POLITECNICO
MILANO 1863

SIDRA PhD School 2019 - Intelligent Collaborative Robotics
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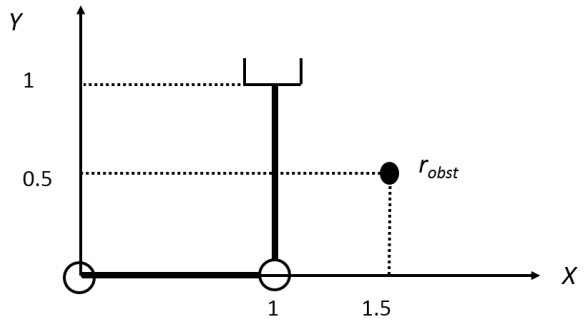
Given and family names .....

Exercise 1

Consider the two-link planar manipulator in the particular configuration sketched in the picture, where both links have unitary lengths. Assume that a static point obstacle is located in point $(1.5, 0.5)$ as in the picture.



1. Write the constraints in terms of linear inequalities in the joint velocities, to be instantaneously satisfied by the robot motion in the given configuration in order to be compliant with the speed and separation monitoring safety standard. Assume that both motors at the joints have the same braking time t_b.
2. Write the optimal control problem that has to be solved in order to scale in an optimal way the robot velocity along a given path, consistent with the speed and separation monitoring safety standard.

Exercise 2

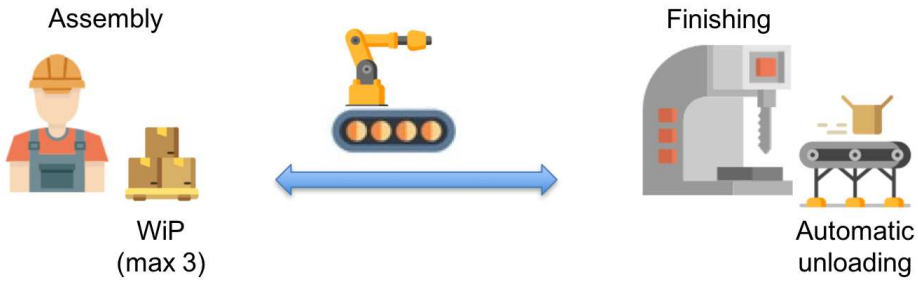
An operator is performing manual operations in the assembly line. A system has observed the following sequence of activities:

$$y_{k-7} = 0, y_{k-6} = 1, y_{k-5} = 0, y_{k-4} = 2, y_{k-3} = 0, y_{k-2} = 1, y_{k-1} = 0$$

Using a Markov Chain of order $n = 2$ trained with all the available data, estimate the probability distribution of the next activity (i.e. y_k) and compare it with the one obtained with a simple Markov chain ($n = 1$).

Exercise 3

A simple assembly job consists of 2 operations (*Assembly* and *Finishing*). The first operation is performed by a human worker, the second by a machinery with an automatic unloading mechanism. A mobile manipulator is responsible for transporting 1 part from the manual station to the other, and for loading it on the machinery. The manual station can store up to 3 WiP parts. The process is exemplified in the following Figure:



Using the guidelines explained during the Summer School, it is asked to design a Petri Net to model the behaviour of the system, and to be used by a scheduling algorithm.
