Representation

STRIPS (Fikes and Nilsson, 1971) first introduced some representational language which in turns was relaxed and morphed into the Action Description Language (ADL). ADL was invented to make it possible to encode more realistic problems. Nebel (2000) was able to form a scheme that compile ADL back into STRIPS. The Problem Domain Description Language (PDDL) was created in 1998 by Ghabllab et al. It's intended to be a computer-parsable that have standardized syntax. It was further improved in 2005 by Gerevini and Long. PDDL has been the standard language for International Planning Competition since 1998 and have been widely used by many algorithms in the space of Logic and Planning. However, the language itself have inherent flaws because it requires explicit representation for state and action. First-Order Logic was introduced to covered those cases and Situation Calculus was created by John McCarthy (1963) and further improved by Ray Reiter (1991, 2001). Binary Decision Diagrams was more of a recent interest in representing plans and have been studied by the hardware verification community (Clarke and Grumber, 1987; McMillan, 1993). Other representations have also been used such as integer programming.

Partial-Order Planning

Decomposition was the direction for this area of researching planner. Linear Planning, by Sacerdoti (1975), attempted to solve the planning by breaking down each subgoal and then string them back together after all subgoals are completed. The approach was soon found to be incomplete and realized the need for interleaving actions to have serializable plan. The needs to come up with a complete plan that allows for interleaving actions of different subplan to be within a single sequence drove the need to develop Partial-Order Planning. Dection of conflicts (Tate, 1975a) and protection of achieved conditions from other interference (Sussman, 1975) formed the underlying goals of research in this area. Starting with the NOAH planner (Sacerdoti, 1975, 1977) and NONLIN system by Tate's (1975, 1977), the industry had spent 20 years of modern planning research surrounding the area of Partial-Order Planning. TWEAK (Chapman, 1987) as a planner that focused on simplicity that allows proofs of completeness and intractability led to the implementation of SNLP (Soderland and Weld, 1991) and UCPOP (Penberthy and Weld, 1992).

State Space Search

Our coding project submitted along with this review shows the importance of this State Space Search paradigm. This area of research came back to the favor of researcher in later 1990s. In 1996, Drew McDermott first suggested using ignore-delete-list heuristic to enhance the algorithm. As Nguyen and Kambhampati (2001) came up with more accurate heuristics for planning graph, their REPOP planner scaled up better than GRAPHPLAN in parallelizable domains. Around similar time frame, the combined effort of Bonet and Geffner (1999), Haslum et al. (2005), and Haslum (2006), Heuristic Search Planner (HSP) were able to search large planning problems. It searches forward with an alternative HSPR that searches backward (regression). FF (Hoffmann, 2001; Hoffmann and Nebel, 2001; Hoffmann, 2005) is the next winner of this arena. In its original form, it won the AIPS 2000 planning competition. Its optimized variation FASTDOWNARD (Helmert and Richter, 2004; Helmert, 2006) won the following 2004 planning competition by preprocessing the action schemas into better representation. Then its successor LAMA with better heuristics won the 2008 competition.

Representation have been the crucial elements for the Algorithms. For example, the limitation of PDDL drove the needs of First Order Logic and its Situation Calculus. Binary Decision Diagram spawn a new area of research. Enhanced schema of the language can be better used to model the real world and covers more edge cases. Better representations of planning system helps make constraints more explicit which yield better or faster performance as well. State Space Search pushes the possibility of solving the planning as Search Algorithm with existing solution that led people into thinking search sub/partial plans in the area of Partial-Order Planning; however, focuses back on the heuristics brought back some attention to the State Space Search approach of the problem. Until now, it's still an evolving field of AI that doesn't have a clear winner. Knowledge and lessons learned from all these evolutions are still critical to be considered together for pushing Planning Search to its future.