AI Planning - a Historical Review

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1 Introduction

AI short for Artificial Intelligence is the engine for the current digital revolution. In particular, Planning is one of the major fields of AI, likewise Machine Learning, Natural Language Processing, Computer Vision and more. But what is Planning (and Searching) and how are the problems represented? In [3], planning is described as *"In which we see how an agent can take advantage of the structure of a problem to construct complex plans of action."* Also, Planning is a key ability for intelligent systems, increasing their autonomy and flexibility through the construction of sequences of actions to achieve their goals. It has been an area of research in artificial intelligence for over three decades[1]. To represent planning problems AI planning uses languages that describes environment's conditions, desired goals and actions based on these conditions. In the following, a short historical review of AI Planning languages is given.

2 Planning Languages

Planning is a form of general problem solving. The procedure is *Problem* $\Rightarrow$ *Language* $\Rightarrow$ *Planner* $\Rightarrow$ *Solution*. Models are required for defining, classifying, and understanding problems and (planning) languages are needed for representing problems.

2.1 STRIPS

STRIPS, short for Stanford Research Institute Problem Solver, is an automated planner developed by Richard Fikes and Nils Nilsson in 1971 at SRI International (see [1]). STRIPS was then used to refer to the formal language of the inputs to this planner. This language has become the base for most of the languages for expressing planning problems.

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[1]http://www.isi.edu/ blythe/cs541/, accessed April 5th, 2017

In STRIPS, the state variables have the domain 0,1 (equivalently FALSE, TRUE), and an action consists of three sets of state variables, the PRECONDITION, the ADD=a1,a2,...,an list, and the DELETE=d1,d2,...,dm list. An action is possible in a state if all the variables in PRECONDITION have the value 1. Taking the action corresponds to executing the following program, consisting of assignment statements only:

2.2 ADL

Action description language or ADL is an automated planning and scheduling system in particular for robots[2]. ADL is considered an advancement of STRIPS and was proposed by Edwin Pednault in 1987[3]. The ADL syntax also consists of an action name, an optional parameter list and four optional groups of clauses labeled Precond, Add, Delete and Update. The extended syntax provided by ADL does increase the convenience over STRIPS with which a domain can be encoded, but can also reduce the size of the domain descriptions needed (see [2].

2.3 PDDL

The Planning Domain Definition Language (PDDL) has become the standard representation language for classical planning. It was created as the planning input language for the International Planning Competition (IPC1, 1998) to standardize the planning representation languages and facilitating comparative analysis of diverse planning systems (see [2]). PDDL is a generalization of STRIPS. The differences of PDDL in comparison to STRIPS are:

- The PRECONDITION may be an arbitrary Boolean combination of atomic facts about the state variables. Atomic facts say something about one state variable, for example a=0 or b=1.

- Instead of the unconditional assignments represented by ADD and DELETE, the effects may be conditional. This means that the effects are of the form, IF condition THEN a := v where the condition is a Boolean combination of facts. STRIPS corresponds to PDDL with trivial conditions that are always true (the condition is the constant TRUE).

- Goals may be Boolean combinations of atomic facts (formulas).

References

[1] Nilsson N. Fikes R. *"STRIPS: A New Approach to the Application of Theorem Proving to Problem Solving"*. 1971.

[2] et al McDermott D. *"PDDL - The Planning Domain Definition Language"*. 1998.

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[2]https:en.wikipedia.orgwikiAction_description_language, retrieved April 13, 2017
[3]http:www.research.ibm.compeopleppednault, retrieved April 13, 2017

[3] Russell S. Norvig P. *Artificial Intelligence, A Modern Approach.* Pearson, 2014.