ACMS Applied Math Seminar

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127 Hayes-Healy
3:30 PM

Multineuronal activity patterns: A framework for computation in the brain

Stereotyped multineuronal activity patterns within local neocortical circuitry are closely tied to sensory input, motor output and behavioral choice. These reliable patterns of pairwise lagged firing are the consequence of connectivity since they are not present in rate matched but unconnected Poisson nulls. However, it is unclear how effectively the statistical dependency of spiking between neocortical neurons identifies causal synaptic connections. We used a network model that showed a diversity of multineuronal activity patterns, consistent with experimental observations, to quantify the effectiveness of algorithmically evaluating multineuronal activity patterns to identify synaptic connections. Using an iterative Bayesian inference algorithm we precisely detected a select subset of monosynaptic connections. Iterative Bayes inference was substantially more precise in identifying causal monosynaptic connections than correlation-based inference, a common alternative approach. We found that precise inference of synaptic connections improved with increasing numbers of diverse multineuronal activity patterns in contrast to increased observations of a single pattern. Surprisingly, neuronal spiking was most effective and precise at revealing causal synaptic connectivity when the lags considered by the iterative Bayesian algorithm encompassed the timescale of synaptic conductance and integration (~10ms), rather than synaptic transmission time (~2ms) - highlighting the importance of synaptic integration in driving post-synaptic spiking. Lastly, strong synaptic connections were detected preferentially, underscoring their special importance in cortical computation. Thus a top down approach to cortical connectivity, from function to structure, is optimal for identifying those connections most closely tied to the generation of multineuronal activity patterns and in turn cortical processing.