heuristic_analysis

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1 Heuristic Analysis

This document is an analysis that collects results obtained at the end of the implementation of the planning air cargo problem. It is divided into two parts. First part compares and contrasts non-heuristic search result metrics (optimality, time elapsed, number of node expansions) for the three given problems. In the second part the anlysis compares and constrasts heuristic search result metrics using A* with the *ignore preconditions* and *level-sum* heuristics for the three given problem.

1.1 Non-heuristic search results

The following tables shows the results obtained by three non-heuristic search: breadth first search, depth first graph search and uniform cost search. Each table represents test overview for the three Air Cargo problems.

1.1.1 Air Cargo Problem 1

Breadth First Search is the best choice in term of time elapsed (0.03 secs) and the plan length is the optimal one (6 units):

Search	Expansions	Goal Tests	New Nodes	Plan Length	Time elapsed in seconds
Breadth First Search	43	56	180	6	0.039
Depth First Graph Search	21	22	84	20	0.030
Uniform Cost Search	55	57	224	6	0.042

We can show the optimal plan calculated by **Breadth First Search**.
Plan: *Load(C1, P1, SFO) -> Load(C2, P2, JFK) -> Fly(P2, JFK, SFO) -> Unload(C2, P2, SFO) -> Fly(P1, SFO, JFK) -> Unload(C1, P1, JFK)*

1.1.2 Air Cargo Problem 2

Uniform Cost Search is the best choice in term of time elapsed (11.02 secs) and the plan length is the optimal one (9 units), while **Breadth First search** still remain the search algorithm with an optimal plan.

Search	Expansions	Goal Tests	New Nodes	Plan Length	Time elapsed in seconds
Breadth First Search	3343	4609	30509	9	11.919
Depth First Graph Search	624	625	5602	619	3.052
Uniform Cost Search	4853	4855	44041	9	11.028

We can show the optimal plan calculated by **Uniform Cost Search**:

Plan: *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)*

1.1.3 Air Cargo Problem 3

Uniform Cost Search is the best choice in term of time elapsed (46.92 secs) and the plan length is the optimal one (12 units), while **Breadth First search** still remain the search algorithm with an optimal plan.

Search	Expansions	Goal Tests	New Nodes	Plan Length	Time elapsed in seconds
Breadth First Search	14663	18098	129631	12	88.568
Depth First Graph Search	408	409	3364	392	1.620
Uniform Cost Search	18223	18225	159618	12	46.929

We can show the optimal plan calculated by **Uniform Cost Search**:

Plan: *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)*

1.1.4 Breadth First Search

Problem1: Load(C1, P1, SFO) Load(C2, P2, JFK) Fly(P2, JFK, SFO) Unload(C2, P2, SFO) Fly(P1, SFO, JFK) Unload(C1, P1, JFK)

Problem2: Load(C1, P1, SFO) Load(C2, P2, JFK) Load(C3, P3, ATL) Fly(P2, JFK, SFO) Unload(C2, P2, SFO) Fly(P1, SFO, JFK) Unload(C1, P1, JFK) Fly(P3, ATL, SFO) Unload(C3, P3, SFO)

Problem3: Load(C1, P1, SFO) Load(C2, P2, JFK) Fly(P2, JFK, ORD) Load(C4, P2, ORD) Fly(P1, SFO, ATL) Load(C3, P1, ATL) Fly(P1, ATL, JFK) Unload(C1, P1, JFK) Unload(C3, P1, JFK) Fly(P2, ORD, SFO) Unload(C2, P2, SFO) Unload(C4, P2, SFO)

#Problem	Expansions	Goal Tests	New Nodes	Plan Length	Time elapsed in seconds
1	43	56	180	6	0.039
2	3343	4609	30509	9	11.919
3	14663	18098	129631	12	88.568

1.1.5 Depth First Graph Search

Problem1: 20 actions Fly(P1, SFO, JFK) Fly(P2, JFK, SFO) Load(C2, P1, JFK) Fly(P1, JFK, SFO) Fly(P2, SFO, JFK) Unload(C2, P1, SFO) Fly(P1, SFO, JFK) Fly(P2, JFK, SFO) Load(C2, P2, SFO) Fly(P1, JFK, SFO) Load(C1, P2, SFO) Fly(P2, SFO, JFK) Fly(P1, SFO, JFK) Unload(C2, P2, JFK) Unload(C1, P2, JFK) Fly(P2, JFK, SFO) Load(C2, P1, JFK) Fly(P1, JFK, SFO) Fly(P2, SFO, JFK) Unload(C2, P1, SFO)

Problem2: 619 actions

Problem3: 392 actions

#Problem	Expansions	Goal Tests	New Nodes	Plan Length	Time elapsed in seconds
1	21	22	84	20	0.030
2	624	625	5602	619	3.052
3	408	409	3364	392	1.620

1.1.6 Uniform Cost Search

Problem1: 6 actions Load(C1, P1, SFO) Load(C2, P2, JFK) Fly(P1, SFO, JFK) Fly(P2, JFK, SFO) Unload(C1, P1, JFK) Unload(C2, P2, SFO)

Problem2: 9 actions 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)

Problem3: 12 actions 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)

#Problem	Expansions	Goal Tests	New Nodes	Plan Length	Time elapsed in seconds
1	55	57	224	6	0.042
2	4853	4855	44041	9	11.028
3	18223	18225	159618	12	46.929