SOE 20: Focus Session: Statistical Physics of Political Systems

One of todays most pressing and consequential issues are whether democracy worldwide is in decline. Thanks to an increasing collection of quantitative data, there is a rising opportunity to develop new quantitative models on the role the economy, international armed conflicts and other events play in the stabilisation of political regime types such as democracy and autocracy. This situation invites the use of statistical physics techniques, since these processes often take place on many time and length scales, from the singular event to multi-year developments, and from local regions to continents.

Organized by Karoline Wiesner and Paula Pirker Diaz (Universität Potsdam)

Time: Thursday 15:00–16:45 Location: MA 001

Invited Talk SOE 20.1 Thu 15:00 MA 001

A closer look at the multiple scales of armed conflict — •Edward Lee — Complexity Science Hub Vienna, Vienna, Austria

Conflicts, like many social processes, are related events that span multiple scales in time, from the instantaneous to multi-year development, and in space, from one neighborhood to continents. Yet, there is little systematic work on connecting the multiple scales, formal treatment of causality between events, and measures of uncertainty for how events are related. We develop a method for extracting causally related chains of events that addresses the limitations. Our method explicitly accounts for an adjustable spatial and temporal scale of interaction for clustering individual events from a detailed data set, the Armed Conflict Event & Location Data Project. With it, we discover a mesoscale ranging from a week to a few months and tens to hundreds of kilometers, where long-range correlations and nontrivial dynamics relating conflict events emerge. Importantly, clusters in the mesoscale, while extracted from conflict statistics, are identifiable with mechanism cited in field studies. We leverage our technique to identify zones of causal interaction around hotspots that naturally incorporate uncertainties. Conflict avalanches represent systematic clusters distinct from qualitative, sociopolitical labels. We use them to identify categories of conflict and are developing techniques to leverage them for conflict prediction in concert with highly resolved data sets on geographic, climatic, and socioeconomic variables. Thus, we show how a systematic, data-driven, and scalable procedure extracts social objects for study, providing a scope for scrutinizing and predicting conflict and other processes.

SOE 20.2 Thu 15:30 MA 001

Conflict Classification Using Multinomial Mixture Models and Conflict Avalanches — •Niraj Kushwaha[1], Edward Lee[1], and Woi Sok oh[2] — [1]Complexity Science Hub Vienna — [2]Princeton University

Armed conflicts are notoriously difficult to systematically characterize and classify[1]. In a recent work, the first problem was tackled using transfer entropy-a measure of information theoretic causality-to group individual conflict events into cohesive cascading structures termed "conflict avalanches"[2]. Our focus now centers on the second problem, wherein leveraging the identified conflict avalanches, we extensively mapped each conflict avalanche to twenty variables commonly linked to armed conflicts in the existing literature. These variables span climatic, socio-economic, demographic, and geographic dimensions. Employing a multi-multinomial mixture model, a novel iteration of the well-established multinomial mixture model, we subjected the conflict avalanches to clustering based on this augmented dataset. The resulting clusters enable us to classify conflicts as compositions of distinct climatic, socioeconomic, demographic, and geographic variables. This systematic classification methodology also identifies crucial underlying determinants for each conflict type and offers insights into the influential factors underpinning each. This innovative classification framework holds promise for advancing our understanding of armed conflicts and improving predictive modeling of armed conflicts. [1] Critical issues in peace and conflict studies: Theory, practice, and pedagogy. Lexington Books, 2011. [2] Kushwaha and Lee, PNAS Nexus, 2023

SOE 20.3 Thu 15:50 MA 001

Digital Democracy: Better than Optimal?! — •Dirk Helbing — ETH Zurich, Computational Social Science — Complexity Science Hub Vienna

Societies are complex systems. This has important implications for how societies should be managed, in particular, how democracies can be upgraded. I will illustrate our insights by means of pattern formation and self-organisation phenomena in social systems as well as applications to self-governance and self-control. Furthermore, I will discuss how collective intelligence and co-creation can be supported in ways that promote favourable systemic outcomes - outcomes that are better than optimal, i.e. better than when optimisation is applied. As an application example, I will present a field study on participatory budgeting, as it has been recently carried out in Aarau, Switzerland. Specifically, I will discuss, how voting rules can be improved to promote individual and systemic benefits, such as inclusion and fairness.

SOE 20.4 Thu 16:10 MA 001

Modelling dynamics of political regime types in the 20th century — •Paula Pirker-Diaz[1], Sönke Beier[1], Matthew Wilson[2], and Karoline Wiesner[1] — [1]Universität Potsdam, Potsdam, Deutschland — [2]University of South Carolina, Columbia, USA

Can the evolution of political systems be predictable? Is there a way to define their state with a maximum of two state variables?

To answer these questions we are analysing part of the V-Dem Research Project dataset, the world*s most detailed democracy ratings. It consists of hundreds of indicators quantifying different aspects that define the democracy level of more than 170 countries, which reveals the complexity of political systems and their definition. (Wilson, Matthew et al., *The Hidden Dimension in Democracy* (2023). V-Dem Working Paper 2023:137)

We apply the dimensionality reduction method called diffusion map and identify a two dimensional manifold containing all datapoints corresponding to all countries and years available, between 1900 and 2021. Being the first coordinate strongly aligned to the Electoral Democracy Index, this novel representation distinguishes autocracies from democracies in a surprisingly clear way. We also identify regions in the manifold that are related to specific regime types and additionally, suffrage types. By fitting a Gaussian Mixture model to the temporal evolution, we detect the collective response of the system to historical events. Based on our results, we suggest a predictive model for the evolution of political systems.

15 min. for final discussion