The University of Chicago
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Master's Seminar

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Memory Capacity of a Hebbian Learning Model with Inhibition

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ABSTRACT

It has been shown that for a general discrete Hebbian-type learning model, when all parameters governing the stochastic learning process are fixed, the storage capacity of the model to learn a stream of uncorrelated stimuli is as low as $O(\log N)$, where N is the number of neurons in the network. If the coding level (proportion of active neurons) of the stimuli can vary with N as $f \sim \log N/N$, then the capacity can be raised to $O(1/f) = O(N/\log N)$. If transition robability can also vary with N, the capacity can reach $O(N^2/\log^2 N)$.

However, these conclusions were made by assuming all stimuli are of a single coding level and by ignoring the covariances between synapses. We derive a general formula for the asymptotic synaptic covariances and extend the analysis to stimuli with two coding levels. In the old setting, it is impossible to set a universal threshold to retrieve the memory of stimuli from two different coding levels. When the inhibition mechanism is properly introduced, it is possible to set a threshold to retrieved stimuli from both coding levels, and the memory capacity remains at the same level as single-level coding.