Project 2
Build a Forward Planning Agent (Classical Planning)
Experimental Results and Report
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Air Cargo Problem 1:

P#	Search Function	Actions	Expansions	Goal Tests	New Nodes	Plan length	Time Elapsed (Seconds)
1	Breadth first search	20	43	56	178	6	0.007588
2	Depth first graph search	20	21	22	84	20	0.004688
3	Uniform cost search	20	60	62	240	6	0.012531
4	Greedy best first graph search h unmet goals	20	7	9	29	6	0.002129
5	Greedy best first graph search h pg level-sum	20	6	8	28	6	0.267858
6	Greedy best first graph search h pg max-level	20	6	8	24	6	0.210448
7	Greedy best first graph search h pg set-level	20	6	8	24	6	0.269473
8	Astar search h unmet goals	20	50	52	206	6	0.012452
9	Astar search h pg level-sum	20	28	30	122	6	0.651940
10	Astar search h pg max-level	20	43	45	180	6	0.645032
11	Astar search h pg setlevel	20	42	44	176	6	0.952679

Greedy best first graph search with h unmet goals is the optimal algorithm for problem 1 as it has taken the minimum time to discover the goal with ideal plan length.

Air Cargo Problem 2:

P#	Search Function	Actions	Expansions	Goal Tests	New Nodes	Plan length	Time Elapsed (Seconds)
1	Breadth first search	72	3343	4609	30503	9	1.449362
2	Depth first graph search	72	624	625	5602	619	1.898989
3	Uniform cost search	72	5154	5156	46618	9	2.339444
4	Greedy best first graph search h unmet goals	72	17	19	170	9	0.025819
5	Greedy best first graph search h pg level-sum	72	9	11	86	9	5.049651
6	Greedy best first graph search h pg max-level	72	27	29	249	9	10.198311
7	Greedy best first graph search h pg set-level	72	27	29	249	9	13.171467
8	Astar search h unmet goals	72	2467	2469	22522	9	1.592088
9	Astar search h pg level-sum	72	357	359	3426	9	133.649235
10	Astar search h pg max-level	72	2887	2889	26594	9	733.815186
11	Astar search h pg setlevel	72	2609	2611	23947	9	1148.871935

Greedy best first graph search with h unmet goals is also the optimal algorithm for problem 2 as it has taken the minimum time to discover the goal with ideal plan length.

Air Cargo Problem 3:

P#	Search Function	Actions	Expansions	Goal Tests	New Nodes	Plan length	Time Elapsed (Seconds)
1	Breadth first search	88	14663	18098	129625	12	7.692388
2	Depth first graph search	88	408	409	3364	392	0.782286
3	Uniform cost search	88	18510	18512	161936	12	10.039204
4	Greedy best first graph search h unmet goals	88	25	27	230	15	0.042273
5	Greedy best first graph search h pg level-sum	88	14	16	126	14	11.271110
6	Greedy best first graph search h pg max-level	88	21	23	195	13	14.560673
7	Greedy best first graph search h pg set-level	88	31	33	293	14	33.652488
8	Astar search h unmet goals	88	7388	7390	65711	12	6.433187
9	Astar search h pg level-sum	88	369	371	3403	12	215.030960
10	Astar search h pg max-level	88	9580	9582	86312	12	3646.497083
11	Astar search h pg setlevel	88	9083	9085	81316	12	5434.598850

Greedy best first graph search with h unmet goals is the optimal algorithm for problem 3 as it has taken the minimum time to discover the goal with ideal plan length.

Air Cargo Problem 4:

P#	Search Function	Actions	Expansions	Goal Tests	New Nodes	Plan length	Time Elapsed (Seconds)
1	Breadth first search	104	99736	114953	944130	14	68.3450927
2	Depth first graph search	104	25174	25175	228849	24132	2595.305326
3	Uniform cost search	104	113339	113341	1066413	14	94.520608
4	Greedy best first graph search h unmet goals	104	29	31	280	18	0.043157
5	Greedy best first graph search h pg level-sum	104	17	19	165	17	23.069931
6	Greedy best first graph search h pg max-level	104	56	58	580	17	54.560858
7	Greedy best first graph search h pg set-level	104	233	235	2488	18	292.095091
8	Astar search h unmet goals	104	34330	34332	328509	14	45.838258
9	Astar search h pg level-sum	104	1208	1210	12210	15	1316.404628
10	Astar search h pg max-level	104	62077	62079	599376	14	38123.047860
11	Astar search h pg setlevel	104	55383	55385	536664	14	59537.720226

Greedy best first graph search with h unmet goals is the optimal algorithm for problem 4 as it has taken the minimum time to discover the goal with ideal plan length.

Analysis of the growth trends as the problem size increases:
As the problem size increase, the algorithms take longer time to find the goal state. Some of the algorithms, especially the Aster Search Max-level and Set-level algorithms took hours to compute the results. While Greedy best first graph search found the goals faster than the rest of the algorithms irrespective of the problem size.

Questions:

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?

Greedy best first graph search h unmet goals would be the most appropriate for planning in a very restricted domain i.e only having a few actions, and needs to operate in real time.

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)?

Uniform cost search would be the most appropriate for planning in very large domains.

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

Breadth First Search would be most appropriate for planning problems where it is important to find on the optimal plans.