

# Mathematical Modeling with Measures: Where Applications, Probability and Determinism Meet

3 – 7 December 2018 @ Snellius

Mathematical communities with different background have met during the workshop: (a) Abstract functional analysis and dynamical systems in spaces of measures on metric spaces with focus on measure-valued balance laws; (b) Structured-population dynamics with a touch on inverse problems; (c) Modeling, analysis and simulation of traffic flows (Braess paradox, junctions); and (d) Probability Theory. 27 Participants came from 9 countries. There were 8 female scientists. The young-to-senior researchers ratio was 13/14.

The aim was at least twofold: (1) Establish the mathematical/modeling source of difficulties for what concerns the analysis of measure-valued balance scenarios (and their particle systems interpretations); (2) Start discussions and collaborations on long-standing ('old') mathematical questions as well as on the newly identified problems deemed as open.

The main directions of the discussions were:

- (i) Measures-valued balance laws (well-posedness, stability, identification of parameters, Bayesian statistics);
- (ii) Traffic evolution systems (from the perspective of conservation laws);
- (iii) Stability for measures-valued structured-population models;
- (iv) Operator splitting techniques for evolution equations.

Everyone has benefitted much from the tutorial lectures and the discussions afterwards. Presentation slides have been made available to the participants for their private use. New collaborations have arisen, typically leading to further contacts in the coming months. Among them, for instance, one is related to the stability for measure-valued solutions to structured-population models, one to the differentiation of measure-valued solutions to structured-population models with respect to parameters, one to population dynamics questions from plant biology, one to non deterministic macroscopic traffic modeling and one to microscopic description of network traffic. In this way mathematical difficulties that occur in a measure framework were clarified and new mathematical topics were started being addressed.

There will be a special issue of the AIMS journal *Mathematical Biosciences and Engineering* (MBE) devoted to the topic of our workshop. 10 potential submissions are already registered. Any participant or group of participants is invited to submit a paper to this special issue (deadline for submission: July 31st 2019).

A popularization article on the theme "Modeling with measures" will be written for 'Nieuw Archief' (the magazine of the Dutch Mathematical Society, deadline for submission: March 1st 2019).

We have received positive feedback from participants, which fully appreciated the program structure, with time for discussion, and presentations that were all interesting. As suggestion for improvement for next time: the open problems can eventually be showcased also via elevator pitches, so that it is apparent who is the 'problem owner' and she/he can easily be contacted for further discussion on the topic.

The participants have agreed that a follow-up workshop in the same research direction and organization spirit would be very much welcome. We agreed to organize the next event on Modeling with Measures at the University of Louisiana at Lafayette, USA in 2021 or in 2022.

**Azmy Ackleh** (Lafayette, USA)

**Rinaldo Colombo** (Brescia, Italy)

**Paola Goatin** (Sophia Antipolis, France)

**Sander Hille** (Leiden, Netherlands)

**Adrian Muntean** (Karlstad, Sweden)