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Semi-semi-Markov processes: a generalized renewal approach for individual based branching processes

Abstract: Individual-based models are a "bottom-up" approach for calculating empirical distributions at the level of the population from simulated individual trajectories. We build a new class of stochastic processes for mathematically formalizing and generalizing these simulation models according to a "top-down" approach, when the individual state changes occur at countable random times. We allow individual population-dependent semi-Markovian transitions in a non closed population such as a branching population.

These new processes are called Semi-Semi-Markov Processes (SSMP) and are generalizations of Semi-Markov processes. We calculate their kernel and their probability law, and we build a simulation algorithm from the kernel.