PROBLEM 3 ON HW 4

```
close all;
stat = readtable("UCLA_EE_grad_2031.csv");
```

(a)

```
y = stat{:,3};
GPA = stat{:,1};
GRE = stat{:,2};
hold on;
scatter(GPA(y == -1), GRE(y == -1), 'blue');
scatter(GPA(y == 1), GRE(y == 1), 'red');
```

(b)

```
x = stat{:,1:2};
y = stat{:,3};
cvx_begin
    variable w(2)
    variable b
    minimize( 1/2 * sum_square_abs(w) )
    subject to
        for i = 1:100
            y(i) * (w' * x(i,:)' + b) >= 1
        end
cvx_end
```

```
Calling SDPT3 4.0: 104 variables, 4 equality constraints
   For improved efficiency, SDPT3 is solving the dual problem.
------------------------------------------------------------

 num. of constraints =  4
 dim. of socp   var  =  4,   num. of socp blk  =  1
 dim. of linear var  = 100
*************************************************************
   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|1.6e+03|2.3e+01|4.9e+04|-2.000000e+03  0.000000e+00| 0:0:00| chol  1  1
 1|0.523|0.525|7.6e+02|1.1e+01|3.3e+04|-1.174305e+03 -7.513991e+01| 0:0:00| chol  1  1
 2|0.366|0.386|4.8e+02|6.8e+00|2.7e+04|-6.430873e+02 -2.287892e+02| 0:0:00| chol  1  1
 3|0.247|0.294|3.6e+02|4.8e+00|2.4e+04|-2.901923e+02 -4.170541e+02| 0:0:00| chol  1  1
 4|0.164|0.240|3.0e+02|3.6e+00|2.3e+04|-1.945426e+01 -6.129483e+02| 0:0:00| chol  1  1
 5|0.109|0.224|2.7e+02|2.8e+00|2.3e+04| 2.095194e+02 -8.126945e+02| 0:0:00| chol  1  1
 6|0.084|0.288|2.5e+02|2.0e+00|2.4e+04| 4.355619e+02 -1.044117e+03| 0:0:00| chol  1  1
 7|0.129|0.943|2.2e+02|1.1e-01|2.3e+04| 7.382631e+02 -1.392626e+03| 0:0:00| chol  1  1
 8|0.122|1.000|1.9e+02|2.2e-06|2.7e+04| 1.327483e+03 -2.316356e+03| 0:0:00| chol  1  1
 9|0.720|0.346|5.3e+01|1.7e-06|1.2e+04| 2.505271e+03 -2.620171e+03| 0:0:00| chol  1  1
10|0.749|1.000|1.3e+01|2.0e-07|9.5e+03| 4.258390e+03 -3.243073e+03| 0:0:00| chol  1  1
11|1.000|1.000|6.4e-13|9.9e-08|5.1e+03| 1.695448e+03 -3.379264e+03| 0:0:00| chol  1  1
12|1.000|0.962|5.9e-12|3.2e-08|2.2e+03| 1.483001e+03 -6.791601e+02| 0:0:00| chol  1  1
13|0.963|1.000|1.9e-12|9.0e-09|7.2e+02| 2.406002e+02 -4.755744e+02| 0:0:00| chol  1  1
14|1.000|1.000|2.6e-12|9.0e-10|2.4e+02| 1.396521e+02 -9.596010e+01| 0:0:00| chol  1  1
15|1.000|1.000|2.5e-13|9.1e-11|8.5e+01| 2.447638e+01 -6.007492e+01| 0:0:00| chol  1  1
```

```
16|1.000|0.999|5.9e-14|1.0e-11|2.9e+01| 1.430668e+01 -1.444949e+01| 0:0:00| chol  1  1
17|1.000|1.000|1.1e-14|1.9e-12|1.0e+01| 2.196689e-01 -1.016041e+01| 0:0:00| chol  1  1
18|0.754|0.822|2.6e-14|1.4e-12|6.7e+00|-3.778618e+00 -1.049978e+01| 0:0:00| chol  1  1
19|1.000|0.839|7.7e-13|1.2e-12|3.5e+00|-4.119932e+00 -7.627466e+00| 0:0:00| chol  1  1
20|0.942|0.958|4.2e-14|1.1e-12|2.4e-01|-6.797549e+00 -7.040376e+00| 0:0:00| chol  1  1
21|0.985|0.974|6.3e-14|1.0e-12|4.1e-03|-6.996935e+00 -7.000998e+00| 0:0:00| chol  1  1
22|0.987|0.982|5.7e-14|1.0e-12|5.6e-05|-6.999961e+00 -7.000017e+00| 0:0:00| chol  1  1
23|0.989|0.985|1.6e-13|1.0e-12|1.5e-06|-6.999999e+00 -7.000000e+00| 0:0:00| chol  1  1
24|0.989|0.987|2.0e-13|1.0e-12|3.8e-08|-7.000000e+00 -7.000000e+00| 0:0:00|
  stop: max(relative gap, infeasibilities) < 1.49e-08
------------------------------------------------------------------
 number of iterations   = 24
 primal objective value = -6.99999997e+00
 dual   objective value = -7.00000000e+00
 gap := trace(XZ)       = 3.79e-08
 relative gap           = 2.53e-09
 actual relative gap    = 2.53e-09
 rel. primal infeas (scaled problem)   = 1.99e-13
 rel. dual     "        "       "      = 1.01e-12
 rel. primal infeas (unscaled problem) = 0.00e+00
 rel. dual     "        "       "      = 0.00e+00
 norm(X), norm(y), norm(Z) = 1.2e+01, 1.7e+01, 4.9e+01
 norm(A), norm(b), norm(C) = 3.5e+01, 2.0e+00, 1.1e+01
 Total CPU time (secs)  = 0.12
 CPU time per iteration = 0.00
 termination code       =  0
 DIMACS: 2.0e-13  0.0e+00  5.6e-12  0.0e+00  2.5e-09  2.5e-09
------------------------------------------------------------------

------------------------------------------------------------
Status: Solved
Optimal value (cvx_optval): +6.5
```

```
w
```

```
w = 2×1
    3.0000
    2.0000
```

```
b
```

```
b = -15.0000
```

```
xv = (2:0.01:4);
plot(xv, (15 - 3 * xv) / 2);
```

(c)

```
P = zeros(100, 100);
for i = 1:100
    for j = 1:100
        P(i,j) = y(i) * y(j) * x(i,:) * x(j,:)';
    end
end
cvx_begin
    variable a(100)
    maximize( sum(a) - 1/2 * quad_form(a, P) )
    subject to
        sum(a .* y) == 0
        for i = 1:100
```

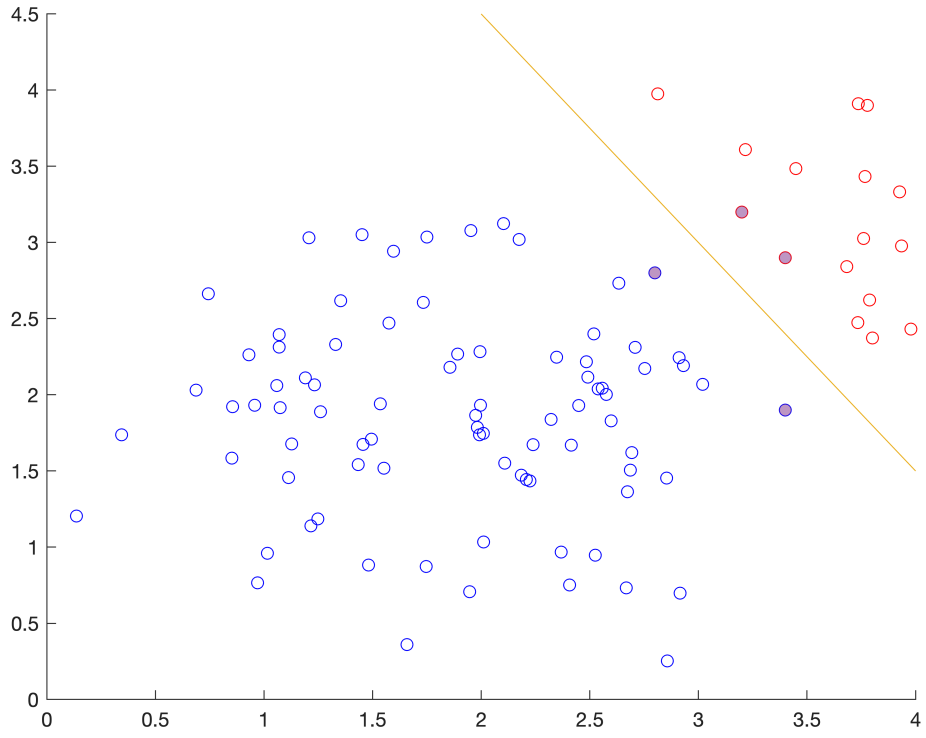
```
            a(i) >= 0
        end
cvx_end
```

```
Calling SDPT3 4.0: 104 variables, 4 equality constraints
------------------------------------------------------------

 num. of constraints =  4
 dim. of socp   var  =  4,   num. of socp blk  =  1
 dim. of linear var  = 100
*****************************************************************
   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|6.8e+02|8.3e-01|2.3e+04|-1.480616e+03  0.000000e+00| 0:0:00| chol  1  1
 1|0.750|0.996|1.7e+02|4.9e-03|6.8e+03|-4.713686e+02 -9.722811e+01| 0:0:00| chol  1  1
 2|0.972|1.000|4.8e+00|2.7e-04|2.7e+02| 2.188681e+01 -5.537854e+01| 0:0:00| chol  1  1
 3|0.969|1.000|1.5e-01|2.7e-05|1.0e+02| 4.551568e+01 -4.852598e+01| 0:0:00| chol  1  1
 4|1.000|1.000|3.1e-07|2.7e-06|5.0e+01| 1.599313e+01 -3.367612e+01| 0:0:00| chol  1  1
 5|1.000|1.000|2.6e-08|3.3e-07|1.6e+01| 5.895252e+00 -9.707110e+00| 0:0:00| chol  1  1
 6|1.000|0.593|2.6e-09|1.6e-07|7.3e+00|-1.614783e+00 -8.923866e+00| 0:0:00| chol  1  1
 7|0.918|1.000|1.2e-08|3.3e-09|2.4e+00|-4.590305e+00 -7.007706e+00| 0:0:00| chol  1  1
 8|0.981|0.974|2.8e-09|1.1e-09|7.9e-02|-6.440585e+00 -6.520081e+00| 0:0:00| chol  1  1
 9|0.988|0.987|1.1e-09|5.9e-10|9.6e-04|-6.499293e+00 -6.500255e+00| 0:0:00| chol  1  1
10|0.988|0.981|1.4e-11|2.4e-10|1.3e-05|-6.499991e+00 -6.500004e+00| 0:0:00| chol  1  1
11|0.997|0.954|1.7e-14|1.4e-11|6.5e-07|-6.500000e+00 -6.500000e+00| 0:0:00| chol  1  1
12|1.000|0.924|1.0e-14|2.0e-12|4.8e-08|-6.500000e+00 -6.500000e+00| 0:0:00|
  stop: max(relative gap, infeasibilities) < 1.49e-08
-------------------------------------------------------------------
 number of iterations   = 12
 primal objective value = -6.49999997e+00
 dual   objective value = -6.50000001e+00
 gap := trace(XZ)       = 4.84e-08
 relative gap           = 3.46e-09
 actual relative gap    = 3.39e-09
 rel. primal infeas (scaled problem)   = 1.03e-14
 rel. dual     "        "       "      = 2.03e-12
 rel. primal infeas (unscaled problem) = 0.00e+00
 rel. dual     "        "       "      = 0.00e+00
 norm(X), norm(y), norm(Z) = 7.8e+00, 8.4e+01, 3.8e+02
 norm(A), norm(b), norm(C) = 1.1e+01, 2.0e+00, 3.7e+02
 Total CPU time (secs)  = 0.08
 CPU time per iteration = 0.01
 termination code       =  0
 DIMACS: 1.0e-14  0.0e+00  2.9e-12  0.0e+00  3.4e-09  3.5e-09
-------------------------------------------------------------------

------------------------------------------------------------
Status: Solved
Optimal value (cvx_optval): +6.5
```

```
scatter(GPA(a >= 0.00001), GRE(a >= 0.00001), 'filled', 'MarkerFaceAlpha', 0.5);
```


4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
3.5
4