

Special Session 10: Flow on Networks With Applications in Traffic, Gas, Supply chains and Telecommunication

Benedetto Piccoli, Istituto per le Applicazioni del Calcolo "Mauro Picone", Italy
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Multiscale control of transport equations

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A nonlocal nonlinear PDE model for a re-entrant production process in a semiconductor factory is studied. Large scale systematic changes in demand for the factory happen on a slow time scale whereas stochastic variations introduce a mismatch of daily production results and daily demand. Following industrial practice we solve the slow scale demand tracking problem by solving a variational problem for the influx while we reduce the daily production-demand mismatch through an adjustment of production priorities inside the factory.

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Quasidifferential equations and P.D.E.s on junctions

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Graziano Guerra

This presentation describes the framework of quasidifferential equations in metric spaces and its effective use to obtain well posedness results for nonlinear systems of balance laws at junctions. First, a result on quasidifferential equations is overviewed. Then, an application to balance laws is considered. In particular, well posedness results for conservation laws at junctions are shown to follow from well posedness of suitable degenerate systems of balance laws with boundary. Specific applications are also considered.

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Optimization of sticky separation in waste paper processing

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The industrial treatment of waste paper in order to obtain recovered paper involves several steps of preparation. One important step is the separation of stickies that are normally attached to the paper. If not properly separated, remaining stickies reduce the quality of the recovered paper or even disrupt the production process. For the separation itself a chain of separators is used. Each one has an input feed and two output streams called the accept and the reject. In the accept the fibers are concentrated, whereas the reject has a higher concentration of stickies. However, after just a single step, the accept still has too many stickies, and the reject too many fibers. To get a proper separation, several separators have to be assembled into a network. From a mathematical point of view this problem can be seen as a multi-commodity network flow problem with a nonlinear distribution function at each node. We present a nonlinear mixed-integer programming model for the simultaneous selection of a subset of separators, the network's topology, and the optimal setup of each separator. Numerical results are obtained via a linearization of the nonlinearities and the use of linear mixed-integer solvers.

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The p-system at a junction

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We consider the evolution of a non viscous isentropic or isothermal fluid, described by the p-system in Eulerian coordinates, in n tubes exiting a single junction. Each tube is modeled by a copy of the real half line, the relative positions and cross sections of the ducts also have an essential role in the model. Our goal is the description of the fluid flow through 1D conservation laws (along the tubes) equipped with suitable coupling conditions at the junction. We consider both the Riemann problem and the Cauchy problem at the junction. This work was done in

collaboration with Rinaldo Colombo.

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Macroscopic models for animal displacements

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We are interested in the derivation of macroscopic models for animal displacements (either diffusive or hyperbolic equation). We first investigate classical models in this topic and we point the necessity of a new model for fish motion, the so-called "Persistent turning walker" (PTW) model. We will derive a macroscopic model (a diffusive equation in this case) from this PTW model. Finally, we show how interactions between fish lead to a new hyperbolic equation that will be illustrated with numerical simulations.

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Second order models of traffic flow

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I will discuss some questions related to second order models of traffic flow, in particular the issue of the different scales involved in the problem, the

(ir)relevance of the corresponding mathematical descriptions and the amount of instability that the models should contain: typically, the role of the sub-characteristic condition in a second order model with source-term.

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Identification of complex production systems via a kinetic approach

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In many complex supply and production systems information about the detailed structure of the system is only available in the form of cycle times for individual lots - usually observed under quasi steady state conditions. Based on gas dynamic methodology, we demonstrate how to construct kinetic and fluid dynamic models using scattering rates extracted from system observations. The final result are macroscopic (long time averaged) models in the form of pde - conservation laws which do not require any detailed knowledge about the precise function of individual nodes. We demonstrate to what extent these models are capable of describing a given system even under non - equilibrium conditions.

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