Research Review
Multi Agent Planning

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Introduction

Multi agent planning is a vast field with many applications. It involves coordinating the resources and actions of multiple (AI) agents. The agents can plan for a common goal, the agent may merge the plans, or they may refine their own plans while negotiating over tasks and resources. In short, the multiple agents work together as a team to perform a task, or reach a goal state. In it multiple agents plan for multiple agents, ensuring that plans are properly coordinated. To ensure that plans are properly coordinated is major challenge in MAP.

In this review, I briefly discuss three key developments in the field of multi agent planning.

1. **Distributed Constraint Satisfaction to Co-ordinate between agents:** Initially proposed by Brafman and Domshalk [1], this solves the multi agent planning problem by compiling it into a particular constraint satisfaction problem (CSP). This has allowed researchers to explore even distributed CSP, thus parallelizing the planning process. In a recent paper by Nissim et al [2], proposed a modification which solves the non-binary constraint problem and large search space. They developed a way to encode the MAP in to DisCSP such that agent interaction graphs are simple (i.e. agents do not interact with each other in complex constraints), keep the domains relatively small. To achieve this they separated the agent's variable in to three separate variables, this gave them flexibility and control in variable and value function. They divide the complex problem into solving a simple relaxed plan (subgoal) for each agent.
2. **Privacy concerned multiagent planning:** Conventionally, the environment in which the agents act are described as deterministic transition systems, and the planning in such systems can be modeled by MA-STRIPS. In a 2016 paper Tozicka et al, propose a multiagent planning approach which combines compilation for a classical state-of-the-art planner along with a compact representation of local plans in the form of finite-state machines. They were able to boost the planner efficiency by using distributed delete-relaxation heuristics and using an approximative local plan analysis.
3. **Distributed Planning through Graph Merging**: Pellier in his paper [4] proposes a distributed planning through graph merger (DPGM) model for distributed multi agent planning. In this method, each agent first expand their individual planning graph, then they merge threats and promotions from other agents, finally it performs a backward search from the last level of its graph for an individual agent plan. The process is continued until a global solution is found or failure termination condition is met..

Refrences:

1. Brafman, Ronen I., and Carmel Domshlak. "Factored planning: How, when, and when not." *AAAI*. Vol. 6. 2006.
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3. Tožička, Jan, et al. "Privacy-concerned multiagent planning." *Knowledge and Information Systems* 48.3 (2016): 581-618.
4. Pellier, Damien. "Distributed planning through graph merging." *International Conference on Agents and Artificial Intelligence*. 2010.