Heuristic Analysis

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Optimal plan

The optimal plan for the three problems are as follows:

Problem 1	Problem 2	Problem 3
Load(C1, P1, SFO) Load(C2, P2, JFK) Fly(P1, SFO, JFK) Fly(P2, JFK, SFO) Unload(C1, P1, JFK) Unload(C2, P2, SFO)	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(C1, P1, JFK) Unload(C2, P2, SFO)	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(C1, P1, JFK) Unload(C2, P2, SFO)

Table 1- Optimal plan for three problems

Uninformed search functions

The following functions search the state space without any domain specific information.

Search	Problem #	Expansions	Goal tests	Time elapsed(s)	Optimality	Plan length (actions)
Breadth first search	1	43	56	0.03733	y	6
	2	3343	4609	18.11	y	9
	3	14663	18098	127.85	y	12
Depth first graph search	1	12	13	0.0136	n	12
	2	582	583	3.8012	n	575
	3	627	628	3.821	n	596

Uniform cost search	1	55	57	0.054	y	6
	2	44	4854	54.36	y	9
	3	18235	18237	479.12	y	12

Table 2 - Uninformed search function performance

Depth first graph search is very quick, however it produces really long solutions. Hence, I would not consider this approach optimal. Comparing breadth first search (BF) and uniform cost search (UC), both reach the optimal solution. However, the time elapsed seems smaller for BF.

Informed search functions

Heuristic used with A* Search	Problem #	Expansions	Goal tests	Time elapsed(s)	Optimality	Plan length (actions)
Ignore preconditions	1	41	43	0.059	y	6
	2	1506	1508	16.5	y	9
	3	5118	5120	107.8	y	12
Levelsum	1	~	~	> 10 min	~	~
	2	~	~	> 10 min	~	~
	3	~	~	> 10 min	~	~

Table 3 - Informed search function performance

Both the heuristics result in providing the optimal solutions. In terms of comparing the two with respect to resources, the levelsum heuristic is excessively long in computation time. Hence, I would prefer the ignore preconditions heuristic.

Comparing the ignore precondition heuristic to the best uninformed search - BF search, I would say that the advantage of ignore precondition is obvious in that convergence to the optimal solution happens with smaller number of node expansions, goal tests and execution time.

Hence, the best approach would be to use A* search with ignore preconditions heuristic for the Air Cargo problem.