Research Review of developments in AI Planning and Search

This is a brief report of main developments and their impact in the field of AI planning and search based on the research work and information provided by the leaders in AI, listed in the references section of this document.

STRIPS (Reference 2)

STRIPS is the first major planning system, designed as the planning component of the software for the Shakey robot. The team working on STRIPS put together their experience in state-space search, theorem proving, control theory and the practical needs/problems of robotics to come up with **STRIPS operator** and the **algorithm for modeling the effects of an operator** based on the "STRIPS assumption" that a plan operator affects only those aspects of the world explicitly mentioned in the operator's deletions and additions lists.
STRIPS automatic Plan generator technique (Reference 2 - STRIPS automatic plan generator section) was essentially the same as that used by backward chaining production rule interpreters developed many years later.
STRIPS was extremely limited in both the scope of planning issues it addressed and the complexity of problems it could solve. And did not deal with multiple agents operating in dynamic environments, STRIPS assumed that only one action could occur at any time, that nothing changed except as a result of the planned actions, and that actions were effectively instantaneous. Even with those limitations, the STRIPS representation and reasoning framework was used as the basis for most automatic planning research for many years.

Type of Planners (Reference 3)

In Current Trends in Automated Planning (Reference 3) Dana S Nau, gives a concise and clear description of the different type of planners and the limitations of classical planning problem.
Automated planning systems can be classified into the following categories, based on whether, and in what way, they can be configured to work in different planning domains: domain-specific planners, domain-independent planners, and domain-configurable planners.

Classical Planning Algorithms (Reference 3)

Plan-Space Planning: The basic idea is to plan for a set of goals {*g*1, …, *gk*} by planning for each of the individual goals more-or-less separately, but maintaining various bookkeeping information to detect and resolve interactions among the plans for the individual goals. A plan-space planner such as **UCPOP** (Penberthy and Weld, 1992) will produce a partially ordered plan
Planning Graphs: For each *n*, level *n* includes every action *a* such that at level *n* – 1, *a*'s preconditions are satisfied and do not violate certain kinds of mutual-exclusion constraints. The literals at level *n* include the literals at level *n* – 1, plus all effects of all actions at level *n*. Thus the planning graph represents a relaxed version of the planning problem in which several actions can appear simultaneously even if they conflict with each other. Researchers have created a large number of planning algorithms based on **Graphplan** including IPP, CGP, DGP, LGP, PGP, SGP, TGP, and others
State-Space Planning: Although state-space search algorithms are very well known, due to the difficulty in coming up with good heuristic function to guide the search, it was not used until it was realized that heuristic values can be derived relatively quickly by extracting from relaxed solutions – planning graphs. This has led to planning algorithms such as **HSP** (Bonet and Geffner 1999) and FastForward (Hoffmann and Nebel 2001)
Translation Into Other Problems. Here, the basic idea consists of three steps. First,translate the planning problem into another kind of combinatorial problem—such as satisfiabilityor integer programming—for which efficient problem solvers already exist. Second, use a satisfiability solver or integer-programming solver to solve the translated problem. Third, take the solution found by the problem solver and translate it into a plan. This approach has led to planners such as **Satplan** (Kautz and Selman 1992).

References:

1. Artificial Intelligence: A Modern Approach by Norvig and Russell
2. STRIPS, a retrospective by Richard E Fikes and Nils J Nilsson
3. Current Trends in Automated Planning by Dana S. Nau (AI Magazine Volume 28 Number 4 2007))
4. Planning as heuristic search by Blai Bonet, Hector Geffner