Heuristic Analysis

Heuristics

Among the non-heuristic methods, BFS and UCS perform similarly with UCS expanding more nodes but getting a better time. DFG is the fastest and expand less nodes but it does not provided an optimal solution.

Among the heuristic methods, A* ignore preconditions is the fastest. It also expands more nodes that A* level sum although less than A* h_1. A* level sum expands fewer nodes than the others do but it is very slow.

Comparing all we can observe that, for small problems (problem 1), heuristic and non-heuristic methods performance are similar. However, with bigger problems, non-heuristic methods perform worse, both in time elapsed and nodes expanded.

Besides, it is important to notice the difference between heuristic. Like the metrics for ignore precondition and level sum show for the second problem, one heuristic can run more than twenty times faster than other do although expanding many more nodes.

Air Cargo Problem 1	Optimal?	Time Elapsed (s)	Node Expansions	Goal Tests	Path Length
Breadth First Search	YES	0.045	43	56	6
Breadth First Tree Search	YES	1.402	1458	1459	6
Depth First Graph Search	NO	0.012	12	13	12
Depth Limited Search	NO	0.14	101	271	50
Uniform Cost Search	YES	0.059	55	57	6
Recursive Best First Search	YES	4.176	4229	4230	6
Greedy Best First Graph Search	YES	0.008	7	9	6
A* h_1	YES	0.061	55	57	6
A* h_ignore_preconditions	YES	0.06	41	43	6
A* h_pg_levelsum	YES	1.103	11	13	6

Optimal Solution

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

Air Cargo Problem 2	Optimal?	Time Elapsed (a)	Node Expansions	Goal Tests	Path Length
Breadth First Search	YES	18.589	3343	4609	9
Breadth First Tree Search		>10min	--	--	--
Depth First Graph Search	NO	4.533	582	583	575
Depth Limited Search		>10min	--	--	--
Uniform Cost Search	YES	17.264	4852	4854	9
Recursive Best First Search		>10min	--	--	--
Greedy Best First Graph Search	NO	3.406	990	992	15
A* h_1	YES	17.344	4852	4854	9
A* h_ignore_preconditions	YES	6.355	1450	1452	9
A* h_pg_levelsum	YES	159.318	86	88	9

Optimal Solution

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

Air Cargo Problem 3	Optimal?	Time Elapsed (s)	Node Expansions	Goal Tests	Path Length
Breadth First Search	YES	140.976	14663	18098	12
Breadth First Tree Search		>10min	--	--	--
Depth First Graph Search	NO	4.352	627	628	596
Depth Limited Search		>10min	--	--	--
Uniform Cost Search	YES	74.658	18235	18237	12
Recursive Best First Search		>10min	--	--	--
Greedy Best First Graph Search	NO	23.483	5614	5616	22
A* h_1	YES	78.374	18235	18237	12
A* h_ignore_preconditions	YES	25.781	5040	5042	12
A* h_pg_levelsum	YES	776.59	315	317	12

Optimal Solution

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)