Performance Metrics Analysis Report

The performance metrics for three breadth first, depth first and uniform cost search are shown in the following table below. Overall, depth first search performs better in terms of the time spent, number of goal tests and number of node expansions, however, it is unlikely to find an optimal solution. Uniform cost search and breadth first search both provide optimal solutions, and their performances are similar in terms of the number of goal tests. Uniform cost search performs worse than breadth first search in terms of node expansions. However, as the problems gets more difficult, uniform cost search performs somewhat better than breadth first search in terms of time.

Problem	Technique	No. of Node Expansions	No. of goal tests	Time elapsed in seconds	Optimal Solution?
Air cargo p1	Breadth first search	43	56	0.0310	Y
Air cargo p1	Depth first graph search	21	22	0.0103	N
Air cargo p1	Uniform cost search	55	57	0.0301	Y
Air cargo p2	Breadth first search	3346	4612	9.0933	Y
Air cargo p2	Depth first graph search	107	108	0.2334	N
Air cargo p2	Uniform cost search	4853	4855	7.7812	Y
Air cargo p3	Breadth first search	14663	18098	73.5398	Y
Air cargo p3	Depth first graph search	408	409	1.3598	N
Air cargo p3	Uniform cost search	17882	17884	35.3427	Y

The performance metrics for A* search using the three different heuristic functions are shown in the table below. Focusing on the heuristics h ignoring preconditions and h pg level sum. Both heuristics give an optimal solution, but as the problem gets more challenging, h ignore pre-conditions spends less time than h pg level sum. However, h ignore preconditions performs more node expansions and more goal tests. Optimal solutions are obtained using them.

Problem	Heuristic	No. of Node Expansions	No. of goal tests	Time elapsed in seconds	Optimal Solution
Air cargo p1	h1	55	57	0.0393	Y

Air cargo p1	h ignore preconditions	41	43	0.0397	Y
Air cargo p1	h pg levelsum	39	41	1.0140	Y
Air cargo p2	h1	4853	4855	7.4832	Y
Air cargo p2	h ignore preconditions	1450	1452	2.9845	Y
Air cargo p2	h pg levelsum	1129	1131	305.63	Y
Air cargo p3	h1	17882	17884	33.9835	Y
Air cargo p3	h ignore preconditions	5034	5036	11.7342	Y
Air cargo p3	h pg levelsum	2025	2027	1123.5612	Y

To compare performance of uninformed search to heuristic search techniques, it may be better to focus on the more challenging air cargo p3. Depth first search is the best technique in terms of time spent, number of node expansions and number of goal tests, however it fails to provide an optimal solution. Among the techniques that give an optimal solution the h ignore precondition heuristic performed best in terms of time spent, however h pg level sum performs best in terms of number of node expansions and number of goal tests. Overall the best heuristic is h ignore preconditions.

One optimal plan for air cargo p1

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

One optimal plan for air cargo p2

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

One optimal plan for air cargo p3

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(C1, P1, JFK)
Unload(C2, P2, SFO)
Unload(C3, P1, JFK)
Unload(C4, P2, SFO)