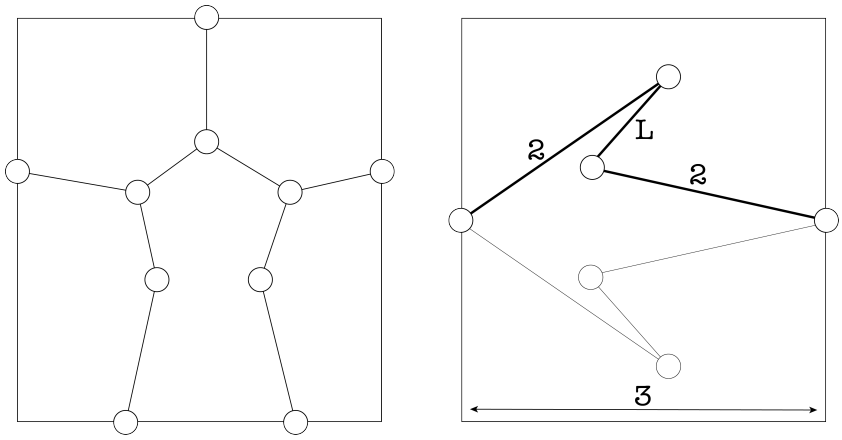
Introduction into Robotics, Fall 2022. Homework 1

Due by midnight of Sept. 15.

Problem 1

All joints are revolute.

- **4 pts** For the figure on the left, determine the number of DoF.
- **6 pts** For the picture on the right, determine, for which l the configuration on the top can be transformed, without breaking the links, to the configuration on the bottom (in other words, when the C-space is connected). The lengths of the links are shown, the distance between the walls is 3.



Problem 2

In $3D$-space consider Pfaffian constraint

$$(Ax_1 + Bx_2)v_1 + (Cx_1 + Dx_2)v_2 - v_3.$$

- **7pts** Under which conditions on values of the constants A, B, C, D the system is holonomic?
- **3pts** For the constants satisfying these conditions, write down the corresponding static constraint.

Problem 3

Consider the linear transformation of $\mathbb{R}^3$ given by the matrix

$$R = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{pmatrix}$$

- **1pts** Is R a rotation?
- **7pts** Find θ and Ω such that

$$R = \exp(\theta\Omega)$$

- **2pts** Find $\exp(3\theta\Omega)$.