Heuristic Analysis

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My Results:

I decided to put the uninformed and heuristic results in separate boxes to make it visually easier to distinguish between the two. The goal of this analysis is to distinguish the difference between different uninformed and heuristic searching algorithms on problems with increasing complexity.

Search Type	Expansions	Goal Tests	New Nodes	Length	Time	Optimal Length
Breadth First Search	43	56	180	6	.0428	Yes
Uniform Cost Search	55	57	224	6	.0520	Yes
Depth First Graph Search	21	22	84	20	.0208	No

Air Cargo Problem 1 Uninformed Results

Search Type	Expansions	Goal Tests	New Nodes	Length	Time	Optimal Length
A* Search h_1	55	57	224	6	0.0512	yes
A* Search Ignore Preconditions	41	43	170	6	0.0595	yes
A* Search h_pg_levelsum	11	13	50	6	.7247	yes

Air Cargo Problem 1 Heuristic Results

On Air Cargo Problem 1 we can see that all algorithms except depth first search found optimal paths, and since they all ran in under one second not a noticeable difference in running time on Air Cargo Problem 1.

Search Type	Expansions	Goal Tests	New Nodes	Length	Time	Optimal Length
Breadth First Search	3343	4609	30509	9	21.9116	Yes
Uniform Cost Search	4853	4855	44041	9	16.5413	yes
Depth First Graph Search	624	625	5602	619	5.43	no

Air Cargo Problem 2 Uninformed Results

Search Type	Expansions	Goal Tests	New Nodes	Length	Time	Optimal Length
A* Search h_1	4853	4855	44041	9	17.0926	Yes
A* Search Ignore Preconditions	1450	1452	13303	9	6.1659	yes
A* Search h_pg_levelsum	86	88	841	9	62.22	

Air Cargo Problem 2 Heuristic Results

Here on Air Cargo Problem 2 we can start seeing a difference in running time

Search Type	Expansions	Goal Tests	New Nodes	Length	Time	Optimal Length
Breadth First Search	14663	18098	129631	12	151.0935	yes
Uniform Cost Search	18223	18225	159618	12	75.8537	yes
Depth First Graph Search	408	409	3364	392	2.3324	no

Air Cargo Problem 3 Uninformed Results

Search Type	Expansions	Goal Tests	New Nodes	Length	Time	Optimal Length
A* Search h_1	18223	18225	159618	12	68.5292	yes
A* Search Ignore Preconditions	5040	5042	44944	12	23.3298	yes
A* Search h_pg_levelsum	325	327	3002	12	388.1280	yes

Air Cargo Problem 3 Heuristic Results

Non heuristic Analysis

Breadth first search will always find the shortest path in decent time but could end up costing a good amount of memory while running. Uniform cost search also found optimal solutions but used more memory than Breadth first search. Depth Search Search found solutions with short running time and a small amount of memory but did not find optimal solutions since it returns the first solution it finds. Between the 3 non heuristic algorithms I would use Depth Search Search if memory is a big concern and I don't care for an optimal solution. If I don't have any memory restrictions and need a quick optimal solution I would use Uniform cost search because it does better on complex problems compared to Breadth first search.

Heuristic Analysis

A* Search Ignore Preconditions was by far the fastest to find optimal solutions as complexity increases, it also uses about 25% the memory of regular A* Search. A* Search Level Sum did terrible in running time by comparison due to its high complexity design. The only thing A* Search Level Sum had going its way was its tiny memory consumption which uses as little as 5% the memory of A* Search on complex problems.

Best Algorithms

Among the non heuristic algorithms I would say that Uniform cost search is the best one because it finds optimal solutions the fastest on big problems. I believe people running the algorithm on huge data care more about running time and can probably get more memory if needed. Among the heuristic algorithms I would go with A* Search Ignore Preconditions because it runs faster than A* Search and uses a fraction of the memory. I believe a quick running time is the deciding factor because memory keeps getting cheaper and algorithm research is more about finding faster solutions than small memory consumption. I am also giving A* Search Ignore Preconditions the overall win because it used less memory than the non heuristic algorithms. Overall I believe A* Search Ignore Preconditions is the most powerful algorithm used in this project.

Best Plans

Here I present the optimal plans and algorithms for each problem. There were a few algorithms for each problem that produced an optimal path but some took more time and/or memory resources than others. I picked the best one to be the one with the best running time because of my personal bias toward time complexity. More often than not I believe the faster algorithm will be chosen over one with less memory consumption.

Problem	Best Algorithm (Optimal length and shortest time)	Optimal Plan
Air Cargo Problem 1	Breadth First Search	Load(C1, P1, SFO) Load(C2, P2, JFK) Fly(P2, JFK, SFO) Unload(C2, P2, SFO) Fly(P1, SFO, JFK) Unload(C1, P1, JFK)
Air Cargo Problem 2	A* Search Ignore Preconditions	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)
Air Cargo Problem 3	A* Search Ignore Preconditions	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)