

# Report on Distributed Multi-Agent Planning

## Introduction

We here studied the one of the hottest planning topic about distributed multi-agent planning (DMAP) problems. According to B.K. Durkota's studying [1], there are three most popular methods to attempt to handle with this hard problem. They are

- Distributed Constraint Satisfaction Problem solving for coordination of the agents and individual planning using local search [2]
- Multi-agent adaptation of A\* with local heuristics [3]
- Distribution of the GraphPlan approach based on merging of planning graphs [4]

## Contents and Relations

In [2], Nissim et al divide this domain into public parts and the private ones. For public aspects (coordination and communication between agents), they design a coordination component to deal with it by constraint satisfaction and CSP searching. They also improve the searching strategy for efficiency with modified planning graph structure. For private aspects, Nissim et al use local planning with individual planning component to solve the other types of constraints and encodes the local parts. This method is called **DisCSP+Planning**.

As for [3], the authors extend the A\* search into the parallel and distributed systems (Multi-agent Distributed A\*, **MA-A\***), which contain multiple agents by simple formulation. The algorithms keep the explored and frontier set for visited and unvisited stats. Each agent just needs to make next action by itself with global explored and local frontier information. Otherwise, there needs some interaction points between agents to make next action in [2].

In [4], Pellier propose a method called Distributed Planning Through Merging (**DPGM**). DPGM replace the different stages of the distributed planning process with a single step. This approach is based on a planning graph structure for agent reasoning and a CSP mechanism for individual plan extraction and coordination. However, DPGM also assumes that no one agent can solve the problem alone. Therefore, like in [2], it will use potential positive interactions to reach the shared goal during the activities.

## Impacts and Conclusions

In multi-agent planning domains with limited agent interaction, **DisCSP+Planning** performs better than centralized method, especially in individual planning with combinatorically hard problem. While **MA-A\*** has advantages in highly coupled domains since it has additive heuristics. As for not tightly coupled or combinatorically easy, **DPGM** shows the bright perspective and efficiency.

## References

- [1] B. K. Durkota, "Comparison of deterministic distributed and multi-agent planning techniques," Master's thesis, CZECH TECHNICAL UNIVERSITY IN PRAGUE, 2013.
- [2] R. Nissim, R. I. Brafman, and C. Domshlak, "A general, fully distributed multi-agent planning algorithm," in *Proceedings of the 9th International Conference on Autonomous Agents and Multiagent Systems: volume 1-Volume 1*. International Foundation for Autonomous Agents and Multiagent Systems, 2010, pp. 1323–1330.
- [3] R. Nissim and R. I. Brafman, "Multi-agent a\* for parallel and distributed systems," in *Proceedings of the 11th International Conference on Autonomous Agents and Multiagent Systems-Volume 3*. International Foundation for Autonomous Agents and Multiagent Systems, 2012, pp. 1265–1266.
- [4] D. Pellier, "Distributed planning through graph merging," in *International Conference on Agents and Artificial Intelligence*, 2010.