

BI-CO MATHEMATICS COLLOQUIUM

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*“Compressed Coding in Sensory Systems:
From Sparse Stimuli to Network
Structure”*

Monday, January 25, 2016

Talk at 4:00 – Park 338

Tea at 3:30 – Park 355, Math Lounge

Abstract:

Considering that many natural stimuli are sparse, can a sensory system evolve to take advantage of this sparsity? We explore this question and show that significant downstream reductions in the numbers of neurons transmitting stimuli observed in early sensory pathways might be a consequence of this sparsity, facilitating accurate and efficient compression of sensory data. First, we model an early sensory pathway using an idealized nonlinear neuronal network comprised of receptors and downstream sensory neurons. Then, by revealing a linear structure intrinsic to neuronal network dynamics, our work points to a potential mechanism for transmitting sparse stimuli, related to compressed-sensing (CS) type data acquisition. Through large-scale simulation, we examine the characteristics of networks that are optimal in sparsity encoding, and the impact of realistic localized receptive fields beyond conventional CS theory. The results of this work suggest a new network framework of signal sparsity, freeing the notion from any dependence on specific component-space representations. We expect our CS network mechanism to provide guidance for studying sparse stimulus transmission along realistic sensory pathways as well as understanding the relationship between neuronal network structure and specialized functionality.

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