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PRESENTATION

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Problem

Solution

About cvxopt
Reformulation of
given equation

Terminal

Optimal solution

September 2, 2019

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PROBLEM

The problem

$$\min_{\mathbf{x}} \mathbf{x}_{11} + \mathbf{x}_{12} \quad (1.1)$$

with constraints

$$\mathbf{x}_{11} + \mathbf{x}_{22} = 1 \quad (1.2)$$

and

$$\mathbf{X} \succeq 0 \quad (1.3)$$

where

$$\mathbf{X} = \begin{pmatrix} \mathbf{x}_{11} & \mathbf{x}_{12} \\ \mathbf{x}_{12} & \mathbf{x}_{22} \end{pmatrix} \quad (1.4)$$

is known as semi-definite programming. Find a numerical solution to this problem.

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About cvxopt

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CVXOPT is a software package for convex optimization based on python programming language. This package includes solvers for linear programming, quadratic programming, semi-definite programming and more.

Reformulation of given equation

The cvxopt solver has to be used in order to find a numerical solution.

For this, the given equation can be reformulated as:

$$\min_{\mathbf{x}} \begin{pmatrix} 1 & 1 & 0 \end{pmatrix} \begin{pmatrix} x_{11} \\ x_{12} \\ x_{22} \end{pmatrix} \quad (2.1)$$

such that

$$\begin{pmatrix} 1 & 0 & 1 \end{pmatrix} \begin{pmatrix} x_{11} \\ x_{12} \\ x_{22} \end{pmatrix} = 1 \quad (2.2)$$

and

$$x_{11} \begin{pmatrix} -1 & 0 \\ 0 & 0 \end{pmatrix} + x_{12} \begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix} + x_{22} \begin{pmatrix} 0 & 0 \\ 0 & -1 \end{pmatrix} \preceq \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix} \quad (2.3)$$

TERMINAL

The code in

```
https://github.com/likhita26/blob/master/semi-definite%20
programming%201.py
```

shows the following terminal.

The terminal window displays the following output:

```
Terminal
pcost      dcost      gap      pres      dres      k/t
0: 5.0000e-01 5.0000e-01 2e+00 3e-16 2e+00 1e+00
1: 2.9243e-02 2.7087e-02 2e-01 5e-16 2e-01 1e-01
2: -2.0474e-01 -2.0483e-01 4e-03 2e-16 3e-03 2e-03
3: -2.0708e-01 -2.0708e-01 4e-05 4e-16 3e-05 2e-05
4: -2.0711e-01 -2.0711e-01 4e-07 8e-17 3e-07 2e-07
5: -2.0711e-01 -2.0711e-01 4e-09 3e-16 3e-09 2e-09
Optimal solution found.
[ 1.46e-01]
[-3.54e-01]
[ 8.54e-01]

-----
(program exited with code: 0)
Press return to continue
```

Figure: Terminal

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From previous, we get the optimal solution as:

$$x_{11} = 0.146$$

$$x_{12} = -0.354$$

$$x_{22} = 0.854$$

Therefore, the required minimum value is -0.208.

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