

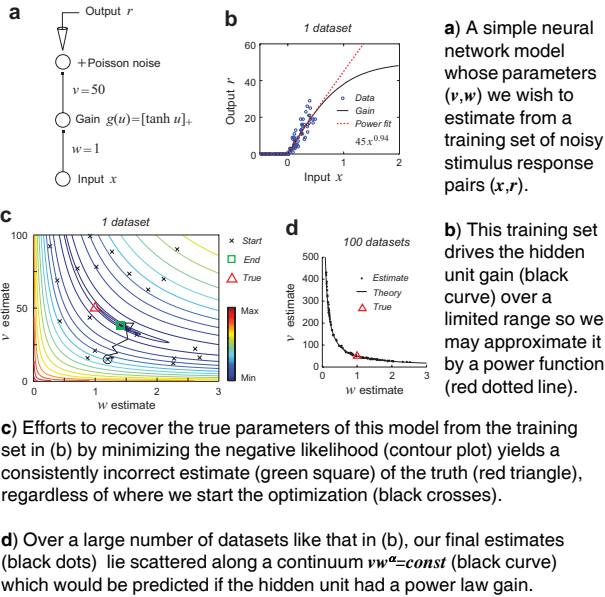
Adaptive Experimental Design for Online Model Comparison

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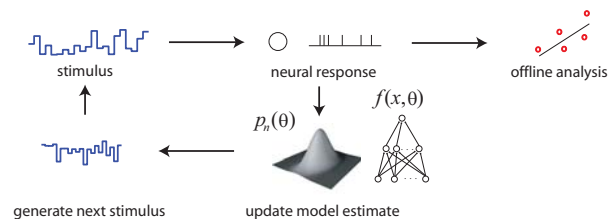
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Network models cannot be estimated accurately without proper stimuli



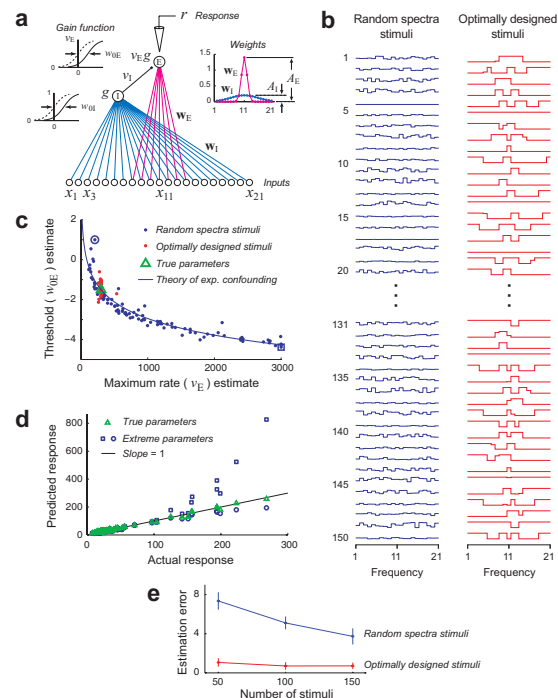
Hidden units must be driven over their full dynamic range to avoid continuous parameter confounding

Optimal experimental design adaptively chooses best stimuli to estimate model



At each step, current information about the system parameters is used to generate the next stimulus

Optimal experimental design for a center-surround neural network



a) Hypothetical neural network of a type II neuron in the dorsal cochlear nucleus, which receives input from the auditory nerve.

b) Left: Random stimuli comprised of tones of varying frequency played at random amplitudes. **Right:** Optimally designed auditory stimuli chosen to minimize the expected posterior entropy.

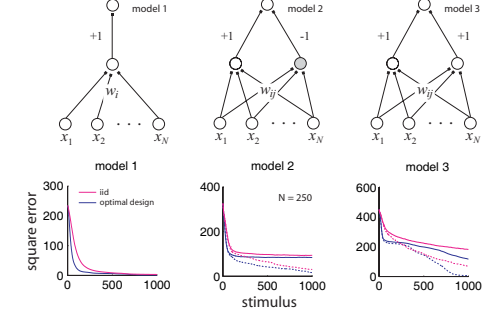
c) We see parameter confounding as predicted by theory when the network is trained with the random data. When trained with optimally designed stimuli, the true model parameters are recovered.

d) Correct recovery of true model parameters is necessary for model to accurately predict responses to a novel class of stimuli.

e) We see that the estimation error is far less for the optimally designed stimuli than with the random stimuli.

Optimally designed stimuli are necessary to avoid continuous confounding in a simple network

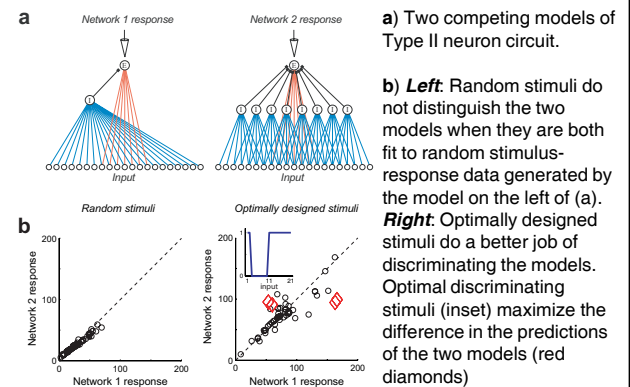
Optimal experimental design for generic three-layer models



Top: Generic three layer neural networks model higher auditory areas where the underlying circuitry is unknown. **Bottom:** Average squared error for IID stimuli (pink) and optimally designed stimuli (blue). For models 2 and 3, some experiments fell into local minima. A subset of experiments (N=50) which find the global minimum are plotted as dashed lines.

Optimally designed stimuli speed convergence

Optimal discriminating stimuli can be generated online to distinguish competing neural models



It may be impossible to distinguish two models with random stimuli, but easy with optimal design.