SOE 11: Physics of Collective Mobility (joint session SOE / DY / BP / jDPG, accompanying the symposium)

Time: Tuesday 14:45–15:30 Location: GÖR 226

SOE 11.1 Tue 14:45 GÖR 226

Ricatti-Langevin Dynamics for Modeling of Air Traffic Performance Disruption and Recovery — •Norbert Fürstenau and Monika Mittendorf — Deutsches Zentrum für Luft- und Raumfahrt, Institut für Flugführung, 38108 Braunschweig, Deutschland

We describe research towards a predictive assistance tool for airport tower controllers to support optimal arrival and departure scheduling under extreme weather conditions (Xevents). As a formal basis we derive a generic nonlinear dynamics model of performance disruption and recovery. It will be used as basis for a predictive algorithm (e.g. extended Kalman filter) as core of the assistance system. We first show that a simple logistic function approach is sufficient for fitting empirical arrival rate data under (disruptive) winter storm disturbance at an international German airport to obtain characteristic traffic performance parameters. A comparable approach was recently published [1] as empirical support for a phase transition hypothesis of the (anticorrelated) normal wind to storm transition. The basic model is formally equivalent to the simplified 2nd-order (two-state) laser equation and allows for simulation of the disruption/recovery dynamics that exhibits the expected controllability of the traffic disruption. The model is derived from a Ricatti-Langevin equation with time dependent control parameters (disruption / recovery time constants) and external deterministic and stochastic disturbance due to wind/gust speed variation.

[1] Fürstenau & Mittendorf (2016): Bernoulli-Langevin wind speed model for simulation of storm events. Z. Naturforsch. A, DOI: 10.1515/zna-2016-0238

SOE 11.2 Tue 15:00 GÖR 226

New York Taxi Rides as Point Processes — •Philip Marszal[1,2], Debsankha Manik[1], Andreas Sorge[1], and Marc Timme[1,2,3] — [1]Network Dynamics, Max Planck Institute for Dynamics and Self-Organization (MPIDS), 37077 Gottingen, Germany — [2]Faculty of Physics, Georg August University Gottingen, 37073 Göttingen, Germany — [3]Department of Physics, University of Darmstadt, 64289 Darmstadt, Germany

Optimized ride sharing promises the flexibility of taxis with an efficiency close to that of public transportation. To provide a test environment for ride sharing algorithms, we here propose stochastic models characterizing the spatio-temporal request dynamics of taxis in New York City. On short time scales (48 minutes) and accumulating across spatial variation, we found the number of taxi pick-up events to be Poisson distributed, suggesting that the pick-up events can be modeled by a Poisson process. On long time scales (24 hours), the ride pick-up events can be modeled by an inhomogeneous Poisson process in space and time. Interestingly, the ride requests follow definitive patterns in time, yet vary strongly in space. Furthermore, a Gaussian mixture model of pick-up locations provides a possibility of inferring likely drop-off locations from initial conditions of a ride.

SOE 11.3 Tue 15:15 GÖR 226

The Simulation Unification: Towards a Python Toolbox to Model and Analyze Collective Mobility Systems — •Andreas Sorge[1,2,3], Marc Timme[1,2,3], and Debsankha Manik[1,2] — [1]MPI for Dynamics and Self-Organization, Göttingen, Germany — [2]Institute for Nonlinear Dynamics, Georg-August-Universität, Göttingen, Germany — [3]Organization for Research on Complex Adaptive Systems (or-cas), Göttingen, Germany

Understanding the nonlinear dynamics, scaling behavior and critical transitions of collective mobility systems is crucial to optimize system performance and individual utility. As discrete events such as pick-ups and drop-offs govern their time evolution, it is intricate to apply standard analytical and computational methods from statistical physics and nonlinear dynamics. We develop a unifying theoretical and computational framework to efficiently model and simulate such systems. Based on a formal language, we develop a Python package that allows the simulationist to assemble modules in a toolbox-like fashion. The package ships with a number of topologies (e.g. $\mathbb{R}^2$, any kind of network) and different dispatching rules to bundle individual requests and assign them to vehicles. The user is free to combine them and to specify their own, as well as to feed in the spatio-temporal mobility demand pattern. An analysis module provides ample statistics to aggregate the dynamics and assess the performance of the simulated instance. We envision our package to facilitate both studying collective mobility and developing the necessary tools to do so in a reproducible manner.