Convex Optimization Report

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Problem

Given robot state $x_t \in R^2$ and control inputs $u_t \in R^2$. The objective is

$$minimize \sum_{t=0}^{T-1} ||x_t - x_{t+1}||_2^2 + ||u_t||_2^2$$

The robot starts from point (0.1, 5) and wants to reach the point (0, -5). The moving speed in the X direction shall not exceed 1, and the moving speed in the Y direction shall not exceed 1. The value of T shall not exceed 15. The dynamics of the system is

$$x_{t+1} = x_t + u_t$$

The robot cannot collide with obstacles (when the robot is on the boundary of the obstacle, we think there is no collision).

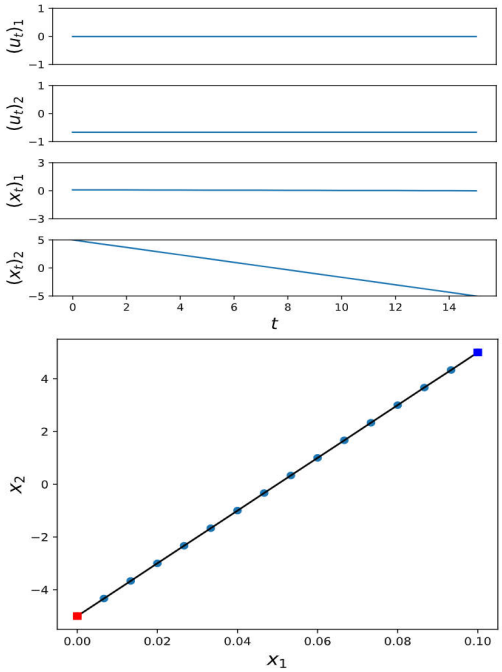
condition 1

There is no obstacle

We just need to change limits of given code to solve this problem.

- state dimension: n = 2
- input dimension: m = 2
- time horizon: T = 15
- state transition matrix: A = I
- input matrix: B = I
- start state: x_0 = [0.1, 5]
- target state: x_T = [0, -5]

The trajectory of the robot in a coordinate system is shown in the following figure.



condition 2

There is a circular obstacle at point (0, 0) and its radius is 2

We can divide the constraint into two parts.

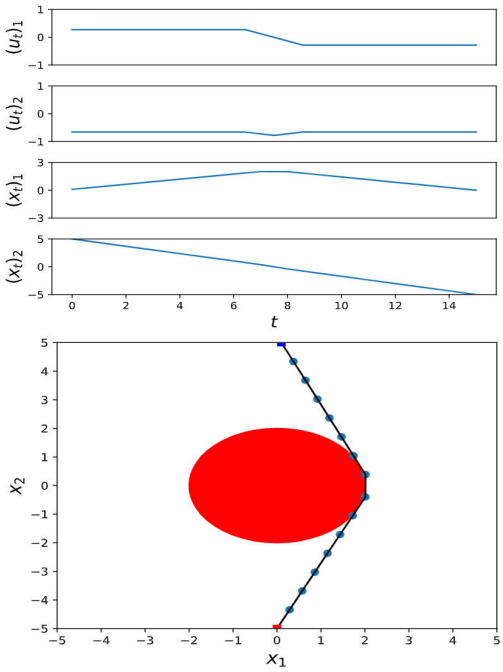
- For first seven steps, add a constraint that every point should be above the tangent of the circle and start point

$$-\frac{\sqrt{21}}{2}x - y + 5 = 0$$

- For the rest steps, add a constraint that every point should be below the tangent of the circle and end point

$$\frac{\sqrt{21}}{2}x - y - 5 = 0$$

The trajectory of the robot in a coordinate system is shown in the following figure.



condition 3

There is a circular obstacle at point (1, 1) and its radius is 1 and a circular obstacle at point (-0.9, -1) and its radius is 1

We can divide the constraint into five parts.

- For steps 1 to 5 , no additional constraints are added
- For steps 6 , add a constraint that the point should be left of line $x = 0$
- For step 7 to 8 , no additional constraints are added
- For steps 9 , add a constraint that the point should be right of line $x = 0.1$
- For step 10 to 15 , no additional constraints are added

The trajectory of the robot in a coordinate system is shown in the following figure.