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On Markovian queueing models with catastrophes

The simplest queueing models with catastrophes have been studied some years ago, see for instance [1, 2]. Nonstationary birth-death process with catastrophes were considered in [3, 4]. Here we study more general situation, namely we suppose catastrophe rates depending on the queue length.

Let $X = X(t)$, $t \geq 0$ be a birth and death process (BDP) with catastrophes, and let $\lambda_n(t) = \nu_n \lambda(t)$, $\mu_n(t) = \eta_n \mu(t)$, and $\xi_n(t) = \zeta_n \xi(t)$ be respectively birth, death, and catastrophe rates. Then (under standard assumptions) the forward Kolmogorov system of differential equations holds:

$$\begin{cases} \frac{dp_0}{dt} = -\lambda_0(t)p_0 + \mu_1(t)p_1 + \sum_{k\geq 1} \xi_k(t)p_k(t), \\ \frac{dp_k}{dt} = \lambda_{k-1}(t)p_{k-1} - \left(\lambda_k(t) + \mu_k(t) + \xi(t)\right)p_k + \mu_{k+1}(t)p_{k+1}, k \geq 1. \end{cases}$$

We study weak ergodicity of $X(t)$ in uniform operator topology in the case of large catastrophe intensity and in strong topology in the general case and obtain some explicit bounds of the rate of convergence using the approach of [4].

[1] Di Crescenzo, A., Giorno, V., Nobile, A. G., Ricciardi, L. M. On the M/M/1 queue with catastrophes and its continuous approximation. *Queueing Syst.* **43** (2003), 329–347.

[2] Di Crescenzo, A., Giorno, V., Nobile, A. G., Ricciardi, L. M. A note on birth-death processes with catastrophes *Statist. Probab. Lett.* **78** (2008), 2248–2257.

[3] Zeifman, A., Satin, Ya., Chegodaev, A., Bening, V., Shorgin, V. Some bounds for $M(t)/M(t)/S$ queue with catastrophes. *SMCtools-2008.*

[4] Zeifman, A.I., Satin, Ya.A., Chegodaev, A.V. On nonstationary queueing systems with catastrophes. *Informatics and Their Appl.*, **3** (2009).