```
>> demo_Polynomial_Dictionary_Learning
Starting to train the dictionary
solving the quadratic problem with YALMIP...

 num. of constraints = 25
 dim. of socp   var  = 26,   num. of socp blk  =  1
 dim. of linear var  = 800
 6 linear variables from unrestricted variable.

 *** convert ublk to linear blk
******************************************************************************↙
********
   SDPT3: homogeneous self-dual path-following algorithms
******************************************************************************↙
********
 version  predcorr  gam  expon
   HKM      1      0.000   1
it pstep dstep pinfeas dinfeas  gap     mean(obj)    cputime    kap   tau    theta
------------------------------------------------------------------------------↙
--------
 0|0.000|0.000|3.1e+00|5.1e+00|3.8e+06| 3.185287e+04| 0:0:00|3.8e+06|1.0e+00|1.↙
0e+00| chol 1  1
 1|0.952|0.952|1.5e-01|2.5e-01|2.3e+05| 3.028581e+04| 0:0:00|6.7e+04|1.0e+00|5.1e-↙
02| chol 1  1
 2|0.703|0.703|9.2e-02|1.5e-01|1.7e+05| 2.570817e+04| 0:0:00|2.4e+04|9.8e-01|2.9e-↙
02| chol 1  1
 3|1.000|1.000|5.0e-02|8.3e-02|1.3e+05| 2.300661e+04| 0:0:00|2.7e+03|8.7e-01|1.4e-↙
02| chol 1  1
 4|0.865|0.865|2.3e-02|3.7e-02|5.3e+04| 1.195229e+04| 0:0:00|1.5e+02|9.8e-01|7.1e-↙
03| chol 1  1
 5|0.883|0.883|2.3e-03|3.8e-03|4.4e+03| 9.432751e+02| 0:0:00|4.1e+01|1.2e+00|8.9e-↙
04| chol 1  1
 6|0.974|0.974|1.4e-03|2.7e-03|2.9e+03| 5.856838e+02| 0:0:00|5.7e+00|1.2e+00|5.6e-↙
04| chol 1  1
 7|1.000|1.000|7.4e-04|1.4e-03|1.5e+03| 2.640930e+02| 0:0:00|4.3e+00|1.3e+00|3.0e-↙
04| chol 1  1
 8|1.000|1.000|2.4e-04|5.0e-04|4.9e+02| 3.437725e+00| 0:0:00|2.2e+00|1.3e+00|1.0e-↙
04| chol 1  1
 9|1.000|1.000|1.3e-04|2.6e-04|2.5e+02|-5.296568e+01| 0:0:00|7.2e-01|1.4e+00|5.8e-↙
05| chol 1  1
10|1.000|1.000|4.4e-05|9.8e-05|8.3e+01|-9.682520e+01| 0:0:00|3.8e-01|1.4e+00|2.0e-↙
05| chol 1  1
11|1.000|1.000|2.1e-05|5.0e-05|3.6e+01|-1.085420e+02| 0:0:00|1.2e-01|1.5e+00|9.9e-↙
06| chol 1  1
12|1.000|1.000|7.1e-06|2.9e-05|1.2e+01|-1.151501e+02| 0:0:00|5.7e-02|1.6e+00|3.6e-↙
06| chol 1  1
13|1.000|1.000|3.5e-06|2.2e-05|5.2e+00|-1.168813e+02| 0:0:00|1.8e-02|1.7e+00|1.9e-↙
06| chol 1  1
14|1.000|1.000|1.6e-06|1.9e-05|2.2e+00|-1.177623e+02| 0:0:00|9.6e-03|1.8e+00|9.1e-↙
07| chol 1  1
15|1.000|1.000|3.3e-07|1.7e-05|4.4e-01|-1.183566e+02| 0:0:00|4.2e-03|1.9e+00|2.0e-↙
07| chol 1  1
16|1.000|1.000|9.1e-08|6.7e-06|1.2e-01|-1.184608e+02| 0:0:00|9.2e-04|1.9e+00|5.6e-↙
08| chol 1  1
```

```
17|1.000|1.000|3.1e-08|2.7e-06|3.9e-02|-1.184872e+02| 0:0:00|2.6e-04|1.9e+00|1.9e-↙
08| chol 1  1
18|1.000|1.000|8.7e-09|1.1e-06|1.1e-02|-1.184977e+02| 0:0:00|9.0e-05|1.9e+00|5.5e-↙
09| chol 1  1
19|1.000|1.000|3.1e-09|4.5e-07|3.8e-03|-1.185004e+02| 0:0:00|2.6e-05|2.0e+00|1.9e-↙
09| chol 1  1
20|1.000|1.000|7.5e-10|1.8e-07|8.6e-04|-1.185016e+02| 0:0:00|8.9e-06|2.0e+00|4.4e-↙
10| chol 1  1
21|1.000|1.000|2.9e-10|7.4e-08|1.8e-04|-1.185019e+02| 0:0:00|2.0e-06|2.0e+00|9.1e-↙
11| chol 1  1
22|1.000|1.000|8.9e-10|7.3e-08|3.9e-05|-1.185019e+02| 0:0:00|4.2e-07|2.0e+00|1.9e-↙
11| chol 1  1
23|1.000|1.000|1.1e-09|7.3e-08|3.8e-06|-1.185019e+02| 0:0:00|9.3e-08|2.0e+00|1.2e-↙
12|
  Stop: max(relative gap,infeasibilities) < 1.00e-07
-------------------------------------------------------------------
 number of iterations   = 23
 primal objective value = -1.18501933e+02
 dual   objective value = -1.18501927e+02
 gap := trace(XZ)       = 3.77e-06
 relative gap           = 3.16e-08
 actual relative gap    = -2.63e-08
 rel. primal infeas     = 1.06e-09
 rel. dual   infeas     = 7.34e-08
 norm(X), norm(y), norm(Z) = 3.5e+01, 1.9e+02, 2.4e+01
 norm(A), norm(b), norm(C) = 9.4e+02, 7.8e+00, 2.5e+02
 Total CPU time (secs)  = 0.24
 CPU time per iteration = 0.01
 termination code       =  0
 DIMACS errors: 1.1e-09  0.0e+00  7.3e-08  0.0e+00  -2.6e-08  1.6e-08
-------------------------------------------------------------------

ans =

  118.5019


 num. of constraints = 25
 dim. of socp   var  = 26,   num. of socp blk  =  1
 dim. of linear var  = 800
 6 linear variables from unrestricted variable.

 *** convert ublk to linear blk
**********************************************************************************↙
********
   SDPT3: homogeneous self-dual path-following algorithms
**********************************************************************************↙
********
 version  predcorr  gam  expon
   HKM      1      0.000   1
it pstep dstep pinfeas dinfeas  gap     mean(obj)    cputime    kap   tau    theta
-----------------------------------------------------------------------------------↙
--------
 0|0.000|0.000|1.4e+00|5.1e+00|2.3e+07| 1.967655e+05| 0:0:00|2.3e+07|1.0e+00|1.↙
```

```
0e+00| chol 1  1
 1|0.948|0.948|7.4e-02|2.7e-01|1.4e+06| 1.807026e+05| 0:0:00|4.6e+05|1.0e+00|5.4e-↙
02| chol 1  1
 2|0.448|0.448|6.9e-02|2.5e-01|1.8e+06| 2.114692e+05| 0:0:00|3.2e+05|8.9e-01|4.3e-↙
02| chol 1  1
 3|1.000|1.000|5.0e-02|1.8e-01|1.9e+06| 2.432761e+05| 0:0:00|6.4e+04|7.2e-01|2.5e-↙
02| chol 1  1
 4|0.713|0.713|3.1e-02|1.1e-01|1.1e+06| 1.795646e+05| 0:0:00|1.4e+04|7.7e-01|1.7e-↙
02| chol 1  1
 5|0.824|0.824|1.5e-02|5.3e-02|4.8e+05| 1.008811e+05| 0:0:00|8.5e+02|9.1e-01|9.3e-↙
03| chol 1  1
 6|0.891|0.891|2.0e-03|7.3e-03|5.3e+04| 1.233613e+04| 0:0:00|3.2e+02|1.2e+00|1.7e-↙
03| chol 1  1
 7|0.723|0.723|1.1e-03|4.1e-03|2.7e+04| 6.964691e+03| 0:0:00|1.3e+02|1.2e+00|9.1e-↙
04| chol 1  1
 8|1.000|1.000|7.0e-04|2.6e-03|1.8e+04| 4.590397e+03| 0:0:00|3.7e+01|1.3e+00|6.2e-↙
04| chol 1  1
 9|1.000|1.000|3.4e-04|1.3e-03|8.5e+03| 2.279408e+03| 0:0:00|2.6e+01|1.3e+00|3.1e-↙
04| chol 1  1
10|1.000|1.000|1.5e-04|6.0e-04|3.7e+03| 9.313273e+02| 0:0:00|1.3e+01|1.3e+00|1.4e-↙
04| chol 1  1
11|1.000|1.000|6.9e-05|2.7e-04|1.6e+03| 3.964289e+02| 0:0:00|5.7e+00|1.4e+00|6.6e-↙
05| chol 1  1
12|1.000|1.000|2.7e-05|1.1e-04|6.1e+02| 1.208759e+02| 0:0:00|2.5e+00|1.4e+00|2.7e-↙
05| chol 1  1
13|1.000|1.000|1.1e-05|5.1e-05|2.4e+02| 2.736989e+01| 0:0:00|9.6e-01|1.5e+00|1.2e-↙
05| chol 1  1
14|1.000|1.000|4.0e-06|2.6e-05|8.3e+01|-1.766877e+01| 0:0:00|3.9e-01|1.6e+00|4.4e-↙
06| chol 1  1
15|1.000|1.000|1.6e-06|1.9e-05|3.2e+01|-3.173221e+01| 0:0:00|1.3e-01|1.7e+00|1.9e-↙
06| chol 1  1
16|1.000|1.000|5.1e-07|1.5e-05|9.1e+00|-3.855866e+01| 0:0:00|5.4e-02|1.8e+00|6.4e-↙
07| chol 1  1
17|1.000|1.000|3.0e-07|1.4e-05|5.1e+00|-3.965271e+01| 0:0:00|1.8e-02|1.8e+00|3.9e-↙
07| chol 1  1
18|0.989|0.989|6.4e-08|1.2e-05|1.0e+00|-4.103614e+01| 0:0:00|1.1e-02|1.9e+00|8.6e-↙
08| chol 1  1
19|1.000|1.000|2.6e-08|1.1e-05|4.2e-01|-4.124738e+01| 0:0:00|2.3e-03|1.9e+00|3.5e-↙
08| chol 1  1
20|0.963|0.963|5.1e-09|4.6e-06|8.2e-02|-4.136608e+01| 0:0:00|1.0e-03|2.0e+00|7.0e-↙
09| chol 1  1
21|1.000|1.000|2.3e-09|1.8e-06|3.7e-02|-4.138033e+01| 0:0:00|1.9e-04|2.0e+00|3.2e-↙
09| chol 1  1
22|1.000|1.000|5.9e-10|7.2e-07|9.2e-03|-4.139090e+01| 0:0:00|8.8e-05|2.0e+00|7.9e-↙
10| chol 1  1
23|1.000|1.000|2.8e-10|2.9e-07|4.0e-03|-4.139279e+01| 0:0:00|2.2e-05|2.0e+00|3.4e-↙
10| chol 1  1
24|1.000|1.000|6.2e-11|1.2e-07|1.1e-03|-4.139396e+01| 0:0:00|9.6e-06|2.0e+00|9.2e-↙
11| chol 1  1
25|1.000|1.000|2.0e-10|1.2e-07|5.0e-04|-4.139418e+01| 0:0:00|2.6e-06|2.0e+00|4.3e-↙
11| chol 1  1
26|1.000|1.000|1.6e-11|1.2e-07|1.3e-04|-4.139433e+01| 0:0:00|1.2e-06|2.0e+00|1.1e-↙
11| chol 1  1
27|1.000|1.000|1.7e-10|1.2e-07|5.6e-05|-4.139435e+01| 0:0:00|3.0e-07|2.0e+00|4.8e-↙
```

```
12| chol 1  1
28|1.000|1.000|2.5e-10|1.2e-07|1.9e-05|-4.139437e+01| 0:0:00|1.3e-07|2.0e+00|1.6e-↙
12| chol 1  1
29|1.000|1.000|1.5e-10|1.2e-07|6.8e-06|-4.139437e+01| 0:0:00|4.5e-08|2.0e+00|5.7e-↙
13| chol 1  1
30|1.000|1.000|2.8e-10|1.2e-07|2.3e-06|-4.139437e+01| 0:0:00|1.6e-08|2.0e+00|1.9e-↙
13| chol 1  1
31|1.000|1.000|1.9e-10|1.2e-07|8.1e-07|-4.139437e+01| 0:0:00|5.6e-09|2.0e+00|5.9e-↙
14| chol 1  1
32|1.000|1.000|2.6e-10|1.2e-07|2.7e-07|-4.139437e+01| 0:0:00|1.9e-09|2.0e+00|9.6e-↙
15|
  Stop: relative gap < infeasibility
-----------------------------------------------------------------
 number of iterations   = 32
 primal objective value = -4.13943721e+01
 dual   objective value = -4.13943738e+01
 gap := trace(XZ)       = 2.34e-06
 relative gap           = 5.53e-08
 actual relative gap    = 2.10e-08
 rel. primal infeas     = 2.79e-10
 rel. dual   infeas     = 1.20e-07
 norm(X), norm(y), norm(Z) = 9.5e+01, 3.1e+02, 1.9e+02
 norm(A), norm(b), norm(C) = 9.4e+02, 4.3e+01, 2.5e+02
 Total CPU time (secs)  = 0.29
 CPU time per iteration = 0.01
 termination code       = -1
 DIMACS errors: 2.8e-10  0.0e+00  1.2e-07  0.0e+00  2.1e-08  2.8e-08
-----------------------------------------------------------------

ans =

   41.3944

Iteration   2   Total error is: 0.02137

 num. of constraints = 25
 dim. of socp   var  = 26,   num. of socp blk  =  1
 dim. of linear var  = 800
 6 linear variables from unrestricted variable.

 *** convert ublk to linear blk
*****************************************************************************↙
********
   SDPT3: homogeneous self-dual path-following algorithms
*****************************************************************************↙
********
 version  predcorr  gam  expon
   HKM      1      0.000   1
it pstep dstep pinfeas dinfeas  gap     mean(obj)    cputime    kap   tau    theta
-----------------------------------------------------------------------------↙
--------
 0|0.000|0.000|1.0e+00|5.2e+01|5.2e+10| 4.635976e+08| 0:0:00|5.2e+10|1.0e+00|1.↙
0e+00| chol 1  1
 1|1.000|1.000|2.4e-01|1.2e+01|1.8e+10| 6.314960e+08| 0:0:00|8.6e+09|8.4e-01|2.0e-↙
```

```
01| chol 1  1
 2|0.821|0.821|3.8e-02|2.0e+00|2.9e+09| 4.276188e+08| 0:0:00|1.6e+08|9.7e-01|3.7e-↙
02| chol 1  1
 3|0.825|0.825|1.9e-02|1.0e+00|1.8e+09| 3.607819e+08| 0:0:00|3.8e+07|9.4e-01|1.8e-↙
02| chol 1  1
 4|0.904|0.904|9.7e-03|5.0e-01|9.5e+08| 2.315233e+08| 0:0:00|2.5e+06|1.0e+00|9.9e-↙
03| chol 1  1
 5|0.949|0.949|4.2e-03|2.2e-01|3.7e+08| 1.072949e+08| 0:0:00|9.0e+05|1.2e+00|4.8e-↙
03| chol 1  1
 6|1.000|1.000|2.7e-03|1.4e-01|2.3e+08| 6.815758e+07| 0:0:00|5.0e+05|1.2e+00|3.2e-↙
03| chol 1  1
 7|1.000|1.000|1.2e-03|6.4e-02|1.0e+08| 3.045501e+07| 0:0:00|3.1e+05|1.2e+00|1.5e-↙
03| chol 1  1
 8|0.953|0.953|5.8e-04|3.0e-02|4.7e+07| 1.481191e+07| 0:0:00|1.5e+05|1.3e+00|7.5e-↙
04| chol 1  1
 9|0.836|0.836|2.9e-04|1.5e-02|2.3e+07| 7.225754e+06| 0:0:00|8.1e+04|1.3e+00|3.8e-↙
04| chol 1  1
10|1.000|1.000|1.6e-04|8.2e-03|1.2e+07| 3.837774e+06| 0:0:00|3.4e+04|1.4e+00|2.2e-↙
04| chol 1  1
11|1.000|1.000|6.9e-05|3.6e-03|5.2e+06| 1.684940e+06| 0:0:00|1.9e+04|1.4e+00|9.7e-↙
05| chol 1  1
12|1.000|1.000|3.0e-05|1.6e-03|2.2e+06| 7.308027e+05| 0:0:00|8.3e+03|1.4e+00|4.4e-↙
05| chol 1  1
13|1.000|1.000|7.0e-06|3.7e-04|5.0e+05| 1.654417e+05| 0:0:00|3.5e+03|1.5e+00|1.1e-↙
05| chol 1  1
14|1.000|1.000|1.5e-06|7.8e-05|9.6e+04| 2.727622e+04| 0:0:00|6.7e+02|1.6e+00|2.4e-↙
06| chol 1  1
15|0.739|0.739|1.1e-06|5.9e-05|6.8e+04| 2.184861e+04| 0:0:00|2.8e+02|1.7e+00|1.9e-↙
06| chol 1  1
16|1.000|1.000|6.9e-07|3.9e-05|4.1e+04| 1.365690e+04| 0:0:00|1.3e+02|1.8e+00|1.2e-↙
06| chol 1  1
17|1.000|1.000|4.0e-07|2.5e-05|2.3e+04| 7.709208e+03| 0:0:00|8.4e+01|1.8e+00|7.2e-↙
07| chol 1  1
18|1.000|1.000|2.0e-07|1.6e-05|1.1e+04| 3.417872e+03| 0:0:00|4.8e+01|1.9e+00|3.7e-↙
07| chol 1  1
19|1.000|1.000|8.8e-08|1.2e-05|4.8e+03| 1.420606e+03| 0:0:00|2.4e+01|1.9e+00|1.7e-↙
07| chol 1  1
20|1.000|1.000|3.5e-08|1.0e-05|1.9e+03| 4.725508e+02| 0:0:00|1.1e+01|1.9e+00|6.7e-↙
08| chol 1  1
21|1.000|1.000|1.1e-08|8.9e-06|5.9e+02| 1.258670e+02| 0:0:00|4.3e+00|2.0e+00|2.2e-↙
08| chol 1  1
22|1.000|1.000|4.0e-09|8.0e-06|2.1e+02| 1.599941e+01| 0:0:00|1.4e+00|2.0e+00|7.8e-↙
09| chol 1  1
23|1.000|1.000|1.4e-09|7.2e-06|7.2e+01|-1.998223e+01| 0:0:00|5.0e-01|2.0e+00|2.7e-↙
09| chol 1  1
24|1.000|1.000|4.6e-10|6.4e-06|2.4e+01|-3.403131e+01| 0:0:00|1.7e-01|2.0e+00|9.1e-↙
10| chol 1  1
25|1.000|1.000|1.3e-10|5.8e-07|6.7e+00|-3.854252e+01| 0:0:00|5.8e-02|2.0e+00|2.5e-↙
10| chol 1  1
26|1.000|1.000|6.7e-11|5.2e-07|3.5e+00|-3.986861e+01| 0:0:00|1.6e-02|2.0e+00|1.3e-↙
10| chol 1  1
27|1.000|1.000|3.4e-11|4.7e-07|1.8e+00|-4.033299e+01| 0:0:00|8.4e-03|2.0e+00|6.7e-↙
11| chol 1  1
28|1.000|1.000|8.3e-12|4.7e-07|4.5e-01|-4.076192e+01| 0:0:00|4.3e-03|2.0e+00|1.7e-↙
```

```
11| chol 1  1
29|1.000|1.000|3.6e-12|4.7e-07|2.0e-01|-4.083836e+01| 0:0:00|1.1e-03|2.0e+00|7.5e-↙
12| chol 1  1
30|1.000|1.000|1.2e-12|4.7e-07|5.2e-02|-4.088486e+01| 0:0:00|4.8e-04|2.0e+00|1.9e-↙
12| chol 1  1
31|1.000|1.000|1.4e-13|4.7e-07|2.3e-02|-4.089363e+01| 0:0:00|1.2e-04|2.0e+00|8.5e-↙
13| chol 1  1
32|1.000|1.000|3.5e-13|4.7e-07|6.4e-03|-4.089885e+01| 0:0:00|5.5e-05|2.0e+00|2.4e-↙
13| chol 1  1
33|1.000|1.000|4.6e-13|4.7e-07|2.7e-03|-4.089994e+01| 0:0:00|1.5e-05|2.0e+00|1.0e-↙
13| chol 1  1
34|1.000|1.000|2.9e-13|4.7e-07|7.7e-04|-4.090056e+01| 0:0:00|6.5e-06|2.0e+00|2.9e-↙
14| chol 1  1
35|1.000|1.000|1.3e-13|4.7e-07|3.3e-04|-4.090069e+01| 0:0:00|1.8e-06|2.0e+00|1.2e-↙
14| chol 1  1
36|1.000|1.000|3.2e-13|4.7e-07|9.1e-05|-4.090077e+01| 0:0:00|7.8e-07|2.0e+00|3.4e-↙
15| chol 1  1
37|1.000|1.000|2.0e-13|4.7e-07|3.9e-05|-4.090078e+01| 0:0:00|2.2e-07|2.0e+00|1.4e-↙
15| chol 1  1
38|1.000|1.000|1.7e-13|4.7e-07|1.3e-05|-4.090079e+01| 0:0:00|9.3e-08|2.0e+00|5.0e-↙
16| chol 1  1
39|1.000|1.000|1.8e-13|4.7e-07|4.8e-06|-4.090079e+01| 0:0:00|3.2e-08|2.0e+00|1.8e-↙
16| chol 1  1
40|1.000|1.000|1.6e-13|4.7e-07|1.7e-06|-4.090080e+01| 0:0:00|1.2e-08|2.0e+00|6.2e-↙
17| chol 1  1
41|1.000|1.000|2.7e-13|4.7e-07|5.8e-07|-4.090080e+01| 0:0:00|4.0e-09|2.0e+00|2.2e-↙
17|
  lack of progess in infeas
------------------------------------------------------------------
 number of iterations   = 41
 primal objective value = -4.09007873e+01
 dual   objective value = -4.09007968e+01
 gap := trace(XZ)       = 1.34e-05
 relative gap           = 3.20e-07
 actual relative gap    = 1.15e-07
 rel. primal infeas     = 1.67e-13
 rel. dual   infeas     = 4.72e-07
 norm(X), norm(y), norm(Z) = 9.5e+01, 3.1e+02, 1.9e+02
 norm(A), norm(b), norm(C) = 1.3e+04, 1.0e+05, 2.5e+02
 Total CPU time (secs)  = 0.44
 CPU time per iteration = 0.01
 termination code       = -9
 DIMACS errors: 1.7e-13  0.0e+00  4.7e-07  0.0e+00  1.1e-07  1.6e-07
------------------------------------------------------------------

ans =

   40.9008

Iteration   3   Total error is: 0.021289

ans =

   40.4915
```

```
Iteration   4   Total error is: 0.021184

ans =

   40.4915

Iteration   5   Total error is: 0.021184

ans =

   40.4915

Iteration   6   Total error is: 0.021184

ans =

   40.4915

Iteration   7   Total error is: 0.021184

ans =

   40.4915

Iteration   8   Total error is: 0.021184
The total representation error of the testing signals is: 0.21357
>>
```