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Predicting the origin of contagion processes on complex, multi-scale networks RAFAEL BRUNE, CHRISTIAN THIEMANN, DIRK BROCKMANN, Northwestern University — Contagion phenomena in space often exhibit complex, multiscale spatio-temporal patterns driven by the interaction of non-local dispersal and nonlinear dynamics. A key challenge is the prediction of dynamic patterns based on information on human interactions, mobility and initial conditions. The development of computational models has thus received considerable attention. However, in many realistic situations, a process has already evolved for some period before detection and identifying the spatial origin is difficult. Surprisingly, this "inverse problem" has received little attention in the past. We show in a paradigmatic model for human disease dynamics that despite the spatial complexity of dynamic patterns, the origin of outbreak can be predicted with high fidelity. Based on the technique of shortest path trees in strongly heterogeneous, multi-scale human mobility networks we show that at any point in time the spatial origin can be reconstructed reliably. This novel perspective on complex spatio-temporal dynamics can be applied to systems beyond human disease dynamics for instance the reconstruction of neolithic diffusion of agriculture into Europe and related migration driven historic phenomena.

Dirk Brockmann
Northwestern University

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