

Planning Heuristic Analysis

Carlos Aguilar

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Optimal plans

Problem 1

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

Problem 2

```
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)
```

Problem 3

```
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(C2, P2, SFO)
Unload(C1, P1, JFK)
```

Non-heuristic search comparison

Problem	Search	Expansions	Goals tested	New nodes	Time (s)	Optimality
Problem 1	Breath First	43	56	180	0.04	6 actions
	Depth First Graph	21	22	84	0.02	20 actions
	Uniform Cost	55	57	224	0.05	6 actions
Problem 2	Breath First	3343	4609	30509	14.63	9 actions
	Depth First Graph	624	625	5602	4.39	619 actions
	Uniform Cost	4853	4855	44041	56.12	9 actions
Problem 3	Breath First	14663	18098	129631	134.31	12 actions
	Depth First Graph	408	409	3364	2.36	392 actions
	Uniform Cost	18223	18225	159618	486.62	12 actions

For this comparison, the Uniform Cost (UC) search was chosen as the third algorithm. According to the table, Depth First Graph (DFG) was by far the fastest and the one with lowest resources consumed. The problem with DFG is that even if it reaches a goal state, the plan found is not close to an optimal one. About Breath First (BF) and UC it seems both reach the goal state with an optimal plan but BF expands less nodes and run faster than UC.

Heuristic search comparison

Problem	Search	Expansions	Goals tested	New nodes	Time (s)	Optimality
Problem 1	h_ignore_preconditions	41	43	170	0.08	6 actions
	h_pg_levelsum	11	13	50	2.39	6 actions
Problem 2	h_ignore_preconditions	1506	1508	13820	27.24	9 actions
	h_pg_levelsum	86	88	841	243.2	9 actions
Problem 3	h_ignore_preconditions	5118	5120	45650	157.16	12 actions
	h_pg_levelsum	414	416	3818	1804.32	12 actions

On the heuristic search side, both heuristics reach an optimal plan but they do differently. The Ignore Preconditions Heuristic (IPH) requires expanding more nodes and test more goal states but the evaluation is a lot faster than the Level Sum Heuristic (LSH). Looking at the results even as LSH expands just a fraction of the nodes expanded by IPH it takes too much time to calculate the sum so it performs poorly compare to IPH in terms of time.

Best heuristic analysis

Looking at the tables the best heuristic in this case is IPH. On the first problem IPH is even the best overall search since it requires less expansion and takes less time than the best non-heuristic that finds the optimal path, BF. Although on problems 2 and 3 it seems that even though IPH expands less nodes,

BF finds the optimal path faster so I would say that for the second and third problems BF is better than IPH.