sciendo

CAIM
ISSN 2038-0909

Commun. Appl. Ind. Math. 9 (2), 2018, 1–3 DOI: 10.2478/caim-2018-0019

Editorial

Preface to the Special Issue Mathematical modelling for complex systems: multi-agents methods

Elena De Angelis

Dipartimento di Scienze Matematiche "Giuseppe Luigi Lagrange"
Politecnico di Torino, Torino, Italy

*Email address for correspondence:
elena.deangelis@polito.it

Received on 01 12, 2017.

This special issue of CAIM collects eight selected research papers covering a broad number of topics and methods, all of them sharing a common thread. This common treat is given by the approach of the investigation, that consists in treating the different systems under analysis as a complex system, that is, a system composed of several living entities which interact among themselves and with the outer environment, in a nonlinear manner, see [1] [2] [3] and references therein.

A broad variety of living systems can be considered as complex, spanning from biological systems to systems whose dynamics receives important inputs from human behaviors, such as for example crowd and traffic dynamics, swarms, opinion formation, political dynamics. In multi-agent settings, the entities or agents not only have to deal with the outer environment, but also with other agents which act, learn, progress and change over time, sharing the experience of the learning process. New ideas and new mathematical methods are needed to understand the main features of the behaviour of such living, and hence, complex systems: as a consequence, the interest of mathematicians in new structures is a fascinating challenging field of research in mathematical sciences.

The publication of a special issue on this hot topic field of research on CAIM Journal is definitively appropriate given the journal's aims and scope, being the Journal of the SIMAI, Italian Society for Industrial and Applied Mathematics. Articles are aimed towards a broad audience with topics covering different mathematical approaches, different mathematical scales and different collective phenomena.

More in detail, in the article entitled *Selective model-predictive control for flocking systems* by Giacomo Albi and Lorenzo Pareschi, [4], the optimal control of alignment models composed by a large number of agents is investigated in presence of a selective action of a controller, acting in order to enhance consensus. A mean-field limit of the feedback selective constrained dynamics is derived, which can be solved numerically by means of a stochastic algorithm, able to simulate efficiently the selective constrained dynamics. Numerical simulations are reported to show the efficiency of the proposed techniques.

The second paper, [5], by Damian A. Knopoff and Germán A. Torres, *On an optimal control strategy in a kinetic social dynamics model*, deals on an optimal control problem applied to a socio-economic kinetic model for wealth distribution in a society. The modeling approach is based on the tools of the so called kinetic theory of active particles. The main idea is to provide a ruler with tools that could let him make strategic decisions in terms of wealth distribution policies, given that - when he rises to power - he has a vision about what kind of society he expects to get in the future.

The third article, *High-order variational time integrators for particle dynamics* by Edie Miglio, Nicola Parolini, Mattia Penati and Roberto Porcù, [6], presentes a new framework for the definition and analysis of Galerkin variational integrators of arbitrary order. The classification is based upon the type of basis function chosen to approximate the trajectories of material points and the numerical quadrature formula used in time. This approach leads to the definition of arbitrarily high order method in time. The proposed methodology is applied to numerical test cases, and in particular to the simulation of brownout phenomena occurring in helicopter take-off and landing.

In the fourth paper, [7], *The political replacement effect in a kinetic model of social dynamics with phase transition* by Marina Dolfin, the author proposes a kinetic model, with stochastic game type interactions, representing a simple society with three interacting group of interests, each of them characterized by two political-economic determinants. The main aim is to translate into the mathematical framework of the kinetic theory applied to social dynamics a model of the game-theoretic literature on macroeconomic policy. Two different phases are introduces in the system: one phase is characterized by a welfare-maximizing policy maker whilst in the other phase the policy maker is not welfare-maximizing. The phase transition is based on the behavior of the so called innovation.

In the next paper by Abdelghani Bellouquid and Jacques Tagoudjeu, *An asymptotic preserving scheme for kinetic models for chemotaxis phenomena*, [8], a method of micro-macro decomposition is proposed in order to construct asymptotic preserving schemes (AP) for kinetic equations describing chemotaxis phenomena. This method leads to an equivalent formulation of the kinetic model that couples a kinetic equation with macroscopic ones. The pattern formation models are derived from the celebrated Keller-Segel model, obtained by the underlying description delivered by generalized kinetic theory methods. The new method propose is validated by various test cases and compared to other standard methods.

Najat M. Omar Dabnoun and Maria Stella Mongiovì have contributed to this special issue with their article *A Contribution to the mathematical modeling of immune-cancer competition*, [9]. Their paper deals with the modeling of interactions between the immune system and cancer cells, in the framework of the mathematical kinetic theory for active particles. Some simulations are showed, aiming at investigating how the state of the various functional subsystems evolve in time, depending on the choice of the free parameters.

The seventh paper, *Student interactions during class activities: a mathematical model*, by Domenico Brunetto, Nicola Parolini, Marco Verani and Chiara Andrà, [10], aims at bridging mathematical modelling and mathematics education by studying the opinion dynamics of students who work in small groups during mathematics classrooms. The model takes into account the interaction among students and the role of the teacher. It assumes that the acceptance or the refusal of the comments coming from the teacher (as well as the acceptance/refusal of the intervention in the group activity) depends both on the perceived competence that each student of the group has about himself in that particular moment, and the competence that he recognises to his classmates and to the teacher in that particular moment.

The last paper, *A Continuous-Time Markov Chain Modeling Cancer-Immune System Interactions* by Diletta Burini, Elena De Angelis and Mirosław Lachowicz, [11] deals on two mathematical models describing, respectively at the microscopic level and at the mesoscopic level, a system of interacting tumor cells and cells of the immune system. The microscopic model is in terms of a Markov chain defined by the generator, the mesoscopic model is developed in the framework of the kinetic theory of active particles. The main result is to prove the transition from the microscopic to mesoscopic level of description.

Acknowledgements

I would like to point out here the continuous support and the very helpful assistance that I and all the Authors have received from Giorgio Fotia and the whole CAIM editorial board.

References

1. N. Bellomo and F. Brezzi, Special issue on mathematical models and methods for complex systems, *Math. Models Methods Appl. Sci.*, vol. 24, no. 2, 2014.
2. N. Bellomo and F. Brezzi, Special issue on dynamics of self-propelled particles, part I, *Math. Models Methods Appl. Sci.*, vol. 27, no. 6, 2017.
3. N. Bellomo and F. Brezzi, Special issue on dynamics of self-propelled particles, part II, *Math. Models Methods Appl. Sci.*, vol. 27, no. 7, 2017.
4. G. Albi and L. Pareschi, Selective model-predictive control for flocking systems, *Commun. Appl. Ind.*

Math., vol. 9, no. 2, pp. 4–21, 2018.

5. D. A. Knopoff and G. A. Torres, On an optimal control strategy in a kinetic social dynamics model, *Commun. Appl. Ind. Math.*, vol. 9, no. 2, pp. 22–33, 2018.
6. M. Penati, E. Miglio, N. Parolini, and R. Porcù, High-order variational time integrators for particle dynamics, *Commun. Appl. Ind. Math.*, vol. 9, no. 2, pp. 34–49, 2018.
7. M. Dolfin, The political replacement effect in a kinetic model of social dynamics with phase transition, *Commun. Appl. Ind. Math.*, vol. 9, no. 2, pp. 50–60, 2018.
8. A. Bellouquid and J. Tagoudjeu, An asymptotic preserving scheme for kinetic models for chemotaxis phenomena, *Commun. Appl. Ind. Math.*, vol. 9, no. 2, pp. 61–75, 2018.
9. N. M. O. Dabnoun and M. S. Mongiovì, A contribution to the mathematical modeling of immune-cancer competition, *Commun. Appl. Ind. Math.*, vol. 2, no. 9, pp. 76–90, 2018.
10. D. Brunetto, C. Andrà, N. Parolini, and M. Verani, Student interactions during class activities: a mathematical model, *Commun. Appl. Ind. Math.*, vol. 9, no. 2, pp. 91–105, 2018.
11. E. D. Angelis, D. Burini, and M. Lachowicz, A continuous–time Markov chain modeling cancer–immune system interactions, *Commun. Appl. Ind. Math.*, vol. 9, no. 2, pp. 106–118, 2018.