e+00 | 2.403e+00 | -0.3 | 4488 |
| 110 | 2.1128404e+02 | 1.3377505e+00 | 1.00e+00 | 2.281e+00 | 0.0 | 4487 |
| 111 | 2.1126457e+02 | 1.3314704e+00 | 1.00e+00 | 2.280e+00 | 0.0 | 4481 |
| 112 | 2.1068336e+02 | 6.4034621e+00 | 1.00e+00 | 2.994e+00 | 0.0 | 4360 |
| 113 | 2.1094801e+02 | 2.1530945e+01 | 1.00e+00 | 5.170e+00 | -0.3 | 4393 |
| 114 | 2.1049068e+02 | 3.7845832e+00 | 1.00e+00 | 2.626e+00 | 0.0 | 4416 |
| 115 | 2.1045250e+02 | 1.0183806e+00 | 1.00e+00 | 2.230e+00 | 0.0 | 4411 |
| 116 | 2.1044019e+02 | 1.0617194e+00 | 1.00e+00 | 2.236e+00 | 0.0 | 4407 |
| 117 | 2.1033062e+02 | 1.4048741e+00 | 1.00e+00 | 2.280e+00 | 0.0 | 4382 |
| 118 | 2.1029670e+02 | 1.7863492e+00 | 1.00e+00 | 2.340e+00 | -0.3 | 4400 |
| 119 | 2.1033030e+02 | 8.3484763e+00 | 1.00e+00 | 3.267e+00 | 0.0 | 4377 |
| 120 | 2.1027075e+02 | 4.5788829e+00 | 1.00e+00 | 2.734e+00 | 0.0 | 4388 |
| 121 | 2.1022973e+02 | 1.1397196e+00 | 1.00e+00 | 2.244e+00 | 0.0 | 4391 |
| 122 | 2.1022140e+02 | 1.1319244e+00 | 1.00e+00 | 2.243e+00 | 0.0 | 4390 |
| 123 | 1.0489951e+02 | 1.0738058e+02 | 1.00e+00 | 3.230e+00 | 0.0 | 5970 |
| 124 | 5.9104968e+01 | 1.8098927e+02 | 1.00e+00 | 2.260e+00 | 0.0 | 17436 |
| 125 | 4.0490700e+01 | 5.6616395e+01 | 1.00e+00 | 5.639e-01 | 0.0 | 16007 |
| 126 | 3.8725297e+01 | 5.0611439e+01 | 1.00e+00 | 5.167e-01 | 0.0 | 14489 |
| 127 | 3.5727392e+01 | 6.1089303e+01 | 1.00e+00 | 5.196e-01 | 0.0 | 12109 |
| 128 | 3.5592683e+01 | 2.0983233e+02 | 1.00e+00 | 1.013e+00 | 0.0 | 10147 |
| 129 | 3.3802483e+01 | 2.3010873e+02 | 1.00e+00 | 1.027e+00 | -0.3 | 10744 |
| 130 | 3.2600730e+01 | 5.2184416e+01 | 1.00e+00 | 4.301e-01 | 0.0 | 10220 |
| 131 | 3.2370238e+01 | 3.4539109e+01 | 1.00e+00 | 3.730e-01 | 0.0 | 10030 |
| 132 | 3.2083273e+01 | 3.3914810e+01 | 1.00e+00 | 3.680e-01 | 0.0 | 9792 |
| 133 | 3.1631137e+01 | 2.0307884e+02 | 1.00e+00 | 8.433e-01 | 0.0 | 8568 |
| 134 | 3.0486952e+01 | 5.6640481e+01 | 1.00e+00 | 4.144e-01 | -0.3 | 8796 |
| 135 | 3.0235622e+01 | 2.7431617e+01 | 1.00e+00 | 3.316e-01 | 0.0 | 8767 |
| 136 | 3.0126445e+01 | 2.9528799e+01 | 1.00e+00 | 3.346e-01 | 0.0 | 8700 |
| 137 | 2.9783713e+01 | 3.1538905e+01 | 1.00e+00 | 3.320e-01 | 0.0 | 8462 |
| 138 | 2.9976785e+01 | 1.1057594e+02 | 1.00e+00 | 5.390e-01 | -0.3 | 8313 |
| 139 | 2.9520477e+01 | 6.5881878e+01 | 1.00e+00 | 4.158e-01 | -0.3 | 8299 |
| 140 | 2.9363743e+01 | 2.5170537e+01 | 1.00e+00 | 3.136e-01 | 0.0 | 8276 |
| 141 | 2.9323341e+01 | 2.5636494e+01 | 1.00e+00 | 3.140e-01 | 0.0 | 8240 |
| 142 | 2.8848558e+01 | 3.1505589e+01 | 1.00e+00 | 3.211e-01 | 0.0 | 7904 |
| 143 | 2.9240559e+01 | 1.0364288e+02 | 1.00e+00 | 5.056e-01 | -0.3 | 7952 |
| 144 | 2.8665579e+01 | 3.8046886e+01 | 1.00e+00 | 3.368e-01 | -0.3 | 8202 |
| 145 | 2.8576701e+01 | 1.9155927e+01 | 1.00e+00 | 2.916e-01 | 0.0 | 7997 |
| 146 | 2.8532414e+01 | 2.0675729e+01 | 1.00e+00 | 2.941e-01 | 0.0 | 7905 |
| 147 | 2.8414971e+01 | 2.3269477e+01 | 1.00e+00 | 2.980e-01 | 0.0 | 7771 |
| 148 | 2.8375713e+01 | 2.3514981e+01 | 1.00e+00 | 2.982e-01 | -0.3 | 7792 |
| 149 | 2.8345061e+01 | 3.7387279e+01 | 1.00e+00 | 3.300e-01 | 0.0 | 7731 |
| 150 | 2.8295874e+01 | 2.0797291e+01 | 1.00e+00 | 2.912e-01 | 0.0 | 7727 |
| 151 | 2.8266025e+01 | 2.0440879e+01 | 1.00e+00 | 2.903e-01 | 0.0 | 7710 |
| 152 | 2.8229967e+01 | 2.0236095e+01 | 1.00e+00 | 2.894e-01 | 0.0 | 7690 |
| 153 | 2.8146739e+01 | 7.5219712e+01 | 1.00e+00 | 4.130e-01 | 0.0 | 7550 |
| 154 | 2.8017781e+01 | 1.8803767e+01 | 1.00e+00 | 2.843e-01 | -0.3 | 7577 |
| 155 | 2.7995828e+01 | 1.8838742e+01 | 1.00e+00 | 2.843e-01 | 0.0 | 7562 |
| 156 | 2.7966969e+01 | 1.8928169e+01 | 1.00e+00 | 2.841e-01 | 0.0 | 7535 |
| 157 | 2.7505593e+01 | 7.7634623e+01 | 1.00e+00 | 4.068e-01 | -0.3 | 7214 |
| 158 | 2.7454141e+01 | 7.2045444e+01 | 1.00e+00 | 3.938e-01 | -0.3 | 7290 |

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  159  2.7297095e+01  1.8771857e+01   1.00e+00  2.780e-01     0.0    7303
  160  2.7276741e+01  1.6267731e+01   1.00e+00  2.723e-01     0.0    7293
  161  2.7250385e+01  1.6281959e+01   1.00e+00  2.718e-01     0.0    7284
  162  2.7108865e+01  4.4154948e+01   1.00e+00  3.278e-01     0.0    7198
  163  2.7254204e+01  9.3638564e+01   1.00e+00  4.343e-01    -0.3    7251
  164  2.7069856e+01  3.7706927e+01   1.00e+00  3.136e-01     0.0    7233
  165  2.7026153e+01  1.6712825e+01   1.00e+00  2.698e-01     0.0    7222
  166  2.7017445e+01  1.6652964e+01   1.00e+00  2.696e-01     0.0    7214
  167  2.6715984e+01  1.0380519e+02   1.00e+00  4.449e-01     0.0    7013
  168  2.6897814e+01  3.6942339e+02   1.00e+00  9.974e-01    -0.3    7077
  169  2.6774960e+01  2.8367015e+02   1.00e+00  8.119e-01     0.0    7267
  170  2.6602820e+01  3.8876569e+01   1.00e+00  3.108e-01     0.0    7140
  171  2.6592100e+01  1.6743176e+01   1.00e+00  2.659e-01     0.0    7117
  172  2.6578412e+01  1.6672373e+01   1.00e+00  2.656e-01     0.0    7080
  173  2.6430864e+01  3.5965055e+01   1.00e+00  3.022e-01     0.0    6951
  174  2.6456288e+01  7.3296196e+01   1.00e+00  3.771e-01    -0.3    6978
  175  2.6393604e+01  3.3359254e+01   1.00e+00  2.966e-01     0.0    6999
  176  2.6377120e+01  1.6888819e+01   1.00e+00  2.638e-01     0.0    6988
  177  2.6370384e+01  1.6877129e+01   1.00e+00  2.637e-01     0.0    6974
  178  2.6215467e+01  4.8836026e+01   1.00e+00  3.252e-01     0.0    6885
  179  2.6244343e+01  6.7880698e+01   1.00e+00  3.634e-01    -0.3    6903
  180  2.6200945e+01  3.9591014e+01   1.00e+00  3.064e-01     0.0    6932
  181  2.6172231e+01  1.6605165e+01   1.00e+00  2.615e-01     0.0    6913
  182  2.6166874e+01  1.6611997e+01   1.00e+00  2.614e-01     0.0    6907
  183  2.6095004e+01  2.0262415e+01   1.00e+00  2.676e-01     0.0    6864
  184  2.6097660e+01  1.7658503e+02   1.00e+00  5.714e-01    -0.3    6871
  185  2.6102088e+01  1.4616031e+02   1.00e+00  5.126e-01    -0.3    6882
  186  2.6040157e+01  2.3981288e+01   1.00e+00  2.743e-01     0.0    6873
  187  2.6034616e+01  1.6288132e+01   1.00e+00  2.594e-01     0.0    6866
  188  2.6021593e+01  1.6366246e+01   1.00e+00  2.594e-01     0.0    6853
  189  2.5976386e+01  4.6803083e+02   1.00e+00  1.127e+00     0.0    6586
  190  2.5613844e+01  5.5282969e+01   1.00e+00  3.296e-01    -0.3    6700
  191  2.5543347e+01  6.5666120e+01   1.00e+00  3.475e-01     0.0    6711
  192  2.5513330e+01  2.1778134e+01   1.00e+00  2.652e-01     0.0    6697
  193  2.5479580e+01  4.0836825e+01   1.00e+00  3.000e-01     0.0    6685
  194  2.5526499e+01  1.6256219e+02   1.00e+00  5.262e-01     0.0    6688
  195  2.5517319e+01  1.6799788e+02   1.00e+00  5.362e-01     0.0    6686
  196  2.5438981e+01  1.6679629e+01   1.00e+00  2.546e-01     0.0    6694
  197  2.5435685e+01  1.6629326e+01   1.00e+00  2.544e-01     0.0    6690
  198  2.5391378e+01  1.5973253e+01   1.00e+00  2.526e-01     0.0    6660
  199  2.5373765e+01  1.2026166e+02   1.00e+00  4.443e-01    -0.3    6669
  200  2.5353252e+01  2.0670182e+01   1.00e+00  2.609e-01    -0.3    6708

ERROR EXIT -- Too many iterations

Products with A     :     277        Total time   (secs) :   184.2
Products with A'    :     201        Project time (secs) :     1.1
Newton iterations   :       4        Mat-vec time (secs) :   182.1
Line search its     :     128        Subspace iterations :       0


================================================================================
PQNL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
================================================================================
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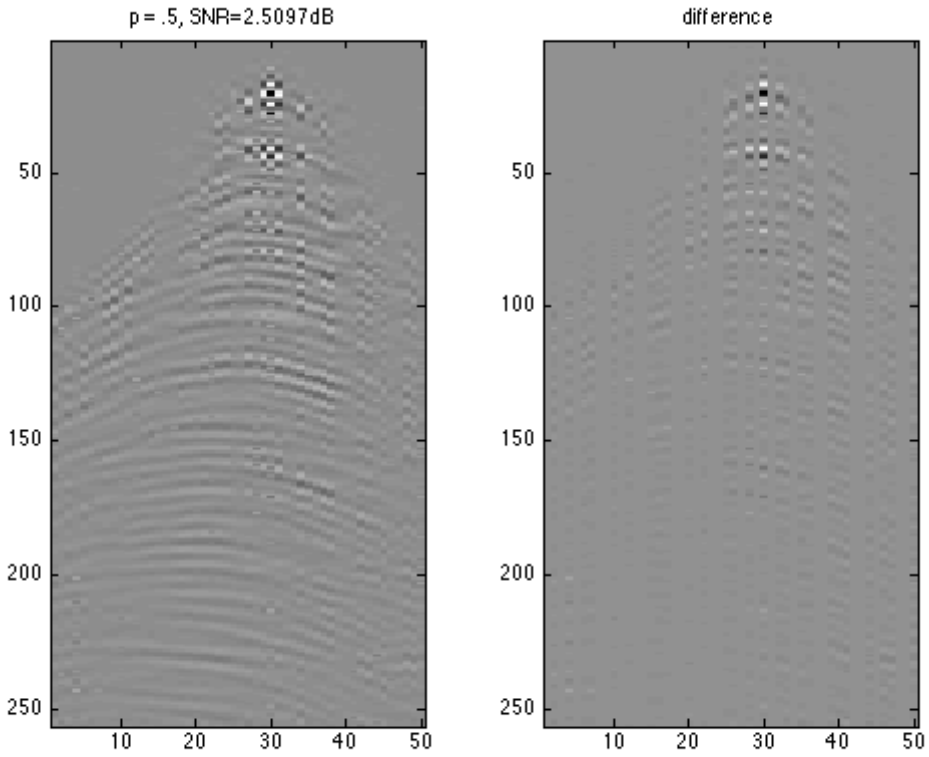
```
 No. rows              :    12800      No. columns           :    34341
 Initial tau           : 0.00e+00      Two-norm of b         : 2.62e+03
 Optimality tol        : 1.00e-04      Target objective      : 0.00e+00
 Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

     0  2.6212440e+03  0.0000000e+00   1.00e+00  1.950e+02     0.0       0

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
         1          1           4     1.00000e+00     1.91796e+03     9.535
         2          1          10     1.00000e+00     1.86943e+03     5.640
         3          1          19     1.00000e+00     1.83199e+03     3.336
         4          1          29     1.00000e+00     1.80938e+03     2.537
         5          1          39     1.00000e+00     1.79278e+03     2.013
         6          1          48     1.00000e+00     1.77959e+03     1.641
         7          1          57     1.00000e+00     1.77089e+03     1.259
         8          1          66     1.00000e+00     1.76289e+03     1.030
         9          1          77     1.00000e+00     1.75670e+03     8.641
        10          1          93     1.00000e+00     1.75224e+03     7.248
        11          1         106     1.00000e+00     1.74957e+03     5.758
        12          1         117     1.00000e+00     1.74711e+03     4.621
        13          1         128     1.00000e+00     1.74566e+03     4.026
        14          1         143     1.00000e+00     1.74470e+03     3.505
        15          1         156     1.00000e+00     1.74413e+03     2.962
break of testUpdateTau    15  1.7441259e+03  9.0964549e-02   1.00e+00  3.4

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
        16          1           4     1.00000e+00     7.88825e+02     1.800
        17          1          10     1.00000e+00     7.24218e+02     1.099
        18          1          19     1.00000e+00     6.67998e+02     6.354
        19          1          27     1.00000e+00     6.37212e+02     4.496
        20          1          37     1.00000e+00     6.17057e+02     3.464
        21          1          46     1.00000e+00     6.01568e+02     2.759
        22          1          55     1.00000e+00     5.90518e+02     2.260
        23          1          64     1.00000e+00     5.82177e+02     1.845
        24          1          75     1.00000e+00     5.74962e+02     1.551
        25          1          88     1.00000e+00     5.69615e+02     1.392
        26          1         100     1.00000e+00     5.65224e+02     1.187
        27          1         111     1.00000e+00     5.61716e+02     1.027
        28          1         122     1.00000e+00     5.58709e+02     9.507
        29          1         136     1.00000e+00     5.56098e+02     9.041
        30          1         152     1.00000e+00     5.53394e+02     8.512
        31          1         169     1.00000e+00     5.51278e+02     7.976
        32          1         188     1.00000e+00     5.49422e+02     7.311
        33          1         202     1.00000e+00     5.47640e+02     6.654
        34          1         220     1.00000e+00     5.46085e+02     6.320
        35          1         239     1.00000e+00     5.44733e+02     5.945
        36          1         258     1.00000e+00     5.43480e+02     5.762
        37          1         281     1.00000e+00     5.42534e+02     5.292
        38          1         297     1.00000e+00     5.41609e+02     4.719
        39          1         311     1.00000e+00     5.40847e+02     4.435
        40          1         332     1.00000e+00     5.40015e+02     4.389
        41          1         349     1.00000e+00     5.39477e+02     4.398
```

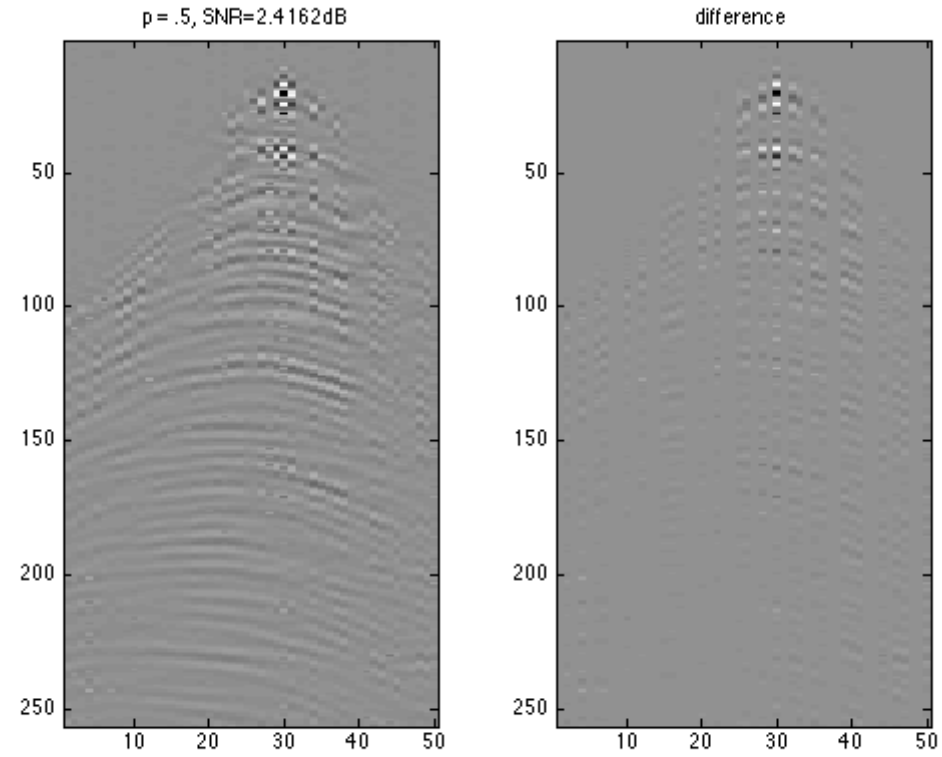
```
          42           1         377     1.00000e+00     5.38813e+02     4.204
          43           1         404     1.00000e+00     5.38198e+02     3.968
          44           1         424     1.00000e+00     5.37683e+02     3.583
          45           1         441     1.00000e+00     5.37224e+02     3.549
          46           1         455     1.00000e+00     5.36755e+02     3.714
          47           1         473     1.00000e+00     5.36435e+02     3.366
          48           1         495     1.00000e+00     5.36046e+02     2.734
          49           1         518     1.00000e+00     5.35713e+02     2.867
          50           1         542     1.00000e+00     5.35451e+02     2.910
break of testUpdateTau    50  5.3545056e+02  6.2549783e-01   1.00e+00  6.6

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
          51           1           4     1.00000e+00     1.79513e+02     6.263
          52           1          10     1.00000e+00     1.61262e+02     4.089
          53           1          19     1.00000e+00     1.43176e+02     2.341
          54           1          27     1.00000e+00     1.33904e+02     1.685
          55           1          36     1.00000e+00     1.27352e+02     1.289
          56           1          47     1.00000e+00     1.22304e+02     1.027
          57           1          59     1.00000e+00     1.18492e+02     8.518
          58           1          70     1.00000e+00     1.15381e+02     7.098
          59           1          81     1.00000e+00     1.13054e+02     6.120
          60           1          92     1.00000e+00     1.11065e+02     5.467
          61           1         106     1.00000e+00     1.09557e+02     4.850
          62           1         120     1.00000e+00     1.08110e+02     4.314
          63           1         134     1.00000e+00     1.06907e+02     4.034
          64           1         150     1.00000e+00     1.05864e+02     3.783
          65           1         166     1.00000e+00     1.04859e+02     3.465
          66           1         181     1.00000e+00     1.04027e+02     3.172
          67           1         195     1.00000e+00     1.03289e+02     2.944
          68           1         211     1.00000e+00     1.02613e+02     2.731
          69           1         227     1.00000e+00     1.01987e+02     2.542
          70           1         244     1.00000e+00     1.01435e+02     2.511
          71           1         261     1.00000e+00     1.00974e+02     2.438
          72           1         278     1.00000e+00     1.00524e+02     2.308
          73           1         295     1.00000e+00     1.00090e+02     2.182
          74           1         312     1.00000e+00     9.96944e+01     2.100
          75           1         327     1.00000e+00     9.93216e+01     2.043
          76           1         345     1.00000e+00     9.89559e+01     2.002
          77           1         364     1.00000e+00     9.86494e+01     1.891
          78           1         386     1.00000e+00     9.83319e+01     1.769
          79           1         406     1.00000e+00     9.80222e+01     1.765
          80           1         429     1.00000e+00     9.77726e+01     1.699
          81           1         457     1.00000e+00     9.75188e+01     1.552
          82           1         477     1.00000e+00     9.72425e+01     1.534
          83           1         499     1.00000e+00     9.70276e+01     1.509
          84           1         521     1.00000e+00     9.67995e+01     1.458
          85           1         541     1.00000e+00     9.65836e+01     1.438
          86           1         559     1.00000e+00     9.63849e+01     1.395
          87           1         581     1.00000e+00     9.61865e+01     1.375
          88           1         600     1.00000e+00     9.60086e+01     1.367
          89           1         626     1.00000e+00     9.58297e+01     1.346
          90           1         646     1.00000e+00     9.56881e+01     1.252
          91           1         668     1.00000e+00     9.55100e+01     1.208
```

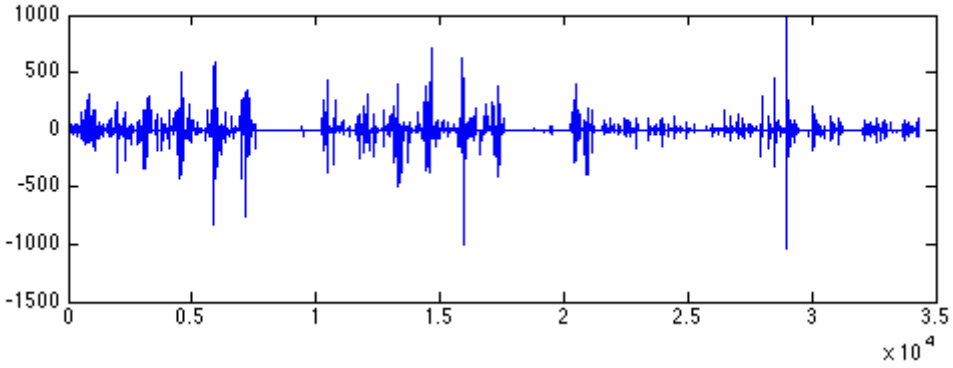
```
          92           1         688     1.00000e+00     9.53472e+01     1.295
          93           1         708     1.00000e+00     9.52309e+01     1.226
          94           1         720     1.00000e+00     9.51106e+01     9.733
          95           1         738     1.00000e+00     9.49532e+01     1.061
          96           1         759     1.00000e+00     9.48439e+01     1.112
          97           1         787     1.00000e+00     9.46981e+01     1.102
          98           1         806     1.00000e+00     9.45862e+01     1.023
          99           1         830     1.00000e+00     9.44448e+01     1.007
         100           1         851     1.00000e+00     9.43537e+01     1.032
         101           1         877     1.00000e+00     9.42301e+01     1.049
         102           1         897     1.00000e+00     9.41260e+01     1.040
         103           1         926     1.00000e+00     9.40104e+01     1.033
         104           1         955     1.00000e+00     9.39101e+01     9.982
         105           1         984     1.00000e+00     9.38091e+01     9.967
         106           1        1007     1.00000e+00     9.37253e+01     9.726
         107           1        1030     1.00000e+00     9.36271e+01     9.414
         108           1        1057     1.00000e+00     9.35414e+01     9.636
         109           1        1073     1.00000e+00     9.34677e+01     8.375
         110           1        1104     1.00000e+00     9.33667e+01     8.205
         111           1        1133     1.00000e+00     9.33002e+01     8.731
         112           1        1162     1.00000e+00     9.32164e+01     9.162
         113           1        1184     1.00000e+00     9.31373e+01     8.702
         114           1        1224     1.00000e+00     9.30438e+01     8.572
         115           1        1251     1.00000e+00     9.29783e+01     8.724
         116           1        1275     1.00000e+00     9.29111e+01     8.201
         117           1        1302     1.00000e+00     9.28296e+01     8.145
         118           1        1326     1.00000e+00     9.27673e+01     8.105
         119           1        1347     1.00000e+00     9.26962e+01     8.016
         120           1        1371     1.00000e+00     9.26351e+01     7.757
         121           1        1404     1.00000e+00     9.25664e+01     7.881
         122           1        1432     1.00000e+00     9.24996e+01     8.207
         123           1        1459     1.00000e+00     9.24422e+01     8.047
         124           1        1466     1.00000e+00     9.24155e+01     7.181
break of testUpdateTau   124  9.2415519e+01  2.9590780e+00   1.00e+00  9.3

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
         125           1           4     1.00000e+00     2.59370e+01     1.084
         126           1          10     1.00000e+00     2.30671e+01     7.333
         127           1          19     1.00000e+00     1.99289e+01     4.312
         128           1          27     1.00000e+00     1.81968e+01     3.084
         129           1          36     1.00000e+00     1.69468e+01     2.353
         130           1          47     1.00000e+00     1.60187e+01     1.868
         131           1          54     1.00000e+00     1.54287e+01     1.788
         132           1          67     1.00000e+00     1.48965e+01     1.571
         133           1          80     1.00000e+00     1.43948e+01     1.255
         134           1          92     1.00000e+00     1.39730e+01     1.038
         135           1         104     1.00000e+00     1.36289e+01     9.447
         136           1         117     1.00000e+00     1.33620e+01     8.644
         137           1         135     1.00000e+00     1.31033e+01     7.839
         138           1         151     1.00000e+00     1.28742e+01     7.119
         139           1         164     1.00000e+00     1.26818e+01     6.523
         140           1         180     1.00000e+00     1.25114e+01     5.998
         141           1         195     1.00000e+00     1.23600e+01     5.665
```

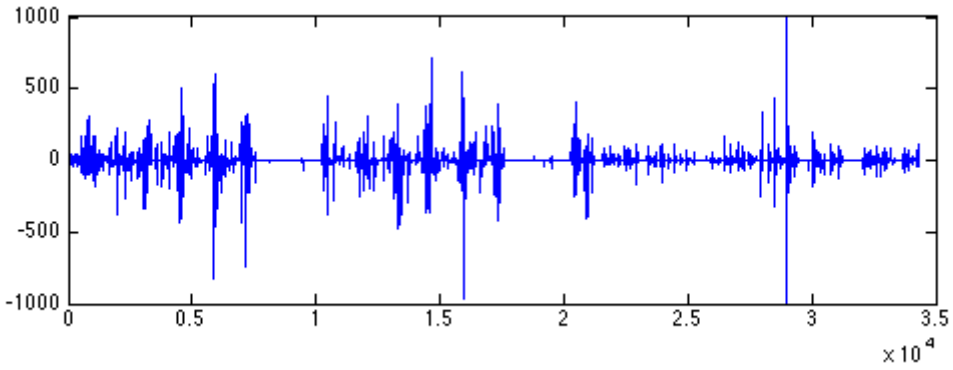
| | | | | | |
|---|---|---|---|---|---|
| 142 | 1 | 214 | 1.00000e+00 | 1.22173e+01 | 5.449 |
| 143 | 1 | 232 | 1.00000e+00 | 1.20897e+01 | 5.147 |
| 144 | 1 | 251 | 1.00000e+00 | 1.19774e+01 | 4.723 |
| 145 | 1 | 267 | 1.00000e+00 | 1.18676e+01 | 4.386 |
| 146 | 1 | 286 | 1.00000e+00 | 1.17783e+01 | 4.139 |
| 147 | 1 | 309 | 1.00000e+00 | 1.16952e+01 | 3.986 |
| 148 | 1 | 331 | 1.00000e+00 | 1.16122e+01 | 3.929 |
| 149 | 1 | 348 | 1.00000e+00 | 1.15344e+01 | 3.903 |
| 150 | 1 | 367 | 1.00000e+00 | 1.14629e+01 | 3.730 |
| 151 | 1 | 386 | 1.00000e+00 | 1.13936e+01 | 3.535 |
| 152 | 1 | 413 | 1.00000e+00 | 1.13251e+01 | 3.509 |
| 153 | 1 | 436 | 1.00000e+00 | 1.12694e+01 | 3.348 |
| 154 | 1 | 461 | 1.00000e+00 | 1.12051e+01 | 3.183 |
| 155 | 1 | 478 | 1.00000e+00 | 1.11472e+01 | 3.192 |
| 156 | 1 | 506 | 1.00000e+00 | 1.10967e+01 | 3.106 |
| 157 | 1 | 526 | 1.00000e+00 | 1.10460e+01 | 2.935 |
| 158 | 1 | 551 | 1.00000e+00 | 1.09974e+01 | 2.801 |
| 159 | 1 | 571 | 1.00000e+00 | 1.09549e+01 | 2.685 |
| 160 | 1 | 591 | 1.00000e+00 | 1.09153e+01 | 2.556 |
| 161 | 1 | 614 | 1.00000e+00 | 1.08767e+01 | 2.517 |
| 162 | 1 | 635 | 1.00000e+00 | 1.08414e+01 | 2.511 |
| 163 | 1 | 652 | 1.00000e+00 | 1.08068e+01 | 2.475 |
| 164 | 1 | 670 | 1.00000e+00 | 1.07728e+01 | 2.402 |
| 165 | 1 | 691 | 1.00000e+00 | 1.07414e+01 | 2.294 |
| 166 | 1 | 710 | 1.00000e+00 | 1.07116e+01 | 2.203 |
| 167 | 1 | 728 | 1.00000e+00 | 1.06825e+01 | 2.149 |
| 168 | 1 | 747 | 1.00000e+00 | 1.06541e+01 | 2.128 |
| 169 | 1 | 766 | 1.00000e+00 | 1.06265e+01 | 2.087 |
| 170 | 1 | 799 | 1.00000e+00 | 1.05948e+01 | 2.163 |
| 171 | 1 | 823 | 1.00000e+00 | 1.05686e+01 | 2.149 |
| 172 | 1 | 845 | 1.00000e+00 | 1.05385e+01 | 2.042 |
| 173 | 1 | 869 | 1.00000e+00 | 1.05136e+01 | 1.957 |
| 174 | 1 | 891 | 1.00000e+00 | 1.04876e+01 | 1.941 |
| 175 | 1 | 916 | 1.00000e+00 | 1.04682e+01 | 1.898 |
| 176 | 1 | 939 | 1.00000e+00 | 1.04454e+01 | 1.836 |
| 177 | 1 | 971 | 1.00000e+00 | 1.04242e+01 | 1.821 |
| 178 | 1 | 978 | 1.00000e+00 | 1.04160e+01 | 1.762 |
| 179 | 1 | 1003 | 1.00000e+00 | 1.03969e+01 | 1.856 |
| 180 | 1 | 1033 | 1.00000e+00 | 1.03758e+01 | 1.861 |
| 181 | 1 | 1066 | 1.00000e+00 | 1.03510e+01 | 1.789 |
| 182 | 1 | 1088 | 1.00000e+00 | 1.03310e+01 | 1.712 |
| 183 | 1 | 1114 | 1.00000e+00 | 1.03101e+01 | 1.638 |
| 184 | 1 | 1140 | 1.00000e+00 | 1.02887e+01 | 1.678 |
| 185 | 1 | 1163 | 1.00000e+00 | 1.02722e+01 | 1.669 |
| 186 | 1 | 1186 | 1.00000e+00 | 1.02519e+01 | 1.625 |
| 187 | 1 | 1210 | 1.00000e+00 | 1.02315e+01 | 1.695 |
| 188 | 1 | 1233 | 1.00000e+00 | 1.02145e+01 | 1.676 |
| 189 | 1 | 1257 | 1.00000e+00 | 1.01955e+01 | 1.639 |
| 190 | 1 | 1286 | 1.00000e+00 | 1.01750e+01 | 1.727 |
| 191 | 1 | 1317 | 1.00000e+00 | 1.01609e+01 | 1.699 |
| 192 | 1 | 1350 | 1.00000e+00 | 1.01415e+01 | 1.666 |
| 193 | 1 | 1385 | 1.00000e+00 | 1.01236e+01 | 1.726 |
| 194 | 1 | 1412 | 1.00000e+00 | 1.01062e+01 | 1.695 |
| 195 | 1 | 1450 | 1.00000e+00 | 1.00880e+01 | 1.641 |

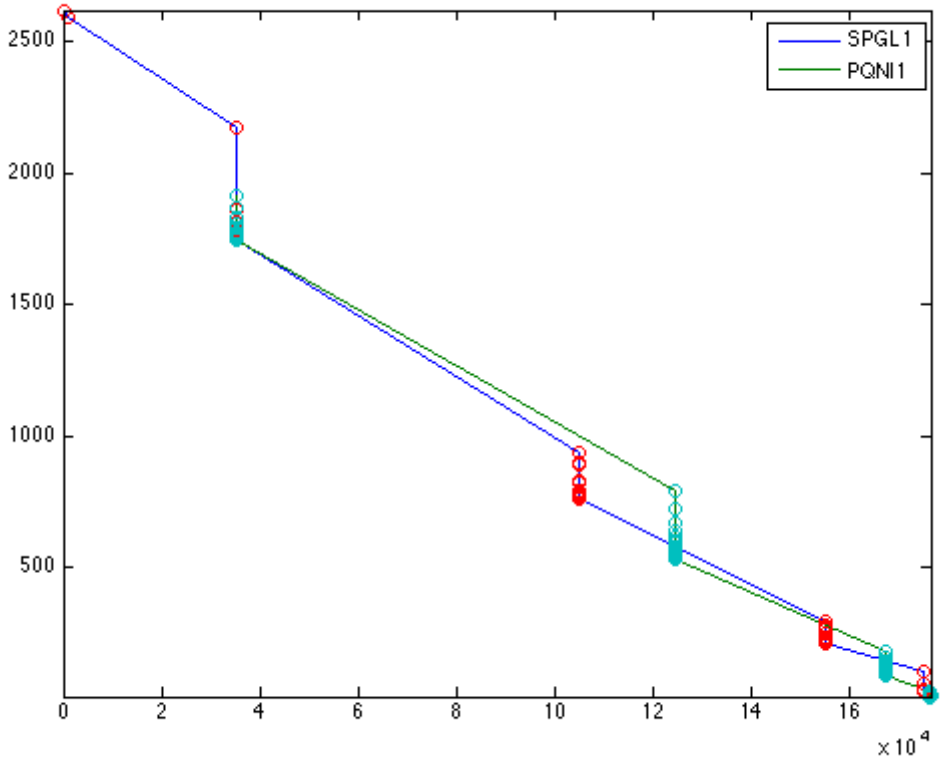
```
      196          1       1473     1.00000e+00     1.00714e+01     1.660
      197          1       1503     1.00000e+00     1.00530e+01     1.597
      198          1       1534     1.00000e+00     1.00303e+01     1.631
      199          1       1566     1.00000e+00     1.00146e+01     1.588
      200          1       1604     1.00000e+00     9.99430e+00     1.541
  200  9.9943037e+00  4.4534626e+01   1.00e+00  9.964e-02     0.0    6974

 ERROR EXIT -- Too many iterations

 Products with A     :     205        Total time   (secs) :   389.6
 Products with A'    :     205        Project time (secs) :   193.5
 Newton iterations   :       5        Mat-vec time (secs) :   165.5


info_spg =

           tau: 1.7510e+05
          rNorm: 25.3533
           rGap: 20.6702
          gNorm: 0.2609
           stat: 5
           iter: 200
         nProdA: 277
        nProdAt: 201
        nNewton: 4
    timeProject: 1.0939
    timeMatProd: 182.0572
        itnLSQR: 0
        options: [1x1 struct]
      timeTotal: 184.2414
          xNorm1: [200x1 double]
          rNorm2: [200x1 double]
          lambda: [200x1 double]


info_pqn1 =

           tau: 1.7763e+05
          rNorm: 9.9943
           rGap: 44.5346
          gNorm: 0.0996
           stat: 5
           iter: 200
         nProdA: 205
        nProdAt: 205
        nNewton: 5
    timeProject: 193.5481
    timeMatProd: 165.5206
        itnLSQR: 0
        options: [1x1 struct]
      timeTotal: 389.6463
          xNorm1: [200x1 double]
          rNorm2: [200x1 double]
          lambda: [200x1 double]
```


p = .5, SNR=2.5097dB
difference
50
100
150
200
250
10
20
30
40
50


p = .5, SNR=2.4162dB
difference
50
100
150
200
250
10
20
30
40
50


1000
500
0
-500
-1000
-1500
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


1000
500
0
-500
-1000
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4




# if given known strict sparse vector

```
[m n] = size(A); k = .2*round(n/log(m));
p = randperm(n); x0 = zeros(n,1); x0(p(1:k)) = sign(randn(k,1));
figure;plot(x0)
b0  = A*x0;

tau = norm(x0,1);

options = spgSetParms('optTol', 1e-4, 'iterations', 200);%, 'fid', fid);
xinit = zeros(size(A,2),1);

xestspg = spgl1(A,b0,tau,[],xinit,options);
xestpqn = pqnl1_2(A,b0,tau,[],xinit,options);
snrspg = SNR(x0,xestspg);
snrpqn = SNR(x0,xestpqn);

figure('Name','strcit sparse vector SPG');
subplot(2,1,1);plot(xestspg);
title(strcat(['p = .5, SNR=' num2str(snrspg) 'dB']))
subplot(2,1,2);plot(xestspg - x0);
title('difference')

figure('Name','strcit sparse vector PQN');
subplot(2,1,1);plot(xestpqn);
```

```
title(strcat(['p = .5, SNR=' num2str(snrpqn) 'dB']))
subplot(2,1,2);plot(xestpqn - x0);
title('difference')

% BPDN
[x_spg,r_spg,g_spg,info_spg] = spgl1(A, b0, 0, 0, zeros(size(A,2),1), options); %

[x_pqn1,r_pqn1,g_pqn1,info_pqn1] = pqnl1_2(A, b0, 0, 0, zeros(size(A,2),1), option

figure; subplot(2,1,1);plot(x_spg);subplot(2,1,2);plot(x_pqn1);
info_spg
info_pqn1

% 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','PQNl1')
axis tight
```

```
Warning: Size vector should be a row vector with integer
elements.
Warning: Integer operands are required for colon operator
when used as index

 ================================================================================
 SPGL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
 ================================================================================
 No. rows              :    12800      No. columns           :    34341
 Initial tau           : 7.26e+02      Two-norm of b         : 1.14e+01
 Optimality tol        : 1.00e-04      Target one-norm of x  : 7.26e+02
 Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

  Iter      Objective   Relative Gap      gNorm   stepG    nnzX    nnzG
     0  1.1383394e+01  1.2266626e+01   1.09e+00     0.0       0       0
     1  2.3011515e+00  2.1453231e+01   1.03e-01     0.0   23310       0
     2  1.6962014e+00  1.7685695e+01   5.00e-02     0.0   19197       0
     3  1.1332185e+00  1.4125420e+01   2.90e-02     0.0   15796       0
     4  7.1783434e-01  1.6399470e+01   2.89e-02     0.0   13707       0
     5  1.0635082e+00  8.2066850e+01   1.13e-01     0.0   12469       0
     6  6.6868879e-01  4.3877176e+01   6.50e-02     0.0   15598       0
     7  3.7063538e-01  3.0809559e+00   7.44e-03     0.0   14168       0
     8  3.4594298e-01  2.9535614e+00   7.09e-03     0.0   13723       0
     9  2.5932858e-01  3.7791574e+00   7.49e-03     0.0   12805       0
    10  3.4606659e-01  3.9405571e+01   5.49e-02     0.0   12179       0
    11  3.2256568e-01  3.9856812e+01   5.68e-02    -0.3   14849       0
    12  1.2842550e-01  2.4972945e+00   4.50e-03     0.0   13020       0
    13  1.1897959e-01  9.0705782e-01   2.27e-03     0.0   12884       0
    14  1.0572101e-01  8.0629903e-01   2.02e-03     0.0   12573       0
    15  7.4489240e-02  2.6243924e+00   4.17e-03     0.0   12181       0
    16  6.3841410e-02  1.3618463e+00   2.44e-03    -0.3   12196       0
    17  5.9097216e-02  8.4617083e-01   1.67e-03     0.0   12131       0
    18  5.6192738e-02  4.2201127e-01   1.07e-03     0.0   12119       0
```

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   19  5.0739702e-02  1.5149818e+00   2.51e-03     0.0   12057       0
   20  5.2244465e-02  4.0825908e+00   6.04e-03    -0.3   12076       0
   21  4.7814034e-02  4.0094244e+00   5.86e-03     0.0   11992       0
   22  4.1281099e-02  2.9514324e-01   7.66e-04     0.0   12011       0
   23  4.0091190e-02  2.8621676e-01   7.42e-04     0.0   12001       0
   24  2.9056679e-02  2.9588677e-01   6.60e-04     0.0   11937       0
   25  3.8436992e-02  5.6617212e+00   7.92e-03    -0.3   11871       0
   26  1.7296284e-02  4.6979725e-01   7.98e-04    -0.3   11893       0
   27  1.5902167e-02  1.4003135e-01   3.30e-04     0.0   11883       0
   28  1.4953962e-02  1.0453981e-01   2.74e-04     0.0   11873       0
   29  1.1696470e-02  1.4210159e-01   2.94e-04     0.0   11849       0
   30  1.0964857e-02  2.2584061e-01   4.06e-04    -0.3   11848       0
   31  1.0528994e-02  4.3922136e-01   6.88e-04     0.0   11840       0
   32  9.7632154e-03  2.2858578e-01   4.00e-04     0.0   11844       0
   33  9.3155090e-03  8.1521527e-02   1.92e-04     0.0   11841       0
   34  8.9406057e-03  6.2501155e-02   1.64e-04     0.0   11841       0
   35  7.5077982e-03  4.1187369e-01   6.26e-04     0.0   11829       0
   36  6.9768329e-03  1.5752128e-01   2.78e-04    -0.3   11829       0
   37  6.7060188e-03  4.8116338e-02   1.24e-04     0.0   11827       0
   38  6.4064146e-03  4.5163894e-02   1.18e-04     0.0   11828       0
   39  5.1857817e-03  5.0721960e-01   7.33e-04     0.0   11807       0
   40  4.7403100e-03  3.4953622e-01   5.21e-04    -0.3   11815       0
   41  4.0846077e-03  2.9264931e-02   7.55e-05     0.0   11810       0
   42  3.9828427e-03  2.8411132e-02   7.36e-05     0.0   11809       0
   43  2.5137326e-03  2.8859467e-02   6.13e-05     0.0   11814       0
   44  3.7110142e-03  5.3943854e-01   7.58e-04    -0.3   11809       0
   45  1.3972943e-03  4.9812288e-02   8.01e-05    -0.3   11803       0
   46  1.2781277e-03  9.0411890e-03   2.34e-05     0.0   11804       0
   47  1.2104062e-03  8.5084809e-03   2.21e-05     0.0   11804       0
   48  9.4158237e-04  1.2619920e-02   2.53e-05     0.0   11803       0

 EXIT -- Optimal solution found

 Products with A     :      65        Total time   (secs) :    51.2
 Products with A'    :      49        Project time (secs) :     0.3
 Newton iterations   :       0        Mat-vec time (secs) :    50.5
 Line search its     :      18        Subspace iterations :       0


 ================================================================================
 PQNL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
 ================================================================================
 No. rows              :    12800      No. columns           :    34341
 Initial tau           : 7.26e+02      Two-norm of b         : 1.14e+01
 Optimality tol        : 1.00e-04      Target one-norm of x  : 7.26e+02
 Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

  Iter      Objective   Relative Gap      gNorm   stepG    nnzX    nnzG
     0  1.1383394e+01  1.2266626e+01   1.09e+00     0.0       0       0
Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
         1          1           4     1.00000e+00     2.05954e+00     1.007
         2          1          10     1.00000e+00     1.58909e+00     6.413
         3          1          18     1.00000e+00     1.03258e+00     3.562
```

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          4          1          27     1.00000e+00     7.64303e-01     2.489
          5          1          38     1.00000e+00     5.59372e-01     1.834
          6          1          50     1.00000e+00     4.15505e-01     1.255
          7          1          64     1.00000e+00     3.06691e-01     8.993
          8          1          80     1.00000e+00     2.33225e-01     6.852
          9          1         102     1.00000e+00     1.70171e-01     5.441
         10          1         124     1.00000e+00     1.26563e-01     4.139
         11          1         144     1.00000e+00     9.12761e-02     3.035
         12          1         172     1.00000e+00     6.53918e-02     2.313
         13          1         199     1.00000e+00     4.63940e-02     1.747
         14          1         234     1.00000e+00     3.14722e-02     1.368
         15          1         260     1.00000e+00     2.04843e-02     9.481
         16          1         292     1.00000e+00     1.21519e-02     6.231
         17          1         325     1.00000e+00     7.23519e-03     3.922
         18          1         375     1.00000e+00     3.89287e-03     2.176
         19          1         425     1.00000e+00     1.81159e-03     1.136
         20          1         472     1.00000e+00     8.61094e-04     5.296
         21          1         533     1.00000e+00     3.04835e-04     2.041
         22          1         601     1.00000e+00     7.20397e-05     5.629
Optimal solution found
    22  7.2039689e-05  5.9935687e-04   1.44e-06     0.0   12856       0
 EXIT -- Optimal solution found

 Products with A     :      24        Total time   (secs) :    60.1
 Products with A'    :      24        Project time (secs) :    40.5
 Newton iterations   :       0        Mat-vec time (secs) :    21.7


 ================================================================================
 SPGL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
 ================================================================================
 No. rows              :    12800      No. columns           :    34341
 Initial tau           : 0.00e+00      Two-norm of b         : 1.14e+01
 Optimality tol        : 1.00e-04      Target objective      : 0.00e+00
 Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

  Iter      Objective   Relative Gap  Rel Error      gNorm   stepG    nnzX
     0  1.1383394e+01  0.0000000e+00   1.00e+00  1.095e+00     0.0       0
     1  1.1310227e+01  1.7109003e+00   1.00e+00  9.214e-01    -0.3       1
     2  6.5025463e+00  1.0016106e+00   1.00e+00  3.011e-01     0.0     405
     3  6.2196356e+00  4.2702424e-01   1.00e+00  2.099e-01     0.0     409
     4  6.1662831e+00  4.2210243e-01   1.00e+00  2.025e-01     0.0     238
     5  6.1547778e+00  1.6911202e-01   1.00e+00  1.665e-01     0.0     209
     6  6.1553584e+00  7.7018324e-01   1.00e+00  2.606e-01     0.0     201
     7  6.1507051e+00  8.2105857e-02   1.00e+00  1.515e-01     0.0     206
     8  6.1503632e+00  5.5096235e-02   1.00e+00  1.474e-01     0.0     204
     9  6.1502603e+00  3.7993484e-02   1.00e+00  1.448e-01     0.0     202
    10  4.8264440e+00  1.2473517e+01   1.00e+00  3.003e-01     0.0    2205
    11  3.2667035e+00  1.0161790e+01   1.00e+00  1.854e-01     0.0    7007
    12  2.9105026e+00  2.2274597e+00   1.00e+00  4.885e-02     0.0    6044
    13  2.8632320e+00  1.7666878e+00   1.00e+00  4.655e-02     0.0    5515
    14  2.7931748e+00  1.2104285e+00   1.00e+00  4.193e-02     0.0    4484
    15  2.7589816e+00  4.5066311e+00   1.00e+00  7.313e-02     0.0    3618
    16  2.7749935e+00  5.7704573e+00   1.00e+00  8.510e-02    -0.3    3433
```

| | | | | | | |
|---|---|---|---|---|---|---|
| 17 | 2.7125792e+00 | 2.5546420e+00 | 1.00e+00 | 5.512e-02 | 0.0 | 3619 |
| 18 | 2.7043684e+00 | 9.9921396e-01 | 1.00e+00 | 3.865e-02 | 0.0 | 3521 |
| 19 | 2.6995549e+00 | 9.8680618e-01 | 1.00e+00 | 3.852e-02 | 0.0 | 3462 |
| 20 | 2.6618485e+00 | 1.4167971e+00 | 1.00e+00 | 4.167e-02 | 0.0 | 2763 |
| 21 | 2.6623786e+00 | 4.4892363e+00 | 1.00e+00 | 7.179e-02 | -0.3 | 2893 |
| 22 | 2.6541018e+00 | 1.3393248e+00 | 1.00e+00 | 4.067e-02 | 0.0 | 2918 |
| 23 | 2.6500575e+00 | 6.7258979e-01 | 1.00e+00 | 3.518e-02 | 0.0 | 2910 |
| 24 | 2.6487987e+00 | 6.9026465e-01 | 1.00e+00 | 3.522e-02 | 0.0 | 2894 |
| 25 | 2.6404528e+00 | 6.4036740e-01 | 1.00e+00 | 3.479e-02 | 0.0 | 2815 |
| 26 | 2.6422275e+00 | 1.9941706e+00 | 1.00e+00 | 4.616e-02 | -0.3 | 2836 |
| 27 | 2.6371776e+00 | 2.6882947e+00 | 1.00e+00 | 5.397e-02 | -0.3 | 2793 |
| 28 | 2.6343147e+00 | 5.2056532e-01 | 1.00e+00 | 3.350e-02 | 0.0 | 2781 |
| 29 | 2.6337079e+00 | 5.1662881e-01 | 1.00e+00 | 3.350e-02 | 0.0 | 2770 |
| 30 | 2.6283607e+00 | 4.2335669e-01 | 1.00e+00 | 3.253e-02 | 0.0 | 2637 |
| 31 | 2.6290148e+00 | 2.7957396e+00 | 1.00e+00 | 5.448e-02 | -0.3 | 2673 |
| 32 | 2.6266906e+00 | 7.4674835e-01 | 1.00e+00 | 3.531e-02 | -0.3 | 2650 |
| 33 | 2.6257399e+00 | 4.0537540e-01 | 1.00e+00 | 3.245e-02 | 0.0 | 2640 |
| 34 | 2.6254481e+00 | 3.9395714e-01 | 1.00e+00 | 3.230e-02 | 0.0 | 2636 |
| 35 | 2.6238863e+00 | 3.3858670e-01 | 1.00e+00 | 3.182e-02 | 0.0 | 2592 |
| 36 | 2.6234843e+00 | 5.2764561e-01 | 1.00e+00 | 3.333e-02 | -0.3 | 2599 |
| 37 | 2.6248032e+00 | 2.7973986e+00 | 1.00e+00 | 5.449e-02 | 0.0 | 2578 |
| 38 | 2.6225947e+00 | 3.7174230e-01 | 1.00e+00 | 3.195e-02 | 0.0 | 2572 |
| 39 | 2.6222987e+00 | 3.2818645e-01 | 1.00e+00 | 3.167e-02 | 0.0 | 2577 |
| 40 | 2.6221152e+00 | 3.2761627e-01 | 1.00e+00 | 3.166e-02 | 0.0 | 2574 |
| 41 | 2.6197841e+00 | 1.0954328e+00 | 1.00e+00 | 3.891e-02 | 0.0 | 2347 |
| 42 | 2.6189042e+00 | 8.1072674e-01 | 1.00e+00 | 3.560e-02 | -0.3 | 2389 |
| 43 | 2.6182535e+00 | 1.7501523e+00 | 1.00e+00 | 4.470e-02 | 0.0 | 2425 |
| 44 | 2.6175854e+00 | 1.5165464e-01 | 1.00e+00 | 2.999e-02 | 0.0 | 2405 |
| 45 | 2.6174896e+00 | 1.4587627e-01 | 1.00e+00 | 2.997e-02 | 0.0 | 2408 |
| 46 | 9.0416625e-01 | 1.7423978e+01 | 9.04e-01 | 2.791e-02 | 0.0 | 9831 |
| 47 | 5.9977857e-01 | 4.2932981e+00 | 6.00e-01 | 1.271e-02 | 0.0 | 14400 |
| 48 | 5.5692008e-01 | 2.1040007e+00 | 5.57e-01 | 7.917e-03 | 0.0 | 12841 |
| 49 | 5.3763499e-01 | 1.5787348e+00 | 5.38e-01 | 7.160e-03 | 0.0 | 12054 |
| 50 | 4.9451818e-01 | 2.1430860e+00 | 4.95e-01 | 7.676e-03 | 0.0 | 9888 |
| 51 | 5.3928583e-01 | 7.4606634e+00 | 5.39e-01 | 1.706e-02 | -0.3 | 9345 |
| 52 | 4.8915110e-01 | 6.1557827e+00 | 4.89e-01 | 1.345e-02 | 0.0 | 9314 |
| 53 | 4.6230763e-01 | 9.4962011e-01 | 4.62e-01 | 5.649e-03 | 0.0 | 9224 |
| 54 | 4.5951127e-01 | 9.4150925e-01 | 4.60e-01 | 5.558e-03 | 0.0 | 9131 |
| 55 | 4.4854377e-01 | 6.8939292e-01 | 4.49e-01 | 5.125e-03 | 0.0 | 8702 |
| 56 | 4.4126994e-01 | 4.9368776e+00 | 4.41e-01 | 1.148e-02 | -0.3 | 8007 |
| 57 | 4.2952256e-01 | 1.3852620e+00 | 4.30e-01 | 6.210e-03 | -0.3 | 8188 |
| 58 | 4.2609133e-01 | 7.3859226e-01 | 4.26e-01 | 4.936e-03 | 0.0 | 8023 |
| 59 | 4.2432237e-01 | 6.3993617e-01 | 4.24e-01 | 4.825e-03 | 0.0 | 7971 |
| 60 | 4.1958100e-01 | 1.6337643e+00 | 4.20e-01 | 6.321e-03 | 0.0 | 7730 |
| 61 | 4.1813062e-01 | 1.1329132e+00 | 4.18e-01 | 5.676e-03 | -0.3 | 7772 |
| 62 | 4.1659055e-01 | 9.4530375e-01 | 4.17e-01 | 5.163e-03 | 0.0 | 7674 |
| 63 | 4.1519206e-01 | 6.3321398e-01 | 4.15e-01 | 4.786e-03 | 0.0 | 7665 |
| 64 | 4.1385382e-01 | 6.2028306e-01 | 4.14e-01 | 4.641e-03 | 0.0 | 7601 |
| 65 | 4.1236634e-01 | 1.2287466e+00 | 4.12e-01 | 5.786e-03 | 0.0 | 7566 |
| 66 | 4.1242084e-01 | 2.3434191e+00 | 4.12e-01 | 7.273e-03 | 0.0 | 7446 |
| 67 | 4.0973354e-01 | 1.4170446e+00 | 4.10e-01 | 6.086e-03 | 0.0 | 7480 |
| 68 | 4.0837841e-01 | 5.8444258e-01 | 4.08e-01 | 4.581e-03 | 0.0 | 7442 |
| 69 | 4.0761282e-01 | 5.7162429e-01 | 4.08e-01 | 4.572e-03 | 0.0 | 7419 |
| 70 | 3.9764892e-01 | 1.2767916e+00 | 3.98e-01 | 5.529e-03 | 0.0 | 7016 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 71 | 4.0052382e-01 | 2.6433234e+00 | 4.01e-01 | 8.173e-03 | -0.3 | 7091 |
| 72 | 3.9530989e-01 | 8.9560764e-01 | 3.95e-01 | 4.915e-03 | 0.0 | 7030 |
| 73 | 3.9452370e-01 | 5.0640855e-01 | 3.95e-01 | 4.360e-03 | 0.0 | 7034 |
| 74 | 3.9403408e-01 | 5.0913266e-01 | 3.94e-01 | 4.353e-03 | 0.0 | 7011 |
| 75 | 3.8418525e-01 | 1.7922931e+00 | 3.84e-01 | 6.466e-03 | 0.0 | 6579 |
| 76 | 3.8786310e-01 | 2.5669482e+00 | 3.88e-01 | 7.325e-03 | -0.3 | 6679 |
| 77 | 3.8171144e-01 | 1.8141141e+00 | 3.82e-01 | 6.543e-03 | 0.0 | 6654 |
| 78 | 3.7976575e-01 | 4.0079559e-01 | 3.80e-01 | 4.045e-03 | 0.0 | 6636 |
| 79 | 3.7949823e-01 | 3.8436115e-01 | 3.79e-01 | 4.031e-03 | 0.0 | 6631 |
| 80 | 3.7814316e-01 | 3.8125655e-01 | 3.78e-01 | 4.002e-03 | 0.0 | 6592 |
| 81 | 3.7780664e-01 | 2.3159308e+00 | 3.78e-01 | 7.298e-03 | -0.3 | 6542 |
| 82 | 3.7544548e-01 | 4.8992722e-01 | 3.75e-01 | 4.126e-03 | -0.3 | 6551 |
| 83 | 3.7486744e-01 | 3.2907916e-01 | 3.75e-01 | 3.910e-03 | 0.0 | 6512 |
| 84 | 3.7458652e-01 | 3.3400786e-01 | 3.75e-01 | 3.901e-03 | 0.0 | 6493 |
| 85 | 3.7377961e-01 | 3.3191052e-01 | 3.74e-01 | 3.916e-03 | 0.0 | 6456 |
| 86 | 3.7349412e-01 | 4.0876887e-01 | 3.73e-01 | 3.974e-03 | -0.3 | 6459 |
| 87 | 3.7331610e-01 | 7.5066023e-01 | 3.73e-01 | 4.637e-03 | 0.0 | 6445 |
| 88 | 3.7288656e-01 | 3.3759835e-01 | 3.73e-01 | 3.868e-03 | 0.0 | 6439 |
| 89 | 3.7266879e-01 | 3.1415909e-01 | 3.73e-01 | 3.862e-03 | 0.0 | 6436 |
| 90 | 3.7239851e-01 | 3.2197864e-01 | 3.72e-01 | 3.860e-03 | 0.0 | 6424 |
| 91 | 3.7127999e-01 | 1.7060447e+00 | 3.71e-01 | 6.256e-03 | 0.0 | 6345 |
| 92 | 3.6982587e-01 | 5.1541274e-01 | 3.70e-01 | 4.116e-03 | -0.3 | 6349 |
| 93 | 3.6950180e-01 | 3.0850339e-01 | 3.70e-01 | 3.823e-03 | 0.0 | 6344 |
| 94 | 3.6935742e-01 | 3.0832728e-01 | 3.69e-01 | 3.819e-03 | 0.0 | 6340 |
| 95 | 3.6475406e-01 | 8.1688879e-01 | 3.65e-01 | 4.653e-03 | 0.0 | 6160 |
| 96 | 3.6516335e-01 | 1.6478569e+00 | 3.65e-01 | 5.895e-03 | -0.3 | 6205 |
| 97 | 3.6419391e-01 | 9.6986218e-01 | 3.64e-01 | 4.920e-03 | 0.0 | 6174 |
| 98 | 3.6365565e-01 | 3.1087446e-01 | 3.64e-01 | 3.774e-03 | 0.0 | 6171 |
| 99 | 3.6355638e-01 | 3.0503578e-01 | 3.64e-01 | 3.769e-03 | 0.0 | 6167 |
| 100 | 3.6281110e-01 | 3.0270294e-01 | 3.63e-01 | 3.751e-03 | 0.0 | 6144 |
| 101 | 3.6248322e-01 | 7.8466508e-01 | 3.62e-01 | 4.591e-03 | -0.3 | 6154 |
| 102 | 3.6209604e-01 | 3.1085223e-01 | 3.62e-01 | 3.754e-03 | -0.3 | 6149 |
| 103 | 3.6197826e-01 | 2.9647026e-01 | 3.62e-01 | 3.744e-03 | 0.0 | 6144 |
| 104 | 3.6180408e-01 | 2.9599982e-01 | 3.62e-01 | 3.736e-03 | 0.0 | 6137 |
| 105 | 3.6107187e-01 | 1.7030711e+00 | 3.61e-01 | 6.126e-03 | 0.0 | 6062 |
| 106 | 3.6018743e-01 | 8.7476459e-01 | 3.60e-01 | 4.623e-03 | -0.3 | 6067 |
| 107 | 3.5968577e-01 | 2.8842745e-01 | 3.60e-01 | 3.712e-03 | 0.0 | 6059 |
| 108 | 3.5961852e-01 | 2.8832561e-01 | 3.60e-01 | 3.709e-03 | 0.0 | 6055 |
| 109 | 3.5825613e-01 | 3.3106381e-01 | 3.58e-01 | 3.773e-03 | 0.0 | 5990 |
| 110 | 3.5916358e-01 | 1.3557264e+00 | 3.59e-01 | 5.419e-03 | -0.3 | 6039 |
| 111 | 3.5779072e-01 | 1.1861158e+00 | 3.58e-01 | 5.196e-03 | -0.3 | 5991 |
| 112 | 3.5748762e-01 | 2.8428341e-01 | 3.57e-01 | 3.679e-03 | 0.0 | 5990 |
| 113 | 3.5739181e-01 | 2.7303587e-01 | 3.57e-01 | 3.670e-03 | 0.0 | 5987 |
| 114 | 3.5727066e-01 | 2.7293021e-01 | 3.57e-01 | 3.664e-03 | 0.0 | 5983 |
| 115 | 3.5686962e-01 | 1.2132526e+00 | 3.57e-01 | 5.244e-03 | 0.0 | 5944 |
| 116 | 3.5673476e-01 | 7.1789553e-01 | 3.57e-01 | 4.355e-03 | -0.3 | 5955 |
| 117 | 3.5635780e-01 | 2.6242533e-01 | 3.56e-01 | 3.645e-03 | 0.0 | 5949 |
| 118 | 3.5630589e-01 | 2.6394622e-01 | 3.56e-01 | 3.644e-03 | 0.0 | 5951 |
| 119 | 3.5576041e-01 | 2.5850922e-01 | 3.56e-01 | 3.633e-03 | 0.0 | 5930 |
| 120 | 3.5624378e-01 | 1.6659563e+00 | 3.56e-01 | 5.875e-03 | -0.3 | 5964 |
| 121 | 3.5491204e-01 | 4.3483438e-01 | 3.55e-01 | 3.938e-03 | -0.3 | 5944 |
| 122 | 3.5465449e-01 | 2.6449884e-01 | 3.55e-01 | 3.632e-03 | 0.0 | 5931 |
| 123 | 3.5456719e-01 | 2.6103066e-01 | 3.55e-01 | 3.628e-03 | 0.0 | 5925 |
| 124 | 3.5434230e-01 | 4.3183479e-01 | 3.54e-01 | 3.901e-03 | 0.0 | 5909 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 125 | 3.5422954e-01 | 1.2288676e+00 | 3.54e-01 | 5.240e-03 | -0.3 | 5914 |
| 126 | 3.5397942e-01 | 2.6096873e-01 | 3.54e-01 | 3.616e-03 | -0.3 | 5909 |
| 127 | 3.5391403e-01 | 2.5628186e-01 | 3.54e-01 | 3.614e-03 | 0.0 | 5904 |
| 128 | 3.5382557e-01 | 2.5733411e-01 | 3.54e-01 | 3.613e-03 | 0.0 | 5899 |
| 129 | 3.5334693e-01 | 1.2506747e+00 | 3.53e-01 | 5.271e-03 | 0.0 | 5862 |
| 130 | 3.5327451e-01 | 6.3693173e-01 | 3.53e-01 | 4.201e-03 | -0.3 | 5865 |
| 131 | 3.5299409e-01 | 2.4885943e-01 | 3.53e-01 | 3.596e-03 | 0.0 | 5860 |
| 132 | 3.5295644e-01 | 2.5072071e-01 | 3.53e-01 | 3.596e-03 | 0.0 | 5860 |
| 133 | 3.5266665e-01 | 2.5097323e-01 | 3.53e-01 | 3.596e-03 | 0.0 | 5847 |
| 134 | 3.5254294e-01 | 8.4767562e-01 | 3.53e-01 | 4.535e-03 | -0.3 | 5845 |
| 135 | 3.5228705e-01 | 8.2184812e-01 | 3.52e-01 | 4.566e-03 | -0.3 | 5841 |
| 136 | 3.5188598e-01 | 2.5816362e-01 | 3.52e-01 | 3.597e-03 | 0.0 | 5834 |
| 137 | 3.5184137e-01 | 2.5431287e-01 | 3.52e-01 | 3.594e-03 | 0.0 | 5830 |
| 138 | 3.5171693e-01 | 2.9851373e-01 | 3.52e-01 | 3.664e-03 | 0.0 | 5823 |
| 139 | 3.5149774e-01 | 1.7397861e+00 | 3.51e-01 | 6.053e-03 | 0.0 | 5797 |
| 140 | 3.5164270e-01 | 1.2109423e+00 | 3.52e-01 | 5.122e-03 | -0.3 | 5794 |
| 141 | 3.5093150e-01 | 4.2416822e-01 | 3.51e-01 | 3.872e-03 | 0.0 | 5792 |
| 142 | 3.5087206e-01 | 2.5313517e-01 | 3.51e-01 | 3.583e-03 | 0.0 | 5791 |
| 143 | 3.5081117e-01 | 2.5196148e-01 | 3.51e-01 | 3.582e-03 | 0.0 | 5784 |
| 144 | 3.5054516e-01 | 3.2274338e-01 | 3.51e-01 | 3.690e-03 | 0.0 | 5774 |
| 145 | 3.5066954e-01 | 8.2160311e-01 | 3.51e-01 | 4.546e-03 | -0.3 | 5776 |
| 146 | 3.5072228e-01 | 8.1821243e-01 | 3.51e-01 | 4.471e-03 | 0.0 | 5772 |
| 147 | 3.5030654e-01 | 2.4757976e-01 | 3.50e-01 | 3.572e-03 | 0.0 | 5773 |
| 148 | 3.5028118e-01 | 2.4873103e-01 | 3.50e-01 | 3.572e-03 | 0.0 | 5769 |
| 149 | 3.5002942e-01 | 2.4723901e-01 | 3.50e-01 | 3.568e-03 | 0.0 | 5766 |
| 150 | 3.4984033e-01 | 1.0057098e+00 | 3.50e-01 | 4.783e-03 | -0.3 | 5775 |
| 151 | 3.4912380e-01 | 3.9524784e-01 | 3.49e-01 | 3.828e-03 | -0.3 | 5772 |
| 152 | 3.4892826e-01 | 2.6419734e-01 | 3.49e-01 | 3.586e-03 | 0.0 | 5757 |
| 153 | 3.4887979e-01 | 2.0130525e-01 | 3.49e-01 | 3.487e-03 | 0.0 | 5753 |
| 154 | 3.4879389e-01 | 2.2030935e-01 | 3.49e-01 | 3.512e-03 | 0.0 | 5744 |
| 155 | 3.4879881e-01 | 6.7296770e-01 | 3.49e-01 | 4.291e-03 | 0.0 | 5741 |
| 156 | 1.6040336e-01 | 4.6582840e+00 | 1.60e-01 | 7.638e-03 | 0.0 | 7694 |
| 157 | 1.1799864e-01 | 1.9568937e+00 | 1.18e-01 | 4.128e-03 | 0.0 | 8692 |
| 158 | 1.0961639e-01 | 3.2265481e-01 | 1.10e-01 | 1.374e-03 | 0.0 | 8493 |
| 159 | 1.0815753e-01 | 2.5221772e-01 | 1.08e-01 | 1.277e-03 | 0.0 | 8545 |
| 160 | 1.0512314e-01 | 2.5254779e-01 | 1.05e-01 | 1.290e-03 | 0.0 | 8393 |
| 161 | 1.0777730e-01 | 1.1468746e+00 | 1.08e-01 | 2.666e-03 | 0.0 | 7958 |
| 162 | 1.0702595e-01 | 1.4171049e+00 | 1.07e-01 | 3.044e-03 | 0.0 | 7892 |
| 163 | 1.0261941e-01 | 3.3161624e-01 | 1.03e-01 | 1.407e-03 | 0.0 | 7911 |
| 164 | 1.0224307e-01 | 1.2315544e-01 | 1.02e-01 | 1.057e-03 | 0.0 | 7864 |
| 165 | 1.0206512e-01 | 1.1840038e-01 | 1.02e-01 | 1.051e-03 | 0.0 | 7836 |
| 166 | 1.0074221e-01 | 2.3598554e-01 | 1.01e-01 | 1.235e-03 | 0.0 | 7438 |
| 167 | 1.0063579e-01 | 4.0903180e-01 | 1.01e-01 | 1.522e-03 | -0.3 | 7437 |
| 168 | 1.0022442e-01 | 2.7696646e-01 | 1.00e-01 | 1.280e-03 | 0.0 | 7382 |
| 169 | 9.9960462e-02 | 9.4682695e-02 | 1.00e-01 | 1.010e-03 | 0.0 | 7376 |
| 170 | 9.9896037e-02 | 9.5966366e-02 | 9.99e-02 | 1.008e-03 | 0.0 | 7360 |
| 171 | 9.9562990e-02 | 9.1672658e-02 | 9.96e-02 | 1.002e-03 | 0.0 | 7288 |
| 172 | 9.9451145e-02 | 2.1355487e-01 | 9.95e-02 | 1.178e-03 | -0.3 | 7247 |
| 173 | 9.9479620e-02 | 3.5490399e-01 | 9.95e-02 | 1.429e-03 | -0.3 | 7235 |
| 174 | 9.9216729e-02 | 9.3572319e-02 | 9.92e-02 | 9.960e-04 | 0.0 | 7218 |
| 175 | 9.9167341e-02 | 9.1142205e-02 | 9.92e-02 | 9.963e-04 | 0.0 | 7203 |
| 176 | 9.9077944e-02 | 9.1603162e-02 | 9.91e-02 | 9.955e-04 | 0.0 | 7180 |
| 177 | 9.8582918e-02 | 6.1261465e-01 | 9.86e-02 | 1.846e-03 | -0.3 | 6921 |
| 178 | 9.7983410e-02 | 2.5002658e-01 | 9.80e-02 | 1.234e-03 | -0.3 | 6926 |

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  179  9.7830203e-02  8.5040747e-02   9.78e-02  9.848e-04     0.0    6918
  180  9.7786882e-02  8.5051672e-02   9.78e-02  9.825e-04     0.0    6912
  181  9.7641325e-02  8.0792990e-02   9.76e-02  9.737e-04     0.0    6875
  182  9.7761078e-02  4.1670155e-01   9.78e-02  1.485e-03     0.0    6850
  183  9.7409317e-02  9.9891616e-02   9.74e-02  1.007e-03    -0.3    6846
  184  9.7358457e-02  8.2571962e-02   9.74e-02  9.748e-04     0.0    6839
  185  9.7320333e-02  8.2187585e-02   9.73e-02  9.740e-04     0.0    6836
  186  9.7208760e-02  1.1937871e-01   9.72e-02  1.028e-03     0.0    6817
  187  9.7177298e-02  8.9495060e-02   9.72e-02  9.888e-04    -0.3    6812
  188  9.7159196e-02  2.6006605e-01   9.72e-02  1.245e-03     0.0    6806
  189  9.7108481e-02  7.9958705e-02   9.71e-02  9.714e-04     0.0    6804
  190  9.7085478e-02  8.2113218e-02   9.71e-02  9.713e-04     0.0    6800
  191  9.7055225e-02  8.1294129e-02   9.71e-02  9.710e-04     0.0    6795
  192  9.6915098e-02  4.7556117e-01   9.69e-02  1.571e-03     0.0    6728
  193  9.6699543e-02  1.1974282e-01   9.67e-02  1.035e-03    -0.3    6728
  194  9.6659314e-02  8.0377357e-02   9.67e-02  9.670e-04     0.0    6724
  195  9.6643991e-02  8.0423130e-02   9.66e-02  9.672e-04     0.0    6722
  196  9.5979523e-02  7.5055357e-01   9.60e-02  2.013e-03     0.0    6602
  197  9.6192548e-02  1.3031157e+00   9.62e-02  2.900e-03    -0.3    6623
  198  9.5868365e-02  7.1132207e-01   9.59e-02  1.945e-03     0.0    6600
  199  9.5778400e-02  7.3640154e-02   9.58e-02  9.533e-04     0.0    6602
  200  9.5764915e-02  7.4589369e-02   9.58e-02  9.535e-04     0.0    6602

 ERROR EXIT -- Too many iterations

 Products with A     :     283        Total time   (secs) :   224.0
 Products with A'    :     201        Project time (secs) :     1.4
 Newton iterations   :       4        Mat-vec time (secs) :   220.9
 Line search its     :     150        Subspace iterations :       0


 ================================================================================
 PQNL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
 ================================================================================
 No. rows              :    12800      No. columns           :    34341
 Initial tau           : 0.00e+00      Two-norm of b         : 1.14e+01
 Optimality tol        : 1.00e-04      Target objective      : 0.00e+00
 Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

     0  1.1383394e+01  0.0000000e+00   1.00e+00  1.095e+00     0.0       0

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
         1          1           4     1.00000e+00     6.84858e+00     4.175
         2          1          10     1.00000e+00     6.28210e+00     1.323
         3          1          17     1.00000e+00     6.18003e+00     3.887
         4          1          24     1.00000e+00     6.16193e+00     2.221
         5          1          31     1.00000e+00     6.15369e+00     1.042
         6          1          40     1.00000e+00     6.15153e+00     6.376
break of testUpdateTau     6  6.1515317e+00  1.2461973e-01   1.00e+00  1.5

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
         7          1           4     1.00000e+00     3.52397e+00     6.006
```

```
         8          1         10     1.00000e+00     3.32449e+00     3.373
         9          1         19     1.00000e+00     3.18382e+00     1.912
        10          1         28     1.00000e+00     3.10937e+00     1.432
        11          1         37     1.00000e+00     3.05483e+00     1.120
        12          1         46     1.00000e+00     3.01418e+00     8.761
        13          1         55     1.00000e+00     2.98380e+00     7.090
        14          1         66     1.00000e+00     2.96124e+00     5.941
        15          1         78     1.00000e+00     2.94352e+00     5.040
        16          1         91     1.00000e+00     2.92820e+00     4.308
        17          1        104     1.00000e+00     2.91647e+00     3.714
        18          1        115     1.00000e+00     2.90670e+00     3.250
        19          1        127     1.00000e+00     2.89878e+00     2.869
        20          1        145     1.00000e+00     2.89149e+00     2.568
        21          1        163     1.00000e+00     2.88664e+00     2.288
        22          1        179     1.00000e+00     2.88268e+00     1.944
        23          1        191     1.00000e+00     2.87921e+00     1.604
        24          1        204     1.00000e+00     2.87636e+00     1.431
        25          1        211     1.00000e+00     2.87510e+00     1.608
break of testUpdateTau    25  2.8751045e+00  4.1753943e-01   1.00e+00  3.6

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
        26          1          4     1.00000e+00     1.07179e+00     3.767
        27          1         10     1.00000e+00     9.65124e-01     2.369
        28          1         19     1.00000e+00     8.67807e-01     1.379
        29          1         27     1.00000e+00     8.14224e-01     9.764
        30          1         37     1.00000e+00     7.77234e-01     7.387
        31          1         48     1.00000e+00     7.49354e-01     5.873
        32          1         57     1.00000e+00     7.28251e-01     4.814
        33          1         68     1.00000e+00     7.12110e-01     4.087
        34          1         79     1.00000e+00     6.98995e-01     3.513
        35          1         92     1.00000e+00     6.87262e-01     3.140
        36          1        104     1.00000e+00     6.77816e-01     2.791
        37          1        116     1.00000e+00     6.69866e-01     2.453
        38          1        128     1.00000e+00     6.62631e-01     2.257
        39          1        142     1.00000e+00     6.56343e-01     2.139
        40          1        162     1.00000e+00     6.50951e-01     1.980
        41          1        178     1.00000e+00     6.46218e-01     1.800
        42          1        195     1.00000e+00     6.42092e-01     1.703
        43          1        213     1.00000e+00     6.37790e-01     1.691
        44          1        226     1.00000e+00     6.34357e-01     1.651
        45          1        243     1.00000e+00     6.30651e-01     1.580
        46          1        258     1.00000e+00     6.27395e-01     1.491
        47          1        277     1.00000e+00     6.24525e-01     1.400
        48          1        299     1.00000e+00     6.21990e-01     1.281
        49          1        322     1.00000e+00     6.19086e-01     1.274
        50          1        342     1.00000e+00     6.17001e-01     1.279
        51          1        360     1.00000e+00     6.15042e-01     1.165
        52          1        383     1.00000e+00     6.13033e-01     1.062
        53          1        408     1.00000e+00     6.11243e-01     1.063
        54          1        420     1.00000e+00     6.09796e-01     9.831
        55          1        441     1.00000e+00     6.08054e-01     9.415
        56          1        461     1.00000e+00     6.06792e-01     9.267
        57          1        485     1.00000e+00     6.05377e-01     9.339
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          58           1         503     1.00000e+00     6.04216e-01     8.888
          59           1         520     1.00000e+00     6.03049e-01     8.359
          60           1         541     1.00000e+00     6.02056e-01     8.045
          61           1         562     1.00000e+00     6.01033e-01     8.179
          62           1         583     1.00000e+00     6.00089e-01     8.540
          63           1         607     1.00000e+00     5.99233e-01     7.958
          64           1         632     1.00000e+00     5.98204e-01     7.520
          65           1         658     1.00000e+00     5.97364e-01     7.714
          66           1         682     1.00000e+00     5.96616e-01     7.391
          67           1         705     1.00000e+00     5.95876e-01     6.842
          68           1         728     1.00000e+00     5.95170e-01     6.724
          69           1         749     1.00000e+00     5.94614e-01     6.508
          70           1         779     1.00000e+00     5.93951e-01     6.351
          71           1         802     1.00000e+00     5.93398e-01     6.024
          72           1         825     1.00000e+00     5.92828e-01     5.907
          73           1         847     1.00000e+00     5.92334e-01     5.887
          74           1         870     1.00000e+00     5.91880e-01     5.508
          75           1         897     1.00000e+00     5.91396e-01     5.263
          76           1         920     1.00000e+00     5.90994e-01     5.226
          77           1         942     1.00000e+00     5.90620e-01     4.806
          78           1         966     1.00000e+00     5.90158e-01     4.670
          79           1         984     1.00000e+00     5.89836e-01     4.760
          80           1        1005     1.00000e+00     5.89568e-01     4.483
break of testUpdateTau    80  5.8956835e-01  2.6856673e-01   5.90e-01  5.9

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
          81           1           4     1.00000e+00     1.64906e-01     7.214
          82           1          10     1.00000e+00     1.45656e-01     4.851
          83           1          19     1.00000e+00     1.24789e-01     2.825
          84           1          27     1.00000e+00     1.13197e-01     2.014
          85           1          36     1.00000e+00     1.05018e-01     1.510
          86           1          46     1.00000e+00     9.89385e-02     1.175
          87           1          58     1.00000e+00     9.42357e-02     9.708
          88           1          70     1.00000e+00     9.05155e-02     8.276
          89           1          81     1.00000e+00     8.74860e-02     7.195
          90           1          92     1.00000e+00     8.50447e-02     6.417
          91           1         105     1.00000e+00     8.28814e-02     5.811
          92           1         121     1.00000e+00     8.10620e-02     5.196
          93           1         135     1.00000e+00     7.93837e-02     4.741
          94           1         151     1.00000e+00     7.80209e-02     4.281
          95           1         164     1.00000e+00     7.66792e-02     3.983
          96           1         180     1.00000e+00     7.56290e-02     3.642
          97           1         195     1.00000e+00     7.45671e-02     3.429
          98           1         216     1.00000e+00     7.36808e-02     3.289
          99           1         233     1.00000e+00     7.28764e-02     3.179
         100           1         252     1.00000e+00     7.20967e-02     3.017
         101           1         267     1.00000e+00     7.14425e-02     2.784
         102           1         285     1.00000e+00     7.07864e-02     2.593
         103           1         302     1.00000e+00     7.02213e-02     2.554
         104           1         320     1.00000e+00     6.96927e-02     2.505
         105           1         338     1.00000e+00     6.92000e-02     2.384
         106           1         355     1.00000e+00     6.87547e-02     2.380
         107           1         381     1.00000e+00     6.83694e-02     2.201
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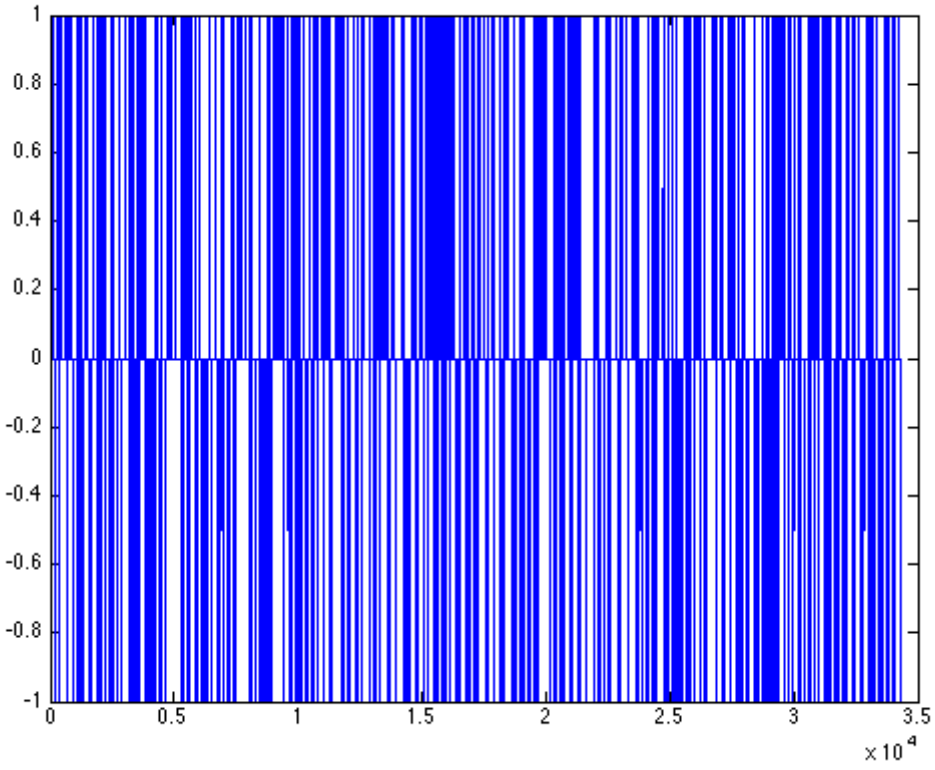
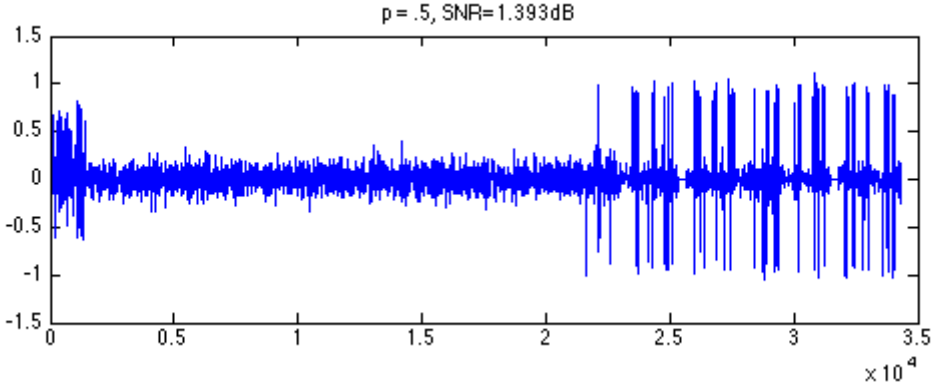
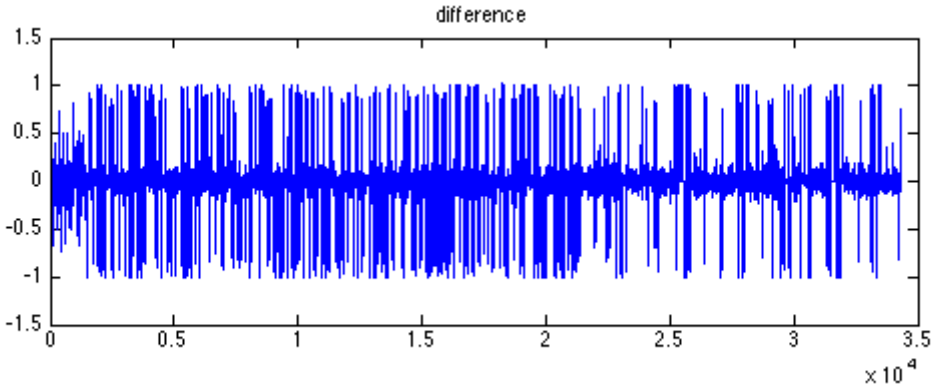
| | | | | | |
|---|---|---|---|---|---|
| 108 | 1 | 402 | 1.00000e+00 | 6.79466e-02 | 2.022 |
| 109 | 1 | 426 | 1.00000e+00 | 6.75965e-02 | 1.963 |
| 110 | 1 | 446 | 1.00000e+00 | 6.72366e-02 | 1.965 |
| 111 | 1 | 472 | 1.00000e+00 | 6.69049e-02 | 1.928 |
| 112 | 1 | 486 | 1.00000e+00 | 6.66048e-02 | 1.801 |
| 113 | 1 | 505 | 1.00000e+00 | 6.62743e-02 | 1.748 |
| 114 | 1 | 524 | 1.00000e+00 | 6.59946e-02 | 1.721 |
| 115 | 1 | 549 | 1.00000e+00 | 6.57113e-02 | 1.665 |
| 116 | 1 | 573 | 1.00000e+00 | 6.54423e-02 | 1.618 |
| 117 | 1 | 591 | 1.00000e+00 | 6.51607e-02 | 1.624 |
| 118 | 1 | 611 | 1.00000e+00 | 6.49049e-02 | 1.587 |
| 119 | 1 | 635 | 1.00000e+00 | 6.46415e-02 | 1.540 |
| 120 | 1 | 658 | 1.00000e+00 | 6.44007e-02 | 1.520 |
| 121 | 1 | 693 | 1.00000e+00 | 6.41636e-02 | 1.538 |
| 122 | 1 | 715 | 1.00000e+00 | 6.39389e-02 | 1.497 |
| 123 | 1 | 738 | 1.00000e+00 | 6.36976e-02 | 1.477 |
| 124 | 1 | 751 | 1.00000e+00 | 6.35502e-02 | 1.440 |
| 125 | 1 | 780 | 1.00000e+00 | 6.33462e-02 | 1.428 |
| 126 | 1 | 814 | 1.00000e+00 | 6.31573e-02 | 1.438 |
| 127 | 1 | 840 | 1.00000e+00 | 6.29768e-02 | 1.354 |
| 128 | 1 | 859 | 1.00000e+00 | 6.27518e-02 | 1.378 |
| 129 | 1 | 884 | 1.00000e+00 | 6.26031e-02 | 1.354 |
| 130 | 1 | 913 | 1.00000e+00 | 6.24188e-02 | 1.315 |
| 131 | 1 | 939 | 1.00000e+00 | 6.22519e-02 | 1.248 |
| 132 | 1 | 971 | 1.00000e+00 | 6.20756e-02 | 1.212 |
| 133 | 1 | 997 | 1.00000e+00 | 6.19244e-02 | 1.189 |
| 134 | 1 | 1020 | 1.00000e+00 | 6.17709e-02 | 1.215 |
| 135 | 1 | 1054 | 1.00000e+00 | 6.16266e-02 | 1.188 |
| 136 | 1 | 1077 | 1.00000e+00 | 6.14884e-02 | 1.125 |
| 137 | 1 | 1098 | 1.00000e+00 | 6.13291e-02 | 1.205 |
| 138 | 1 | 1141 | 1.00000e+00 | 6.12126e-02 | 1.203 |
| 139 | 1 | 1167 | 1.00000e+00 | 6.10451e-02 | 1.166 |
| 140 | 1 | 1190 | 1.00000e+00 | 6.09299e-02 | 1.104 |
| 141 | 1 | 1216 | 1.00000e+00 | 6.07909e-02 | 1.049 |
| 142 | 1 | 1250 | 1.00000e+00 | 6.06754e-02 | 1.033 |
| 143 | 1 | 1275 | 1.00000e+00 | 6.05529e-02 | 1.049 |
| 144 | 1 | 1301 | 1.00000e+00 | 6.04325e-02 | 1.039 |
| 145 | 1 | 1330 | 1.00000e+00 | 6.03154e-02 | 9.854 |
| 146 | 1 | 1360 | 1.00000e+00 | 6.01850e-02 | 1.025 |
| 147 | 1 | 1387 | 1.00000e+00 | 6.00798e-02 | 1.059 |
| 148 | 1 | 1411 | 1.00000e+00 | 5.99611e-02 | 1.018 |
| 149 | 1 | 1445 | 1.00000e+00 | 5.98468e-02 | 9.711 |
| 150 | 1 | 1469 | 1.00000e+00 | 5.97317e-02 | 1.039 |
| 151 | 1 | 1498 | 1.00000e+00 | 5.96323e-02 | 1.025 |
| 152 | 1 | 1539 | 1.00000e+00 | 5.94993e-02 | 9.978 |
| 153 | 1 | 1574 | 1.00000e+00 | 5.93946e-02 | 1.006 |
| 154 | 1 | 1599 | 1.00000e+00 | 5.93043e-02 | 9.560 |
| 155 | 1 | 1633 | 1.00000e+00 | 5.91889e-02 | 1.003 |
| 156 | 1 | 1663 | 1.00000e+00 | 5.91078e-02 | 9.398 |
| 157 | 1 | 1695 | 1.00000e+00 | 5.89758e-02 | 9.495 |
| 158 | 1 | 1724 | 1.00000e+00 | 5.88800e-02 | 1.016 |
| 159 | 1 | 1761 | 1.00000e+00 | 5.87967e-02 | 9.331 |
| 160 | 1 | 1803 | 1.00000e+00 | 5.86699e-02 | 9.055 |
| 161 | 1 | 1828 | 1.00000e+00 | 5.85993e-02 | 8.832 |

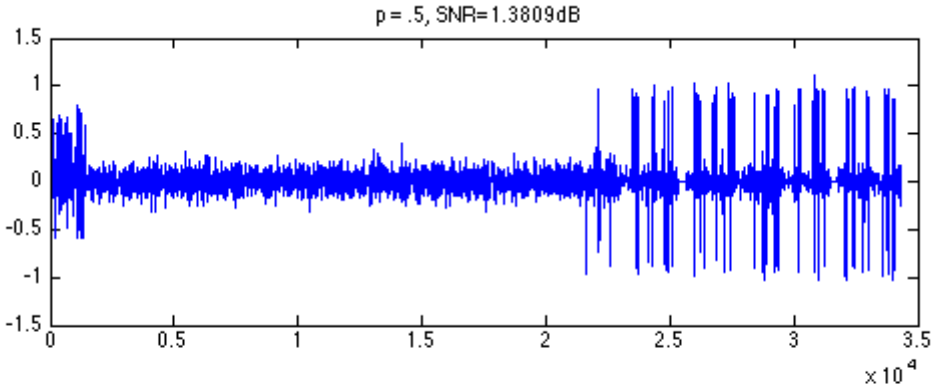
```
   162          1       1868     1.00000e+00     5.84988e-02     8.627
   163          1       1898     1.00000e+00     5.84160e-02     8.145
   164          1       1923     1.00000e+00     5.83216e-02     8.239
   165          1       1952     1.00000e+00     5.82542e-02     8.277
   166          1       1979     1.00000e+00     5.81692e-02     8.733
   167          1       1991     1.00000e+00     5.81227e-02     6.995
   168          1       2026     1.00000e+00     5.80059e-02     7.486
   169          1       2057     1.00000e+00     5.79611e-02     7.901
   170          1       2100     1.00000e+00     5.78621e-02     8.588
   171          1       2125     1.00000e+00     5.77956e-02     7.843
   172          1       2158     1.00000e+00     5.77080e-02     6.927
   173          1       2198     1.00000e+00     5.76381e-02     7.311
   174          1       2236     1.00000e+00     5.75713e-02     7.604
   175          1       2272     1.00000e+00     5.74757e-02     8.369
   176          1       2320     1.00000e+00     5.74138e-02     7.971
   177          1       2350     1.00000e+00     5.73486e-02     6.479
   178          1       2381     1.00000e+00     5.72841e-02     6.487
   179          1       2427     1.00000e+00     5.72220e-02     7.214
   180          1       2458     1.00000e+00     5.71561e-02     7.516
   181          1       2491     1.00000e+00     5.70812e-02     7.081
   182          1       2521     1.00000e+00     5.70182e-02     6.518
   183          1       2568     1.00000e+00     5.69431e-02     7.799
   184          1       2591     1.00000e+00     5.68935e-02     7.984
   185          1       2632     1.00000e+00     5.68149e-02     7.130
   186          1       2663     1.00000e+00     5.67573e-02     6.816
   187          1       2704     1.00000e+00     5.67049e-02     7.176
   188          1       2735     1.00000e+00     5.66460e-02     7.285
   189          1       2772     1.00000e+00     5.65708e-02     7.413
   190          1       2800     1.00000e+00     5.65073e-02     7.304
   191          1       2832     1.00000e+00     5.64526e-02     6.448
   192          1       2861     1.00000e+00     5.63909e-02     6.747
   193          1       2888     1.00000e+00     5.63468e-02     7.142
   194          1       2926     1.00000e+00     5.62694e-02     7.425
   195          1       2977     1.00000e+00     5.62091e-02     6.830
   196          1       3010     1.00000e+00     5.61448e-02     6.201
   197          1       3038     1.00000e+00     5.60932e-02     6.181
   198          1       3068     1.00000e+00     5.60446e-02     5.889
   199          1       3096     1.00000e+00     5.59861e-02     5.938
   200          1       3123     1.00000e+00     5.59319e-02     6.392
 200  5.5931881e-02  3.8992993e-02   5.59e-02  5.526e-04     0.0    6286

 ERROR EXIT -- Too many iterations

 Products with A     :     205        Total time   (secs) :   559.8
 Products with A'    :     205        Project time (secs) :   328.8
 Newton iterations   :       5        Mat-vec time (secs) :   189.7


info_spg =

          tau: 636.6014
        rNorm: 0.0958
         rGap: 0.0746
        gNorm: 9.5349e-04
```

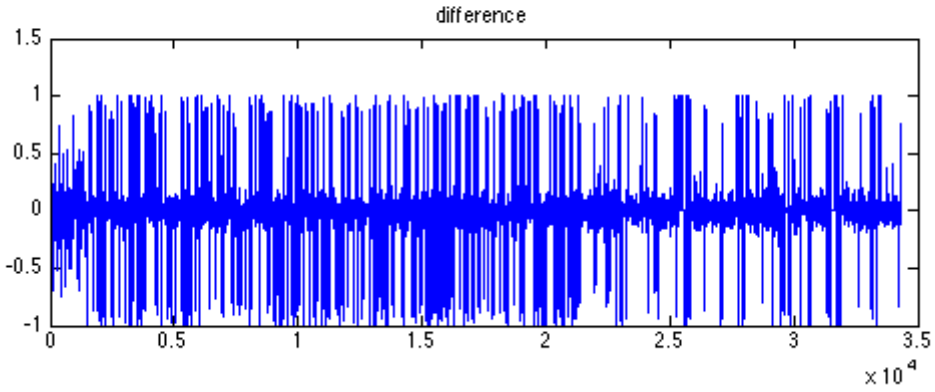
```
              stat: 5
              iter: 200
            nProdA: 283
           nProdAt: 201
           nNewton: 4
       timeProject: 1.4086
       timeMatProd: 220.8912
           itnLSQR: 0
           options: [1x1 struct]
         timeTotal: 223.9994
             xNorm1: [200x1 double]
             rNorm2: [200x1 double]
             lambda: [200x1 double]


info_pqn1 =

               tau: 645.8713
             rNorm: 0.0559
              rGap: 0.0390
             gNorm: 5.5264e-04
              stat: 5
              iter: 200
            nProdA: 205
           nProdAt: 205
           nNewton: 5
       timeProject: 328.7529
       timeMatProd: 189.7315
           itnLSQR: 0
           options: [1x1 struct]
         timeTotal: 559.8079
             xNorm1: [200x1 double]
             rNorm2: [200x1 double]
             lambda: [200x1 double]
```

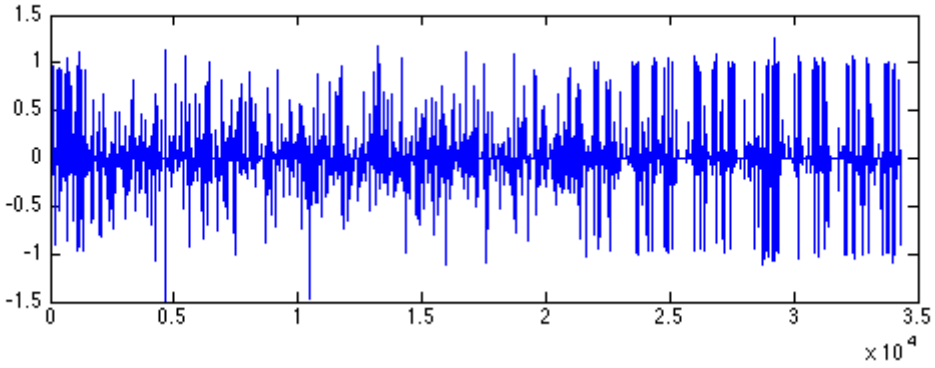

1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4

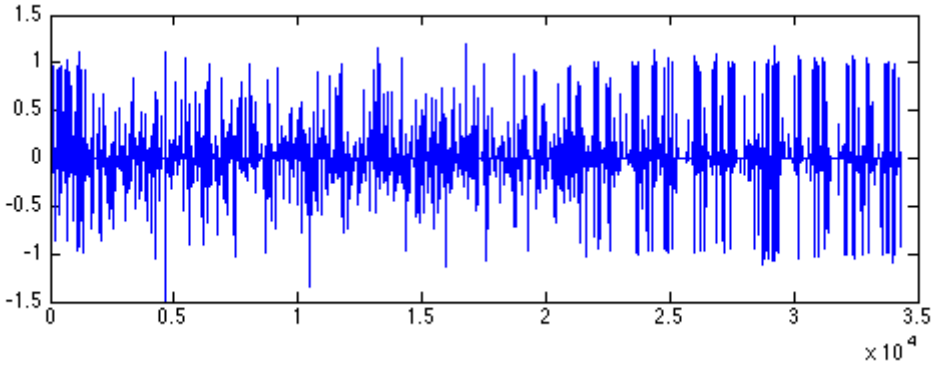

p = .5, SNR=1.393dB
1.5
1
0.5
0
-0.5
-1
-1.5
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4

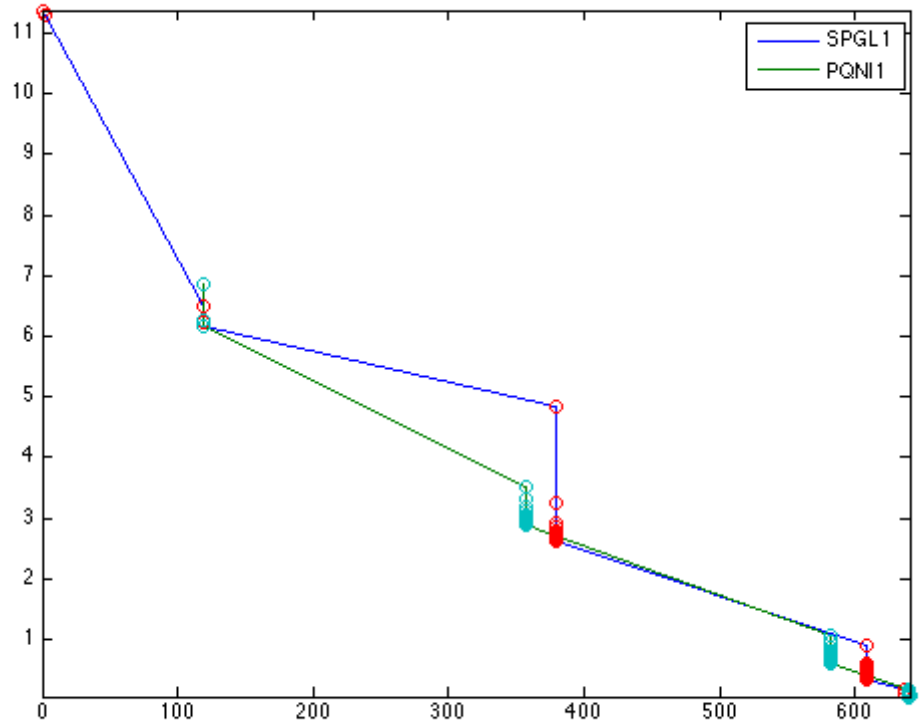

difference
1.5
1
0.5
0
-0.5
-1
-1.5
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


p = .5, SNR= 1.3809dB
1.5
1
0.5
0
-0.5
-1
-1.5
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


difference
1.5
1
0.5
0
-0.5
-1
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


1.5
1
0.5
0
-0.5
-1
-1.5
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


1.5
1
0.5
0
-0.5
-1
-1.5
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4




# if given known compressible vector

```
nn = linspace(0,1,n);
x0_compress = exp(-nn.^.1);
x0_compress = x0_compress - min(x0_compress);
figure;plot(x0_compress)
x0_compress = x0_compress(:);
b_compress  = A*x0_compress + 0.005 * randn(m,1);


tau = norm(x0_compress,1);

options = spgSetParms('optTol', 1e-4, 'iterations', 200);%, 'fid', fid);
xinit = zeros(size(A,2),1);

xestspg = spgl1(A,b_compress,tau,[],xinit,options);
xestpqn = pqnl1_2(A,b_compress,tau,[],xinit,options);
snrspg = SNR(x0_compress,xestspg);
snrpqn = SNR(x0_compress,xestpqn);

figure('Name','compressible vector SPG');
subplot(2,1,1);plot(xestspg);
title(strcat(['p = .5, SNR=' num2str(snrspg) 'dB']))
subplot(2,1,2);plot(xestspg - x0_compress);
title('difference')
```

```
figure('Name','compressible vector PQN');
subplot(2,1,1);plot(xestpqn);
title(strcat(['p = .5, SNR=' num2str(snrpqn) 'dB']))
subplot(2,1,2);plot(xestpqn - x0_compress);
title('difference')

% BPDN
[x_spg,r_spg,g_spg,info_spg] = spgl1(A, b_compress, 0, 0, zeros(size(A,2),1), opti

[x_pqn1,r_pqn1,g_pqn1,info_pqn1] = pqnl1_2(A, b_compress, 0, 0, zeros(size(A,2),1)

figure; subplot(2,1,1);plot(x_spg);subplot(2,1,2);plot(x_pqn1);
info_spg
info_pqn1

% 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','PQNl1')
axis tight
```

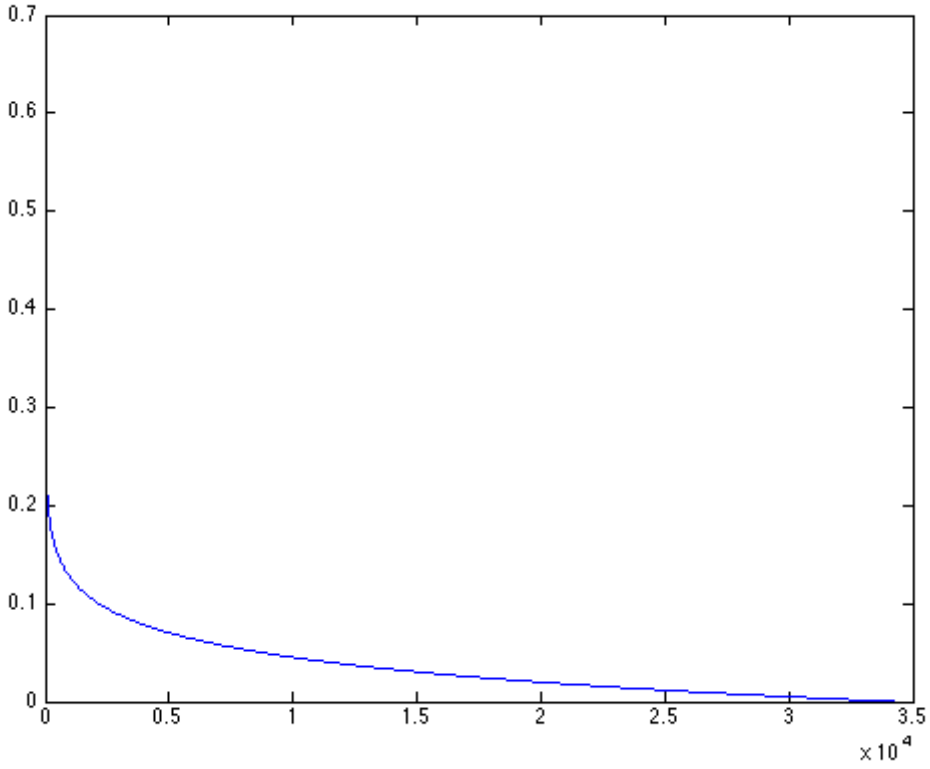
```
================================================================================
SPGL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
================================================================================
No. rows              :    12800      No. columns           :    34341
Initial tau           : 1.25e+03      Two-norm of b         : 4.20e+00
Optimality tol        : 1.00e-04      Target one-norm of x  : 1.25e+03
Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

 Iter      Objective   Relative Gap      gNorm   stepG    nnzX    nnzG
    0  4.1974555e+00  3.4598654e+01   2.43e-01     0.0       0       0
    1  5.7672876e-01  3.7636200e+01   2.99e-02    -0.3   14498       0
    2  4.1307993e-01  8.2857100e-01   6.62e-04     0.0   20810       0
    3  4.1298391e-01  5.3050161e-14   4.24e-17     0.0   20644       0

EXIT -- Optimal solution found

Products with A     :       6        Total time   (secs) :     4.4
Products with A'    :       4        Project time (secs) :     0.0
Newton iterations   :       0        Mat-vec time (secs) :     4.4
Line search its     :       2        Subspace iterations :       0


================================================================================
PQNL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
================================================================================
No. rows              :    12800      No. columns           :    34341
Initial tau           : 1.25e+03      Two-norm of b         : 4.20e+00
Optimality tol        : 1.00e-04      Target one-norm of x  : 1.25e+03
Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200
```

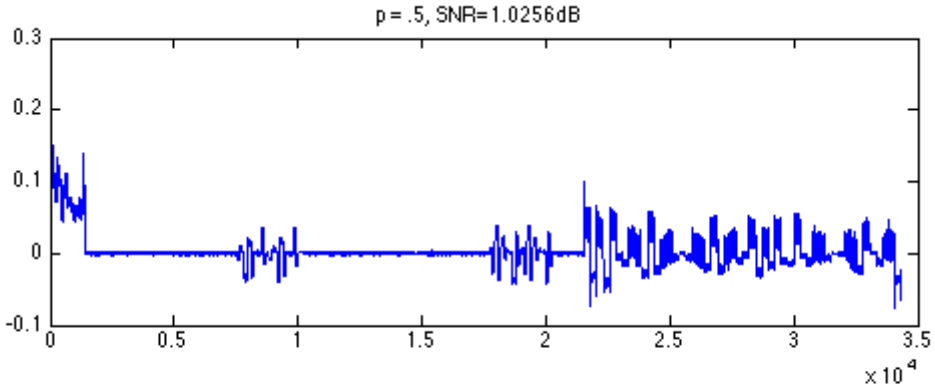
```
  Iter      Objective   Relative Gap      gNorm   stepG    nnzX    nnzG
     0  4.1974555e+00  3.4598654e+01   2.43e-01     0.0       0       0
Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
         1          1           4     1.00000e+00     4.12984e-01     1.579
First-Order Optimality Conditions Below optTol
     1  4.1298391e-01  6.5016422e-14   5.15e-17     0.0   27189       0
 EXIT -- Optimal solution found

 Products with A     :       3        Total time   (secs) :     2.7
 Products with A'    :       3        Project time (secs) :     0.0
 Newton iterations   :       0        Mat-vec time (secs) :     2.6


 ================================================================================
 SPGL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
 ================================================================================
 No. rows              :    12800      No. columns           :    34341
 Initial tau           : 0.00e+00      Two-norm of b         : 4.20e+00
 Optimality tol        : 1.00e-04      Target objective      : 0.00e+00
 Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

  Iter      Objective   Relative Gap  Rel Error      gNorm   stepG    nnzX
     0  4.1974555e+00  0.0000000e+00   1.00e+00  2.433e-01     0.0       0
     1  4.1749404e+00  1.6923769e+00   1.00e+00  2.025e-01    -0.3       1
     2  2.8088676e+00  1.4831404e+00   1.00e+00  1.105e-01     0.0     753
     3  2.7151954e+00  2.2367028e-01   1.00e+00  5.693e-02     0.0    1362
     4  2.7106675e+00  7.9520940e-02   1.00e+00  4.968e-02     0.0    1258
     5  2.7087786e+00  5.0830281e-02   1.00e+00  4.851e-02     0.0    1213
     6  2.7061834e+00  1.1050255e-01   1.00e+00  5.137e-02     0.0    1112
     7  2.7065672e+00  1.4805041e-01   1.00e+00  5.376e-02    -0.3    1101
     8  2.7050354e+00  8.7615582e-02   1.00e+00  5.026e-02     0.0    1105
     9  2.7046449e+00  2.6450234e-02   1.00e+00  4.737e-02     0.0    1103
    10  2.7044562e+00  2.3395122e-02   1.00e+00  4.722e-02     0.0    1091
    11  2.7036235e+00  4.6996808e-02   1.00e+00  4.864e-02     0.0    1001
    12  2.7045615e+00  1.6942917e-01   1.00e+00  5.474e-02    -0.3     967
    13  2.7042925e+00  2.6552459e-01   1.00e+00  5.970e-02     0.0    1010
    14  2.7031404e+00  3.8397591e-02   1.00e+00  4.821e-02     0.0     999
    15  2.7030982e+00  1.9654477e-02   1.00e+00  4.728e-02     0.0     995
    16  8.8796432e-01  4.4755027e+00   8.88e-01  2.307e-02     0.0    4949
    17  7.2407373e-01  1.4041838e+00   7.24e-01  1.335e-02     0.0    6770
    18  6.9561604e-01  6.9918757e-01   6.96e-01  9.553e-03     0.0    6467
    19  6.7920729e-01  6.6343240e-01   6.79e-01  9.222e-03     0.0    6299
    20  6.3796035e-01  1.5104116e+00   6.38e-01  1.176e-02     0.0    5512
    21  6.7346455e-01  4.5070303e+00   6.73e-01  2.576e-02    -0.3    5580
    22  6.3239444e-01  2.1056620e+00   6.32e-01  1.396e-02     0.0    5364
    23  6.1148212e-01  4.9168499e-01   6.11e-01  7.345e-03     0.0    5509
    24  6.0945861e-01  4.8732131e-01   6.09e-01  7.276e-03     0.0    5424
    25  6.0341277e-01  4.0437989e-01   6.03e-01  6.788e-03     0.0    5177
    26  6.1087241e-01  2.1471751e+00   6.11e-01  1.422e-02     0.0    4661
    27  5.9755618e-01  6.6397317e-01   5.98e-01  7.904e-03    -0.3    4917
    28  5.9546045e-01  2.2126573e-01   5.95e-01  5.861e-03     0.0    4823
    29  5.9496614e-01  1.6851368e-01   5.95e-01  5.625e-03     0.0    4812
```

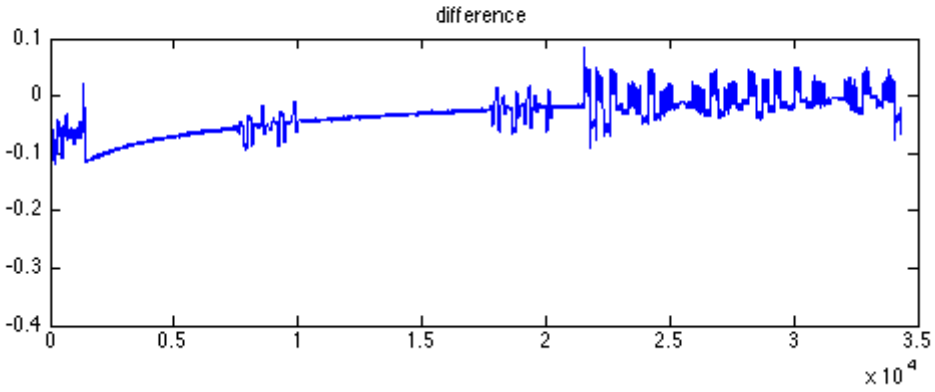
```
   30  5.9463922e-01  1.6918210e-01   5.95e-01  5.611e-03     0.0    4771
   31  5.9458256e-01  4.2333292e-01   5.95e-01  6.747e-03     0.0    4788
   32  5.9481662e-01  5.9941490e-01   5.95e-01  7.482e-03     0.0    4735
   33  5.9428017e-01  8.9441665e-02   5.94e-01  5.262e-03     0.0    4769
   34  5.9424429e-01  8.7515070e-02   5.94e-01  5.251e-03     0.0    4765
   35  5.9415813e-01  8.1425107e-02   5.94e-01  5.223e-03     0.0    4763
   36  5.9370315e-01  5.6331297e-01   5.94e-01  7.329e-03     0.0    4707
   37  5.9362666e-01  3.1272618e-01   5.94e-01  6.272e-03    -0.3    4748
   38  5.9332403e-01  1.4123089e-01   5.93e-01  5.482e-03     0.0    4716
   39  5.9328506e-01  5.5513798e-02   5.93e-01  5.107e-03     0.0    4722
   40  5.9326512e-01  5.0951810e-02   5.93e-01  5.085e-03     0.0    4721
   41  5.8582212e-01  4.1125644e+00   5.86e-01  9.820e-03    -0.3    7500
   42  4.1771034e-01  2.8694423e-01   4.18e-01  1.481e-03     0.0   16221
   43  4.1298391e-01  1.6403686e-14   4.13e-01  5.533e-17     0.0   14647

 EXIT -- Found a BP solution

 Products with A     :      54        Total time   (secs) :    44.6
 Products with A'    :      44        Project time (secs) :     0.3
 Newton iterations   :       3        Mat-vec time (secs) :    43.9
 Line search its     :      18        Subspace iterations :       0


 ================================================================================
 PQNL1_SLIM v. 46  (Tue, 14 Jun 2011) based on v.1017
 ================================================================================
 No. rows              :    12800      No. columns           :    34341
 Initial tau           : 0.00e+00      Two-norm of b         : 4.20e+00
 Optimality tol        : 1.00e-04      Target objective      : 0.00e+00
 Basis pursuit tol     : 1.00e-06      Maximum iterations    :      200

     0  4.1974555e+00  0.0000000e+00   1.00e+00  2.433e-01     0.0       0

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
         1          1           4     1.00000e+00     2.89815e+00     2.858
         2          1          11     1.00000e+00     2.74253e+00     6.690
         3          1          18     1.00000e+00     2.72132e+00     2.971
         4          1          24     1.00000e+00     2.71548e+00     1.861
         5          1          33     1.00000e+00     2.71304e+00     1.646
         6          1          44     1.00000e+00     2.70997e+00     1.516
         7          1          56     1.00000e+00     2.70793e+00     1.165
         8          1          70     1.00000e+00     2.70662e+00     8.776
break of testUpdateTau     8  2.7066164e+00  7.8468992e-02   1.00e+00  4.9

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
         9          1           4     1.00000e+00     1.07145e+00     2.844
        10          1          10     1.00000e+00     9.34896e-01     1.743
        11          1          19     1.00000e+00     8.14068e-01     9.774
        12          1          28     1.00000e+00     7.65278e-01     7.178
        13          1          39     1.00000e+00     7.30872e-01     5.776
        14          1          52     1.00000e+00     7.10023e-01     4.936
        15          1          64     1.00000e+00     6.93069e-01     3.908
```

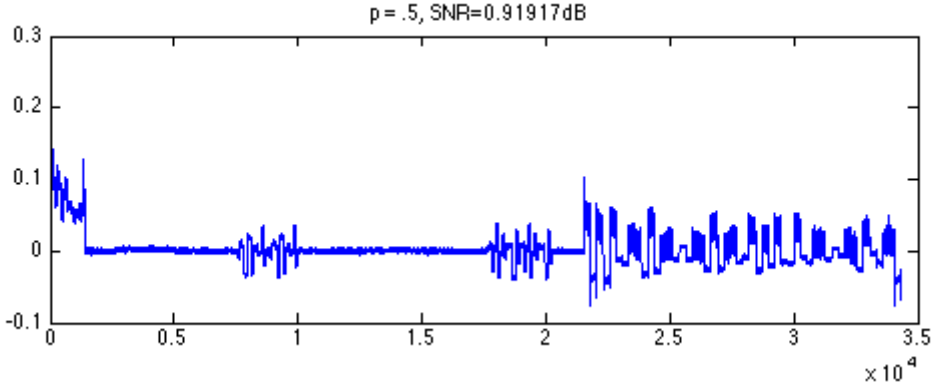
```
        16          1          78     1.00000e+00     6.79887e-01     3.241
        17          1          90     1.00000e+00     6.70974e-01     2.738
        18          1         104     1.00000e+00     6.65355e-01     2.143
        19          1         117     1.00000e+00     6.61942e-01     1.602
        20          1         128     1.00000e+00     6.59934e-01     1.187
        21          1         142     1.00000e+00     6.58799e-01     8.966
        22          1         154     1.00000e+00     6.58064e-01     6.540
        23          1         167     1.00000e+00     6.57659e-01     5.112
        24          1         181     1.00000e+00     6.57378e-01     4.324
break of testUpdateTau    24  6.5737796e-01  1.4276056e-01   6.57e-01  6.6

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
        25          1           4     1.00000e+00     4.13107e-01     8.818
        26          1           9     1.00000e+00     4.13035e-01     5.539
break of testUpdateTau    26  4.1303518e-01  1.4320740e-02   4.13e-01  1.1

Inside of minConf_PQN
 Iteration   FunEvals Projections     Step Length          rNorm2        O
        27          1           4     1.00000e+00     4.12984e-01     1.685
First-Order Optimality Conditions Below optTol


 EXIT -- Found a BP solution

 Products with A     :      32        Total time   (secs) :    40.0
 Products with A'    :      32        Project time (secs) :    12.1
 Newton iterations   :       4        Mat-vec time (secs) :    27.3


info_spg =

           tau: 296.1655
          rNorm: 0.4130
           rGap: 1.6404e-14
          gNorm: 5.5328e-17
           stat: 3
           iter: 43
         nProdA: 54
        nProdAt: 44
        nNewton: 3
    timeProject: 0.2826
    timeMatProd: 43.9480
        itnLSQR: 0
        options: [1x1 struct]
      timeTotal: 44.6406
         xNorm1: [43x1 double]
         rNorm2: [43x1 double]
         lambda: [43x1 double]


info_pqn1 =

            tau: 1.8148e+03
```

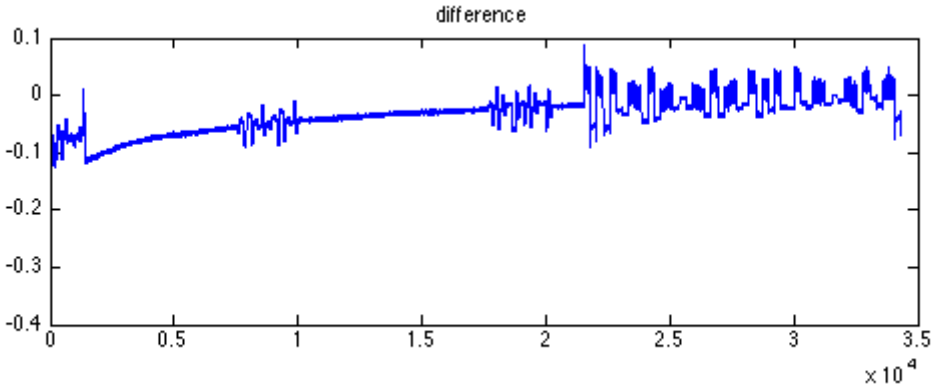
```
        rNorm: 0.4130

         rGap: 1.2127e-13
        gNorm: 6.6422e-17
         stat: 3
         iter: 27
       nProdA: 32
      nProdAt: 32
      nNewton: 4
  timeProject: 12.1035
  timeMatProd: 27.2601
      itnLSQR: 0
      options: [1x1 struct]
    timeTotal: 39.9531
        xNorm1: [27x1 double]
        rNorm2: [27x1 double]
        lambda: [27x1 double]
```

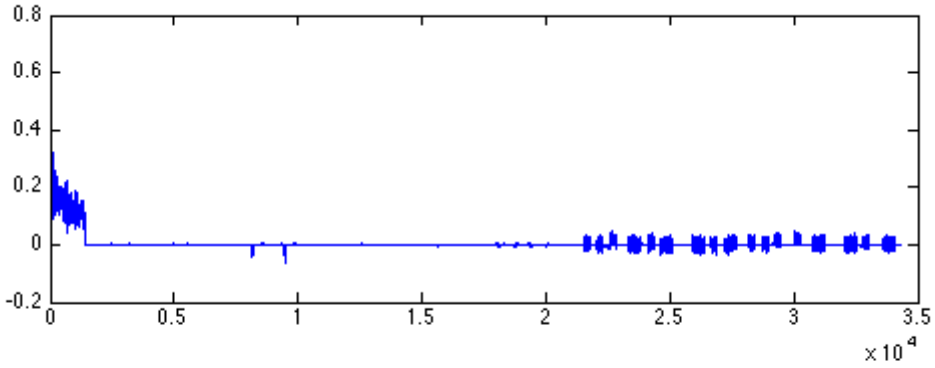


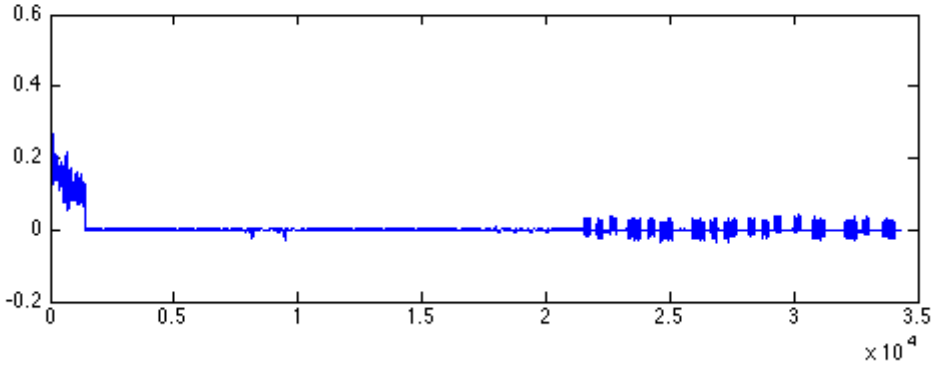

p = .5, SNR=1.0256dB
0.3
0.2
0.1
0
-0.1
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4

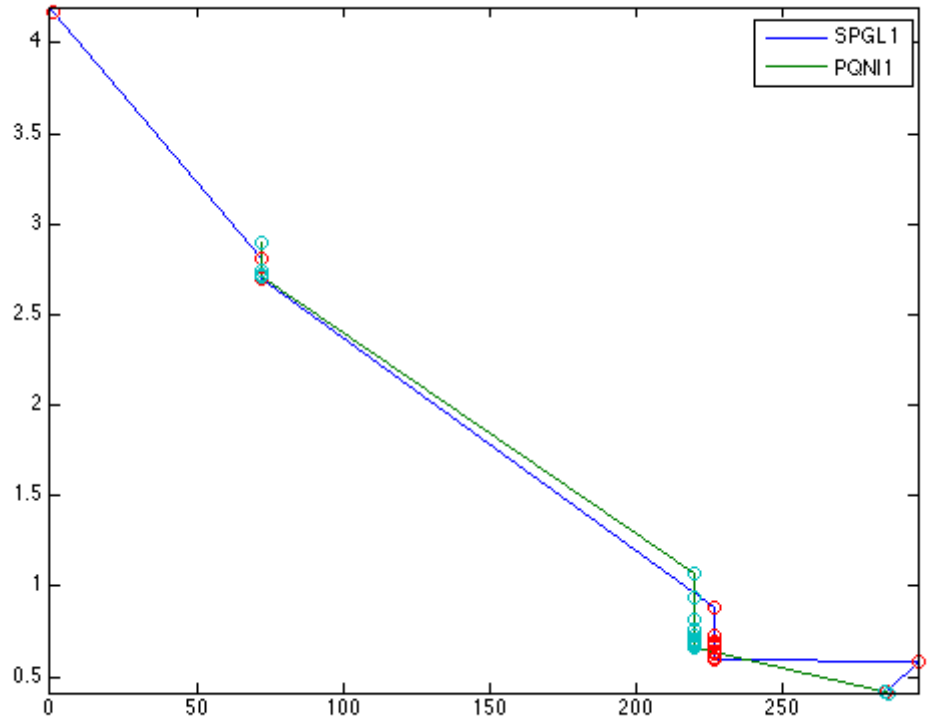

difference
0.1
0
-0.1
-0.2
-0.3
-0.4
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


p = .5, SNR=0.91917dB
0.3
0.2
0.1
0
-0.1
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


difference
0.1
0
-0.1
-0.2
-0.3
-0.4
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


0.8
0.6
0.4
0.2
0
-0.2
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


0.6
0.4
0.2
0
-0.2
0
0.5
1
1.5
2
2.5
3
3.5
x 10^4


SPGL1
PQNI1
4
3.5
3
2.5
2
1.5
1
0.5
0
50
100
150
200
250

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