**Air Cargo Planning Heuristic Analysis**

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Udacity AIND – Implementation of Planning Search

The following tables show the results gathered after solving the air cargo problems with both uninformed and informed based search. The goal of this analysis is to document the results obtained from each search type and find an optimal solution for each air cargo problem, that is; a search algorithm that finds the lowest path among all possible paths from start to goal.

For each set of problems, the optimal and fastest solution has been highlighted with green color. Red color indicated that the test was stopped as it wasa taking longer time to conclude the search and produce an optimal path.

Below is the Air Cargo Action Schema:

Action(Load(c, p, a),

PRECOND: At(c, a) ∧ At(p, a) ∧ Cargo(c) ∧ Plane(p) ∧ Airport(a)

EFFECT: ¬ At(c, a) ∧ In(c, p))

Action(Unload(c, p, a),

PRECOND: In(c, p) ∧ At(p, a) ∧ Cargo(c) ∧ Plane(p) ∧ Airport(a)

EFFECT: At(c, a) ∧ ¬ In(c, p))

Action(Fly(p, from, to),

PRECOND: At(p, from) ∧ Plane(p) ∧ Airport(from) ∧ Airport(to)

EFFECT: ¬ At(p, from) ∧ At(p, to))

Optimal plan for Problems 1, 2, and 3 are given below along with comparison of the performance in terms of **speed** (execution time, measured in seconds), **memory usage** (measured in search node

expansions) and **optimality** (Yes, if a solution of optimal length is found; No, otherwise). The number of goal tests and number of new nodes are not included in the optimality check since they do not change the results of our analysis below.

1. *Problem 1*:

Below are the initial and goal states,

Init(At(C1, SFO) ∧ At(C2, JFK)

∧ At(P1, SFO) ∧ At(P2, JFK)

∧ Cargo(C1) ∧ Cargo(C2)

∧ Plane(P1) ∧ Plane(P2)

∧ Airport(JFK) ∧ Airport(SFO))

Goal(At(C1, JFK) ∧ At(C2, SFO))

Optimal path is,

Load(C1, P1, SFO)

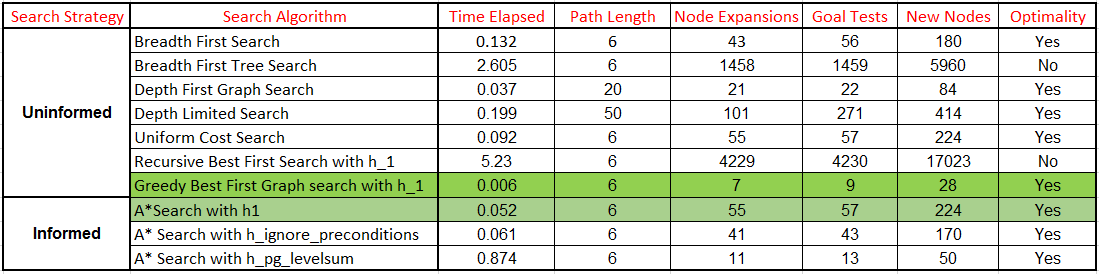
Load(C2, P2, JFK)

Fly(P1, SFO, JFK)

Fly(P2, JFK, SFO)

Unload(C1, P1, JFK)

Unload(C2, P2, SFO)



1. *Problem 2*:

Below are the initial and goal states,

Init(At(C1, SFO) ∧ At(C2, JFK) ∧ At(C3, ATL)

∧ At(P1, SFO) ∧ At(P2, JFK) ∧ At(P3, ATL)

∧ Cargo(C1) ∧ Cargo(C2) ∧ Cargo(C3)

∧ Plane(P1) ∧ Plane(P2) ∧ Plane(P3)

∧ Airport(JFK) ∧ Airport(SFO) ∧ Airport(ATL))

Goal(At(C1, JFK) ∧ At(C2, SFO) ∧ At(C3, SFO))

Optimal path is,

Load(C3, P3, ATL)

Fly(P3, ATL, SFO)

Unload(C3, P3, SFO)

Load(C1, P1, SFO)

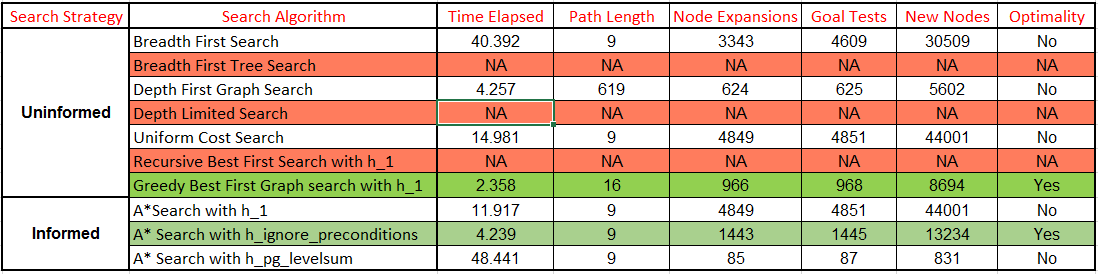
Fly(P1, SFO, JFK)

Unload(C1, P1, JFK)

Load(C2, P2, JFK)

Fly(P2, JFK, SFO)

Unload(C2, P2, SFO)



1. *Problem 3*:

Below are the initial and goal states,

Init(At(C1, SFO) ∧ At(C2, JFK) ∧ At(C3, ATL) ∧ At(C4, ORD)

∧ At(P1, SFO) ∧ At(P2, JFK)

∧ Cargo(C1) ∧ Cargo(C2) ∧ Cargo(C3) ∧ Cargo(C4)

∧ Plane(P1) ∧ Plane(P2)

∧ Airport(JFK) ∧ Airport(SFO) ∧ Airport(ATL) ∧ Airport(ORD))

Goal(At(C1, JFK) ∧ At(C3, JFK) ∧ At(C2, SFO) ∧ At(C4, SFO))

Optimal path is,

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)

