```matlab
clear all;
close all;
AA = [-0.7 3; 0.2 1.4; -0.4 -2; 1.7 -3];
bb = [3 5 -2 13]';

fi = linspace(0, 2*pi, 100);
x_ball = [cos(fi); sin(fi)];    % unit ball
th = -pi/3; R60n = [cos(th) sin(th); -sin(th) cos(th)];  % pos.
 rotation
th = -pi/4; R45n = [cos(th) sin(th); -sin(th) cos(th)]; % neg.
 rotation
lam1 = [2; 1]; lam2 = [1 3];       % semiaxis length
xc1 = [0; 2]; xc2 = [-1; 2];     % ellipse centre

x_ball_r1 = R60n*diag(lam1)*x_ball + xc1*ones(1,size(x_ball,2));
x_ball_r2 = R45n*diag(lam2)*x_ball + xc2*ones(1,size(x_ball,2));

invP1 = inv(R60n*diag(lam1)*diag(lam1)*R60n');  % ellipse 1
invP2 = inv(R45n*diag(lam2)*diag(lam2)*R45n');  % ellipse 2

% second order penalty function
A = [2 1; 1 3]; f = [1; -1]; c = 2;
[XX, YY] = meshgrid(-2:0.1:2, -1:0.1:3);
ZZ = zeros(size(XX));
for i = 1:size(XX,1),
    for j = 1:size(XX,2),
        z = [XX(i,j); YY(i,j)];
        ZZ(i,j) = quad_form(z, A) + f'*z + c;
    end;
end;
figure(2), contour(XX, YY, ZZ, 30), grid on;

%figure(4), contour(XX, YY, ZZ), grid on;
hold on
    plot(x_ball_r1(1,:), x_ball_r1(2,:), 'm--',...
         x_ball_r2(1,:), x_ball_r2(2,:), 'm--');
hold off
% cvx minimization QPQC
cvx_begin
    variable x(2);
    minimize (quad_form(x, A) + f'*x + c);
    subject to
        AA*x - bb <= 0;
        quad_form(x - xc1, invP1) <= 1;
        quad_form(x - xc2, invP2) <= 1;
cvx_end
min_val = cvx_optval;
x_min = x;
hold on
    plot(x_min(1),x_min(2),'ks');
hold off
disp(['minimization = ', num2str(min_val),...
```

```
    ' for ', num2str(x_min(1)), '  ', num2str(x_min(2))]);
```

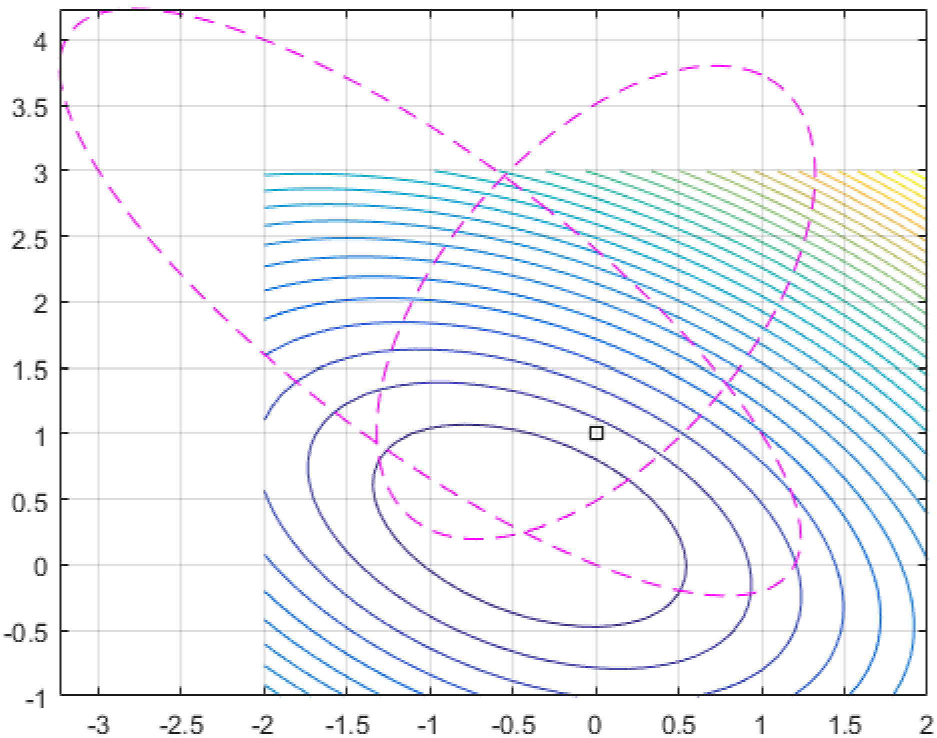
```
Calling SDPT3 4.0: 18 variables, 5 equality constraints
   For improved efficiency, SDPT3 is solving the dual problem.
------------------------------------------------------------

 num. of constraints =  5
 dim. of socp   var  = 12,   num. of socp blk  =  3
 dim. of linear var  =  6
*******************************************************************
   SDPT3: Infeasible path-following algorithms
*******************************************************************
 version  predcorr  gam  expon  scale_data
    NT      1      0.000   1        0
it pstep dstep pinfeas dinfeas  gap      prim-obj      dual-obj
 cputime
-------------------------------------------------------------------
 0|0.000|0.000|3.8e+00|2.2e+00|1.9e+03| 3.102987e+02  0.000000e+00|
 0:0:00| chol  1  1
 1|1.000|0.679|2.9e-06|7.2e-01|7.9e+02| 1.571141e+02 -2.192632e+01|
 0:0:00| chol  1  1
 2|0.935|0.938|1.8e-06|4.5e-02|8.5e+01| 4.582125e+01 -7.131415e+00|
 0:0:00| chol  1  1
 3|0.990|1.000|2.7e-07|1.5e-04|7.9e+00| 3.109280e-01 -7.500145e+00|
 0:0:00| chol  1  1
 4|0.888|0.842|9.1e-08|3.5e-05|1.1e+00|-5.905612e+00 -6.956286e+00|
 0:0:00| chol  1  1
 5|0.487|1.000|6.5e-08|1.5e-06|5.5e-01|-6.088512e+00 -6.633935e+00|
 0:0:00| chol  1  1
 6|0.980|0.894|2.6e-09|3.0e-07|2.7e-02|-6.486661e+00 -6.513587e+00|
 0:0:00| chol  1  1
 7|0.978|1.000|1.4e-09|1.5e-08|3.1e-03|-6.497802e+00 -6.500882e+00|
 0:0:00| chol  1  1
 8|0.989|0.989|2.2e-10|1.9e-09|3.5e-05|-6.499975e+00 -6.500010e+00|
 0:0:00| chol  1  1
 9|0.989|0.988|3.8e-12|6.6e-11|3.9e-07|-6.500000e+00 -6.500000e+00|
 0:0:00| chol  1  1
10|0.995|0.994|6.5e-13|1.4e-12|4.8e-09|-6.500000e+00 -6.500000e+00|
 0:0:00|
  stop: max(relative gap, infeasibilities) < 1.49e-08
-------------------------------------------------------------------
 number of iterations   = 10
 primal objective value = -6.50000000e+00
 dual   objective value = -6.50000000e+00
 gap := trace(XZ)       = 4.84e-09
 relative gap           = 3.46e-10
 actual relative gap    = 3.38e-10
 rel. primal infeas (scaled problem)   = 6.49e-13
 rel. dual     "        "       "      = 1.43e-12
 rel. primal infeas (unscaled problem) = 0.00e+00
 rel. dual     "        "       "      = 0.00e+00
 norm(X), norm(y), norm(Z) = 9.3e+00, 1.4e+00, 1.7e+01
 norm(A), norm(b), norm(C) = 9.3e+00, 6.3e+00, 2.1e+01
```

```
 Total CPU time (secs)  = 0.48
 CPU time per iteration = 0.05
 termination code       =  0
 DIMACS: 6.8e-13  0.0e+00  1.5e-12  0.0e+00  3.4e-10  3.5e-10
-------------------------------------------------------------------

------------------------------------------------------------
Status: Solved
Optimal value (cvx_optval): +4

minimization = 4 for 4.5247e-10  1
```



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