Norwegian University of Science and Technology
Department of Engineering Cybernetics

Optimization and regulation TTK 4135 Spring 2021

Exercise set 4

2 **b)** The constraints and the objective function can be seen in figure 1.

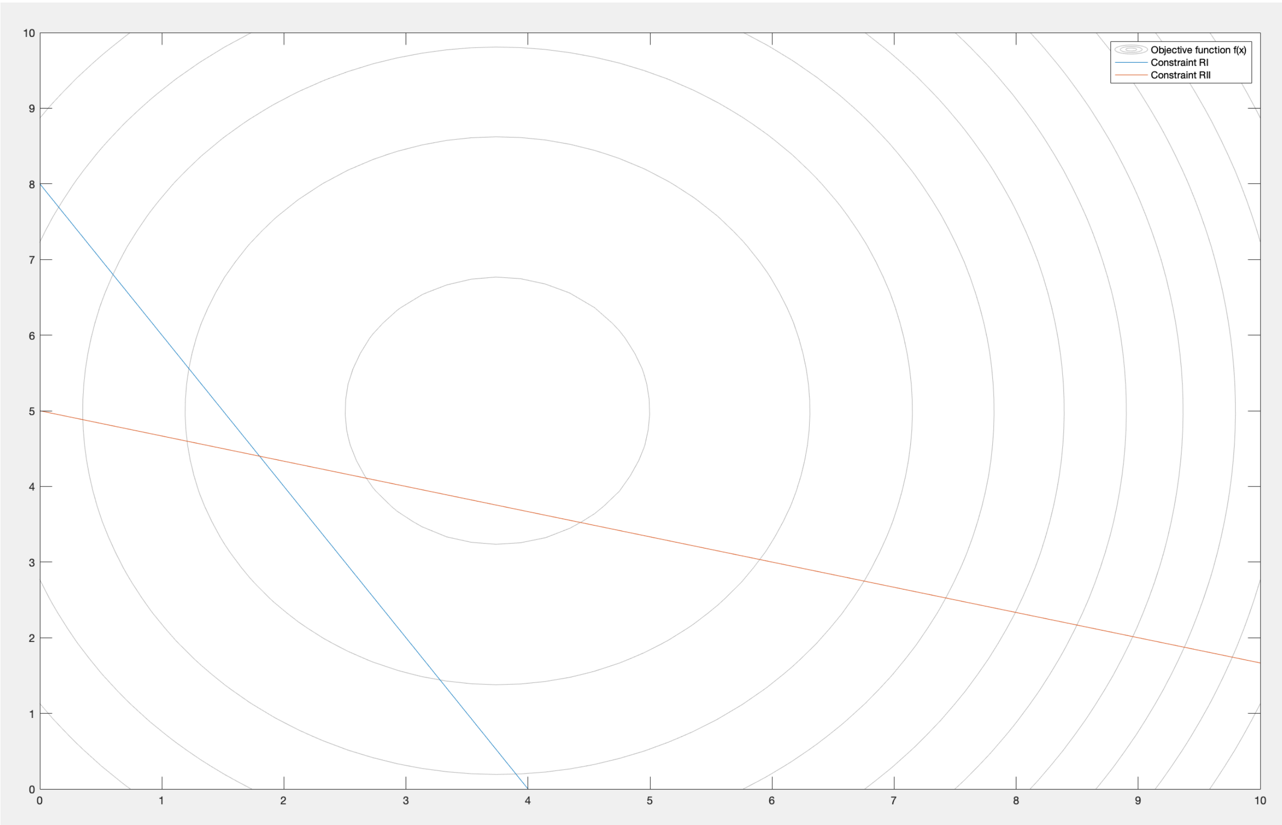

Figure 1: Constraints and objective function.

c) The following file was used to solve the problem:

```
% ****************************************************
% *                                                  *
% *       Optimalisering og regulering               *
% *              ?ving 3 Oppgave   V?r 2003          *
% *                                                  *
```

```
% *       Bjarne Foss 1996 *
% * *
% * qp_prodplan.m *
% * *
% * m-file for calculating QP solution. *
% * *
% * Oppdated 10/1-2001 by Geir Stian Landsverk *
% * *
% * Verified to work with MATLAB R2015a, *
% *     Andreas L. Fl?ten *
% * *
% * Verified to work with MATLAB R2018b, *
% *     Joakim R. Andersen *
% * *
% ****************************************************


global XIT; % Storing iterations in a global variable
global IT;  % Storing number of iterations in a global variable
global x0;  % Used in qp1.m (line 216).

IT=1; XIT=[];

x0 = [0 0]'; % Initial value
vlb = [0 0]; % Lower bound on x
vub = [];    % Upper bound on x

% min 0.5*x'*G*x + x'*c
%  x
%
% s.t. A*x <= b

```

```
% Objective function
G = [0.8  0;
       0  0.4];
c = [-3 ; -2];

% Linear constraints
A = [2  1;
       1  3];
b = [8 ; 15];

options = optimset('LargeScale','Off');
[x,lambda] = quadprog123(G,c,A,b,[],[],vlb,vub,x0,options);

disp('Iteration sequence:')
disp(XIT');
disp('Solution:')
disp(x);
```

The solution found was $[2.25\ 3.5]^\top$. At this point we have that:

$$
\begin{aligned}
2x_1 + x_2 &= 8 \\
x_1 + 3x_2 &= 12.75 < 15
\end{aligned}
$$

So just one of the constraints are active here (thus not in a a point of intersection). The iterations are marked in figure 2.

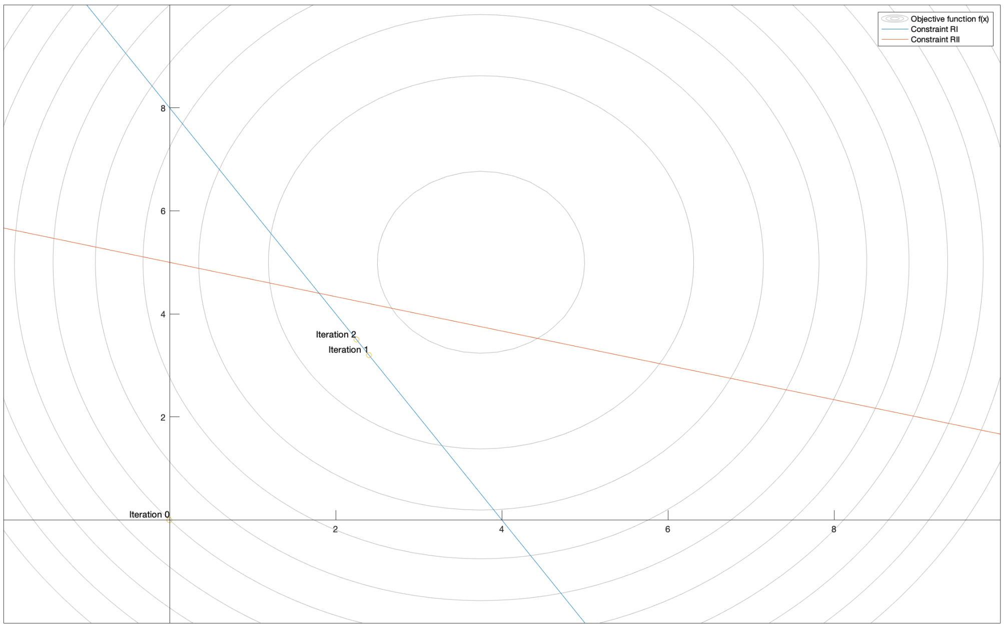

Figure 2: Constraints and objective function.

d) The active set method for QPs works by solving a quadratic subproblem with equality constraints by using a working set. The working set consists of all equality constraints (none in this case) and by choosing some subset of the inequality constraints (in this case the constraint with index 1). If we are able to find a step p that is 0 we have found the solution. If not we have to decide how much we can follow the step p, which in this case was not a lot until we found the solution with the working set with just index 1.

e) As mentioned the solution found is not in a point of intersection between the constraints, this contrasts the solution in Problem 1c) from Exercise 3 since this solution was found in an intersection between constraints. QPs differ a lot from LPs due to that the solution can be found anywhere inside the feasible region, while LPs will always have a solution at an intersection between constraints due to the linear objective function.