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# Stochastic Modeling by Inhomogeneous Continuous Time Markov Chains

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**Abstract:** Homogeneous continuous time Markov chain (HCTMC), with the assumption of time-independent constant transition rates, is one of the most frequent applied methods for stochastic modeling. In realistic situations, with varying external factors influencing the transition processes, the transition rates can no longer be considered time-independent. Under these circumstances, the inhomogeneous CTMC (ICTMC) is more suited for modeling the stochastic processes. One drawback of ICTMC is that an analytical solution is difficult, if not impossible, to obtain. Then, one must resort to numerical approaches e.g. Monte Carlo simulation, uniformization, state-space enrichment, and numerical differential equation solvers. This presentation aims at comparing the methods, making reference to a simple but challenging case study.

**Keywords:** Inhomogeneous continuous time Markov chain, Runge-Kutta methods, uniformization, Monte Carlo simulation, state-space enrichment.