Heuristic analysis

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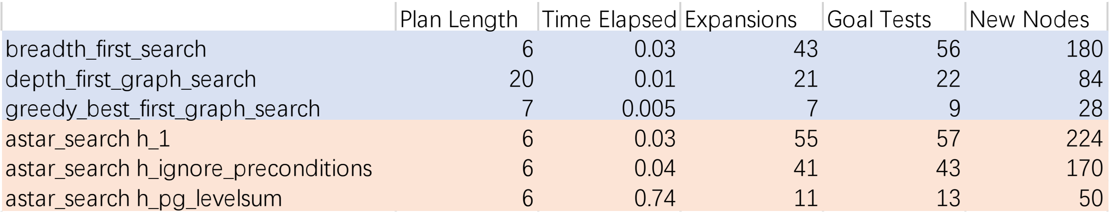
This article is my review for AIND-planning project. Below the content, there are several search functions deal with three air cargo problem in different complexity.

The graphs presented below show us the solving the problems with both uninformed and informed search strategy. Some strategies are not chosen to be present due to infinity time elapsed. in other word, it cannot find plan in acceptable time.

Air_cargo_problem_1

Optional plan:
Load(C1, P1, SFO)
Load(C2, P2, JFK)
Fly(P1, SFO, JFK)
Fly(P2, JFK, SFO)
Unload(C1, P1, JFK)
Unload(C2, P2, SFO)



	Plan Length	Time Elapsed	Expansions	Goal Tests	New Nodes
breadth_first_search	6	0.03	43	56	180
depth_first_graph_search	20	0.01	21	22	84
greedy_best_first_graph_search	7	0.005	7	9	28
astar_search h_1	6	0.03	55	57	224
astar_search h_ignore_preconditions	6	0.04	41	43	170
astar_search h_pg_levelsum	6	0.74	11	13	50

The first problem is pretty simple. In non-heuristic search strategies, we can notice that only breadth first search gave us the optimal plan. But the greedy best first search uses the least expansions, goal tests and new nodes. It is also use the least time to give us an acceptable solution. In heuristic search strategies, all of them can give us the optimal plan. The “ignore preconditions” heuristics uses more expansions goal test and nodes to calculate but spends less time compared with “level sum” heuristics.

Air_cargo_problem_2

Optional plan:
Load(C1, P1, SFO)
Load(C2, P2, JFK)
Load(C3, P3, ATL)
Fly(P1, SFO, JFK)
Fly(P2, JFK, SFO)
Fly(P3, ATL, SFO)
Unload(C1, P1, JFK)
Unload(C2, P2, SFO)
Unload(C3, P3, SFO)

	Plan Length	Time Elapsed	Expansions	Goal Tests	New Nodes
breadth_first_search	9	14.63	3343	4609	30509
depth_first_graph_search	619	3.42	624	625	5062
greedy_best_first_graph_search	21	2.57	998	1000	8982
astar_search h_1	9	11.89	4853	4855	44041
astar_search h_ignore_preconditions	9	5.39	1450	1452	13303
astar_search h_pg_levelsum	9	67.37	86	88	841

The first problem is a bit more complex. Although the optimal plan length just increase 6 to 9. All the resources like time or memory is enlarged significantly. And depth first search use the least expansions, goal tests and new nodes. But the shortage of depth first search is present. It is not an optimal method and execute unstable. It just can find a first solution it met. The first solution is not in a good place in searching graph, which caused 619 plan lengths. It is hard to accept such a solution based on just 9 steps for optimal plan. In non-heuristic search strategies, the greedy best research still performs a good result in time elapsed. It is obvious to see that the breadth first search and plain astar search need a lot of space to execute. Between the “ignore preconditions” and “level sum” heuristics. We can know the previous one need 10 percent time but 20 times on other resources.

Air_cargo_problem_2

Optional plan:

Load(C1, P1, SFO)
Load(C2, P2, JFK)
Fly(P1, SFO, ATL)
Load(C3, P1, ATL)
Fly(P2, JFK, ORD)
Load(C4, P2, ORD)
Fly(P2, ORD, SFO)
Fly(P1, ATL, JFK)
Unload(C4, P2, SFO)
Unload(C3, P1, JFK)
Unload(C2, P2, SFO)
Unload(C1, P1, JFK)

	Plan Length	Time Elapsed	Expansions	Goal Tests	New Nodes
breadth_first_search	12	102.62	14120	17673	124926
depth_first_graph_search	288	1.15	292	293	2388
greedy_best_first_graph_search	22	16.29	5614	5616	49429
astar_search h_1	12	53.63	18235	18327	159716
astar_search h_ignore_preconditions	12	21.06	5040	5042	44944
astar_search h_pg_levelsum	12	371.49	325	327	3002

The optimal plan length in problem 3 increased to 12, which is twice as large as first problem. But depth first just use 1 second to find a solution. The reason I think is the goal is near the first searching branch. “ignore preconditions” strategy still draw a good result in time elapsed while finding optimal solution. “levelsum” strategy use much less expansions, goal tests and new nodes to find as optimal solution compared with other heuristic strategy. While the time elapsed is much longer than any other search.

Conclusions

For heuristic strategies, they base one a good heuristic function. More precisely, the heuristic cannot overestimate the goal astar_with_h_ignore_preconditions performs well in all three problem because of the good searching feature the strategy had, that is, relaxes the problem with ignoring preconditions. But if we don't care about the optimal solution and just focus on whether the plan is feasible, breadth first search will be the best choice.