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AIND Research Review

Research Reviews

Requirements and Outcome:

Read up on important historical developments in the field of AI planning and search. Write a one-page report on three of these developments, highlighting the relationships between the developments and their impact on the field of AI as a whole.
Appropriate sources (such as books or magazine or journal articles) should be cited, and you should use citations in-line for sourced facts, quotations, and inferences.

Review:

Each of these papers: *Planning Graph as the Basis for Deriving Heuristics for Plan Synthesis by State Space and CSP Search[1], Constraints and AI Planning, Constraint Programming [2], The FF Planning: Fast Plan Generation Through Heuristic Search[3]*, expand capabilities of a planning, which is known to be PSPACE-complete, very important in the field of AI, which tries to tackle NP or PSPACE complete problems. They all relay on searches and heuristics to find optimal path lengths at a reasonable time frame. Nguyen et al [1], to reduce memory requirements which can be unreasonable, use GRAPHPLAN to extend the Planning Graph up to the estimated optimal path length. Doing so, their system was able to provide a solution when others due to memory requirements just stopped. They also had to modify their heuristic, they could not use the max function….

While one may assume that a combination between a great search algorithm and heuristic should be enough to solve any problems, which was true when building a game player, Nareyek et al [2] show that the "language" used to represent partial view of the planning problem can also have impact on what can or cannot be within AI possibilities. For instance, by moving from a "restricted constraints to propositional formulas and constrains variables to Boolean domain" [2] to a, constraint planning, CP, one can have access to more variable types, even if they are required to have finite domains. CP describes problems as constraint satisfaction problems (CSPs): where each variable is associated with a domain and a set of constraints [2]. Just like classical planning, CSP can be represented as a graph, where nodes are variables and constraints. Variables are connected to constraints if the corresponding constraint relation contains the variable. Most importantly, CP's global constraint can capture domain specific dependencies, and hence, can exploit higher-level domain knowledge. This is a great step in AI planning, now researchers and practitioners have a more general framework of solving planning problems.

Hoffman et al [3], build Fast-Forword Planning System that won the AIPS-2000 planning competition. The system combines an enforced form of hill-climbing and a systematic search. Like in Nareyek et al [2], it also uses GRAPHPlan, but it uses first enforced hill-climbing to find the goals, but if enforced hill-climbing fails, it calls upon a complete heuristic search—also called Greedy Best first Search. It either selects a set of promising successors for each search node, or it cuts out branches if the same goal has been achieved before. While one cannot prove theoretically that it works, in practice, the heuristic usually finds optimal or close to optimal solution. What is interesting, it never has to go more than 2 steps ahead for the optimal length path.
These three papers all extend AI in planning applications, by expanding AI application to problems that can be solved using AI [1], of by reducing search space by restricting GRAPHPLAN number of layers [2], or by adding heuristics that make finding a close or optimal solution possible[3].

Papers Reviewed:

1. Nguyen X., S. Kambhampati, and R. S. Nigendo, *Planning Graph as the Basis for Deriving Heuristics for Plan Synthesis by State Space and CSP Search,* Artificial Intelligence 135 (2002) 73-123
2. Nareyek A., al, *Constraints and AI Planning, Constraint Programming,* IEEE Intelligent Systems, 2005-03.
3. Hoffmann J., B. Nebel*, The FF Planning: Fast Plan Generation Through Heuristic Search*, Journal of Artificial Intelligence Research 14 (2001) 253-302