

Heuristic Analysis

Planning Search for Air Cargo Transport System

Performance Summary

Three **uninformed search** algorithms are evaluated and their respective KPIs are as follows.

Problem	Name	Is Optimal	Time Elapsed	Node Expansions	Goal Tests	New Nodes
1	Breadth First Search	True	0.0284	43	56	180
2	Breadth First Search	True	3.8321	1855	2582	14801
3	Breadth First Search	True	37.3692	14120	17673	124926
1	Depth First Graph Search	False	0.0124	21	22	84
2	Depth First Graph Search	False	0.3721	184	185	1143
3	Depth First Graph Search	False	1.081	292	293	2388
1	Uniform Cost Search	True	0.03170	55	57	224
2	Uniform Cost Search	True	5.4067	2724	2726	21377
3	Uniform Cost Search	True	45.4621	18223	18225	159618

Three **automatic heuristics with A* search** algorithms are evaluated and their respective KPIs are as follows.

Problem	Name	Is Optimal	Time Elapsed	Node Expansions	Goal Tests	New Nodes
1	A* with h_1	True	0.0330	55	57	224
2	A* with h_1	True	5.9361	2724	2726	21377
3	A* with h_1	True	49.8126	18223	18225	159618
1	A* with h_ignore_preconditions	True	0.0325	41	43	170
2	A* with h_ignore_preconditions	True	2.2290	876	878	7199
3	A* with h_ignore_preconditions	True	15.6028	5040	5042	44944
1	A* with h_pg_levelsum	True	0.5447	11	13	50
2	A* with h_pg_levelsum	True	57.2826	238	240	1911
3	A* with h_pg_levelsum	True	241.8140	325	327	3002

Performance Comparison

From the above performance summary, **the A* search with h_ignore_preconditions heuristic appears to be the best planning algorithm for air cargo planning**. The reasons are as follows.

1. The algorithm is optimal.
2. Among all optimal algorithms, it has the second least node expansions, that is, the second least resource constraints on target system.
3. Among all optimal algorithms, it has the fastest running time and scales well as the problem complexity goes up.

Compared with uninformed algorithms, namely BFS, UFS and A* with trivial heuristic, the best one has far less node expansions due to the knowledge induced by informative heuristic. Since less node expansions means less resource constraints on target system, the best algorithm is on the one hand resource friendly.

On the other hand, although the A* with h_pg_levelsum has the least number of node expansions, it suffers from significant runtime overhead incurred by the dynamic construction of planning graph. It makes the algorithm not scalable as the problem complexity goes up.

To sum up, the A* search with h_ignore_preconditions heuristic is the best planning algorithm for air cargo planning.