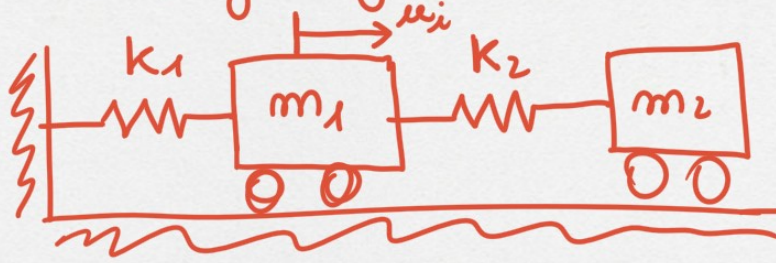


• Homework: Cooperative Tracking through SVFB

Let's consider a multi-agent system where:

① Each single agent S_i is described as follows:



$$S_i: \begin{cases} \dot{x}_i = A x_i + B u_i \\ y_i = x_i \end{cases}$$

$$S_i: x_i = \begin{bmatrix} x_{i,1} \\ x_{i,2} \end{bmatrix}$$

$x_{i,1}$ = displacement of m_i

$x_{i,2}$ = velocity of m_i

$$m_1 = 1.1 \text{ kg}$$

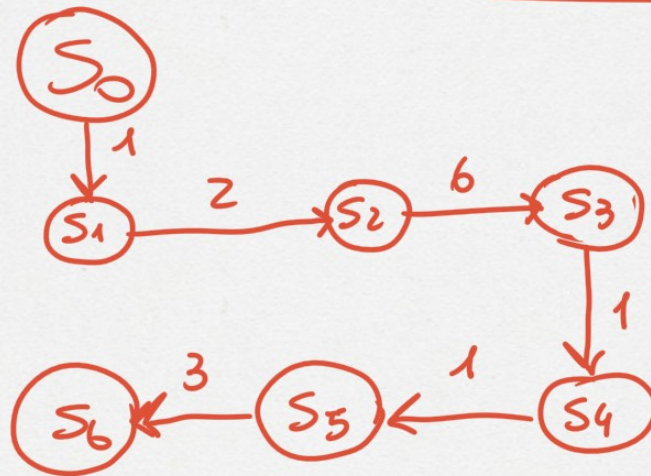
$$m_2 = 0.9 \text{ kg}$$

$$k_1 = 1.5 \text{ N/m}$$

$$k_2 = 1 \text{ N/m}$$

$$S_0: \begin{cases} \dot{x}_0 = Ax_0 \\ y_0 = x_0 \end{cases}$$

② Communication network is described by the following graph topology:



Problem: design SVFB (design K, c) according to the
control protocol discussed in theory, such that the
global disagreement error $\delta(t) \xrightarrow[t \rightarrow \infty]{} 0$

How to solve the algebraic Riccati equation presented in the slides:

↪ MATLAB COMMAND: `ore`
 $P = \text{ore}(A, B \cdot R^{-1} \cdot B^T, Q)$

- ① Solve the SVFB problem applying theorem 1
- ② Build the controlled multi-agents system with the SVFB distributed control protocol
- ③ Simulate the system by assuming initially that $x_i(\phi) = \phi$ for $i = 1, 2, \dots, N$
or $x_0(\phi) = \begin{bmatrix} 1\phi \\ \phi \end{bmatrix}$
- ④ Discuss the behavior of the controlled multi-agents system and check if the global disagreement error $S(t) \xrightarrow[t \rightarrow \infty]{} \phi$
- ⑤ In order to better investigate the behavior of the controlled system you are invited to change the initial condition $x_i(\phi)$ $i = 0, \dots, N$ and you have also to investigate the effect of the coupling gain c (how the value of c affects the performance?)

- ⑥ How can you modify the reference behavior dictated by the leader agent?
(Could you modify the reference behavior by acting on a local control loop closed around the leader node?)
- ⑦ In particular, try to design an whole control system such that all the agents' outputs are converging (for $t \rightarrow \infty$) to the same constant value
- ⑧ Try to modify the structure of the communication network (i.e. the graphs G, \bar{G}) in order to analyze the effect of the network structure on the behaviour of the controlled multi-agents system