Research Review

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This is a brief review of 3 research developments themed around partial-order planning, all of which are highlighted at the end of Chapter 10: Classicial Planning of the textbook (Russell & Norvig, 2010). Here I start with a short paragraph of the overall impact of these researches, then summarize the output of each individual research, and explicitly discussed about the relationship among these developments, based on how each researcher thought of his own work and how they referred to others'.

Overall Impact

These 3 researches are some of the milestones in the great progress of building a general-purpose planner that comprehensively and rigorously resolved the issues left behind by its predecessor total-order planning. And it's hard to imagine, without their work, this partial-order planning field would have stayed active and mainstream for as long as 20 years (Russell & Norvig, p. 394).

(Sacerdoti, 1975)

Research Summary – It created a new action representation named Procedure Net and using that, developed a framework to represent a plan as partial ordering of actions with regard to time, and implemented in NOAH (Nets of Action Hierarchies) program to solve planning problems by expanding solution in hierarchy from high-level to detail-level. And the same structure is versatile enough to be tasked for execution monitoring and interaction with human users. (Sacerdoti, p. 88)

Relationship – This research and NOAH is the first solution to work with partially ordered plans in the process of being generated, therefore allowing interleaving sub-plans (Russell & Norvig, 2010). Notably, it resolved in a systematic way (Sussman Anomaly, n.d.), which used to be handled in an ad-hoc manner during previous research. Sacerdoti's work was the pioneer in the area of partial-order planning, its successful hierarchical and nonlinear structure became a solid foundation for future work, including but not limited to the next 2 to be discussed; and its suggested extension (Sacerdoti, p. 115) pointed out many directions researchers could pursue in future.

(Chapman, 1987)

Research Summary – It combined and distilled state-of-art representations and technique in the same field and developed a nonlinear (partial-order) domain-independent planner TWEAK. And it unites all conjunctive planning algorithms, whether linear or nonlinear, into the same framework and vocabulary. Along the way, the research gave rigorous mathematical proofs on many basic properties of this whole class (Chapman, p. 365) including: correctness or completeness; feasibility of more expressive action representation; upper-bound of time required, etc.

Relationship – Put in his own intuitive words, there is a "neat" and "scruffy" (Chapman, p. 334) pair of relationship between Chapman's and Sacerdoti's work. This research formalized many aspects of the preceding efforts from Sacerdoti, one significant example is that ad-hoc constructive critics (Sacerdoti, p. 126) became part of well-structured goal-achievement procedure (Chapman, p. 341). All math rigor not only corroborates previous research, but also encourages peers to keep advancing.

(Soderland & Weld, 1991)

Research Summary – It evaluated the efficiency of the partial-order planning vs. that of the total-order planning with a combination of analytic comparisons and empirical studies, the latter of which adopted the same problem sets, algorithms and data structures for both linear and nonlinear candidates to ensure fairness. One finding justified partial-order planning more than expected is that linear (total-order) planner has overhead costs increasing rapidly and surpassing that of partial-order one when Domain Theory Size (# of initial conditions) grows (Soderland & Weld, p. 9).

Relationship – Philosophically similar to Chapman's work, this research replaced intuition in Sacerdoti's work and other preceding ones, that partial-order planners are generally more efficient than their linear counterparts, with mathematical rigor. But different from and complementary to Chapman's focus on "effectiveness", Soderland and Weld went in the "efficiency" direction, which seems to have more practical merits.

References

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