**Introduction to AI, Test T2**
10-JAN-2022, online, 16:00-18:00

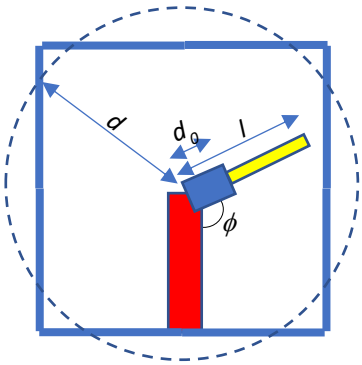
*Without notes, no communication.*
*Write the answer of each exercise in a different piece of paper.*
*Do not forget to put you name in each sheet.*
*The points assigned to each question appear between brackets* […].
*Always justify your answers.*

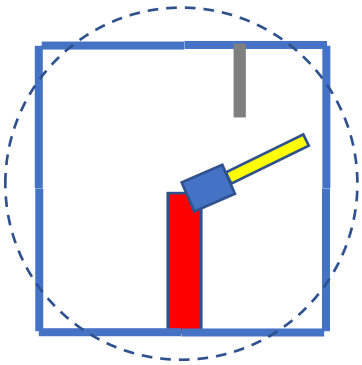
1. [3] Imagine that you want to develop a software to recognize a language **L** defined as follows: in **L**, sentences are made of the 26 letters of the alphabet, plus 4 special characters. Assuming that your character set does not contain uppercase letters, and **L** is treated with a bigram model:
   (a) Which are the dimensions of the matrix containing the conditioned probabilities of the bigram model?
   (b) If the conditioned probability of the bigram "aa" is zero, what does it mean?
   (c) Imagine that the conditioned probability of the bigram "xy" is one. In this case, which of the following statements are true? Which are false? Justify your answers.
   - (i) Each time a letter "x" appears in the training corpus, it is followed by the letter "y",
   - (ii) in the training corpus, the number of letters "x" is lower than or equal to the number of letters "y",
   - (iii) in the matrix of conditioned probabilities, all other entries of "x" and any other letter different from "y" are zero.

   (Remember that the conditioned probability of bigram "pq" is the probability of finding letter "q" in position *i*, given that letter "p" appears in position *i*-1).

2. [1] What is the optical flow? In which conditions is computed? What is it used for?

3. [4] Consider the robot of the left figure: it is composed of a fixed pillar and a telescopic arm, connected to the pillar by a joint. The robot can only move on a plain, and it is enclosed in a box, with floor, walls and ceiling. The joint is at the centre of the box. The arm can rotate from 0º to 360º on the pillar joint, and it can vary its length from a minimal length of $d_0$ to a maximum length of $d$. Using as internal coordinates the angle $\phi$ formed from the pillar and the arm, and the length $l$ of this telescopic arm, provide **a qualitative description of the configuration space** (draw a diagram and explain it) considering the following cases:
   (a) when the robot collides with itself;
   (b) when the robot collides with the floor;
   (c) when the robot collides with the walls and ceiling;
   (d) consider the right figure: it is the same robot and environment, plus a hanging obstacle; show how to modify the configuration space to prevent collisions with this new element.



4. [2] On the philosophical and ethical reflections on AI:
   (a) define *strong AI*, *weak AI* and *general AI*; which are their similarities and differences?,
   (b) from an ethical point of view, describe the major difference of autonomous weapons with respect to other weapons guided thermically or by laser.