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Convex Optimization

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Hw8 - Q6:

```matlab
clear;
clc;
close all;
% Load Data:
run('rank_aggr_data.m');
```

```matlab
cvx_begin
    variables r(n) v(m)
        minimize (sum(square_pos(v)));
        subject to
        v == r(preferences(:,2)) + 1 - r(preferences(:,1))
cvx_end
```

```
Calling SDPT3 4.0: 4050 variables, 2000 equality constraints
------------------------------------------------------------

 num. of constraints = 2000
 dim. of sdp     var  = 2000,   num. of sdp  blk  = 1000
 dim. of linear var  = 1000
 dim. of free    var  = 50 *** convert ublk to lblk
*********************************************************************
   SDPT3: Infeasible path-following algorithms
*********************************************************************
 version  predcorr  gam  expon  scale_data
   HKM      1       0.000   1        0
it pstep dstep pinfeas dinfeas  gap      prim-obj      dual-obj     cputime
-------------------------------------------------------------------
 0|0.000|0.000|4.5e+01|4.5e+01|4.2e+06| 1.000000e+04  0.000000e+00| 0:0:00| spchol  1  1
 1|0.291|0.290|3.2e+01|3.2e+01|2.5e+06| 4.103705e+04 -2.800853e+04| 0:0:00| spchol  1  1
 2|0.300|0.288|2.2e+01|2.3e+01|2.1e+06| 7.521042e+04 -5.899901e+04| 0:0:00| spchol  1  1
 3|0.427|0.367|1.3e+01|1.5e+01|1.7e+06| 1.274127e+05 -1.040431e+05| 0:0:00| spchol  1  1
 4|0.518|0.366|6.2e+00|9.2e+00|1.3e+06| 1.834733e+05 -1.514857e+05| 0:0:01| spchol  1  1
 5|0.622|0.393|2.3e+00|5.6e+00|9.2e+05| 2.120756e+05 -1.873299e+05| 0:0:01| spchol  1  1
 6|1.000|0.703|3.5e-08|1.7e+00|4.0e+05| 1.571673e+05 -1.616662e+05| 0:0:01| spchol  1  1
 7|0.903|0.420|1.7e-08|9.6e-01|2.9e+05| 1.110025e+05 -1.453620e+05| 0:0:01| spchol  1  1
 8|1.000|0.229|8.3e-09|7.4e-01|2.4e+05| 8.652046e+04 -1.322940e+05| 0:0:01| spchol  1  1
 9|0.921|0.430|4.9e-09|4.2e-01|1.5e+05| 5.107646e+04 -9.501722e+04| 0:0:01| spchol  1  1
10|1.000|0.290|1.5e-09|3.0e-01|1.2e+05| 3.709095e+04 -7.707471e+04| 0:0:01| spchol  1  1
11|1.000|0.396|7.3e-10|1.8e-01|7.6e+04| 2.131729e+04 -5.337317e+04| 0:0:01| spchol  1  1
12|1.000|0.363|2.6e-10|1.2e-01|5.1e+04| 1.280308e+04 -3.739376e+04| 0:0:01| spchol  1  1
13|1.000|0.369|9.8e-11|7.3e-02|3.4e+04| 7.710632e+03 -2.544559e+04| 0:0:01| spchol  1  1
14|1.000|0.371|3.6e-11|4.6e-02|2.2e+04| 4.612463e+03 -1.694654e+04| 0:0:01| spchol  1  1
15|1.000|0.389|1.3e-11|2.8e-02|1.4e+04| 2.725668e+03 -1.075432e+04| 0:0:01| spchol  1  1
16|1.000|0.395|4.3e-12|1.7e-02|8.3e+03| 1.633149e+03 -6.588822e+03| 0:0:01| spchol  1  1
17|1.000|0.413|1.5e-12|1.0e-02|4.9e+03| 1.047005e+03 -3.789685e+03| 0:0:01| spchol  1  1
18|1.000|0.439|5.5e-13|5.6e-03|2.7e+03| 7.361046e+02 -1.956427e+03| 0:0:02| spchol  1  1
```

```
19|1.000|0.502|4.0e-13|2.8e-03|1.3e+03|  5.906788e+02 -7.321116e+02|  0:0:02|  spchol  1  1
20|1.000|0.574|2.8e-13|1.2e-03|5.6e+02|  5.380895e+02 -1.733895e+01|  0:0:02|  spchol  1  1
21|1.000|0.667|2.1e-13|3.9e-04|1.8e+02|  5.252952e+02  3.422110e+02|  0:0:02|  spchol  1  1
22|1.000|0.652|1.2e-13|1.4e-04|6.3e+01|  5.233418e+02  4.599515e+02|  0:0:02|  spchol  1  1
23|1.000|0.211|9.9e-14|1.1e-04|5.0e+01|  5.234002e+02  4.732038e+02|  0:0:02|  spchol  1  1
24|1.000|0.551|1.2e-13|4.9e-05|2.3e+01|  5.231197e+02  5.006132e+02|  0:0:02|  spchol  1  1
25|1.000|0.737|1.0e-13|1.3e-05|5.9e+00|  5.230317e+02  5.171246e+02|  0:0:02|  spchol  1  1
26|1.000|0.240|9.7e-14|9.7e-06|4.5e+00|  5.230272e+02  5.185367e+02|  0:0:02|  spchol  1  1
27|1.000|0.420|1.1e-13|5.6e-06|2.6e+00|  5.230256e+02  5.204129e+02|  0:0:02|  spchol  1  1
28|1.000|0.633|1.5e-13|2.1e-06|9.6e-01|  5.230171e+02  5.220592e+02|  0:0:02|  spchol  1  1
29|1.000|0.696|1.1e-13|6.3e-07|2.9e-01|  5.230158e+02  5.227246e+02|  0:0:02|  spchol  1  1
30|1.000|0.538|1.1e-13|1.4e-05|1.4e-01|  5.230155e+02  5.228810e+02|  0:0:03|  spchol  1  1
31|1.000|0.981|1.9e-15|6.7e-06|3.1e-03|  5.230155e+02  5.230129e+02|  0:0:03|  spchol  1  1
32|0.983|0.988|5.4e-16|1.6e-07|4.3e-05|  5.230154e+02  5.230154e+02|  0:0:03|  spchol  1  1
33|1.000|0.987|1.7e-15|2.1e-09|1.1e-06|  5.230154e+02  5.230154e+02|  0:0:03|
  stop: max(relative gap, infeasibilities) < 1.49e-08
-------------------------------------------------------------------
 number of iterations   = 33
 primal objective value =  5.23015428e+02
 dual   objective value =  5.23015427e+02
 gap := trace(XZ)        = 1.08e-06
 relative gap            = 1.03e-09
 actual relative gap     = 8.65e-10
 rel. primal infeas (scaled problem)   = 1.73e-15
 rel. dual      "          "           = 2.14e-09
 rel. primal infeas (unscaled problem) = 0.00e+00
 rel. dual      "          "           = 0.00e+00
 norm(X), norm(y), norm(Z) = 5.7e+01, 5.7e+01, 7.3e+01
 norm(A), norm(b), norm(C) = 8.2e+01, 4.6e+01, 3.3e+01
 Total CPU time (secs)  = 2.72
 CPU time per iteration = 0.08
 termination code       =  0
 DIMACS: 4.0e-14  0.0e+00  3.5e-08  0.0e+00  8.7e-10  1.0e-09
-------------------------------------------------------------------

-------------------------------------------------------------
Status: Solved
Optimal value (cvx_optval): +523.015
```

```
v_sq = pos(v);
num_viol_sq = sum(v_sq>0.001)
```

```
num_viol_sq = 781
```

find rankings with sum of violations penalty:

```
cvx_begin
    variables r(n) v(m)
        minimize (sum(pos(v)));
        subject to
        v == r(preferences(:,2)) + 1 - r(preferences(:,1))
cvx_end
```

```
Calling SDPT3 4.0: 2050 variables, 1000 equality constraints
-------------------------------------------------------------

 num. of constraints = 1000
 dim. of linear var  = 2000
 dim. of free   var  = 50 *** convert ublk to lblk
*********************************************************************
   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|9.7e-01|6.8e+01|5.0e+06| 4.472136e+04  0.000000e+00| 0:0:00| spchol  1  1
 1|1.000|0.985|1.2e-06|1.3e+00|1.2e+05| 4.315623e+04  2.792196e+02| 0:0:00| spchol  1  1
 2|1.000|0.796|6.1e-07|3.4e-01|3.5e+04| 2.090350e+04  2.702304e+02| 0:0:00| spchol  1  1
 3|0.950|0.927|1.7e-06|5.0e-02|4.6e+03| 4.006383e+03  2.464098e+02| 0:0:00| spchol  1  1
 4|1.000|0.285|4.6e-07|3.8e-02|1.2e+03| 1.283506e+03  2.480964e+02| 0:0:00| spchol  1  1
 5|1.000|0.582|1.4e-07|1.6e-02|4.5e+02| 6.899956e+02  2.750029e+02| 0:0:00| spchol  1  1
 6|1.000|0.471|8.9e-08|8.7e-03|2.7e+02| 5.654146e+02  3.075140e+02| 0:0:00| spchol  1  1
 7|1.000|0.347|3.9e-08|5.7e-03|1.6e+02| 4.794613e+02  3.256277e+02| 0:0:00| spchol  1  1
 8|1.000|0.346|1.6e-08|3.7e-03|1.1e+02| 4.464732e+02  3.405462e+02| 0:0:00| spchol  1  1
 9|1.000|0.399|5.7e-09|2.2e-03|6.9e+01| 4.204149e+02  3.543100e+02| 0:0:00| spchol  1  1
10|1.000|0.339|2.1e-09|1.5e-03|4.7e+01| 4.079290e+02  3.624283e+02| 0:0:00| spchol  1  1
11|1.000|0.388|8.4e-10|9.0e-04|2.9e+01| 3.981258e+02  3.699967e+02| 0:0:00| spchol  1  1
12|1.000|0.324|3.0e-10|6.1e-04|2.1e+01| 3.943753e+02  3.742778e+02| 0:0:01| spchol  1  1
13|0.908|0.586|1.4e-10|2.5e-04|8.5e+00| 3.894307e+02  3.812073e+02| 0:0:01| spchol  1  1
14|1.000|0.340|3.0e-11|1.7e-04|5.2e+00| 3.879943e+02  3.829889e+02| 0:0:01| spchol  1  1
15|1.000|0.666|1.2e-11|5.6e-05|1.6e+00| 3.871671e+02  3.856030e+02| 0:0:01| spchol  1  1
16|0.978|0.948|3.1e-12|2.9e-06|8.2e-02| 3.870056e+02  3.869260e+02| 0:0:01| spchol  1  1
17|0.988|0.988|9.3e-12|5.4e-06|1.8e-03| 3.870001e+02  3.869991e+02| 0:0:01| spchol  2  2
18|1.000|0.989|1.8e-12|1.2e-07|4.7e-05| 3.870000e+02  3.870000e+02| 0:0:01| spchol  4  4
19|1.000|0.989|2.8e-12|3.1e-09|1.1e-06| 3.870000e+02  3.870000e+02| 0:0:01|
  stop: max(relative gap, infeasibilities) < 1.49e-08
-------------------------------------------------------------------------
 number of iterations   = 19
 primal objective value =  3.87000000e+02
 dual   objective value =  3.87000000e+02
 gap := trace(XZ)       = 1.15e-06
 relative gap           = 1.48e-09
 actual relative gap    = 8.91e-10
 rel. primal infeas (scaled problem)   = 2.82e-12
 rel. dual     "        "        "     = 3.11e-09
 rel. primal infeas (unscaled problem) = 0.00e+00
 rel. dual     "        "        "     = 0.00e+00
 norm(X), norm(y), norm(Z) = 5.4e+01, 1.9e+01, 3.1e+01
 norm(A), norm(b), norm(C) = 7.8e+01, 3.3e+01, 3.3e+01
 Total CPU time (secs)  = 0.79
 CPU time per iteration = 0.04
 termination code       =  0
 DIMACS: 4.6e-11  0.0e+00  5.1e-08  0.0e+00  8.9e-10  1.5e-09
-------------------------------------------------------------------------


-------------------------------------------------------------
Status: Solved
Optimal value (cvx_optval): +387
```
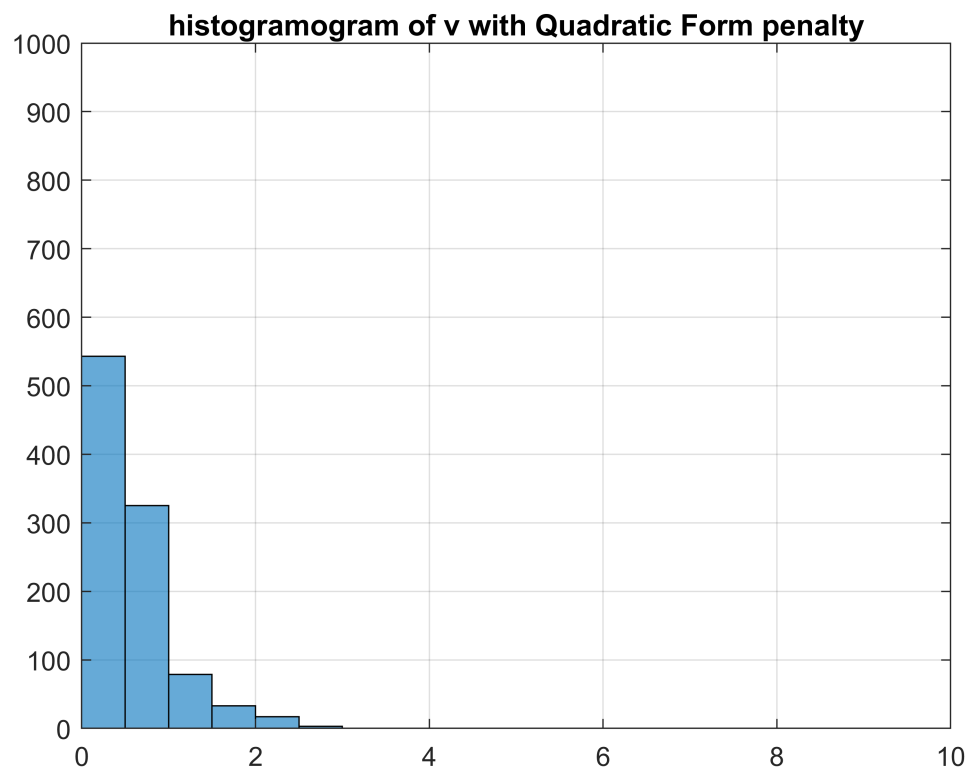
```
v_lin = pos(v);
num_viol_lin = sum(v_lin>0.001)
```

```
num_viol_lin = 235
```

plot Figures:

```
Fig1= figure();
histogram(v_sq,0:0.5:7.5);
title('histogramogram of v with Quadratic Form penalty');
grid on
xlim([0 10]);
ylim([0 1000]);
```



```
Fig2 = figure();
histogram(v_lin,0:0.5:7.5);
xlim([0 10]);
ylim([0 1000]);
title('histogramogram of v with Linear penalty');
grid on
```

histogramogram of v with Linear penalty