Research Review

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Date: 2017/03/19

Partial-order planning

Partial-order planning is an approach to automated planning that leaves decisions about the ordering of actions as open as possible**[1]**. To better understand that, it might be helpful to know what planning is, and then what ordered planning entails. To that end, planning is "the task of coming up with a sequence of actions that will achieve a goal"**[2]**. There are several types of algorithms that allow us to construct a plan, such as regression planning and progression planning, which Norvig taught in the videos, and partial-order is also one of the kind. But what distinguishes partial-order planning from the other two - it is not totally-ordered as we see in progression and regression planning. Instead, partial-order planning enables us to "take advantage of problem decomposition." The algorithm "works on several subgoals independently, solves them with several sub-plans, then combines the sub-plans". In addition, he notes that, "such an approach also has the advantage of flexibility in the order in which it constructs the plan. That is, the planner can work on 'obvious' or 'important' decisions first, rather than being forced to work on steps in chronological order." In the 1980s and 90s, partial-order planning was seen as the best way to handle planning problems with independent subproblems—after all, it was the only approach that explicitly represents independent branches of a plan. On the other hand, it has the disadvantage of not having an explicit representation of states in the state-transition model. That makes some computations cumbersome. By 2000, forward-search planners had developed excellent heuristics that allowed them to efficiently discover the independent subproblems that partial- order planning was designed for. As a result, partial-order planners are not competitive on fully automated classical planning problems.**[3]**

Graphplan

Graphplan is an algorithm for automated planning developed by Avrim Blum and Merrick Furst in 1995.**[4]** The name graphplan is due to the use of a novel planning graph, to reduce the amount of search needed to find the solution from straightforward exploration of the state space graph. There are two stages in Graphplan, extend and search.**[5]** Given a set of proposition at level t, Graphplan uses it with forward search to create action at level t and propositions at level t+1. And then Graphplan uses backward search level by level to search for a valid plan. Before GraphPlan appeared in 1995, most planning researchers were working under the framework of "plan-space search". GraphPlan outperformed those prior planners by orders of magnitude GraphPlan started researchers thinking about fundamentally different frameworks, such as IPP, STAN.[6]

Satplan

Satplan converts the planning problem instance into an instance of the Boolean satisfiability problem, which is then solved using a method for establishing satisfiability such as the DPLL algorithm or WalkSAT.**[7]** The satisfiability approach not only provides a more flexible framework for stating different kinds of constraints on plan, but more accurately reflects the theory behind constraint-based planning systems.**[8]** Satisfiability is finding a model of axioms, which is complementary approach to deducibility. Satplan framework lead to large improvements when it was first introduced, especially in the area of optimal planning. At that time there was much recent progress in satisfiability solvers, this work was an attempt to leverage that work by reducing planning to satisfiability.[9]

References

- [1] Wiki: Partial-order planning
- [2] Russell, Stuart and Norvig, Peter. Artificial Intelligence: A Modern Approach 2nd Edition, P. 375.
- [3] Russell, Stuart and Norvig, Peter. Artificial Intelligence: A Modern Approach 3rd Edition, P. 391.
- [4] Wiki: Graphplan
- [5] Handout: 15-887A - AI Planning, Execution, and Learning, Reid Simmons
- [6] Russell, Stuart and Norvig, Peter. Artificial Intelligence: A Modern Approach 3rd Edition, P. 395.
- [7] Wiki: Satplan
- [8] H. A. Kautz and B. Selman (1992). Planning as satisfiability. In Proceedings of the Tenth European Conference on Artificial Intelligence (ECAI'92), pages 359-363.
- [9] Handout: CS-533 - Intelligent Agents & Decision