VII ECCOMAS Young Investigators Conference
YIC2023
19-21 June 2023, Porto, Portugal

Recent Advances on modelling and simulations of Collective dynamics

Scientific area: Computational Applied Mathematics

Collective behavior arises in different contexts, both for non-living and living systems, ranging from simple robots, bacteria colonies and cell aggregates to flocks of birds and human crowds. Regardless of the nature of the agents involved, the main feature of collective behavior is that the individual dynamics is highly influenced by the presence of other individuals and by the external environment. The complexity of the interactions and of the individuals' response to such stimuli requires an accurate description, often giving rise to mathematical models that can be hardly studied analytically. This leads to investigating the models numerically and, consequently, to computational challenges arising from the need to tackle such complex models.
The aim of this minisymposium is to gather researchers who are interested in discussing recent mathematical models of collective dynamics, aimed at reproducing real-world phenomena. Depending on the scale of observation of the phenomena under study, microscopic, macroscopics and recent hybrid multi-scale approaches will be presented.
The focus will be on the computational aspects encountered in the study of the models and to open challenges. Typical examples concern Monte Carlo methods for large systems of individuals in microscopic models, structure preserving schemes for Fokker-Planck and kinetic transport equations, finite volume and finite difference schemes for macroscopic diffusion equations. Advantages and drawbacks of the different techniques will be discussed, together with possible development of algorithms aimed at reducing computational costs.

[1] Loy N. & Preziosi L. (2020). Kinetic models with non-local sensing determining cell polarization and speed according to independent cues. Journal of Mathematical Biology. 80. 10.1007/s00285-019-01411-x.
[2] Loy N. & Zanella M. (2021). Structure preserving schemes for Fokker–Planck equations with nonconstant diffusion matrices. Mathematics and Computers in Simulation. 188.10.1016/j.matcom.2021.04.018.
[3] Cristiani E., Menci M., Papi M. & Brafman L. (2021). An all-leader agent-based model for turning and flocking birds. Journal of Mathematical Biology, 83(4), 1-22.
[4] Cristiani E., De Santo A. & Menci M. (2022). A generalized mean-field game model for the dynamics of pedestrians with limited predictive abilities. arXiv:2108.00086. To appear in Communications in Mathematical Sciences.
[5] Cristiani E., Loy N., Menci M., Tosin A. Boltzmann-type equations for multi-agent systems with an all-leader dynamics. In preparation.

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