CD Cells

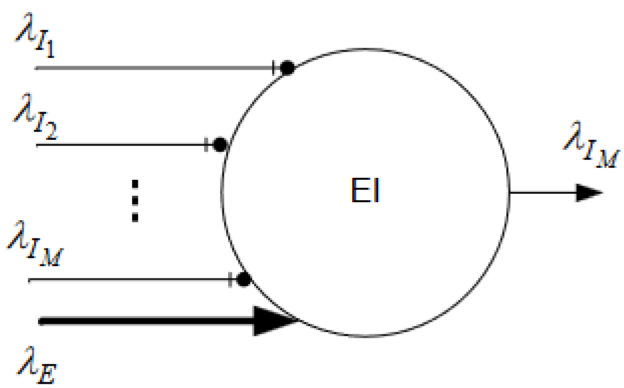
Stochastic Properties of Coincidence Detector Cells by Krips and Furst (2020).

Instantaneous rate can be derived analytically.
Assumptions:

(1) Inputs behave as non-homogeneous poisson process (NHPP)
(2) Coincidence interval is smaller than the refractory period

EI Cell

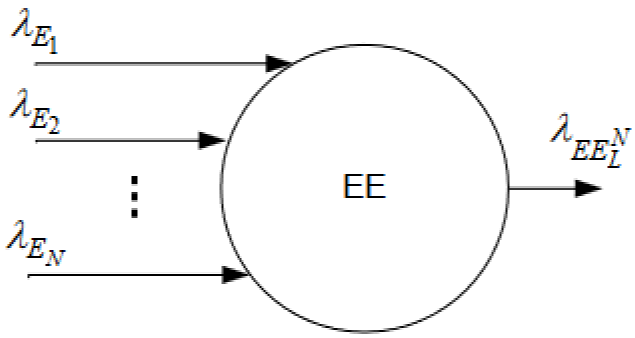
Generate a spike if during the \delta time interval the excitatory input spike and non of the inhibitory inputs spikes.



$$\lambda_{EI_M} = \lambda_E(t)\prod_{i=1}^{M}\left[1 - \int_{t-\Delta}^{t} \lambda_{I_i}(\zeta)\,d\zeta\right]$$

EE Cell

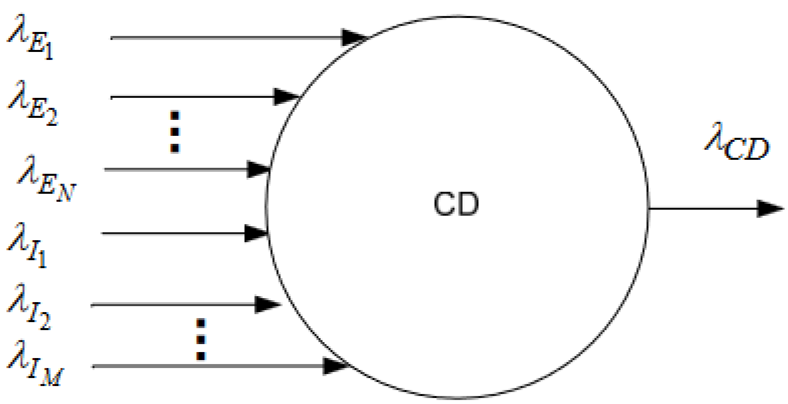
Generate a spike if during the \delta time interval there are at least L/N excitatory inputs spike.



$$\lambda_{EE_L}(t) = \sum_{l=1}^{L} \lambda_{E_l}(t) \prod_{\substack{j=1 \\ j \neq l}}^{L} \int_{t-\Delta}^{t} \lambda_{E_j}(t')\,dt'$$

General CD Cell

Generate a spike if during the \delta time interval there are at least P more excitatory spikes than inhibitory spikes.



$$\lambda_{CD} = \sum_{k=0}^{\min(N-P,M)} \lambda_{CD_K}$$

$$\lambda_{CD_K} = \begin{cases} \lambda_{EE^N_{=P}(\Psi)} \cdot \lambda_{I(\Omega)} & K = 0 \\ \lambda_{EE^N_{=P+K}(\Psi)} \left(1 - \int_{t-\Delta}^{t} \lambda_{EE^N_{K+1}(\Omega)}(t')\,dt' \right) & 1 \le K \le \min\{M-1, N-P\} \\ \lambda_{EE^N_{P+K}(\Psi)} & K = M \end{cases}$$

EE^N_{=P} is a excitatory cell with exactly P excitatory spikes:

$$\lambda_{EE^N_{=l}(\Psi)} = \sum_{i=1}^{\binom{N}{l}} \lambda_{EE_l}\left(\Psi_{l_i}\right) \lambda_I\left(\Omega_{l_i}\right)$$

lambda_I indicate the rate of inputs that does not spike at all:

$$\lambda_{I\left(\Omega_{l_i}\right)} = \prod_{E_j^{(i)} \in \Omega_{l_i}} \left(1 - \int_{t-\Delta}^{t} \lambda_{E_j^{(i)}}(t')\,dt' \right) = \prod_{j=l+1}^{N} \left(1 - \int_{t-\Delta}^{t} \lambda_{E_j^{(i)}}(t')\,dt' \right)$$