# AGSOE 8: Traffic Dynamics, Urban and Regional Systems II

Time: Tuesday 10:15–12:45 Location: BAR 205

AGSOE 8.1 Tue 10:15 BAR 205

**New Laws of City Growth** — •Diego Rybski[1], Hernan D. Rozenfeld[1], Jose S. Andrade Jr.[2], Michael Batty[3], H. Eugene Stanley[4], and Hernan A. Makse[1] — [1]Levich Institute and Physics Department, City College of New York, New York, NY 10031, USA — [2]Departamento de Fisica, Universidade Federal do Ceara, 60451-970 Fortaleza, Ceara, Brazil — [3]Centre for Advanced Spatial Analysis, University College London, 1-19 Torrington Place, London WC1E 6BT, UK — [4]Center for Polymer Studies and Physics Department, Boston University, Boston, MA 02215, USA

An important issue in the study of cities is defining a metropolitan area. A commonly employed method of defining a metropolitan area is the Metropolitan Statistical Areas (MSA), based on rules attempting to capture the notion of city as a functional economic region, and is constructed using experience. Here, we introduce a new method to designate metropolitan areas, denoted the "City Clustering Algorithm" (CCA). The CCA is based on spatial distributions of the population at a fine geographic scale, defining a city beyond the scope of its administrative boundaries. We use the CCA to examine Gibrat's law of proportional growth. We find that the mean growth rate of a cluster utilizing the CCA exhibits deviations from Gibrat's law, and that the standard deviation decreases as a power-law with respect to the city size. The CCA allows for the study of the underlying process leading to these deviations. These results have socio-political implications, such as those pertaining to the location of new economic development in cities of varied size.

AGSOE 8.2 Tue 10:45 BAR 205

**Comparing fluctuations in traffic flow with thermal noise in physical pattern forming systems** — •Martin Treiber — TU Dresden, Dresden, Germany

Thermal noise in physical pattern-forming fluid systems (such as Rayleigh-Benard convection or Taylor-Couette flow) increases in a characteristic way when approaching a linear stability threshold from below. This can be described quantitatively by generalizing the fluctuation-dissipation theorem to nonequilibrium systems.

In this contribution, I show that the same is true when (non-thermal) noise is applied to pattern-forming systems driven by nonphysical forces, with traffic flow being a prominent example. Sufficiently far away from threshold, many concepts of equilibrium thermodynamics carry over to the traffic system although neither energy nor momentum are conserved. Particularly, the fluctuations allow to determine a generalized "interaction potential" from the data.

Simulations show that, when approaching the linear stability, the fluctuations increase in the traffic system as well. Moreover, correlations appear that anticipate, in a way, the patterns of stop-and go traffic observed once above threshold. Both results could be described nearly quantitatively by analytical methods that have been successfully applied to the thermal fluctuations of the physical pattern-forming systems.

AGSOE 8.3 Tue 11:15 BAR 205

**Spatiotemporal dynamics of supply network growth** — •Karsten Peters — Institute for Traffic and Economis, TU Dresden

Supply networks are complex networks designed to fulfill certain functional requirements. Based on expansion data of a large grocery retailer network for more than 40 years we developped a model for the spatiotemporal expansion of supply networks, involving the setup of new stores an the coevolution of a distribution center network. Surprisingly the evolution of such networks reveals properties which are similar to the growth of tumors in tissues. Using this model, we where able to investigate the influence of different expansion strategies to the overall development, potential earnings and spatial coverage of such business structures. It turns out, that the tradeoff between large spatial expansion steps and optimal local coverage leads over the time to significant differences in the efficiency of different strategies. These results can be used to optimize the structure of retailer and supply networks but point also towards a new modelling paradigm for spatial economic growth, which uncovers the analogies with other, biological spatiotemporal expansion processes.

AGSOE 8.4 Tue 11:45 BAR 205

**Universality in Geometric Properties of German Road Networks: Empirical Analysis and Modelling** — •Sonic Chan[1], Reik Donner[1], Stefan Lämmer[1], and Dirk Helbing[2] — [1]TU Dresden, Andreas-Schubert-Str. 23, 01062 Dresden, Germany — [2]ETH Zürich, Universitätstr. 41, CH-8092 Zürich

In order to understand the development of urban road networks, we have investigated the structural properties of a variety of German cities. A considerable degree of universality is found in simple geometric features such as the distributions of link lengths, cell areas and cell degrees. In particular, German cities are mainly characterized by perpendicular intersections and splittings of straight roads, deviations of the link angle distributions from the rectangular pattern follow in good approximation stretched exponential distributions.

It is shown that most empirical features of the studied road networks can be surprisingly well reproduced by a simple self-organizing evolving network model. For this purpose, we suggest a two-step procedure with a stochastic generation of new nodes in the presence of a sophisticated interaction potential, which is followed by the establishment of new links according to some deterministic rules. In this model, rectangular patterns naturally emerge due to basic economic considerations. It will be further discussed to which extent similar mechanisms do significantly contribute also in other technological or biological transportation networks.

AGSOE 8.5 Tue 12:15 BAR 205

**The Pareto-positive stable distribution: a descriptive model for city size data** — •Jose Maria Sarabia and Faustino Prieto — University of Cantabria, Santander, Spain

The Pareto-positive stable (PPS) distribution is introduced as a new model for describing city size data in several countries. The PPS distribution provides a flexible model for fitting all the range of a set of city size data, where zero and unimodality are possible, and the classical Pareto and Zipf distributions are included as a particular case.

The new model has a twofold origin. Initially, it can be obtained by mixing the shape parameter of a classical Pareto distribution with a positive stable distribution. In this way we can model the possible heterogeneity in the set of city sizes. The distribution obtained is also genuine by extending the range of the characteristic exponent in the stable law. PPS distribution can be also obtained from a monotonic transformation of the classical Weibull distribution.

Probabilistic properties are studied and several descriptive measures are obtained. Maximum likelihood estimators are proposed. Initial estimators of the parameters can be obtained using regression methods. A simple graphical method for studying the adequacy of the data to model is given.

Finally, we consider city size data for USA and Spain for several years, because they are the countries with highest migration shocks in recent years. Some classical distributions as well as PPS distribution are fitted, and we conclude that PPS distribution outperforms previous models.

AGSOE 8.6 Tue 12:30 BAR 205

**Potential and Spatial Evolution of Location Patterns** — •Yuri Yegorov — University of Vienna,, BWZ, Vienna, Austria

The spatial location of household and business represents a complex and evolving pattern that is driven by agglomeration and congestion forces. The origin of agglomeration forces is in scale economies, while congestion force is a cumulative negative externality. Since population and economy are growing, while technology is developing, the spatial structure is always evolving having only partial equilibrium at each time. The goal of this article is to develop a theory that can give some hint to equilibrium spatial structures and evolution of spatial patterns. The analysis starts from discrete case and then goes to continuous case. The analysis of interaction between two cities in discrete set up shows that market forces can either lead to dispersion or agglomeration, and polarized equilibrium is also possible. In the continuous static case the concept of potential of interaction between agent and CBD is introduced. Congestion function depends on population density. Interaction between these two forces can lead to heterogeneous spatial densities. Dynamics of spatial evolution depends of functional forms of potentials and can lead to different types of PDE equations

of parabolic type.