ANALYSIS

Non Heuristic Searches-

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| Problem | Breadth\_first\_search | Depth\_first\_graph\_search | Uniform\_cost\_search |
| Air Cargo Problem 1 | Expansions-43  Goal Tests-56  New Nodes-180  Time- 0.030782620000536554  Optimal Path-  Load(C1, P1, SFO)  Load(C2, P2, JFK)  Fly(P2, JFK, SFO)  Unload(C2, P2, SFO)  Fly(P1, SFO, JFK)  Unload(C1, P1, JFK) | Expansions-21  Goal Tests-22  New Nodes-84  Time- 0.014805071994487662  Path length is 20-  Hence not optimal | Expansions-55  Goal Tests-57  New Nodes-224  Time-  0.04118156401091255  Optimal Path-  Load(C1, P1, SFO)  Load(C2, P2, JFK)  Fly(P1, SFO, JFK)  Fly(P2, JFK, SFO)  Unload(C1, P1, JFK)  Unload(C2, P2, SFO) |
| Air Cargo Problem 2 | Expansions-3346  Goal Tests-4612  New Nodes-30534  Time- 13.897042825992685  Optimal Path-  Load(C1, P1, SFO)  Load(C2, P2, JFK)  Load(C3, P3, ATL)  Fly(P1, SFO, JFK)  Unload(C1, P1, JFK)  Fly(P2, JFK, SFO)  Unload(C2, P2, SFO)  Fly(P3, ATL, SFO)  Unload(C3, P3, SFO) | Expansions-107  Goal Tests-108  New Nodes-959  Time-  0.3423971490119584  Path length is 105-  Hence not optimal | Expansions-4852  Goal Tests-4854  New Nodes-44030  Time- 45.0311206089973  Optimal Path-  Load(C1, P1, SFO)  Load(C2, P2, JFK)  Load(C3, P3, ATL)  Fly(P1, SFO, JFK)  Fly(P2, JFK, SFO)  Fly(P3, ATL, SFO)  Unload(C3, P3, SFO)  Unload(C2, P2, SFO)  Unload(C1, P1, JFK) |
| Air Cargo Problem 3 | Expansions-3599  Goal Tests-6338  New Nodes-31930  Time- 20.77853937400505  Optimal Path-  Load(C1, P1, SFO)  Load(C2, P2, JFK)  Fly(P1, SFO, ATL)  Load(C3, P1, ATL)  Fly(P2, JFK, SFO)  Unload(C2, P2, SFO)  Fly(P1, ATL, JFK)  Unload(C1, P1, JFK)  Unload(C3, P1, JFK) | Expansions-93  Goal Tests-94  New Nodes-783  Time- 0.280162385024596  Path length is 92-  Hence not optimal | Expansions-7368  Goal Tests-7370  New Nodes-66215  Time- 136.17521741401288  Optimal Path-  Load(C1, P1, SFO)  Load(C2, P2, JFK)  Fly(P1, SFO, ATL)  Load(C3, P1, ATL)  Fly(P2, JFK, SFO)  Fly(P1, ATL, JFK)  Unload(C3, P1, JFK)  Unload(C2, P2, SFO)  Unload(C1, P1, JFK) |

* As it can be seen depth first search clearly takes the least amount of time to search but its searches are not optimal
* The path length generated by dfs is not optimal and is much more than bfs and uniform cost search
* BFS and uniform cost search generate similar paths to achieve the goals.
* But BFS takes less time than uniform cost search,hence BFS is the optimal searching technique amongst the three.
* BFS has an average searching time less than UCS in all the three cases.
* Heuristic Searches-

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| Problem | A\*\_h\_ignore\_preconditions | A\*\_h\_pg\_levelsum |
| Air Cargo Problem 1 | Expansions-41  Goal Tests-43  New Nodes-170  Time- 0.03225685301003978  Optimal Path-  Load(C1, P1, SFO)  Fly(P1, SFO, JFK)  Unload(C1, P1, JFK)  Load(C2, P2, JFK)  Fly(P2, JFK, SFO)  Unload(C2, P2, SFO) | Expansions-11  Goal Tests-13  New Nodes-50  Time- 1.5453272760205436  Optimal Path-  Load(C1, P1, SFO)  Fly(P1, SFO, JFK)  Load(C2, P2, JFK)  Fly(P2, JFK, SFO)  Unload(C1, P1, JFK)  Unload(C2, P2, SFO) |
| Air Cargo Problem 2 | Expansions-1506  Goal Tests-1508  New Nodes-13820  Time- 12.385466430016095  Optimal Path-  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) | Expansions- 86  Goal Tests- 88  New Nodes- 841  Time- 155.16828671601252  Optimal Path-  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) |
| Air Cargo Problem 3 | Expansions- 870  Goal Tests- 872  New Nodes-7571  Time-  5.399042153003393  Optimal Path-  Load(C1, P1, SFO)  Fly(P1, SFO, ATL)  Load(C3, P1, ATL)  Fly(P1, ATL, JFK)  Unload(C3, P1, JFK)  Load(C2, P2, JFK)  Fly(P2, JFK, SFO)  Unload(C2, P2, SFO)  Unload(C1, P1, JFK) | Expansions-71  Goal Tests-73  New Nodes-625  Time- 195.00131706500542  Optimal Path-  Load(C1, P1, SFO)  Fly(P1, SFO, ATL)  Load(C3, P1, ATL)  Fly(P1, ATL, JFK)  Load(C2, P2, JFK)  Fly(P2, JFK, SFO)  Unload(C3, P1, JFK)  Unload(C2, P2, SFO)  Unload(C1, P1, JFK) |

* The h\_ignore\_preconditions heuristic always takes less time than the h\_levelsum for all the problems.
* But the h\_ignore\_precondtions heuristic expands more nodes as it does not constrain itself to any condtions and thus resulting into creation of more nodes.
* h\_pg\_levelsum does not expand many nodes as it is constrained to precontions and the effects.
* Both the heursitics generate optimal paths of same length and are very similar in the actions.
* But the h\_ignore\_preconditions must be considered optimal as it relaxes the problem and searches in lesser time.
* The heuristic method h\_ignore\_preconditions can be considered more optimal than the non heuristic bfs method as it takes a lot less time to search and also the expansions are significantly lesser.