SOE 3: Poster

Time: Monday 17:30–19:30 Location: SOEp

SOE 3.1 Mon 17:30 SOEp

Effective curvature of street networks — •David Bantje, Stephan Herminghaus, and Knut M. Heidemann — Max-Planck Institute for Dynamics and Self-Organization, Am Fassberg 17, 37077 Göttingen, Germany

Demand responsive ride pooling (DRRP) could contribute significantly to the transition towards sustainable mobility. In mean-field theories of DRRP [1], such systems are currently modelled in the Euclidean plane. We investigate if by assigning an effective Gaussian curvature, the metric properties of the street network can be incorporated into the existing theoretical framework. This poster illustrates the calculation scheme of effective curvature and presents results for model and real street networks.

[1] S. Herminghaus (2019). Mean field theory of demand responsive ride pooling systems. Transportation Research Part A: Policy and Practice, 119. https://doi.org/10.1016/j.tra.2018.10.028

SOE 3.2 Mon 17:30 SOEp

Persistence length of ride-sharing bus trajectories — •Steffen Mühle and Helge Heuer — Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany

On-demand ride-sharing services have the potential to drastically decrease urban traffic, mobility costs, carbon emissions and the need for owning a private car. While the benefits of a well-coordinated bus fleet capable of serving live incoming transport requests are compelling, predicting the spatio-temporal dynamics even of single buses is far from trivial. Typically, a bus' trajectory does not originate in isolation but emerges from its interplay with incoming requests, the street network, other buses and fleet-wide policies.

Given the latter, namely the maximally allowed detour an accepted request may entail, $\delta_{\max}$, we treat bus trajectories as random walks and inspect them from the perspective of polymer theory. To this end, we generate random walks purely geometrically, and also run full-scale ride-sharing simulations using MatSim. In both cases, we observe that for long times a bus' trajectory becomes diffusive, which allows us to assign a persistence length to them.

This creates a quantitative link between the (tunable) parameter $\delta_{\max}$ and the (observed) typical length scale on which a bus changes its direction, enabling us to predict e.g. how much time a bus spends in a certain district or how far it travels over the course of one day.

SOE 3.3 Mon 17:30 SOEp

Evaluation of demand responsive ride pooling on real life taxi data — •Michael Sternbach[1,2,3], Felix Jung[1], Puneet Sharma[1,2], Stepahn Herminghaus[1,2], and Knut Heidemann[1,2] — [1]Max Planck Institute for Dynamics and Self-Organization, Göttingen, Germany — [2]Institut for Dynamics and Complex Systems, University of Göttingen, Germany — [3]Campus Institute for Dynamics of Biological Networks, Göttingen, Germany

Climate change caused by human greenhouse gas (GHG) emissions is one of the vital challenges of humankind. Passenger cars contribute significantly to human GHG emissions. To reduce this effect, more eco-friendly transport modes are needed. Demand responsive ride pooling (DRRP) offers door-to-door service similar to taxi or personal car while pooling customers with similar routes on the same vehicle, thereby reducing emissions and the number of cars needed. In this study, we measure the performance of a DRRP system on real life taxi request data and evaluate under which conditions e. g. request rate, number of vehicles, allowed detour or waiting time DRRP can operate more efficiently than taxi service at a reasonable service quality. We compare our results to a mean field description of DRRP [1] to analyze the effect of road network structure and spatial request distribution. Our results provide significant insight on the prerequisites for ecological and economic feasibility of DRRP.

[1] Herminghaus, S. (2019). Mean field theory of demand responsive ride pooling systems. Transportation Research Part A: Policy and Practice, 119, 15-28.

SOE 3.4 Mon 17:30 SOEp

Bi-modal demand responsive ride pooling — •Puneet Sharma, Helge Heuer, Stephan Herminghaus, and Knut Heidemann — Max Planck Institute for Dynamics and Self-Organization, Goettingen

Commuting is an indispensable part of modern human lives. While modern cities offer various modes of transportation, considered separately, none of them is both efficient, i.e., sustainable, and convenient. A taxi service is convenient, in a sense, due to door-to-door service, but is inefficient since it usually serves one customer only. Demand responsive ride pooling (DRRP) with minibuses is more efficient, but leads to undue competition with line services (LS), which provide even better pooling (average number of passengers per vehicle) but are less convenient due to fixed routes and stops. A combination of both modes, DRRP and LS, may provide an ideal solution but is challenging to organize. Here we derive conditions for efficient and convenient transportation for a bi-modal service based on a simple square-grid geometry. We relate the optimal mesh size, i.e., distance between stations, to external parameters like passenger density and traveling behavior. We also compare the carbon footprint of the bi-modal service with private cars so as to measure it*s efficiency.

SOE 3.5 Mon 17:30 SOEp

Numerical study of phase transition in the bipartite *z*-matching — •Till Kahlke[1], Martin Fränzle[2], and Alexander K. Hartmann[1] — [1]Institut of Physics, University of Oldenburg, Germany — [2]Institut of Computer Science, University of Oldenburg, Germany

We study numerically [1] the many-to-one bipartite *z-matching*, a generalisation of the matching problem. It can be used, e.g., to model a wireless communication network of users and servers, where z denotes the maximum number of users a server can treat at one time. Within a bipartite graph representation, there are links from each user to all servers which are feasible, e.g., close enough. The maximum matching capacity of this graph is the largest total number of users all servers can serve. After mapping to standard maximum matching, we use a numerically *exact algorithm* (Edmonds blossom shrinking) to solve the z-matching problem. First, we compare it with previous analytic results [2]. Next, we look at the saturation probability as order parameter and *observe phase transitions* when varying the average number of neighbors. We describe these transitions by their critical points and an universal critical exponent. When comparing the matchings of the exact algorithm with a commonly used matching *heuristic*, we observe that the heuristic starts to differ from the optimal solution right at the critical point.

[1] A.K. Hartmann, *Big Practical Guide to Computer Simulations* (World Scientific, 2015).
[2] E. Kreačić and G. Bianconi, Europhys. Lett. **126**, 28001 (2019).

SOE 3.6 Mon 17:30 SOEp

Burstiness and accuracy of collective decision-making — •Mariko Ito — Rikkyo University, Tokyo, Japan

In the decision-making of an individual, others' opinions can significantly affect when and what he/she states. Kurvers et al. [1] empirically showed that informative individuals tend to answer earlier than the others when each individual in a group is allowed to answer any time for a binary choice problem. They also exhibited that the group performance is high in the collective decision-making with such self-organised orders compared to that in the case where individuals make decisions independently. Here my interest is whether the distribution of the interval between statements has any information about the quality of their collective decision-making as well as the order of the statements.

I analysed the data in Kurvers et al. and derived the burstiness parameter B, the strength of burstiness [2]. Burst is the phenomenon where events, i.e., statements in our case, frequently occur in short periods while that rarely occur in long periods. I found that the greater is B, the higher is the group performance. The value of B was positively correlated with the group performance even when individuals made decisions independently. These results suggest that individuals with stronger confidence can cause a more bursty sequence of their statements.

[1] Kurvers et al., R. Soc. Open Sci., 2015. [2] Goh and Barabási, EPL, 2008.

SOE 3.7 Mon 17:30 SOEp

Cascade dynamics in Reddit communities — •Joao Pinheiro Neto and Knut Heidemann — Max Planck Institute for Dynamics

and Self-Organization

Social media has a large role in modern society, making studying its dynamics fundamental to understand social and political events. Reddit is one of the biggest social media platforms in the world, and individual subcommunities (called "subreddits") have been involved in some of the biggest events in recent times. Discussions in Reddit happen in threads that follow a tree structure, with each comment spawning a new branch. This has been modeled with directed percolation-like models such as the Hawkes process, and it has been shown that the probability distributions of both thread size and total score follow power-laws [1,2]. Here we explore how these distributions and other observables vary across different subreddits. In particular, we show that i) subreddits can display both power-laws and non-power-law distributions, and ii) that the measured power-law exponents can vary considerably. We relate that to subreddit features such as the type of content and size of the userbase.

References

1. Medvedev, A. N., Delvenne, J. C., Lambiotte, R., & Cherifi, H. (2018). Journal of Complex Networks, 7(1), 67*82

2. Medvedev, A. N., Lambiotte, R., & Delvenne, J.-C. (2019) In Springer Proceedings in Complexity (pp. 183*204).

SOE 3.8 Mon 17:30 SOEp

Dirac Algebra Generalized Matrix Inverses — •Martin Erik Horn — IUBH - Internationale Hochschule, Campus Berlin

More and more introductory business mathematics textbooks present generalized matrix inverses as elementary part of the foundations of mathematical economics. Therefore Moore-Penrose generalized matrix inverses as the scalar part of Pauli Algebra generalized matrix inverses had been discussed at the DPG spring meeting 2018 of the Physics of Socio-economic Systems Division in Berlin in a geometric way.

As this geometry is based on the Euclidean structure of space, it is quite reasonable to ask, what happens if generalized matrix inverses are constructed in pseudo-Euclidean, hyperbolic spacetimes. This will be discussed in this poster presentation: Spacetime generalized matrix inverses are constructed as the scalar part of Dirac Algebra generalized matrix inverses. And again the algebraic reasoning of textbooks will be completed by analyzing the geometry it is based on.