

Forward Progression Search for State Space Planning

Abstract

State Space planning is a method used to a series of steps that will start with an initial state and eventually reach a goal state. In this particular project the problem was to find an optimal series of steps to move cargo, using planes, between airports. The problem was formulated in Planning Domain Definition Language and the search as performed by various tree search algorithms to find the optimal path to the goal.

Optimal Path for all three problems

Problem 1

Plan length: 6 Time elapsed in seconds: 0.0793347509988962

Load(C1, P1, SFO)

Load(C2, P2, JFK)

Fly(P1, SFO, JFK)

Fly(P2, JFK, SFO)

Unload(C1, P1, JFK)

Unload(C2, P2, SFO)

Problem 2

Plan length: 9 Time elapsed in seconds: 18.351426774001084

Load(C3, P3, ATL)

Fly(P3, ATL, SFO)

Unload(C3, P3, SFO)

Load(C1, P1, SFO)

Fly(P1, SFO, JFK)

Unload(C1, P1, JFK)

Load(C2, P2, JFK)

Fly(P2, JFK, SFO)

Unload(C2, P2, SFO)

Problem 3

Plan length: 12 Time elapsed in seconds: 114.6617773479993

Load(C2, P2, JFK)

Fly(P2, JFK, ORD)

Load(C4, P2, ORD)

Fly(P2, ORD, SFO)

Unload(C4, P2, SFO)

Load(C1, P1, SFO)

Fly(P1, SFO, ATL)

Load(C3, P1, ATL)

Fly(P1, ATL, JFK)

Unload(C3, P1, JFK)

Unload(C1, P1, JFK)

Unload(C2, P2, SFO)

Planning times

Problem	Search Method	Path Length	Expansion	Goal Test	New Nodes	Time
Problem 1	Depth First Search	20	21	22	84	.02
Problem 1	Breadth First Search	6	43	56	180	.05
Problem 1	A Star Ignore Preconditions	6	41	43	170	.05
Problem 1	A Star pg level sum	6	49	51	200	8.88
Problem 1	A star H1	6	55	57	224	.07
Problem 2	Depth First Search	619	624	625	5602	5.57
Problem 2	Breadth First Search	9	3343	4609	30509	19.62
Problem 2	A Star Ignore Preconditions	9	1506	1508	13820	18.71
Problem 2	A Star pg level sum					Did not finish
Problem 2	A star H1	9	4852	4854	44030	63.67
Problem 3	Depth First Search	392	408	409	3364	3.03
Problem 3	Breadth First Search	12	14663	18098	129631	154.15
Problem 3	A star Ignore Preconditions	12	5118	5120	45650	114.66
Problem 3	A Star pg level sum					Did not finish
Problem 3	A star H1	12	18235	18237	159716	539.19

Analysis

The depth first search was by far the worst performer in the whole group. While the search method usually found a solution quickly, the solution found was much less than optimal. The breadth first search algorithm performed pretty well, nearly as well as the informed search algorithms in all cases. For the informed searches the A star ignore preconditions performed the best, with the H1 algorithm being second. The algorithm that did the worst was the level sum informed metric as it would not complete, even given a couple hours of search. Overall the best was the A star ignore preconditions, which given its status as an informed algorithm, and one with more intelligence a constant heuristic, was not surprising.