Heuristic Analysis by Ng Fang Kiang

Udacity – Artificial Intelligence Nanodegree (Class of 2017)

Air Cargo Problem 1

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Init(At(C1, SFO) ∧ At(C2, JFK)
∧ At(P1, SFO) ∧ At(P2, JFK)
∧ Cargo(C1) ∧ Cargo(C2)
∧ Plane(P1) ∧ Plane(P2)
∧ Airport(JFK) ∧ Airport(SFO))
Goal(At(C1, JFK) ∧ At(C2, SFO))
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Air Cargo Problem 1					
Search	Expansions	Goal_Tests	New Nodes	Plan Length	Time
breadth_first_search	43	56	180	6	0.084193586
breadth_first_tree_search	1456	1459	5960	6	2.817626083
depth_first_graph_search	12	13	48	12	0.022848891
depth_limited_search	101	271	414	50	0.207606009
uniform_cost_search	55	57	224	6	0.108275467
recursive_best_first_search h_1	4229	4230	17029	4230	8.009237971
greedy_best_first_graph_search h_1	7	9	28	6	0.013341891
astar_search h_1	55	57	224	6	0.1030313
astar_search h_ignore_preconditions	41	43	170	6	0.087809522
astar_search h_pg_levelsum	11	13	50	6	0.545721415

Best plan consist of 6 actions:

1. Load(C1, P1, SFO)
2. Load(C2, P2, JFK)
3. Fly(P1, SFO, JFK)
4. Fly(P2, JFK, SFO)
5. Unload(C1, P1, JFK)
6. Unload(C2, P2, SFO)

The best performance is greedy_best_first_graph_search h_1.

Air Cargo Problem 2

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Init(At(C1, SFO) ∧ At(C2, JFK) ∧ At(C3, ATL)
∧ At(P1, SFO) ∧ At(P2, JFK) ∧ At(P3, ATL)
∧ Cargo(C1) ∧ Cargo(C2) ∧ Cargo(C3)
∧ Plane(P1) ∧ Plane(P2) ∧ Plane(P3)
∧ Airport(JFK) ∧ Airport(SFO) ∧ Airport(ATL))
Goal(At(C1, JFK) ∧ At(C2, SFO) ∧ At(C3, SFO))
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Air Cargo Problem 2					
Search	Expansions	Goal_Tests	New Nodes	Plan Length	Time
breadth_first_search	3401	4672	31049	9	36.24551419
breadth_first_tree_search	inf	inf	inf	inf	inf
depth_first_graph_search	350	351	3142	346	3.543807292
depth_limited_search	254020	2344879	2345254	50	2604.373427
uniform_cost_search	4761	4762	43206	9	43.96447017
recursive_best_first_search h_1	inf	inf	inf	inf	inf
greedy_best_first_graph_search h_1	550	552	4950	9	4.998992351
astar_search h_1	4761	4763	43206	9	46.4472368
astar_search h_ignore_preconditions	1450	1452	13303	9	13.64528777
astar_search h_pg_levelsum	86	88	841	9	51.4787299

Best plan consist of 9 actions:

1. Load(C1, P1, SFO)
2. Load(C2, P2, JFK)
3. Load(C3, P3, ATL)
4. Fly(P1, SFO, JFK)
5. Fly(P2, JFK, SFO)
6. Fly(P3, ATL, SFO)
7. Unload(C3, P3, SFO)
8. Unload(C2, P2, SFO)
9. Unload(C1, P1, JFK)

The best performance is depth_first_graph_search in Air Cargo Problem 2, but the plan length with 346 is not optimal. The greedy_best_first_graph_search h_1 has best optimal plan together with the performance.

Air Cargo Problem 3

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Init(At(C1, SFO) ∧ At(C2, JFK) ∧ At(C3, ATL) ∧ At(C4, ORD)
∧ At(P1, SFO) ∧ At(P2, JFK)
∧ Cargo(C1) ∧ Cargo(C2) ∧ Cargo(C3) ∧ Cargo(C4)
∧ Plane(P1) ∧ Plane(P2)
∧ Airport(JFK) ∧ Airport(SFO) ∧ Airport(ATL) ∧ Airport(ORD))
Goal(At(C1, JFK) ∧ At(C3, JFK) ∧ At(C2, SFO) ∧ At(C4, SFO))
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Air Cargo Problem 3					
Search	Expansions	Goal_Tests	New Nodes	Plan Length	Time
breadth_first_search	14663	18098	129631	12	350.2327689
breadth_first_tree_search	inf	inf	inf	inf	inf
depth_first_graph_search	627	628	5176	596	11.2504045
depth_limited_search	inf	inf	inf	inf	inf
uniform_cost_search	18235	18237	159716	12	333.1951215
recursive_best_first_search h_1	inf	inf	inf	inf	inf
greedy_best_first_graph_search h_1	5614	5616	49429	22	98.42954981
astar_search h_1	18235	18237	159716	12	313.1379738
astar_search h_ignore_preconditions	5040	5042	44944	12	96.92856017
astar_search h_pg_levelsum	318	320	2934	12	398.0241286

Best plan consist of 12 actions:

1. Load(C2, P2, JFK)
2. Fly(P2, JFK, ORD)
3. Load(C4, P2, ORD)
4. Fly(P2, ORD, SFO)
5. Unload(C4, P2, SFO)
6. Load(C1, P1, SFO)
7. Fly(P1, SFO, ATL)
8. Load(C3, P1, ATL)
9. Fly(P1, ATL, JFK)
10. Unload(C3, P1, JFK)
11. Unload(C1, P1, JFK)
12. Unload(C2, P2, SFO)

The best performance is depth_first_graph_search in Air Cargo Problem 3, but the plan length with 596 is not optimal. The astar_search h_ignore_preconditions has best optimal plan together with the performance.