AI Planning Heuristic Analysis
Uninformed vs Informed Search Methods

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In this report, the results obtained by 10 different strategies, 7 uninformed strategies and 3 informed strategies, when applied to 3 problems in the Air Cargo domain are compared. The problems have the same action schema, but different initial states and goals. The metrics that are going to be used to compare the results are: number of node expansions required, number of goal tests, time elapsed and optimality of solution (if the optimal path length is found).

Uninformed Search Strategies

Strategies	Metrics	Air Cargo Problems		
		Problem 1	Problem 2	Problem 3
Breadth First Search	Node expansions	43	3343	14663
	Goal tests	56	4609	18098
	Time elapsed (s)	0.118	34.866	176.133
	Path length / Optimality	**6 / Yes**	**9 / Yes**	**12 / Yes**
Breadth First Tree Search	Node expansions	1458	-	-
	Goal tests	1459	-	-
	Time elapsed (s)	3.877	>600	>600
	Path length / Optimality	**6 / Yes**	-	-
Depth First Graph Search	Node expansions	12	**582**	**627**
	Goal tests	13	**583**	**628**
	Time elapsed (s)	0.036	14.345	**14.005**
	Path length / Optimality	12 / No	575 / No	596 / No
Depth Limited Search	Node expansions	101	-	-
	Goal tests	271	-	-
	Time elapsed (s)	0.355	>600	>600
	Path length / Optimality	50 / No	-	-
Uniform Cost Search	Node expansions	55	4853	18151
	Goal tests	57	4855	18153
	Time elapsed (s)	0.150	50.223	210.013
	Path length / Optimality	**6 / Yes**	**9 / Yes**	**12 / Yes**
Recursive Best First Search	Node expansions	4229	-	-
	Goal tests	4230	-	-
	Time elapsed (s)	11.658	>600	>600
	Path length / Optimality	6 / Yes	-	-
Greedy Best First Graph Search	Node expansions	**7**	998	5398
	Goal tests	**9**	1000	5400
	Time elapsed (s)	**0.021**	**10.638**	63.984
	Path length / Optimality	**6 / Yes**	21 / No	26/ No

The results of the algorithms applied to different problems show how the cost of their performance in terms of memory and time, and in some cases the accuracy, increase with the complexity of the problem. Nevertheless, optimal solutions were found for the three problems in an affordable time lapse with the algorithms Breath First Search and Uniform Cost Search.

On the other hand, if reducing the cost of the performance had priority over finding the optimal path length, both Depth First Graph Search and Greedy Best First Graph Search would be also plausible solutions, being the first one specially optimized in terms of time and the second one achieving path lengths which are not far from being optimal.

Some tests took too long to find a solution and had to be interrupted.

Informed Search Strategies

Strategies	**Metrics**	**Air Cargo Problems**		
		Problem 1	Problem 2	Problem 3
A* Search	Node expansions	55	4853	18151
	Goal tests	57	4855	18153
	Time elapsed (s)	0.143	57.539	207.285
	Path length / Optimality	**6 / Yes**	**9 / Yes**	**12 / Yes**
A* Search (Ignore Preconditions)	Node expansions	41	**1450**	**5038**
	Goal tests	43	**1452**	**5040**
	Time elapsed (s)	0.148	**19.511**	**70.244**
	Path length / Optimality	**6 / Yes**	**9 / Yes**	**12 / Yes**
A* Search (Levelsum)	Node expansions	**11**	-	-
	Goal tests	**13**	-	-
	Time elapsed (s)	**4.362**	>600	>600
	Path length / Optimality	**6 / Yes**	-	-

Again, results show how time and memory consumed by the algorithms increase with the complexity of the problem. Also, the metrics of these resources are not far from the ones achieved with uninformed search strategies. On the other hand, none of the informed search strategies lost accuracy when increasing the complexity of the problem, finding the optimal path length for all the tests that could achieve a solution in less than 10 minutes. Some tests took too long to find a solution and had to be interrupted.

Among the informed search strategies tested, both in terms of resources and accuracy, the algorithm A* Search in combination with the heuristic for ignoring preconditions had the best results.

Results

According to the previous results, tests with the best performances have been run again and the sequences found for optimal path lengths with the preferred strategies were:

Air Cargo Problems	Problem 1	Problem 2	Problem 3
Strategy	Greedy Best First Graph Search	A* Search (Ignore Preconditions)	A* Search (Ignore Preconditions)
Result	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) Fly(P1, SFO, JFK) Unload(C1, P1, JFK) Load(C2, P2, JFK) Fly(P2, JFK, SFO) Unload(C2, P2, SFO) Load(C3, P3, ATL) Fly(P3, ATL, SFO) Unload(C3, P3, SFO)	Load(C1, P1, SFO) Fly(P1, SFO, ATL) Load(C3, P1, ATL) Fly(P1, ATL, JFK) Unload(C1, P1, JFK) Load(C2, P2, JFK) Fly(P2, JFK, ORD) Load(C4, P2, ORD) Fly(P2, ORD, SFO) Unload(C2, P2, SFO) Unload(C3, P1, JFK) Unload(C4, P2, SFO)