[P1] Percolation transition on multiplex lattices: cascade of activations and deactivations

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Many complex systems are best modeled by multiplex networks of layers of various types of connections. Functional cooperativity between network layers such as interdependency has shown to affect the percolation properties of multiplex networks by inducing discontinuity and hysteresis. Here we study the percolation transitions of the so-called multiplex viability models [B. Min and K.-I. Goh, Phys. Rev. E 89, 040802(R) (2014)] on two-layer square lattices. Depending on the way establishing the viability, either by the cascade of activations (CA) or by the cascade of deactivations (CD), the model was shown to exhibit different critical points and thereby hysteresis. In this study we found by extensive Monte Carlo simulations on two-layer square lattice that the two processes not only have different percolation transition points but also exhibit different critical behaviors with distinct sets of
critical exponents. For CA, the order parameter exponent β and the correlation length exponent ν are obtained to be consistent with those of ordinary percolation (OP) in 2D. For CD, however, the transition belongs to different universality class from OP but shows the same critical behaviors as the 2D mutual percolation model. The viable cluster size distributions of the two processes show distinct behaviors
from OP including the unusual exponent $\tau < 2$. The obtained results are tested forconsistency through the scaling relations.

† B. Min and K.-I. Goh, Phys. Rev. E **89**, 040802(R) (2014)