Experiment with Air Cargo Problem

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Implement a Planning Search

All the Air Cargo problems uses the following 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))
```

Part 1 - Planning problems:

Analysis

Table 1 to 3 show the metric for uniformed planning searches for `air_cargo_p1`, `air_cargo_p2`, `air_cargo_p3` problems. By looking at the all the metrics, we can see not all the search methods does not give us the optimal result. Depth first graph search for problem 2 and third does not reach optimal search. Given the execution time, the Uniform cost search provide the optimal search results during this experiment.

`air_cargo_p1`	Breadth First	Depth First Graph	Uniform Cost Search
Node Expansions	43	12	55
Goal Tests	56	13	57
Time Elapsed	0.053	0.015	0.064
Optimality	Yes	Yes	Yes

Table 1: Metrixs for non-huristic planning solution searches for `air_cargo_p1`

air_cargo_p2	Breadth First	Depth First Graph	Uniform Cost Search
Node Expansions	3401	350	4761
Goal Tests	4672	351	4763
Time Elapsed	20.8	2.2	18.36
Optimality	Yes	No	Yes

Table 2: Metrixs for non-huristic planning solution searches for air_cargo_p2

air_cargo_p2	Breadth First	Depth First Graph	Uniform Cost Search
Node Expansions	14491	3491	17615
Goal Tests	17947	3492	17617
Time Elapsed	147.28	71.8	76.0
Optimality	Yes	No	Yes

Table 3: Metrixs for non-huristic planning solution searches for air_cargo_p3

Part 2 - Domain-independent heuristics:

Analysis

Table 4 to 6 shows the problems air_cargo_p1, air_cargo_p2 and air_cargo_p3 with 3 different heuristics functions. All the functions reach the optimal solution including the A* search with level sum heuristic even it took over 10min to run (took 22 minutes. data left black in table 3). By looking at all the running times of each function, it is evident the A* search with ignore predictions heuristic perform the best.

air_cargo_p1	A* (h1 heuristic)	A* (ignore predictions heuristic)	A* (level sum heuristic)
Node Expansions	55	41	11
Goal Tests	57	43	13
Time Elapsed	0.06	0.06	1.8
Optimality	Yes	Yes	Yes

Table 4: metrics of A* searches for air_cargo_p1

air_cargo_p1	A* (h1 heuristic)	A* (ignore predictions heuristic)	A* (level sum heuristic)
Node Expansions	4761	1450	86
Goal Tests	4763	1452	88
Time Elapsed	18.3	6.9	277
Optimality	Yes	Yes	Yes

Table 5: metrics of A* searches for air_cargo_p2

air_cargo_p1	A* (h1 heuristic)	A* (ignore predictions heuristic)	A* (level sum heuristic)
Node Expansions	17615	4728	–
Goal Tests	17617	4730	–
Time Elapsed	77	25	–
Optimality	Yes	Yes	–

Table 6: metrics of A* searches for air_cargo_p3