

## 12 Bird flocking and swarm intelligence (MF/AC)

This project consists of numerically modeling bird flocking (birds that fly in an organized group). This phenomenon is one example of a more general phenomenon occurring in biological systems known as swarm intelligence. The system is constituted by a population of agents which can move randomly without any central control structure dictating their behavior. Yet a simple set of rules governing the interaction between agents can lead to global organized structures.

In this project, the goal is to implement a model of agents with biologically motivated interactions, governed by simple rules, that exhibits the emergence of self-ordered motion. The model known as the Vicsek model (1995) could be a good starting point. It can be implemented on the basis of Monte-Carlo simulations. Self-organization appears after a symmetry breaking associated with a dynamical phase transition, which can be identified and characterized.

A swarm-optimization algorithm can then be implemented, inspired by the bird-flocking phenomenon, to optimize a more general class of problems (For example, optimizing the location of transmission infrastructure for wireless communication networks).



### Bibliography:

- [1] Craig W. Reynolds, Flocks, Herds, and Schools: A Distributed Behavioral Model, SIGGRAPH Comput. Graph., **21**, (1987) 25-34.
- [1] T. Vicsek, A. Czirok, E. Ben-Jacob, I. Cohen, and O. Shochet, Phys. Rev. Lett. **75**, (1995) 1226. Novel Type of Phase Transition in a System of Self-Driven Particles.