Convergence and Pattern-Stabilization in the Boltzmann Machine

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Abstract: The Boltzmann Machine has been introduced as a means to perform global optimization for multimodal objective functions using the principles of simulated annealing. In this paper we consider its utility as a spurious-free content-addressable memory, and provide bounds on its performance in this context. We show how to exploit the machine's ability to escape local minima, in order to use it, at a constant temperature, for unambiguous associative pattern-retrieval in noisy environments. An association rule, which creates a sphere of influence around each stored pattern, is used along with the Machine's dynamics to match the machine's noisy input with one of the pre-stored patterns. Spurious fIxed points, whose regions of attraction are not recognized by the rule, are skipped, due to the Machine's fInite probability to escape from any state. The results apply to the Boltzmann machine and to the asynchronous net of binary threshold elements (Hopfield model'). They provide the network designer with worst-case and best-case bounds for the network's performance, and allow polynomial-time tradeoff studies of design parameters.