**AIND Planning – Written Analysis**

*Overall performance of search algorithms*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Non-heuristic search | | | | | | |
| Problem | Search Algorithm | Node Expansions | Goal tests | New nodes | Time taken (s) | Plan length |
| Air\_cargo\_p1 | Breadth-first | 43 | 56 | 180 | 0.1199 | 6 |
| Depth-first graph | 12 | 13 | 48 | 0.03399 | 12 |
| Uniform | 55 | 57 | 224 | 0.1389 | 6 |
| Air\_cargo\_p2 | Breadth-first | 3346 | 4612 | 30534 | 46.34 | 9 |
| Depth-first graph | 859 | 860 | 7745 | 14.11 | 846 |
| Uniform | 4853 | 4855 | 4401 | 58.24 | 9 |
| Air\_cargo\_p3 | Breadth-first | 14120 | 17673 | 124926 | 262.29 | 12 |
| Depth-first graph | 1401 | 1402 | 11649 | 24.45 | 1345 |
| Uniform | 18223 | 18225 | 159618 | 253.23 | 12 |
| Heuristic search | | | | | | |
| Air\_cargo\_p1 | AStar with h\_1 | 55 | 57 | 224 | 0.144 | 6 |
| AStar with ignore\_precondition | 41 | 43 | 170 | 0.1163 | 6 |
| AStar with level\_sum | 11 | 13 | 50 | 0.4697 | 6 |
| Air\_cargo\_p2 | AStar with h\_1 | 4853 | 4855 | 44041 | 57.25 | 9 |
| AStar with ignore\_precondition | 1450 | 1452 | 13303 | 18.07 | 9 |
| AStar with level\_sum | 86 | 88 | 841 | 35.75 | 9 |
| Air\_cargo\_p3 | AStar with h\_1 | 18223 | 18225 | 159618 | 259.07 | 12 |
| AStar with ignore\_precondition | 5040 | 5042 | 44944 | 80.29 | 12 |
| AStar with level\_sum | 325 | 327 | 3002 | 185.09 | 12 |

As a whole, the best heuristic search schemes outperform the best non-heuristic ones, with the level sum heuristic giving the overall best performance, especially in the more complicated search problems. However, the worst performing heuristic search (AStar with h1) performs worse than some of the non-heuristic searches.

For non-heuristic search, we can see that overall, a depth-first search returns us the results very quickly compared to breadth-first or uniform search. This could be due to the fact that going deep down a branch is much faster than expanding the network at each level, as with breadth-first search. However, the overall plan length is extremely long as not always the best move is made.

For heuristic search, we can see that all schemes return the shortest possible plan length. The level sum heuristic explores the least number of nodes compared to all other schemes, suggesting that the estimation is a rather good estimation of the problem. However, it takes a considerable amount of time compared to the ignore preconditions heuristic. The ignore preconditions heuristic, however, explores much more nodes compared to the level sum. This could be due to the fact that we essentially “add” edges to the graphical model, meaning that we need to visit more nodes in order to find the optimal solution.

The best heuristic search is the AStar with level sum heuristic search. It performs much better than the best performing non-heuristic search, the depth-first graph. It also manages to return an optimal plan length. It appears as since each move is independent from each other, the level sum gives a good estimate of the cost to the overall goal. However, in terms of search speed, it is unable to match the depth-first search.