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Relation between firing statistics of spiking neuron with delayed feedback and without feedback

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We consider a class of spiking neuronal models with threshold 2, defined by a set of conditions typical for basic threshold-type models, such as the leaky integrate-and-fire or the binding neuron model and also for some artificial neurons. A neuron is fed with a Poisson process. Each output impulse is applied to the neuron itself after a finite delay Δ. This impulse is identical to those delivered from the input stream. We derive a general relation which allows calculating exactly the probability density function (pdf) $p(t)$ of output inter-spike intervals of a neuron with feedback based on known pdf $p^0(t)$ for the same neuron without feedback, intensity of the input stream and the properties of the feedback line (the Δ value).
In addition to this, we calculate exactly the model-independent initial segment of pdf $p(t)$ for a neuron with feedback that is the same for any neuron satisfying the imposed conditions. Also, relations between moments of pdf $p(t)$ for a neuron with feedback and pdf $p^0(t)$ for the same neuron without feedback are derived. The obtained expressions are checked numerically by means of Monte Carlo simulation.
The course of $p(t)$ has a δ-function peculiarity, which makes it impossible to approximate $p(t)$ by Poisson or another simple stochastic process.

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