

SOE 2: Computational Social Science and Data Science I

Time: Monday 9:30–11:00

Location: H17

SOE 2.1 Mon 9:30 H17

Machine intelligence for network science and evolutionary dynamics? — ●JAN NAGLER¹ and MARC TIMME² — ¹Frankfurt School — ²TU Dresden

Does machine learning truly matter in network science or other sectors of statistical physics? Many network scientists, in particular those with a strong background in statistical physics, remain sceptical. This may be because computer science, traditionally, is more focussed on performance than on getting insights, offering transparency, being general or finding a minimal model. In [Timme & Nagler, *News and Views: Pattern of Propagation*, *Nature Physics*, in print] we argue that if fundamental principles underlying network dynamics are identified prior to the employment of intransparent black box feature extraction, not only hard tasks can be solved but also valuable insights may be provided. But this requires to frame our mathematical predictions according to the conditions under which the natural and artificial networks around us reveal themselves. Thus, this requires to bridge different disciplines through collaborations with researchers of complementary expertise. This talk aims to spread this message. We will exemplify this for seemingly universally optimal strategies (Generous Zero Determinant Strategies) and seemingly unresolvable (Prisoner's dilemma) conflicts of networked actors in complex noisy environments.

SOE 2.2 Mon 10:00 H17

Modeling the rise and fall of online topics — ●FREDERIK WOLF^{1,2}, PHILIPP LORENZ-SPREEN³, NATASA CONRAD⁴, and PHILIPP HÖVEL^{3,5} — ¹Potsdam Institute for Climate Impact Research, Research Domain 4 — ²HU Berlin, Department of Physics — ³TU Berlin, Department of Physics — ⁴Zuse Institute, Berlin — ⁵University College Cork, School of Mathematical Sciences

Hashtags are widely used for communication in online media. As a condensed version of information, they characterize topics and discussions. In this study, we split a weighted temporal network constructed from hashtag co-occurrences into static snapshots and utilize a higher order memory approach to produce a matching protocol that is robust toward temporal fluctuations and instabilities of the static community detection of each snapshot [Lorenz, Philipp, et al. "Capturing the Dynamics of Hashtag-Communities." *Int. Wo. Compl. Netw. Appl.*, 2017].

The observations are characterized by bursty behaviors in the increases and decreases of hashtag usage. We consider the size of the communities in time as a proxy for online popularity and find that the gains and losses, as well as the interevent times are broadly distributed indicating occasional, but large and sudden changes in the usage of hashtags. Inspired by typical website designs, we propose a stochastic model that incorporates a ranking with respect to a time-dependent prestige score. The interplay of these mechanisms causes occasional cascades of rank shift events and reproduces the observations with good agreement. This offers an explanation for the observed dynamics, based on characteristic elements of online media.

SOE 2.3 Mon 10:15 H17

Activity-driven radicalization phenomena in public discussions — ●FABIAN BAUMANN¹, PHILIPP LORENZ-SPREEN², PHILIPP HÖVEL², and IGOR M. SOKOLOV¹ — ¹Institut für Physik - Humboldt-Universität zu Berlin — ²Institut für Theoretische Physik - TU Berlin

We aim for a novel model for the description of the adoption of extreme opinions in a population of socially interacting agents, which we term radicalization. Inspired by multiple reports of strong opinion polarization, measurable from social media data and our own empirical insights into pre-election debates on Twitter, we investigate on the possible mechanisms of opinion reinforcement by peers. In a minimal scenario of binary opinion formation within a population, we introduce a simple mechanism of increasing conviction upon contacts to like-minded peers.

Combined with established concepts from constructive opinion dynamics models, this leads to two qualitatively different outcomes: (1) a global consensus and (2) a separation into two polarized (political) camps. On modern communication platforms, like Twitter, spreading information among a large number of peers became possible at low cost. Furthermore it is now, on a large-scale, possible to measure the occurring interactions. Extending our model by a simple mechanism for the activation of agents we aim for an explanatory link between the observed political opinion landscape and the (heterogeneously distributed) activities of social media users.

SOE 2.4 Mon 10:30 H17

A microscopic model of spatio-temporal language dynamics — ●MICHAEL LEITNER¹, KATHARINA PROCHAZKA^{2,3}, and GERO VOGL² — ¹Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München, 85748 Garching, Germany — ²Fakultät für Physik, Universität Wien, 1090 Wien, Austria — ³Institut für Slawistik, Universität Wien, 1090 Wien, Austria

With today's modes of long-distance communication, the local spatial scale is only of secondary importance for present cases of language shift. In contrast, in former times language dynamics was driven by the relocations and physical contacts between people on small scales. An ideal study object is afforded by the multinational Austro-Hungarian Empire, displaying both naturally evolving boundaries between language-defined populations, as well as small-scale heterogeneity due to colonist settlements [1].

For describing language dynamics at the scale of individual settlements, conventional reaction-diffusion approaches [2] are not applicable. Here we present a microscopic stochastic model, where individual births, deaths, relocations and language conversions are explicitly modelled. We parametrize our model with the historical census data available in ten-year intervals and give an interpretation of our findings in terms of the spatial interaction scale as well as a bias towards conversion to the language of the dominant group.

[1] K. Prochazka and G. Vogl, *PNAS* **114**, 4365 (2017)

[2] A. Kandler, R. Unger, and J. Steele, *Phil. Trans. R. Soc. B* **365**, 3855 (2010)

15 min. break