Udacity Artificial Intelligence Nanodegree Assignment 3

Key Developments in AI Planning and Search

Richard C. Stilborn

Introduction

This is a review of several papers related to AI planning and search including planning graph analysis, partial order planning, and local search for planning graphs.

GraphPlan

In 1997 Avrim Blum and Merrick Furst implemented a new approach to constraint satisfaction problem based planning called GraphPlan [1] This algorithm used Planning Graph Analysis. A Planning Graph encodes the problem such that useful constraints inherent in the problem are used to reduce the amount of search needed. These graphs have polynomial size and can be built in polynomial time. The output is similar to a parallel plan [2] in that the output consists of a series of steps each containing multiple sequence-independent actions.

New Heuristics for RePOP

In 2001 Nguyen and Kambhampati [3] presented several novel heuristics that made partial order planning competitive with state of the art planning synthesis algorithms. Their results showed that RePOP [4] could outperform GraphPlan in several “parallel” domains by applying the ideas of distance based heuristics, disjunctive representations for planning constraints and reachability analysis.
The plans generated by RePOP have more execution flexibility than those produced by other algorithms. This is interesting because most of the real-world planning domains tend to have loose ordering among actions and the ability for generating loosely ordered plans is very important in hybrid methods that involve on-line integration of planning with scheduling.

Local Search for Planning Graphs

In 2002 Gerevini and Serina [5] proposed LPG, a planner based on local search and planning graphs, which considerably extended their work from 1999 [6]. LPG uses various heuristics based on a parameterized objective function. These parameters weight different types of inconsistencies in the partial plan represented by the current search state, and are dynamically evaluated during search using Lagrange multipliers. LPG can also handle action costs to produce good quality plans.

References

[1] A. Blum and M.L. Furst. Fast planning through planning graph analysis. Artificial Intelligence 90, 1997.
[2] C. Knoblock. Generating parallel execution plans with a partial order planner. AIPS 94, 1994.
[3] X. Nguyen and S. Kambhampati. Reviving partial order planning. IJCAI'01 Vol. 1. 2001
[4] C. Backstrom. Computational aspects of reordering plans. JAIR Vol. 9, 1998
[5] A. Gerevini and I. Serina. LPG: A planner based on local search for planning graphs. AIPS’02, 2002
[6] A. Gerevini and I. Serina. Fast planning through greedy action graphs. AAAI-99, 1999.