Project No.	Project Title	
2022-01-224	Applications of distributed optimization algorithms on service-oriented problems	
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Abstract

Multi-Agent Optimization Problem (MAO) have many realistic applications in environments where autonomous entities cooperate to achieve a global objective. In a service-oriented MAO, the objective is to allocate service providing agents to service requiring tasks. Service providing agents decide to which of the service requiring agents to provide service and in what order. The utility derives depends on the quality of the service, the time it took to provide it and the cooperation among service providing agents. The solution for the problem is a schedule for each agent, with an aim to maximize the team's global utility.

A common method for solving such problems is by modeling them as Distributed Constraint Optimization Problems (**DCOPs)** and applying DCOP algorithms for solving them. However, the standard DCOP structure is not suitable for representing such problems due to their natural division between service-providers and service-requesters. Moreover, service-providers interact only with service-requesters and vice-versa, so the structure of the graph representing service-oriented problems is bipartite.

Transforming DCOPs to a bipartite graph, in which there is a clear distinction between two sets of nodes, will allow us to address the limitation of the standard DCOP model and run existing algorithms to solve service-oriented problems. **"Max-Sum"** is one such algorithm; it is the "belief propagation" version that solves DCOP, and it operates on a bipartite graph. This makes "Max-Sum" a natural choice for solving service-oriented multi-agent problems.

In our project, we focused on solving the problem mentioned above using "Max-Sum". The main challenge we encountered is **symmetry**; When multiple service-providers are required to fully serve a service-requester, due to the nature of "Max-sum", the common result is that all of the service-providers are being attracted to the service-requester, or none of them. We proposed heuristics to overcome this phenomenon.

Previous work proposed the Service-Oriented Multi-Agent Optimization Problem (**SOMAOP**) model and algorithms for solving it. In our project, we applied "Max-Sum" to SOMAOP, and compared it with SOMAOP algorithms.

Keywords: Multi-Agent System; Task Allocation; Distributed Constraint Optimization Problems (DCOPs); Max-Sum.