
Ethological Theories: Optimal Auditory Processing
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Using as a starting point the postulate that sensory systems have evolved to perform optimal transformations on behaviorally relevant or natural stimuli, we will use systems analysis methods and information theoretic principles to develop a theory of auditory processing. The goals of our theory will be to predict the stimulus-response transformations that are found at different stages of auditory processing. First, we will obtain theoretical predictions for the distribution of linear receptive fields by jointly maximizing signal to noise ratio and entropy in the output of the ensemble of filters when presented with natural sounds. Second, we will derive non-linear stimulus-response transformations that can be obtained with biologically plausible networks and that will minimize the mutual information across neurons. These neural networks will perform a form of independent component analysis, in which the resulting operation is to extract independent acoustical features in natural sounds. We will also develop novel methods to estimate the information transmitted by single neurons and ensembles of neurons in songbirds.

At the meeting, I will describe new parametric methods that we have recently derived to estimate the information transmitted by single neurons (Hsu et al., 2004) and by ensemble of neurons. Using these methods, we found that the rate of information was higher for natural sounds than for synthetic sounds with match acoustical properties. Be examining the linear fraction of the neurons response, we can shows that some of this tuning for natural sounds is caused by a whitening of the spectrum of the amplitude modulations found in natural sounds.

Project Website

http://psychology.berkeley.edu/directories/facultypages/theunissenresearch.html

Publications

Anne Hsu, Sarah M. N. Woolley, Thane E. Fremouw, and Frédéric E. Theunissen "Modulation Power and Phase Spectrum of Natural Sounds Enhance Neural Encoding Performed by Single Auditory Neurons"

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