Dynamics of plastic networks of excitatory and inhibitory spiking neurons

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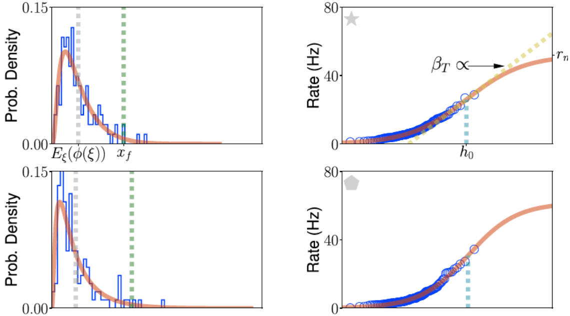
Inferring the transfer function from ITC data



Measuring the *static* transfer function from novel images assuming that input currents are Gaussian variables

$$\phi(\xi) = \frac{r_{max}}{1 + \exp \beta(\xi - \xi_0)}$$

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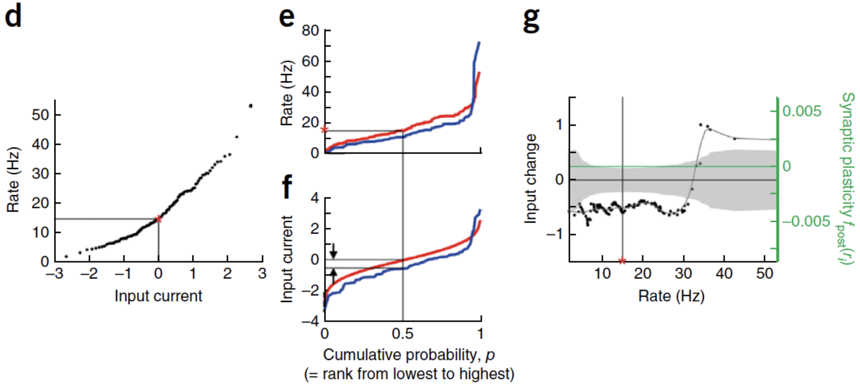
[1][Peirera and Brunel, Neuron. 2018]

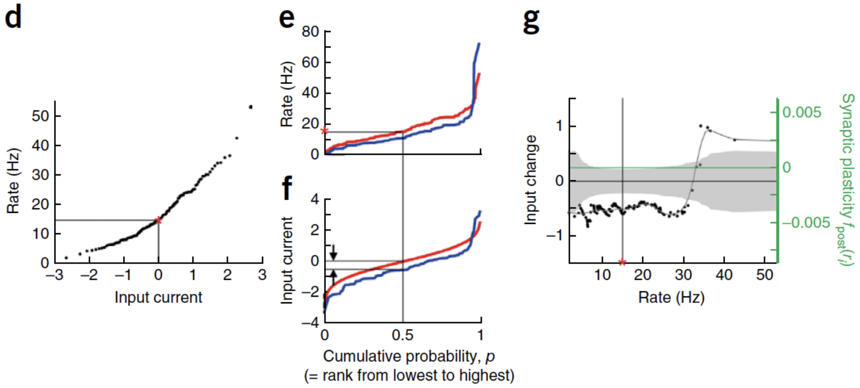
Inferring the learning rule from ITC data



Inferring the change in input current ξ_{in} from the change in firing rate in novel relative to familiar stimuli [2]

[2] [Lim et al., Nature Neuroscience. 2015]

Inferring the learning rule from ITC data



The change in input current to a neuron can then be read from the firing rate of that neuron when presented a novel stimulus

$$\Delta\xi_i(r) \propto (2q + 1 - \tanh(\beta(r - x)))$$

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[3] [Lim et al., Nature Neuroscience. 2015]

A Hebbian update for synaptic weights

Assuming that $\Delta W_{ij} \propto f(r_i)g(r_j)$, the change in input current is related to synaptic plasticity by

$$\Delta\xi_i \propto f(r_i)\sum_j g(r_j)r_j$$

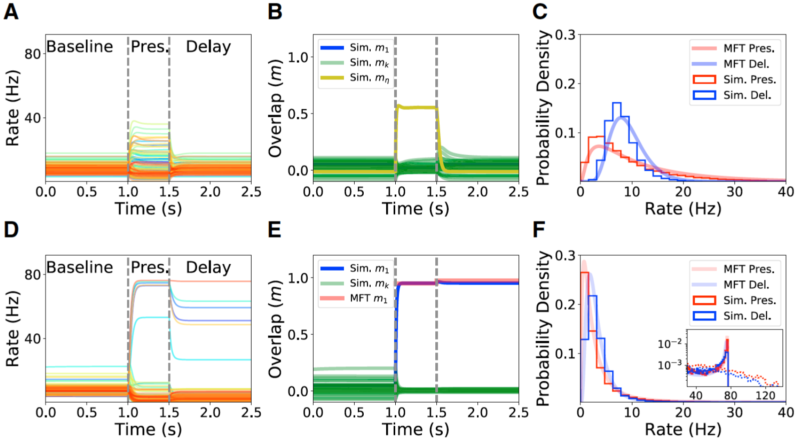
which we have fit from the data as

$$\Delta\xi_i(r) \propto (2q + 1 - \tanh(\beta(r - x)))$$

so we can write

$$f(r_i) = \frac{(2q + 1 - \tanh(\beta(r - x)))}{\sum_j g(r_j)r_j}$$

Presenting novel and familiar stimuli to the network



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[4] [Peirera and Brunel, Neuron. 2018]