Planning Project – Research Review

Logic and planning are an important part of the larger field of Artificial Intelligence (AI). In this review, we discuss several developments in planning that were influential on the field of AI.

STRIPS

"AI planning arose from investigations into state-space search, theorem proving and control theory and from practical needs for robotic, scheduling and other domains. STRIPS (Fikes and Nilsson, 1971), the first major planning system, illustrates the interaction of these influences." [*Artificial Intelligence a Modern Approach (AIMA)*, 3rd ed, Norvig and Russel]. "The representation language used by STRIPS has been far more influential than its algorithmic approach; what we call the 'classical' language is close to what STRIPS used" [*AIMA*, 3rd ed, Norvig and Russel]. The Planning Domain Definition Language is another example of a planning language. It was derived from the original STRIPS planning language. The PDDL was introduced as a computer-parsable, standardized syntax for representing planning problems and has been used as the standard language for the international planning competition since 1998 [*AIMA* 3rd ed, Norvig and Russel].

Partial-order Planning

"The construction of partially ordered plans (then called task networks) was pioneered by the NOAH planner (Sacerdoti, 1975, 1977) and by Tate's (1975b, 1977) NONLIN system" [*AIMA*, 3rd ed, Norvig and Russel]. Partial-order planning (POP) had some advantages over linear planning such as, the ability to interleave actions from different subplans within a single sequence. Partial-order planning was dominant in the field of planning research for almost 20 years after its introduction [*AIMA* 3rd ed, Norvig and Russel].

GRAPHPLAN

"Avrim Blum and Merrick Furst (1995, 1997) revitalized the field of planning with their GRAPHPLAN system, which was orders of magnitude faster than the POP planners of the time. Other graph-planning systems, such as IPP (Koehler et al., 1997), STAN (Fox and Long, 1998), and SGP (Weld et al., 1998), soon followed" [*AIMA* 3rd ed, Norvig and Russel]. Further developments extended the system's ability to handle expressive action languages, metric resources, and uncertainty [Weld 1999]. The AI planning systems that resulted from the advancement sparked by GRAPHPLAN were used to control a real NASA spacecraft, demonstrating that AI planning had matured enough as a field to increase the number of fielded applications [Weld 1999].

Planning based on Markov Decision Processes

"Planning based on Markov Decision Processes (MDPs) is designed to deal with nondeterminism, probabilities, partial observability, and extended goals. Its key idea is to represent the planning problem as an optimization problem" [*Automated Planning*, Ghalleb et al]. In this system, the planning domain is modelled as a stochastic system, where uncertainty about action outcomes is modelled with a probability distribution. Goals are utility functions, plans are policies, and partial observability is modelled by observations that return a probability distribution over the state space, called belief states [*Automated Planning*, Ghalleb et al].

Conclusion

STRIPS algorithm was influential in creating the language for structuring planning problems and allowed for linear planners to solve problems in PSPACE-complete domains. Partial-order planning was able to improve upon the linear planning or total-order planning by allowing for inter-leaving of actions. GRAPHPLAN was influenced by the STRIPS planner as it used a STRIPS-like domain to construct its model [Blum and Furst 1997] and improved upon the partial order planners by orders of magnitudes in some problem domains. Planning based on Markov Decision Processes allowed for designing planners that could deal with partially observable domains.

References:

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Weld, D. S. (1999), Recent Advances in AI planning. *AIMag*, 20(2) 93-122. Retrieved from https://pdfs.semanticscholar.org/590b/d05f3b293a1f1f6c4bf7556f0d67e68485da.pdf