AIND-Planning

Planning Problem Representation:

1. Optimal sequence of action for each problem:

1.1 Air cargo problem 1

Load(C1, P1, SFO)

Fly(P1, SFO, JFK)

Load(C2, P2, JFK)

Fly(P2, JFK, SFO)

Unload(C1, P1, JFK)

Unload(C2, P2, SFO)

1.2 Air cargo problem 2

Load(C1, P1, SFO)

Fly(P1, SFO, JFK)

Load(C2, P2, JFK)

Fly(P2, JFK, SFO)

Load(C3, P3, ATL)

Fly(P3, ATL, SFO)

Unload(C3, P3, SFO)

Unload(C2, P2, SFO)

Unload(C1, P1, JFK)

1.3 Air cargo problem 3

Load(C1, P1, SFO)

Fly(P1, SFO, ATL)

Load(C3, P1, ATL)

Fly(P1, ATL, JFK)

Load(C2, P2, JFK)

Fly(P2, JFK, ORD)

Load(C4, P2, ORD)

Fly(P2, ORD, SFO)

Unload(C4, P2, SFO)

Unload(C3, P1, JFK)

Unload(C2, P2, SFO)

Unload(C1, P1, JFK)

Performance Comparison:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **air\_cargo\_p1** | | | | |
|  | **Expansions** | **Goal Tests** | **New Nodes** | **time(s)** | **plan length** |
| BFS | 43 | 56 | 180 | 0.37 | 6 |
| DFGS | 12 | 13 | 48 | 0.24 | 12 |
| UCS | 55 | 57 | 224 | 0.31 | 6 |
| A\* - h\_pg\_levelsum | 11 | 13 | 50 | 1.029 | 6 |
| A\* - ignore preconditions | 41 | 43 | 170 | 0.32 | 6 |

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| --- | --- | --- | --- | --- | --- |
| **air\_cargo\_p2** | | | | | |
|  | **Expansions** | Goal Tests | New Nodes | **time(s)** | **pair length** |
| BFS | 3,401 | 4,672 | 31,049 | 6.54 | 9 |
| DFGS | 350 | 351 | 3,142 | 0.97 | 346 |
| UCS | 4,761 | 4,763 | 43,206 | 7.37 | 9 |
| A\* - h\_pg\_levelsum | 86 | 88 | 841 | 8.27 | 9 |
| A\* - ignore preconditions | 1,450 | 1,452 | 13,303 | 4.53 | 9 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **air\_cargo\_p3** | | | | | |
|  | **Expansions** | **Goal Tests** | **New Nodes** | **time(s)** | **pair length** |
| BFS | 14,491 | 17,947 | 128,184 | 33.4 | 12 |
| DFGS | 1,948 | 1,949 | 16,253 | 4.91 | 1878 |
| UCS | 17,783 | 17,785 | 155,920 | 26.59 | 12 |
| A\* - h\_pg\_levelsum | 311 | 313 | 2,863 | 42 | 12 |
| A\* - ignore preconditions | 5,003 | 5,005 | 44,506 | 15.12 | 12 |

Analysis of algorithms:

BFS: Is optimal, although the time taken is small only because the depth is small. Because BFS time required increases exponentially with depth. (Russell & Norvig, 2010, pp. 81-83)

DFGS: Non optimal (Russell & Norvig, 2010, pp. 85-87)

UCS: Optimal (Russell & Norvig, 2010, pp. 83-85)

A\*: For A\* search to be optimal the heuristic has to be admissible (i.e should not overestimate the cost to reach the goal).

A\*-levelsum: because this is the sum of paths to the goals it either estimates correctly or underestimates the cost to reach the goal. (Russell & Norvig, 2010, p. 382)

A\*-ignore precondition: heuristics generated from ignoring preconditions are admissible(video), and if a heuristic is admissible we can say it is optimal. (Russell & Norvig, 2010, p. 95)

Reference:

Russell, S., & Norving, P. (2010). *Artificial intelligence* (3rd ed.). New Jersey: Pearson.