Abstract:
Epidemic-like stochastic processes with time-varying parameters have been introduced to model viral behaviors in communication and social networks, cybersecurity systems and financial markets. Under a mean-field scaling, we show that such density-dependent stochastic population processes with time-varying behavior converge to a time-varying dynamical system. We analogously establish that the optimal control of such density-dependent stochastic population processes converges to the optimal control of the limiting dynamical system. In addition, we observe that such stochastic processes can include interactions between local (micro) and global (macro) behaviors within the process, involving migration from one operating regime to another and transitions within each regime. To address this phenomena, we consider herein nearly completely decomposable (NCD) structures in epidemic-like stochastic processes with time-varying behaviors. In doing so, we extend known results for NCD processes to include time-varying parameters and we devise mean-field limits of such epidemic-like processes as regime-switching dynamical systems.