AKSOE 16: Traffic Dynamics, Urban, and Regional Systems

Time: Friday 9:30–12:00 Location: H8

AKSOE 16.1 Fri 9:30 H8

Crowd Turbulence: The Physics of Crowd Disasters — •Dirk Helbing and Anders Johansson — Institute for Transport and Economics, TU Dresden, Andreas-Schubert-Str. 23, 01062 Dresden

In the past, physicists have discovered various self-organized phenomena in pedestrian crowds such as the formation of lanes of uniform walking direction, oscillations at bottlenecks in bi-directional flows, the formation of stripes in cross-flows, or "freezing-by-heating" and "faster-is-slower" effects in panicking crowds. These phenomena have all been successfully described by driven many-particle models, as will be demonstrated by animated computer simulations and video recordings of real crowds.

Panic stampedes are a serious concern during mass events. However, despite huge numbers of security forces and crowd control measures, hundreds of lives are lost in crowd disasters each year. A high-performance tracking analysis of unique video recordings of the Muslim pilgrimage in Mina/Makkah, Saudi Arabia, has now revealed that high-density flows can even turn "turbulent", which causes people to fall. The occuring eruptions of pressure release bear analogies with earthquakes and are de facto uncontrollable. This talk presents an analysis and interpretation of our recent discoveries and presents a quantity that is suitable for an advance warning of critical crowd conditions.

AKSOE 16.2 Fri 10:00 H8

Brain activity during simulated driving and three-phase traffic theory — •André Bresges — Universität Duisburg-Essen, Didaktik der Physik, 47048 Duisburg.

We have volunteers participiating in our simulated car traffic environment, driving in situations with different complexities. While learning to drive, we monitor their brain activity with a 1,5 Tesla Siemens Avanto functional Magnet Resonance Imager. Results show, that with increased routine the control of the car is transferred to lower and - in evolutionary perspective - "older" parts of the brain, namely the cerebrellum. This makes the behavior of car drivers more uniform, less error-prone and more predictable, compared to the complex behavior humans usually show when using higher brain areas. The neurologic evidence may serve as a foundation for microscopic or multi-agent-approaches in the field of dynamic car traffic simulation.

Possible implications regarding three-phase traffic theory (B. Kerner et al.) will be demonstrated using a freeway traffic simulator running on a modified two-Lane Lee-Algorithm (H.K. Lee et al., 2004).

AKSOE 16.3 Fri 10:30 H8

Modelling traffic flow with Fokker-Planck equations — •Friedrich Lenz and Holger Kantz — Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Strasse 38, 01187 Dresden, Germany

Traffic flow gives rise to interesting phenomena and problems, e.g. jams and synchronized flow. We take data measured in Germany on the ring of motorways around Cologne for a macroscopic modelling approach. A Fokker-Planck equation in two dimensions with coefficients which depend on the time of day is used to model the dynamics at every gauging station. We estimate the time-dependent drift- and the diffusion coefficients from the measured data. In order to assess the quality of this model we integrate a corresponding Langevin equation and compare the histogram in phase space of the model data with the original data. The model allows us to obtain information about dynamical properties of the transition from synchronized flow to free flow and vice versa.

AKSOE 16.4 Fri 11:00 H8

Model-Creation by Analysing NGSIM-Vehicular-Datasets — •Christof Liebe — Universität Rostock, Institut für Physik, Germany

Within the american **N**ext **G**eneration **S**imulation **P**rogram (NGSIM) several vehicular datasets were recorded. The first dataset was published in 2003 and provide trajectories with a length of about 900 m. Three more datasets were published in 2005, showing shorter trajectories including a jam. They can be used to calibrate and validate traffic models.

In order to analyse the single car time series data and to compare it with traffic models, we show how significant quantities can be extracted. For this purpose we have investigated space-time plots and flow diagrams in the headway-velocity space.

The abrupt appearence of jams, which are stable over several minutes, is visible in space-time plots. Flow diagrams are investigated to get new insights in traffic modeling. A model including dynamical traps will be presented. It takes into account, that a driver is able to control its velocity much better then its headway.

AKSOE 16.5 Fri 11:30 H8

Global traffic analysis reveals geographical modules across political boundaries — •D. Brockmann[1], F. Theis[1], and L. Hufnagel[2] — [1]MPI for Dynamics and Self-Organization, 37018 Göttingen — [2]Kavli Institute for Theretical Physics, Santa Barbara, CA 93106

Geographical boundaries are key determinants of various spatially extended dynamical phenomena. Examples are migration dynamics of species, the spread of infectious diseases, bioinvasive processes, and the spatial evolution of language. As political boundaries have become less important, it is difficult to quantify their impact on spatially extended human dynamics. The evolved complexity of contemporary human travel may exhibit intrinsic modularities and effective boundary structures, which not necessarily coincide with existing political boundaries.

We investigate a large scale complex network of human travel between the approx. 3000 counties in the US. We construct the network by analyzing the flux of over 10 million dollar bills reported at the bill-tracking website wheresgeorge.com which extends the dataset of a previous study (Brockmann et al., Nature 2006) by a factor of 20. We investigate to what extend geographical information is intrinsically encoded in the topology of the network by applying two graph cutting algorithms (Newman&Girvan, Phys.Rev.E 2004 and an extension of Lee&Seung, Nature 1999) in order to identify effective clusters. Although both algorithms employ two completetely different paradigms they identify approx. 10, nearly identical effective clusters in the network. Surprisingly, these clusters are spatially compact regions, although both algorithms have no prior knowledge of geographical information. Most importantly, the geographic boundaries between the clusters only partially overlap with the political state boundaries. We conclude that graph cutting algorithms can efficiently determine effective clusters in geographically embedded transport networks. The results may aid the development of models for dynamical phenomena evolving on these networks.