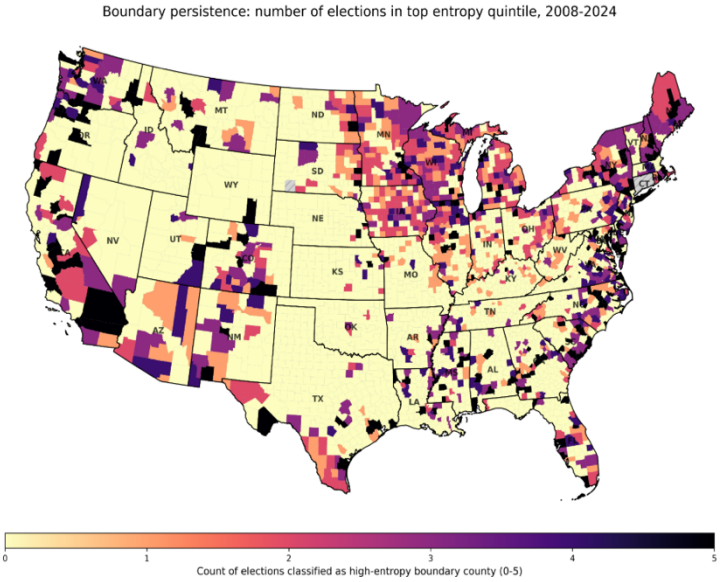
Frustration-Induced Criticality and Polarised Consensus in Antagonistic Multiplex Networks

Jack C.M.Hughes, Herbert Jelinek, Glenn Muschert and Fedor V. Kusmartsev

Physics Department, Khalifa University, UAE

We introduce a minimal nonlinear model of opinion dynamics on antagonistically coupled multiplex networks. Each layer follows intra-layer majority-rule dynamics, while inter-layer coupling is inhibitory, representing competition between internally cohesive but mutually antagonistic communities. This simple mechanism generates a frustrated non-equilibrium system in which local consensus formation competes with cross-layer inhibition.



Our main contribution is to show that antagonistic multiplex coupling can produce a frustration-induced transition between two polarized consensus states. Mean-field analysis identifies an unstable balanced fixed point separating the two consensus basins. Numerical simulations on random regular multiplex networks show that, near this boundary, the dynamics become metastable, convergence times grow sharply and the Shannon entropy of final outcomes exhibits a pronounced peak. Finite-size analysis shows that the width of this high-entropy region decreases approximately as a power law, $\Delta r \sim N^{-0.53}$ indicating a sharpening of the transition with system size. A comparison with cooperative inter-layer coupling demonstrates that the entropy peak and metastable region are not generic consequences of majority-rule dynamics, but arise from antagonistic feedback between layers. We successfully applied the developed model to describe the 5 latest presidential elections in the USA. In the figure, we show the high-entropy states identified by the model, which are playing a key role in the election.