Planning Research Review – Planning Search

Author: Bruno Gonçalves de Aquino
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Subject 1: The creation of the PDDL 2.1 for expressing quantity and temporal planning domains

In 1998, Drew McDermott released a Planning Domain Description Language, PDDL. As commented by Maria Fox and Derek Long in their paper (PDDL2.1: An Extension to PDDL for Expressing Temporal Planning Domains, 2003), "…become a community standard for the representation and exchange of planning domain models. … The introduction of PDDL has facilitated the scientific development of planning."

Yet, those authors above have commented that pasted some time, the community became unsatisfied with some restrictions of the PDDL, mainly because most real-world problems require to reason about time and numeric quantities, and in their paper, Fox & Long tell that there was a gap between the modelling requirements of such domains and what can be expressed in PDDL.

Later, at the third International Planning Competition in 2002, a group of respectful authors in this subject took the first step to close the latent gap in the first PDDL. This new language, called PDDL2.1, was fully retro-compatible with the old PDDL and added the features needed to represent the physical properties of the real-world problems, such as fuel consumption, time spent, etc.

This new language was very important to the field of Planning algorithms and have opened new horizons to developments forward the most avant-garde techniques as PDDL3.1.

Reference: Fox, M. & Long, D. (2003). PDDL2.1: An Extension to PDDL for Expressing Temporal Planning Domains.

Subject 2: Preferences and Soft Constraints in PDDL3

As the main gap of the PDDL was solved, as covered previously in the subject 1, another problem with the PDDL language arises: the constraints in the real-world problems are sometimes not so hard stated that can't be ignored for a plan. In the paper Preferences and Soft Constraints in PDDL3, by Alfonso Gerevini and Derek Long, they comment about it:

> "In many real-world planning domains, we have to address problems with a large set of solutions, or with a set of goals that cannot all be achieved. In these problems, it is important to generate plans of good or optimal quality achieving as many goals as possible. When only a subset of goals can be achieved (because they conflict with each other, or because achieving all goals is computationally too expensive), the ability to distinguish the importance of different goals is critical."

So, following these needs, Gerevini & Long proposed add some features to the PDDL language that differentiate strong goals (that should be achieved) from soft goals (that must be satisfied as possible).

A good implementation example of soft goal given by Gerevini & Long: "we would like that at the end of the plan all trucks are clean and at their source location;".

To manage priority between soft goals, they proposed a weight system that adds a different weight to each soft goal, then they try to find the solution that deliver the higher weight possible, so, if not all goals can be achieved, the system chose the higher priority.

These modifications in the PDDL language have brought a new level of quality in the planning deliveries, becoming a new standard in the scene and being large adopted by the professionals of this subject.

Reference: Gerevini, A. & Long, D. (2006). Preferences and Soft Constraints in PDDL3.

Subject 3: Temporal Planning with Preferences and Time-Dependent Continuous Costs

In this paper, Temporal Planning with Preferences and Time-Dependent Continuous Costs, J. Benton, Amanda Coles and Andrew Coles suggest a new PDDL implementation that unify the previously explained PDDL3 and the PDDL+, creating a language they call Optic (Optimizing Preferences and Time-dependent Costs).

We already cover the concepts of PDDL3, so I will not back to it. The PDDL+ tries to solve determinate problem of the PDDL3, derived from PDDL2.1, it handle costs and other measurement in a stochastic approach. For example, if a goal at(fruit, destination) is achieved, this results determined cost in PDDL3, but in PDDL+ a cost function can be used to generate a cost curve in function of the time spent to achieve the goal at(fruit, destination). For this reason, it is called "Time-Dependent Continuous Cost.

So, in a sum of the benefits of PDDL3 and PDDL+, applied to a POPF method (Partial Order Planning Forward), the authors of this work claim to be found an optimal system, that can excel all the other methods, in features and in speed, because the POFP allow to apply a search pruning, avoiding lots of irrelevant nodes.

Their work seems to be well advanced, they even developed a working software to apply the theory, called KCL, that can be found in the official site: https://nms.kcl.ac.uk/planning/index.html.

Reference: Benton, J., Coles, Amanda & Coles, Andrew. (2012). Temporal Planning with Preferences and Time-Dependent Continuous Costs.