Task: Run uninformed planning searches for air\_cargo\_p1, air\_cargo\_p2, and air\_cargo\_p3; provide metrics on number of node expansions required, number of goal tests, time elapsed, and optimality of solution for each search algorithm. Include the result of at least three of these searches, including breadth-first and depth-first, in your write-up (breadth\_first\_search and depth\_first\_graph\_search).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Problem | Search Type | Node Expansions | Goal Tests | Time Elapsed | Optimality |
| P1 | Breadth\_first\_search | 43 | 56 | 0.037 seconds | Second most optimal for P1 (of three surveyed) |
| P1 | Depth first graph search | 21 | 22 | 0.020 seconds | Most optimal for P1 (of three surveyed) |
| P1 | astar\_search h\_1 | 55 | 57 | 0.048 seconds | Least optimal for P1 (of three surveyed) |
| P2 | Breadth\_first\_search | 477 | 1110 | 1.920 seconds | Second most optimal for P2 (of three surveyed) |
| P2 | Depth first graph search | 184 | 185 | 0.767 seconds | Most optimal for P2 (of three surveyed) |
| P2 | astar\_search h\_1 | 1462 | 1464 | 4.300 seconds | Least optimal for P2 (of three surveyed) |
| P3 | Breadth\_first\_search | 324 | 787 | 1.450 seconds | Most optimal for P3 (of three surveyed) |
| P3 | Depth first graph search | 4489 | 4400 | 29.299 seconds | Least optimal for P3 (of three surveyed) |
| P3 | astar\_search h\_1 | 1067 | 1069 | 3.848 seconds | Second most optimal for P3 (of three surveyed) |

Overall summary – for simpler problems such as P1 and P2, depth-first graph search is the most optimal, followed by breadth-first search and finally astar\_search h\_1; for P3 the order is revised, with breadth-first search most optimal, followed by astar\_search h1 and finally

Task: Run A\* planning searches using the heuristics you have implemented on air\_cargo\_p1, air\_cargo\_p2 and air\_cargo\_p3. Provide metrics on number of node expansions required, number of goal tests, time elapsed, and optimality of solution for each search algorithm and include the results in your report.

8. astar\_search h\_1

9. astar\_search h\_ignore\_preconditions

10. astar\_search h\_pg\_levelsum

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Problem | Search Type | Node Expansions | Goal Tests | Time Elapsed | Optimality |
| P1 | astar\_search h\_1 | 55 | 57 | 0.046 s |  |
| P1 | astar\_search h\_ignore\_preconditions | 41 | 43 | 0.035 s |  |
| P1 | astar\_search h\_pg\_levelsum | 55 | 57 | 14.514 s |  |
| P2 | astar\_search h\_1 | 1462 | 1464 | 4.340 s |  |
| P2 | astar\_search h\_ignore\_preconditions | 153 | 155 | 0.490 s |  |
| P2 | astar\_search h\_pg\_levelsum | 1462 | 1464 | 549.433 s |  |
| P3 | astar\_search h\_1 | 1067 | 1069 | 4.214 s | Path length of 6 |
| P3 | astar\_search h\_ignore\_preconditions | 123 | 125 | 0.541 s | Path length of 6 |
| P3 | astar\_search h\_pg\_levelsum | 1067 | 1069 | 550.752 s | Path length of 6 |

* Provide an optimal plan for Problems 1, 2, and 3.

An optimal plan for Problem 2 is:

An optimal plan for Problem 3 is:

Load(C1, P1, SFO)

Load(C2, P2, JFK)

Fly(P1, SFO, JFK)

Fly(P2, JFK, SFO)

Unload(C2, P2, SFO)

Unload(C1, P1, JFK)

* Compare and contrast non-heuristic search result metrics (optimality, time elapsed, number of node expansions) for Problems 1,2, and 3. Include breadth-first, depth-first, and at least one other uninformed non-heuristic search in your comparison; Your third choice of non-heuristic search may be skipped for Problem 3 if it takes longer than 10 minutes to run, but a note in this case should be included.
* Compare and contrast heuristic search result metrics using A\* with the "ignore preconditions" and "level-sum" heuristics for Problems 1, 2, and 3.
* 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?
* Provide tables or other visual aids as needed for clarity in your discussion.