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POSTER PRESENTATION

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# A maximum likelihood estimator of neural network synaptic weights

Wahiba Taouali\*, Bruno Cessac

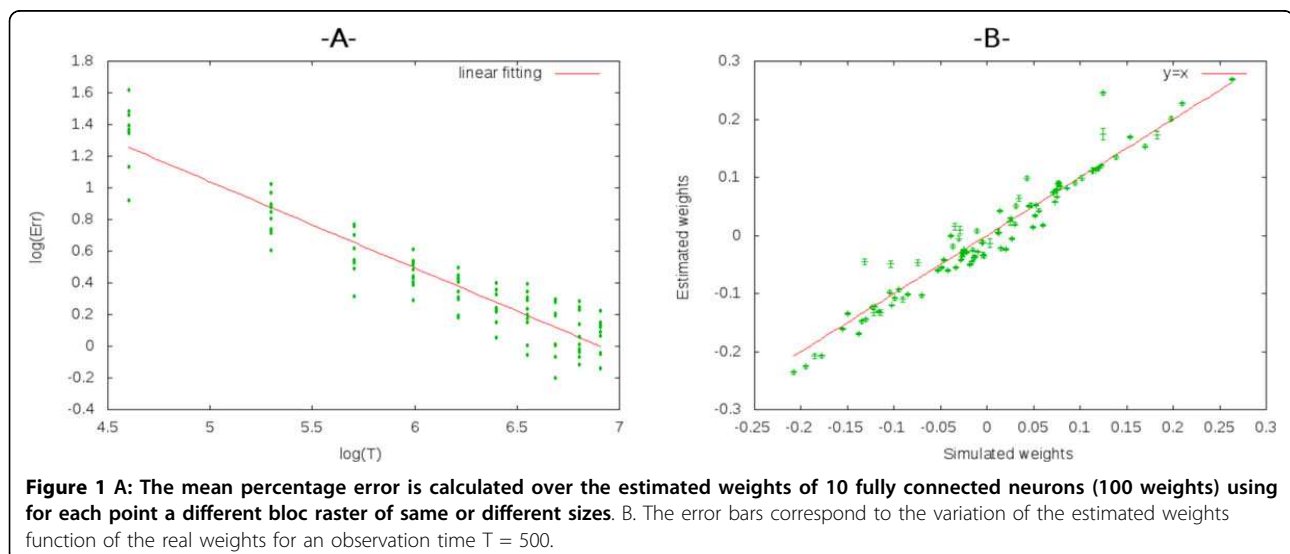
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The statistics of spikes in a neuronal network is constrained on one hand by the stimulus and shared noise, and on the other hand by neuron interactions and collective dynamics. The joint spike statistics and its spatio-temporal correlations can be explicitly computed in conductance-based Integrate-and-Fire models [1,2]. The probability distribution of spike is a Gibbs distribution (in its most general definition allowing to consider non-stationarity) which encompasses existing statistical models such as Maximum Entropy models or Generalized-Linear Models.

Moreover, the dependence of spike statistics in network parameters such as synaptic weights and stimulus is explicit.

Here, we address the following reverse engineering problem. Given a conductance-based Integrate-and-Fire

model as above where the spike statistics dependence on synaptic weights is known, can one reconstruct this network of synaptic weights from the observation of a raster plot generated by the network? We have solved this inverse problem using an explicit expression of a maximum likelihood estimator based on the Newton-Raphson method. This estimator employs analytically computed gradients and Hessian of the likelihood function given by the product of conditional probabilities. The explicit form of these conditional probabilities can be found in [1]. Our results show that this method allows to estimate the set of connections weights knowing the input, the noise distribution and the leak function. Moreover, we found that, in a log scale scheme, the estimation mean percentage error Err decreases linearly with observation time  $T$  (Figure 1).



This estimator is based on a plausible probabilistic model of spiking activity, and not a Poisson likelihood processing. So, it offers a flexible framework that should allow better statistical analysis of real data.

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#### References

1. Cessac B: **Statistics of spike trains in conductance-based neural networks: Rigorous results.** *The journal of Mathematical Neuroscience* 2011, **1**:8.
2. Cofré R, Cessac B: **Dynamics and spike trains statistics in conductance-based Integrate-and-Fire neural networks with chemical and electric synapses, to appear in.** *Chaos, Solitons and Fractals* 2013.

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