Research Review (AI planning and search)

Introduction

If we consider AI (artificial intelligence) fields of use and planning as general, we have to first differentiate between Logistic planning (Russell, 2010) which sole purpose is the planning itself and other fields which uses planning as one of its techniques (such as autonomous robots (Russell, 2010)). For purpose of this paper we will use planning techniques regardless of specialization.

Goal of Review

Consider three important developments on planning in AI and highlight relationship between these developments and impact on AI as whole.

STRIPS

STRIPS state for (STanford Research Institute Problem Solver) and was initially implemented in LIPS and the basic idea is to transform world models with the help of applicable operators to other world models in search for world where our goal is achievable (Fikes, 1971).

The problem space in STRIPS is defined as initial world models, the set of available operators and their effects on world models, and the goal statement (Fikes, 1971). Example of initial and goal state below.

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Initial state: At(A), Level(low), BoxAt(C), BananasAt(B)
Goal state:    Have(bananas)
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[1]

STRIPS important role in AI field is that it creates framework for describing real word in quite simple way and allow creation of more advance languages for planning.

Planning Graphs

Graph planning is new approach for planning in the STRIPS-like domains, introduces new type of planer – Graphplan (Blum, 1997). The basic idea behind is that unlike standard planning methods the Graphplan starts with creating structure – Planning Graph. If we simplify things the Planning Graph can be seen as guide for the search and it can guarantee that the shortest plan will be found.

Planning graph is composed of edges that represent the relations between actions and propositions. Other part is of the graph is mutex restrictions which specifically mean that no plan can contain actions that cannot be true at same time and no states that cannot be simultaneously true.

[1] https://en.wikipedia.org/wiki/STRIPS

Main impact on AI planning gained from planning graph is way of optimizing planning techniques and possibility to construct guide for classic search in polynomial time and in polynomial size. The plan itself also can be annotated, analyzed and play with (Blum, 1997).

Heuristic Search Planner (HSP)

HSP is basically heuristic search, so it tries to add some additional value to search which in this case is basically to calculate estimated distance to the goal (Bonet, 2001). The heuristics are mainly derived from actions and goals commonly done from relaxed problem.

Interesting part is that the algorithm is that it extracts the heuristic automatically from the STRIPS encoding (Russell, 2010). This is done iteratively by generating states by the actions whose preconditions held in the previous state set (Bonet, 2001). Formula representation at

$$g_s(p) := \min\left[\, g(p)\ ,\ 1 + \sum_{i=1,n} g_s(r_i)\ \right]$$

[2]

HSP impacted the AI basically by allowing the searches to derive the heuristic automatically from the problem interpretation (e.g. STRIPS model).

Resources

(Russell, 2010) RUSSELL, Stuart J., Peter. NORVIG a Ernest. DAVIS. Artificial intelligence: a modern approach. 3rd ed. Upper Saddle River: Prentice Hall, c2010. ISBN 978-0-13-604259-4.

(Fikes, 1971) Fikes, R. and Nilsson, N. STRIPS: A new approach to the application of theorem proving to problem solving. Artif Intell. 2, 3,4 [Jan. 1971}, 189-208

(Blum, 1997) Blum, A. L., & Furst, M. L. (1997). Fast planning through planning graph analysis. Artificial Intelligence, 90(1–2), 281–300. https://doi.org/10.1016/s0004-3702(96)00047-1

(Bonet, 2001) Bonet, B., & Geffner, H. (2001). Planning as heuristic search. Artificial Intelligence, 129(1–2), 5–33. https://doi.org/10.1016/s0004-3702(01)00108-4

[2] (Bonet, 2001)