The Relationship Between Choice Of Representation, Network Structure And Performance In Harmony Theory Networks

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Harmony Theory (HT) networks [1] are capable of solving constraint-satisfaction tasks in parallel via simulated annealing, whereas a global maximum (peak) of the internal-consistency landscape of the problem-space is found. Due to their capacity of directly encoding constraints, connectivity and the weight vector need not be formulated through a training phase but can be mathematically defined once the choice of representation (what part of the problem each network node and connection stands for) has been decided upon. This piece of research investigates the effect of the choice of representation and of the ensuing representation-dependent structure of a HT network on the internal-consistency landscape and subsequently on performance. This is of special interest in order to:

(1) Establish how the landscape is "sculpted" by the choice of representation.

HT network implementations of a given problem employing different representations [2] vary in terms of: a) the explicit versus implicit coding of the constraints of the problem [2], b) the weights [1] (values depend on the cardinality of the connections emanating from a node) and c) the strengths [1] (expressing the priority of a node in being satisfied). These determine the internal-consistency landscape describing the problem-space. Each point of the landscape corresponds to a possible state of the network, its "height" specifying its internal consistency. During simulated annealing [1], gradual ascent converges to a peak of the landscape, i.e. a solution to the problem.

(2) Determine the characteristics of the "optimal" landscape which allow for the best behavior in order to ascertain the attributes of the representation which can offer that.

The states of the network receive "heights" which vary according to the representation employed. Consequently, the form of the landscape (relative "height" and distance of the peaks and other points, configuration of valleys and plateaus, steepness and smoothness of the slopes) is representation-dependent and affects network performance in terms of: i) the power of convergence (the ability to reach a solution, the relative frequency with which each state is settled upon and the manner in which gradual crystallization becomes evident), ii) the accuracy of settling (the occurrence of probabilistic errors and of symmetry-breaking failures) and iii) the speed of settling, (the number of iterations necessary for settling, i.e. extreme values of temperature, decrements and critical values).

1. Smolensky, P., (1986). Foundations Of Harmony Theory, pp. 194-281, in "Parallel Distributed Processing: Foundations".

2. Tambouratzis, T., (1991). Harmony Theory Networks For Scene Analysis, pp. 1743-1746, in "Artificial Neural Networks".