

Research Review: A Brief History of Classical Planning

Research into intelligent agents for planning accelerated in the latter half of the 20th century to address the practical needs of robotics, scheduling, and other domains (Russell & Norvig, 2010).

In 1971, Fikes and Nilsson (1971) created STRIPS, the first major planning system for Stanford's *Shakey* robot project. STRIPS represented a world model as an arbitrary collection of first-order predicate calculus formulas and sought to find a sequence of operators that would transform a given world model into a world model in which a goal formula can be proven true. This representation language, now called "classical" language, became incredibly influential and served as the foundation of Ghallab et al.'s (1998) Problem Domain Description Language (PDDL).

Due to the limitations discovered of linear planning, researchers spent most of 1980 – 2000 building systems based on partial-order planning. In 1987, Chapman published the first formal exposition of this approach with his system, TWEAK. TWEAK consisted of three layers: (1) a plan representation, (2) a goal-achievement procedure, and (3) a top-level control structure, using backtracking search to recover from wrong choices. Chapman's approach was revolutionary because it was simple enough to allow proofs for completeness and intractability.

However, partial-order planning lost popularity towards the end of the 20th century with the emergence of more computationally efficient approaches. John McCarthy's situation calculus (1963) is one such approach. Refined by Ray Reiter in 1991 and 2001, modern-day situation calculus represents a dynamic set of first-order logic formulas. The three major components of this representation are (1) actions that can be performed in the world, (2) fluents

that describe the state of the world, and (3) situations that describe paths of action and their impact on the domain.

References

1. *Artificial Intelligence: A Modern Approach (3rd Edition)* – S. Russell & P. Norvig (2010)
2. *STRIPS: A New Approach to the Application of Theorem Proving to Problem Solving* – R. E. Fikes & N. J. Nilsson (1971)
3. *PDDL - The Planning Domain Definition Language* – M. Ghallab, D. McDermott, A. Howe et al. (1998)
4. *Planning for conjunctive goals* – D. Chapman (1987)
5. *Situations, Actions, and Causal Laws* – J. McCarthy (1963)
6. *The frame problem in situation calculus: A simple solution (sometimes) and a completeness result for goal regression* – R. Reiter (1991)
7. *On knowledge-based programming with sensing in the situation calculus* – R. Reiter (2001)