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 preformed faster.