

## Heuristic Analysis

### Air Cargo Results Comparison Matrix

The table below summarizes the results obtained from running 6 types of searches: 3 non-heuristic, and 3 heuristic approaches for each of 3 air cargo problems: P1, P2, and P3

Problem #	Search Type	Expansion	Goal Tests	New Nodes	Plan Length	Time (s)
P1	<i>sbreadth_first_search</i>	43	56	180	6	0.028
	<i>depth_first_graph_search</i>	12	13	48	12	0.007
	<i>uniform_cost_search</i>	55	57	224	6	0.036
	<i>using astar_search with h_1</i>	55	57	224	6	0.035
	<i>h_ignore_preconditions</i>	41	43	170	6	0.027
	<i>h_pg_levelsum</i>	11	13	50	6	1.055
P2	<i>breadth_first_search</i>	3343	4609	30509	9	12.95
	<i>depth_first_graph_search</i>	1669	1670	14863	1444	12.35
	<i>uniform_cost_search</i>	4853	4855	44041	9	11.88
	<i>using astar_search with h_1</i>	4853	4855	44041	9	12.10
	<i>h_ignore_preconditions</i>	1450	1452	13303	9	4.016
	<i>h_pg_levelsum</i>	86	88	841	9	184.48
P3	<i>breadth_first_search</i>	13601	16987	106167	12	91.16
	<i>depth_first_graph_search</i>	1292	1293	5744	875	3.68
	<i>uniform_cost_search</i>	17004	17006	132060	12	48.37
	<i>using astar_search with h_1</i>	17004	17006	132060	12	45.79
	<i>h_ignore_preconditions</i>	6550	6552	52021	13	18.23
	<i>h_pg_levelsum</i>	381	383	2565	12	701.63

The optimal solutions in terms of Plan Length & Time Taken are highlighted in yellow.

In terms of path length & time taken, **Breadth First Search (BFS)** and **Uniform Cost Search** (Weighted BFS/Dijkstra's) performed better. BFS performs faster, uses less memory, and is guaranteed to find the shortest path and hence it is the most optimal solution and recommended search strategy. **Depth First Graph Search (DFS)** on the other hand is the fastest, and uses the least amount of memory, but doesn't find the optimal solution as it keeps on probing deeper into the tree resulting in larger path lengths (from above table).

Non-heuristic searches (BFS) performed better with simple problems, such as P1 and P2, while heuristic approach (**A\* Search**) performed better when the problem space was large indicating that heuristic search scales much better for complicated problems (real life problems).

Reference:

- Stuart J. Russel, Peter Norvig (2010), Artificial Intelligence: A Modern Approach (3<sup>rd</sup> edition)

