Ideas on extending the causal connectivity work

Reformulating in max likelihood method

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Setup

Likelihood formulation

$$\mathcal{L}(\lambda) = \prod_{i=1}^{N} \lambda p_{\mathrm{A}}(t_i) + (1 - \lambda p_{\mathrm{B}}(t_i))$$

with t_i as the N spikes measured in cell C. $p_{\mathrm{A}}(t_i)$ and $p_{\mathrm{B}}(t_i)$ are the PDFs for cell C spiking at t_i, assuming that is was caused by cell A or B. The parameter λ gives the fraction of spikes in C caused by A.

Likelihood formulation

cinpla

In a very simplified approach, a spiking neuron causes a spike in a connected neuron with a certain delay and a certain uncertaity. If neuron A spikes at t_j^{A}, then the pdf for neuron C to spike at time t is given by

$$p(t|t_j^{\mathrm{A}}) = \mathcal{N}(\mu = t_j^{\mathrm{A}} + \Delta t, \sigma = \sigma_{\mathrm{delay}})$$

Thus $p_{\mathrm{A}}(t)$ can be written as

$$p_{\mathrm{A}}(t) = \sum_{j=1}^{M} w_j p(t|t_j^{\mathrm{A}})$$

with a weighting factor w_j and $\sum_j w_j = 1$. Likewise for B.

Likelihood formulation

- If B is not a single cell, but a population of cells, $p_{\mathrm{B}}(t_i)$ can eventually be replaced by the ave3raged firing rate of population B
- The actual shape of $p_{\mathrm{A}}(t_i)$ and $p_{\mathrm{B}}(t_i)$ can be extracted from the model
- Refractory periods can be encorporated in the framework by adjusting the PDFs
- This is not a proposal of a new method, but an extention and proper reformulation of the existing work in a more solid framework
- (The current analysis can also be understood in term of PDFs where the PDFs are just box-shaped function)