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A multiscale look at crowd dynamics by time-evolving measures

The dynamics of particle-like living systems, such as human crowds, are mainly ruled by mutual interactions among the individuals. This is because the latter have the ability to express different behavioral strategies depending on the presence of other individuals in the environment. For instance, pedestrians heading for a certain destination deviate from their preferred paths when encountering other pedestrians. Remarkably, interactions are usually non-cooperative, i.e., walkers do not pursue a goal collectively.

Due to the intrinsic granularity (discreteness) of the system (the number N of pedestrians is possibly large, yet the approximation $N \to \infty$ may not be acceptable), interactions are better described at an individual-based level. On the other hand, an ensemble representation of the crowd is often preferable over an agent-based one, in order to catch the average group behavior spontaneously emerging from interactions (self-organization) and also in view of further analysis, numerics, and optimization issues. Measure-theoretic stochastic approaches, such as those that will be discussed in this talk, offer useful conceptual tools to this purpose. Indeed, they make possible an Eulerian particle-free representation of the crowd, in which single pedestrians are blurred into the probability distribution of their spatial positions. At the same time, they allow the description of the interactions to stem from (stochastic) individual-based reasonings. Finally, they enable one to treat discrete and continuous models under a common framework, as well as to deduce models at intermediate scales with interesting implications on the predicted dynamics.

References

[1] L. Bruno, A. Tosin, P. Tricerri, F. Venuti. *Non-local first-order modelling of crowd dynamics: A multidimensional framework with applications*, Appl. Math. Model., **35**, 426–445, 2011.

[2] E. Cristiani, B. Piccoli, A. Tosin. *Multiscale modeling of granular flows with application to crowd dynamics*, Multiscale Model. Simul., **9**, 155–182, 2011.

[3] B. Piccoli, A. Tosin. *Time-evolving measures and macroscopic modeling of pedestrian flow*, Arch. Ration. Mech. Anal., **199**, 707–738, 2011.

[4] A. Tosin, P. Frasca. *Existence and approximation of probability measure solutions to models of collective behaviors*, Netw. Heterog. Media, 2011 (to appear).

[5] E. Cristiani, B. Piccoli, A. Tosin. *Modeling self-organization in pedestrians and animal groups from macroscopic and microscopic viewpoints*, in G. Naldi, L. Pareschi, G. Toscani (Eds.), Mathematical Modeling of Collective Behavior in Socio-Economic and Life Sciences, 337–364, Brikäuser, 2010.

[6] B. Piccoli, A. Tosin. *Pedestrian flows in bounded domains with obstacles*, Contin. Mech. Termodyn., **21**, 85–107, 2009.