

# Heuristic Analysis

## Problem 1

SEARCH	EXPANSIONS	GOAL TESTS	TIME ELAPSED
BREADTH FIRST SEARCH	43	45	0.0392
DEPTH FIRST SEARCH	12	13	0.011
DEPTH LIMITED SEARCH	101	271	0.101
GREEDY BEST FIRST GRAPH SEARCH	7	9	0.007
A* IGNORE PRECONDITIONS	41	43	0.058
A* LEVELSUM	11	13	2.349

### Optimal Solution

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

## Problem 2

SEARCH	EXPANSIONS	GOAL TESTS	TIME ELAPSED
BREADTH FIRST SEARCH	3343	4609	14.58
DEPTH FIRST SEARCH	582	583	3.185
DEPTH LIMITED SEARCH	222719	2053741	1246.684
GREEDY BEST FIRST GRAPH SEARCH	998	1000	7.783
A* IGNORE PRECONDITIONS	1506	1508	16.035
A* LEVELSUM	86	88	275.743

### Optimal Solution

- Load(C3, P3, ATL)

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

### Problem 3

SEARCH	EXPANSIONS	GOAL TESTS	TIME ELAPSED
BREADTH FIRST SEARCH	14663	18098	110.407
DEPTH FIRST SEARCH	627	628	3.305
DEPTH LIMITED SEARCH	Over 10 minutes		
GREEDY BEST FIRST GRAPH SEARCH	5578	5580	140.376
A* IGNORE PRECONDITIONS	5118	5120	101.076
A* LEVELSUM	414	416	2145.485

#### Optimal Solution

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

**Compare and contrast heuristic search result metrics using A\* with the "ignore preconditions" and "level-sum" heuristics for Problems 1, 2, and 3.**

- In all cases, the "ignore preconditions" heuristic found the optimal solution faster than the "level sum" heuristic. However it expanded and tested many more nodes. In

problem 2 it expanded 1700% as many nodes, however it finished in 5% of the time. The reason that the “ignore preconditions” heuristic is so much faster is because it does not need to traverse the problem graph at all.

**What was the best heuristic used in these problems? Was it better than non-heuristic search planning methods for all problems? Why or why not?**

- The level-sum heuristic was the best if you can ignore cost. However that is not practical. Even though the level-sum heuristic expanded 17 times less node than the ignore-preconditions heuristic, I would say the ignore-preconditions heuristic is better because it performs the search faster, which is the end goal of a heuristic.

The ignore-preconditions heuristic outperformed all non-heuristic searches in problems 2 and 3, but in problem 1 GBFS performed faster.