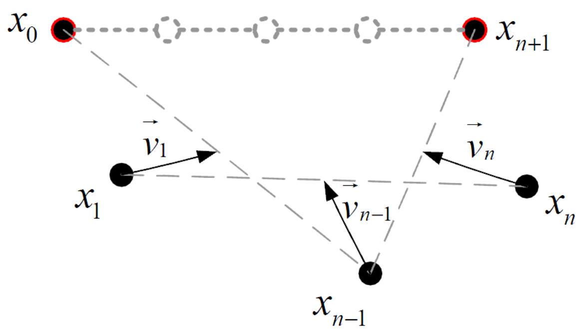
E3 - Multiagent systems

Start from the simple special case of multiagent interaction. Consider N agents in the plane. Their task is to stay equidistantly on a segment between two given points x_0 and x_{N+1}.



The proposed strategy: each i-th agent tends to allocate itself in the middle of a segment with the endpoints in its $(i-1)$-th and $(i+1)$-th neighbors. In this case the agents use information from their neighbours only (the i-th agent communicates with $(i-1)$-th and $(i+1)$-th agents).

Tasks for Week 1

1. Write down the equations describing the agent's dynamics in the form:

$$\dot{x}_i = \sum_{j=1}^{N} a_{ij}(x_j - x_i) \quad \text{or} \quad \dot{x} = Ax$$

2. Characterize matrix A. Describe as many properties of A as you can.
3. Model the proposed dynamics. Show that for difference initial coordinates the agents remain capable to reach their goal.

Tasks for Week 2

1. Simulate the second-order algorithm from [1] (Session 3)
2. Derive and explain the conditions when the 1st and the 2nd-order algorithms for equidistant arrangement of agents on line are stable.
3. Simulate so-called Van Loan scheme [3] (Session 2).
4. Explain Theorem 1 from [3]. How to describe the resulting ellipsoid?

References

1. Kvinto, Y. I., Parsegov, S. E. (2012). Equidistant arrangement of agents on line: Analysis of the algorithm and its generalization. Automation and Remote Control, 73(11), 1784-1793. Chapter 1-2. `https://clck.ru/R6VgX`
2. Gene H. Golub and Charles F. Van Loan. Matrix Computations, 3d Edition, 1996. `https://twiki.cern.ch/twiki/pub/Main/AVFedotovHowToRootTDecompQRH/Gol_VanLoan.Matr_comp_3ed.pdf`
3. P. S. Shcherbakov (2011). Formation Control: The Van Loan Scheme and Other Algorithms. Automation and Remote Control, 72(10), 2210–2219.