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LAGRANGE NEURAL NETWORK FOR SOLVING CONSTRAINT SATISFACTION PROBLEM

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Abstract. *The constraint satisfaction problem (CSP) is a combinatorial problem to find a solution which satisfies all given constraints. The CSP can represent various problems which appear in the fields of Artificial Intelligence. In this paper, we propose a neural network called Lagrange programming neural network with polarized high-order connections for constraint satisfaction problem (LPPH-CSP) to solve the CSP. Every equilibrium point of this neural network is a solution of the CSP, and vice versa. Thus LPPH-CSP is not trapped by any point which is not a solution of the CSP. We compare LPPH-CSP with a generic neural network approach called GENET which is a famous CSP-solver. Experimental results show that our method is as efficient as GENET. However our neural network can update all neurons simultaneously for solving the CSP. In contrast, GENET must update variables sequentially. We consider that this is an advantage for the VLSI implementation.*

Keywords: Neural network, Constraint satisfaction problem, Local search, Lagrangian method

1. **Introduction.** The Hopfield neural network [1] has been used for solving combinatorial problems such as the traveling salesman problem. This network is also well known to be trapped by a local minimum of the energy function. Therefore, it needs some mechanism like the restart strategy to find a global minimum. We proposed a neural network called Lagrange programming neural network with polarized high-order connections (LPPH) [2-4] for solving the satisfiability problem (SAT). The SAT is a problem to find an assignment of truth values to variables which satisfies a given conjunctive normal form (CNF). LPPH has gradient descent dynamics for variables and gradient ascent dynamics for Lagrange multipliers. Thus, the dynamics of LPPH changes its energy landscape dynamically, and LPPH is not trapped by any point which is not a solution of the SAT. Experimental results show that our method is effective.

In this paper, we generalize this neural network for solving the constraint satisfaction problem (CSP), and propose a neural network called Lagrange programming neural network with polarized high-order connections for constraint satisfaction problem (LPPH-CSP). The CSP is a problem to find a variable assignment which satisfies all given constraints and is a well known NP complete problem. Because the CSP has a well defined abstract formulation, it can effectively represent various problems in the computer science. The SAT can also represent many problems. However, when practical problems are