Historical Developments: AI Planning and Search

In this short document, we try to briefly summarize the following three key developments in the history of AI planning and search:

1. The representation of planning problems, or say the action description languages;
2. The planner algorithms, including:
   i. State-space planning;
   ii. Partial-order planning.

The representation of planning problem fundamentally shapes how further planning algorithms can be and how solutions are. The most famous and commonly used ones such as STRIPS (1971) and PDDL (1998) are based on state variables. Each possible state of the world is an assignment of values to the state variables, and actions determine how the values of the state variables change when that action is taken. Another fundamentally different language for describing planning problems is that of hierarchical task networks (first arose in the mid 1970s), in which a set of tasks is given, and each task can be either realized by a primitive action or decomposed into a set of other tasks.

Based on the modeling of STRIPS, ADL and PDDL is the state-space planning, which usually leads to totally ordered action sequences. The early linear programming (1975) suffers from its incompleteness. A complete planner must allow for interleaving of actions from different subplans within a single sequence. One early solution was goal-regression planning (1975), searching backward from the goals instead of search forward from initial state. However, from then to mid 1990s, major concentration was on the partial-order planning as we will mention in the next paragraph. From 1996, leading by the UnPOP program and other planner algorithms, state-space planning again become revived: forward chaining with heuristics and backward chaining with state constraints became popular. These trends keeps on to nowadays.

Meanwhile, as we've mentioned in the previous paragraph, partial-order planning plays an important role in the planning and search history. The detection of conflicts and the protection of achieved conditions from interference are important for the construction of partially ordered plans (task networks). One widely distributed such planner is UCPOP (1992). Though partial-order planning is not preferred in the 1990s as faster state-space planning method emerged, some later work like RePOP (2001) starts to reconsider the approach.