

Project No.	Project Title	
2021-01-094	Tie breaking in incomplete inference algorithms	
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Abstract

Many different applications in our world are naturally distributed, such as Mobile sensor nets, automatic meeting scheduling by smart calendars, and IOT applications. Distributed Constraint Optimization Problem (DCOP) is a general framework for describing distributed problems including constraints, which can be represented by a graphical model and solved using message passing algorithms. DCOPs are known to be NP-Hard, and thus require the use of incomplete algorithms for realistic purposes.

In this project we will focus on Max-sum, an incomplete inference algorithm for solving DCOPs, based on beliefs calculated by agents regarding the best possible value assignments. The algorithm operates on a factor graph including variable-nodes and function-nodes. On tree-structured graphs Max-sum is known to converge to the optimal solution. But in graphs with cycles, the duplication of propagated information leads to inaccurate and inconsistent beliefs and sub-optimal assignment selection.

A route in such a setting is a concatenation of cost cells chosen in each iteration for a specific vector entry in a function-node message. In a single cycle, an inconsistent route can exist with a smaller normalized cost than the cost of the optimal route. In this case, Max-sum will not converge to the optimal solution. A tie between beliefs can happen in many cases and may cause the algorithm to oscillate. There has been almost no research trying to better understand implications of ties on Max-sum, although two solutions have been proposed: "dust" spreading and Value propagation. Each of them has limitations. Using the minimal route and the backtrack cost tree (BCT), which reveal the components that were summed in order to generate a propagated belief, we try to prove that one will encounter a tie when applying Max-sum to a single cycle graph on which the algorithm does not converge. That proof will help future research to analyze the behavior of the algorithm in the presence of ties and find better solutions to such problems.

So far, we proved our claim for the simple case where there are two variable nodes with domain size of 2. For future research we intend to continue and generalize our proof to a larger graphs, and hopefully to find better ways to bypass this problem.

Keywords: DCOP, Multi-Agent System, Incomplete Algorithms, Max-Sum