

Convex Optimization

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```
% Hw-8 Question 5
clear;
clc;
close all;

% Load Data:
run('treatment_planning_data.m');
```

```
cvx_begin
    variable b(n); % bj ha
    0 <= b;
    b <= Bmax;

    Atarget*b >= Dtarget % Feasibility of the problem ==> Treatment shall work
    minimize (sum(square_pos(Aother*b-Dother))) % minimize square excess dose delivered to other

cvx_end
```

Calling SDPT3 4.0: 2100 variables, 1000 equality constraints
For improved efficiency, SDPT3 is solving the dual problem.

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num. of constraints = 1000
dim. of sdp var = 800, num. of sdp blk = 400
dim. of linear var = 900
*****
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|1.6e+03|2.7e+01|9.6e+06| 1.413870e+05 0.000000e+00| 0:0:00| spchol 1 1
1|0.781|0.639|3.6e+02|9.8e+00|4.2e+06| 2.480374e+05 -9.294132e+04| 0:0:00| spchol 1 1
2|0.846|0.524|5.5e+01|4.7e+00|2.3e+06| 2.774105e+05 -1.451749e+05| 0:0:00| spchol 1 1
3|1.000|0.855|2.8e-05|6.9e-01|5.2e+05| 1.757058e+05 -9.529972e+04| 0:0:00| spchol 1 1
4|0.711|0.906|1.2e-05|7.0e-02|1.3e+05| 7.834864e+04 -3.240759e+04| 0:0:00| spchol 1 1
5|0.987|0.906|4.9e-07|8.5e-03|3.2e+04| 1.582509e+04 -1.389546e+04| 0:0:00| spchol 1 1
6|1.000|0.965|1.7e-07|9.7e-04|6.5e+03| 3.504278e+03 -2.858838e+03| 0:0:00| spchol 1 1
7|0.913|1.000|4.5e-08|2.2e-04|1.6e+03| 1.030825e+03 -5.305508e+02| 0:0:00| spchol 1 1
8|1.000|1.000|4.8e-09|6.5e-05|3.0e+02| 1.577167e+02 -1.438395e+02| 0:0:00| spchol 1 1
9|0.957|0.960|8.7e-10|8.8e-06|6.1e+01| 3.954550e+01 -2.126165e+01| 0:0:01| spchol 1 1
10|0.967|1.000|2.9e-11|6.5e-07|2.0e+01| 1.181702e+01 -8.308412e+00| 0:0:01| spchol 1 1
11|0.931|0.951|2.0e-12|9.4e-08|3.1e+00| 1.674100e+00 -1.404809e+00| 0:0:01| spchol 1 1
12|1.000|1.000|1.5e-15|6.5e-09|1.3e+00| 4.901093e-01 -8.449113e-01| 0:0:01| spchol 1 1
13|1.000|1.000|1.2e-15|6.5e-10|5.0e-01| -2.307448e-03 -5.061127e-01| 0:0:01| spchol 1 1
14|0.959|0.965|1.6e-15|8.7e-11|7.3e-02| -2.648661e-01 -3.375499e-01| 0:0:01| spchol 1 1
```

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15|1.000|1.000|3.5e-15|7.5e-12|3.3e-02|-2.887525e-01 -3.216327e-01| 0:0:01| spchol 1 1
16|0.934|0.935|3.9e-15|2.1e-12|2.5e-03|-3.066281e-01 -3.091109e-01| 0:0:01| spchol 1 1
17|0.994|0.995|7.8e-15|1.1e-12|3.0e-04|-3.079146e-01 -3.082167e-01| 0:0:01| spchol 1 1
18|1.000|1.000|1.6e-14|1.0e-12|1.2e-04|-3.080207e-01 -3.081414e-01| 0:0:01| spchol 1 1
19|1.000|1.000|1.0e-14|1.0e-12|1.7e-05|-3.080809e-01 -3.080978e-01| 0:0:01| spchol 1 1
20|1.000|1.000|2.4e-14|1.0e-12|3.3e-06|-3.080888e-01 -3.080921e-01| 0:0:01| spchol 1 1
21|1.000|1.000|7.7e-14|1.0e-12|5.9e-07|-3.080903e-01 -3.080909e-01| 0:0:01| spchol 1 1
22|1.000|1.000|5.5e-13|1.0e-12|1.0e-07|-3.080906e-01 -3.080907e-01| 0:0:01| spchol 1 1
23|1.000|1.000|2.0e-11|6.2e-13|1.6e-08|-3.080907e-01 -3.080907e-01| 0:0:01|

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stop: max(relative gap, infeasibilities) < 1.49e-08

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```

-----
number of iterations    = 23
primal objective value = -3.08090673e-01
dual  objective value = -3.08090687e-01
gap := trace(XZ)       = 1.56e-08
relative gap           = 9.64e-09
actual relative gap    = 8.77e-09
rel. primal infeas (scaled problem) = 2.02e-11
rel. dual      "      "      "      = 6.23e-13
rel. primal infeas (unscaled problem) = 0.00e+00
rel. dual      "      "      "      = 0.00e+00
norm(X), norm(y), norm(Z) = 2.1e+01, 1.0e+01, 1.4e+02
norm(A), norm(b), norm(C) = 1.7e+02, 2.1e+01, 1.9e+02
Total CPU time (secs) = 1.03
CPU time per iteration = 0.04
termination code      = 0
DIMACS: 2.1e-10  0.0e+00  2.5e-12  0.0e+00  8.8e-09  9.6e-09
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Status: Solved
Optimal value (cvx_optval): +0.308091

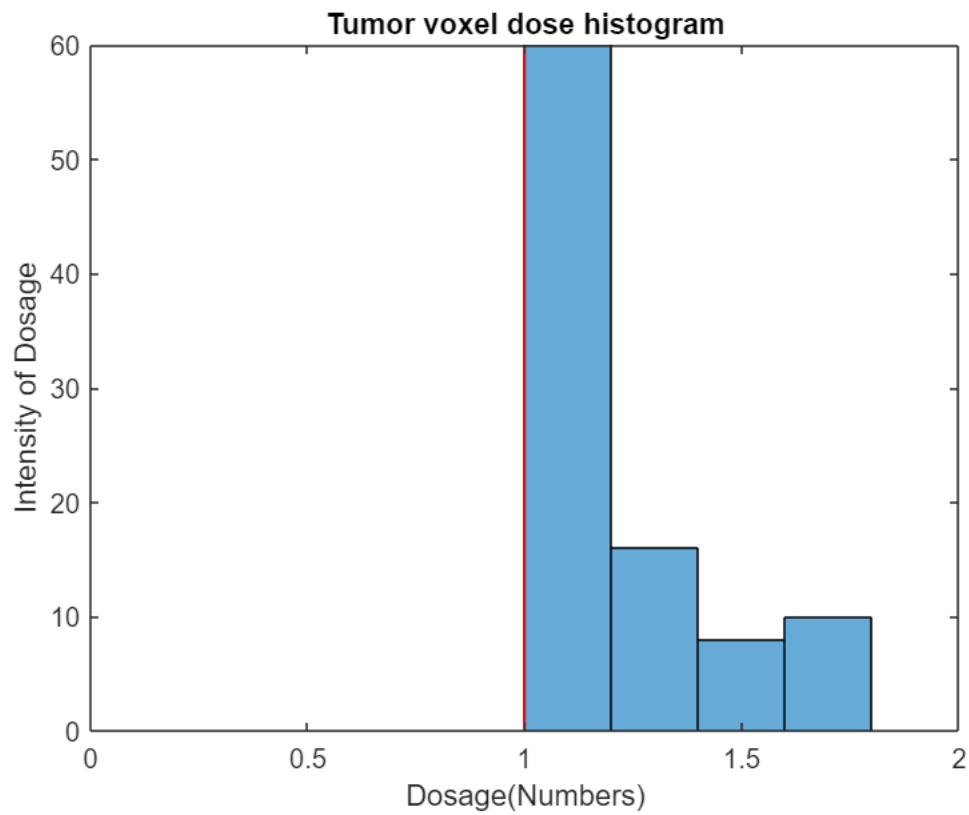
```

```

Fig1 = figure();
histogram(Atarget*b);

axis([0 2 0 60]);
hold on;
L = 20;
plot(Dtarget*ones(1,L),linspace(0,60,L),'r'); % To darw a line
title('Tumor voxel dose histogram');
xlabel('Dosage(Numbers)')
ylabel('Intensity of Dosage')

```



```
Fig2 = figure();
histogram(Aother*b);
axis([0 2 0 150]);
hold on;
plot(Dother*ones(1,L),linspace(0,150,L),'r'); % To darw a line
title('Other voxel dose histogram')
xlabel('Dosage(Numbers)')
ylabel('Intensity of Dosage')
```

