SIS Dynamics on Temporal Multiplex Networks with Activity-Driven Layers

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Abstract—We investigate the susceptible–infected–susceptible (SIS) process on a temporal multiplex where a persistent static layer is overlaid with an activity-driven layer of one-step contacts. Simulations on several random network families (Erdős–Rényi, Watts–Strogatz, Barabási–Albert) show a clear extinction–persistence transition that shifts systematically as the number of contacts per activation is increased. To explain this behavior, we linearize the dynamics near the disease-free state and replace the random temporal contacts by their mean effect, which produces a simple early-time operator: the static adjacency plus a rank-one, all-to-all mixing term. This leads to a compact mean-field onset rule depending only on the spectral radius of the static layer and on the temporal parameters, and it closely tracks the empirical phase boundary obtained from simulations. Overall, the results indicate that a low-dimensional, simulation-guided approximation is sufficient to relate structural metrics and temporal mixing to measurable epidemic outcomes on heterogeneous networks.

Index Terms—SIS dynamics, temporal networks, activity-driven networks, multiplex, spectral threshold.