STIPS

The first planning publication came from Fikes and Nilsson in their 1971 paper “STRIPS: A New Approach to the Application of Theorem Proving to Problem Solving” on STanford Research Institute Problem Solver (STRIPS). The STRIPS model based from situation calculus, uses well-formed formulas (wffs) of first-order predicate calculus to represent the world, and the solution to a problem is built using action routines (operators).Most importantly, this paper introduced the strips assumption. The assumption is that only positive effects explicitly mentioned can cause changes to a situation by an action. They also introduced simple syntax for planning action schemas. All of which are still used today. These include the state of the applicability conditions (preconditions), and the components that make up the effects of an operator. More specifically, the components include the add effects, that are the wffs that need to be added to the model, as well as the delete effects that list the wffs that are false and should be deleted. These features are present in the PDDL languages and are flexible enough to provide the expression necessary in complex planning problems.

UnPOP

In the mid-90s Drew McDermott published the paper “A Heuristic Estimator for Means-Ends Analysis in planning”. In the paper McDermott used the idea of using heuristic guided search. At each search state, an exhaustive sub-goal analysis was performed using greedy regression-match graphs. Previously, the analysis was performed over a blanket of search steps. The result of this analysis at every search state was that a good heuristic could be generated automatically. His results were a surprise, since others had previously attempted the heuristic approach and failed. This is because, in the past, the heuristic was created by hand, and so creating a function that could guide the planner to make all the right choices was not easy.

BDD

The book mentions Binary Decision Diagram (BDD) as an area of development. BDDs are directed acyclic graphs with labeled arcs and labeled vertices. The conditions for BDDs include: all nodes without outgoing arcs (sinks) are labeled as 0 or 1, there is only one node without any incoming arcs (root), all other nodes are labeled with a variable. For BDDs the transition relation of pre and post conditions describe the planning actions. The Benefit of using BDDs is that they can reduce the amount of memory used, and often reduce processing time. This is because, as the search depth increases, the number of variables does not. This is an advantage they have over SAT-based and constraint-based planning systems. In the paper “Limits and Possibilities of BDDs in State Space Search*”, by Edelkamp and Kissman, the authors demonstrate this advantage by benchmarks on the “robot gripper” problem, with the conclusion that exponentially many states can be represented in a polynomial sized BDD. and tables the usefulness of BDDs by describing the reduced memory requirements that BDDs need in for large planning problems. Another note in favor of BDDs is that, in the 2014 cost-optimal sequential planning track of the International Planning Competition, 4 of the 5 top systems used state-set exploration with BDDs in their implementation.