Report

Configuration No.	Problem	Search Function	Actions	Expansions	Goal Tests	New Nodes	Plan Length	Time Elapsed in Seocnds
4	Air Cargo Problem 1	greedy_best_first_graph_search with h_unmet_goals	20	7	9	29	6	0.0006628
1	Air Cargo Problem 1	breadth_first_search	20	43	56	178	6	0.0024761
3	Air Cargo Problem 1	uniform_cost_search	20	60	62	240	6	0.0038261
8	Air Cargo Problem 1	astar_search with h_unmet_goals	20	50	52	206	6	0.004196
6	Air Cargo Problem 1	greedy_best_first_graph_search with h_pg_maxlevel	20	6	8	24	6	0.0630325
5	Air Cargo Problem 1	greedy_best_first_graph_search with h_pg_levelsum	20	6	8	28	6	0.0848862
9	Air Cargo Problem 1	astar_search with h_pg_levelsum	20	28	30	122	6	0.2104747
10	Air Cargo Problem 1	astar_search with h_pg_maxlevel	20	43	45	180	6	0.2202614
7	Air Cargo Problem 1	greedy_best_first_graph_search with h_pg_setlevel	20	6	8	28	6	0.2842309
11	Air Cargo Problem 1	astar_search with h_pg_setlevel	20	33	35	138	6	0.6715172
15	Air Cargo Problem 2	greedy_best_first_graph_search with h_unmet_goals	72	17	19	170	9	0.0082981
12	Air Cargo Problem 2	breadth_first_search	72	3343	4609	30503	9	0.799493
19	Air Cargo Problem 2	astar_search with h_unmet_goals	72	2467	2469	22522	9	0.8610764
14	Air Cargo Problem 2	uniform_cost_search	72	5154	5156	46618	9	1.3005226
16	Air Cargo Problem 2	greedy_best_first_graph_search with h_pg_levelsum	72	9	11	86	9	1.7483885
17	Air Cargo Problem 2	greedy_best_first_graph_search with h_pg_maxlevel	72	27	29	249	9	2.6982766
18	Air Cargo Problem 2	greedy_best_first_graph_search with h_pg_setlevel	72	9	11	84	9	7.4954428
20	Air Cargo Problem 2	astar_search with h_pg_levelsum	72	357	359	3426	9	47.8149332
21	Air Cargo Problem 2	astar_search with h_pg_maxlevel	72	2887	2889	26594	9	280.1468923
22	Air Cargo Problem 2	astar_search with h_pg_setlevel	72	1037	1039	9605	9	665.4191312
30	Air Cargo Problem 3	astar_search with h_unmet_goals	88	7388	7390	65711	12	3.2742643
23	Air Cargo Problem 3	breadth_first_search	88	14663	18098	129625	12	4.1577935
25	Air Cargo Problem 3	uniform_cost_search	88	18510	18512	161936	12	5.5483303
31	Air Cargo Problem 3	astar_search with h_pg_levelsum	88	369	371	3403	12	89.0059526
32	Air Cargo Problem 3	astar_search with h_pg_maxlevel	88	9580	9582	86312	12	1623.53806
33	Air Cargo Problem 3	astar_search with h_pg_setlevel	88	3423	3425	31596	12	3749.162255
28	Air Cargo Problem 3	greedy_best_first_graph_search with h_pg_maxlevel	88	21	23	195	13	4.1381493
27	Air Cargo Problem 3	greedy_best_first_graph_search with h_pg_levelsum	88	14	16	126	14	4.3373842
41	Air Cargo Problem 4	astar_search with h_unmet_goals	104	34330	34332	328509	14	22.2198201
34	Air Cargo Problem 4	breadth_first_search	104	99736	114953	944130	14	38.2138937
36	Air Cargo Problem 4	uniform_cost_search	104	113339	113341	1066413	14	44.8501822
43	Air Cargo Problem 4	astar_search with h_pg_maxlevel	104	62077	62079	599376	14	16861.15377
44	Air Cargo Problem 4	astar_search with h_pg_setlevel	104	22606	22608	224229	14	40126.40928
26	Air Cargo Problem 3	greedy_best_first_graph_search with h_unmet_goals	88	25	27	230	15	0.0142307
42	Air Cargo Problem 4	astar_search with h_pg_levelsum	104	1208	1210	12210	15	514.8252299
38	Air Cargo Problem 4	greedy_best_first_graph_search with h_pg_levelsum	104	17	19	165	17	7.3278638
39	Air Cargo Problem 4	greedy_best_first_graph_search with h_pg_maxlevel	104	56	58	580	17	12.6913729
29	Air Cargo Problem 3	greedy_best_first_graph_search with h_pg_setlevel	88	35	37	345	17	40.9914455
37	Air Cargo Problem 4	greedy_best_first_graph_search with h_unmet_goals	104	29	31	280	18	0.0244637
2	Air Cargo Problem 1	depth_first_graph_search	20	21	22	84	20	0.0013456
40	Air Cargo Problem 4	greedy_best_first_graph_search with h_pg_setlevel	104	107	109	1164	23	190.2474776
24	Air Cargo Problem 3	depth_first_graph_search	88	408	409	3364	392	0.4110362
13	Air Cargo Problem 2	depth_first_graph_search	72	624	625	5602	619	1.0530057
35	Air Cargo Problem 4	depth_first_graph_search	104	25174	25175	228849	24132	1536.723059

Table for the following Criteria 1~3.

Criteria 1. Analyze the search complexity as a function of domain size, search algorithm, and heuristic.

Report includes a table or chart to analyze the number of nodes expanded against number of actions in the domain.

- The chart or table includes data for all search & heuristic combinations for air cargo problems 1 and 2
- The chart or table includes data **at least** one uninformed search, two heuristics with greedy best first search, and two heuristics with A* on air cargo problems 3 and 4
- Report includes at least a one paragraph discussion of these results that analyzes the growth trends as the problem size increases

➔ As the domain size increases, the number of expanded nodes tends to increase.

➔ Maximum number of expanded nodes: uniform_cost_search

➔ Minimum number of expanded nodes: greedy_best_first_graph_search with h_pg_levelsum

Criteria 2. Analyze search time as a function of domain size, search algorithm, and heuristic..

Report includes a table or chart to analyze the search time against the number of actions in the domain.

- The chart or table includes data for all search & heuristic combinations for air cargo problems 1 and 2
- The chart or table includes data at least one uninformed search, two heuristics with greedy best first search, and two heuristics with A* on air cargo problems 3 and 4
- Report includes at least a one paragraph discussion of these results that analyzes the growth trends as the problem size increases

➔ The search time tends to increase as the domain size increases. It is important to choose a proper search policy and heuristics since that can dramatically decrease the search time giving the (almost) same result.

➔ Longest search time: astar_search with h_pg_setlevel

➔ Shortest search time: greedy_best_first_graph_search with h_unmet_goals

Criteria 3. Analyze the optimality of solution as a function of domain size, search algorithm, and heuristic.

Report includes a table or chart to analyze the length of the plans returned by each algorithm on all search problems.

- The chart or table includes data for all search & heuristic combinations for air cargo problems 1 and 2
- The chart or table includes data at least one uninformed search, two heuristics with greedy best first search, and two heuristics with A* on air cargo problems 3 and 4

➔ The plan length tends to increase as the domain size increases.

➔ Longest plan length: depth_first_graph_search

➔ Shortest plan length: astar_search with h_unmet_goals

Criteria 4. Report answers all required questions.

Submission includes a short answer to each of the following questions. (A short answer should be at least 1–2 sentences at most a small paragraph.)

- Which algorithm or algorithms would be most appropriate for planning in a very restricted domain (i.e., one that has only a few actions) and needs to operate in real time?

→ In Air Cargo Problem 1 (having the fewest actions), depth_first_graph_search, breadth_first_search, and uniform_cost_search algorithms take almost the shortest search time, while the algorithms actually give the antithesis of the result in a huge domain. Therefore, it is enough to utilize such algorithms in a very restricted domain.

- Which algorithm or algorithms would be most appropriate for planning in very large domains (e.g., planning delivery routes for all UPS drivers in the U.S. on a given day)

  → In a very large domain, on the other hands, greedy-like algorithms are often preferred due to a limited time and computational resource. In that case, greedy_best_first_graph_search with h_unmet_goals/h_pg_levelsum/h_pg_maxlevel and astar_search with h_unmet_goals would be appropriate algorithms.

- Which algorithm or algorithms would be most appropriate for planning problems where it is important to find only optimal plans?

  → For all problems, astar_search with h_unmet_goals provides the shortest plan length in the shortest search time. Therefore, astar_search with h_unmet_goals would be the most appropriate in this case.