Artificial Intelligence Nanodegree

Project 2: Building a Forward Planning Agent

Tables

Table 1 : Air Cargo Problem 1 search algorithm results

Air Cargo Problem 1						
Search Algorithms	**Actions**	**Expansions**	**Goal Tests**	**New Nodes**	**Plan Length**	**Time elapsed (in seconds)**
astar_search h_pg_levelsum	20	28	30	122	6	0.2947153599998270000
astar_search h_pg_maxlevel	20	43	45	180	6	0.3124633229999740000
astar_search h_pg_setlevel	20	37	39	149	6	1.5390048110002600000
astar_search h_unmet_goals	20	50	52	206	6	0.0096813579993977300
breadth_first_search	20	43	56	178	6	0.0063747109998075700
depth_first_graph_search	20	21	22	84	20	0.0036279400017845900

greedy_best_first_graph_search h_pg_levelsum	20	6	8	28	6	0.1310910160000270000
greedy_best_first_graph_search h_pg_maxlevel	20	6	8	24	6	0.0801995629999510000
greedy_best_first_graph_search h_pg_setlevel	20	6	8	24	6	0.2908339570003590000
greedy_best_first_graph_search h_unmet_goals	20	7	9	29	6	0.0017598949998500700
uniform_cost_search	20	60	62	240	6	0.0102081670002007000

Table 2 : Air Cargo Problem 2 search algorithm results

Air Cargo Problem 2						
Search Algorithms	**Actions**	**Expansions**	**Goal Tests**	**New Nodes**	**Plan Length**	**Time elapsed (in seconds)**
astar_search h_pg_levelsum	72	357	359	3426	9	61.8486305979999000000
astar_search h_pg_maxlevel	72	27	29	249	9	3.6254118900000000000
astar_search h_pg_setlevel	72	5290	5292	47753	9	445.4367862120270000000
astar_search h_unmet_goals	72	2467	2469	2252	9	7.2046173630000100000
breadth_first_search	72	3343	4609	30503	9	3.8086176059999800000
depth_first_graph_search	72	624	625	5602	619	6.3010916239999800000
greedy_best_first_graph_search h_pg_levelsum	72	9	11	86	9	5.0647536410000300000
greedy_best_first_graph_search h_pg_maxlevel	72	27	29	249	9	7.7281798479999600000
greedy_best_first_graph_search h_pg_setlevel	72	5401	5403	48611	15	397.4757273090070000000
greedy_best_first_graph_search h_unmet_goals	72	17	19	170	9	0.0390714549999984000
uniform_cost_search	72	5154	5156	46618	9	10.8906397089999000000

Table 3 : Air Cargo Problem 3 search algorithm results

Air Cargo Problem 3

Search Algorithms	Actions	Expansions	Goal Tests	New Nodes	Plan Length	Time elapsed (in seconds)
astar_search h_pg_levelsum	88	369	371	3403	12	343.2753178940000000000
astar_search h_pg_maxlevel	88	9580	9582	86312	12	288.1842159330260000000
astar_search h_pg_setlevel	88	19734	19736	171851	12	2693.3230876700200000000
astar_search h_unmet_goals	88	7388	7390	65711	12	18.8425092210000000000
breadth_first_search	88	14663	18098	129625	12	29.0637472090001000000
depth_first_graph_search	88	408	409	3364	392	4.0118952000000200000
greedy_best_first_graph_search h_pg_levelsum	88	14	16	126	14	6.0223311719998900000
greedy_best_first_graph_search h_pg_maxlevel	88	21	23	195	13	6.2188139559998400000
greedy_best_first_graph_search h_pg_setlevel	88	20401	20403	176970	16	2487.6375237780100000000
greedy_best_first_graph_search h_unmet_goals	88	25	27	230	15	0.1210696980000420000
uniform_cost_search	88	18510	18512	161936	12	32.0134615560000000000

Table 4 : Air Cargo Problem 4 search algorithm results

Air Cargo Problem 4						
Search Algorithms	**Actions**	**Expansions**	**Goal Tests**	**New Nodes**	**Plan Length**	**Time elapsed (in seconds)**
astar_search h_pg_levelsum	104	1208	1210	12210	15	110.0541261499740000000
astar_search h_pg_maxlevel	104	62077	62079	599376	14	3721.5514168710200000000
astar_search h_pg_setlevel	104	120510	120510	1128834	14	28483.9644108529000000000
astar_search h_unmet_goals	104	34330	34332	328509	14	55.8466988469999000000
breadth_first_search	104	99736	114953	94410	14	100.8058762300000000000
depth_first_graph_search	104	25174	25175	228849	24132	999.2428124779830000000
greedy_best_first_graph_search h_pg_levelsum	104	17	19	165	17	9.7293156449999800000
greedy_best_first_graph_search h_pg_maxlevel	104	56	58	580	17	18.1252650719999000000
greedy_best_first_graph_search h_pg_setlevel	104	124001	124003	1157611	20	23962.5315372100000000000
greedy_best_first_graph_search h_unmet_goals	104	29	31	280	18	0.1152170769998970000

uniform_cost_search	104	113339	113341	1066413	14	240.0018904590000000000

Questions:

Which algorithm or algorithms would be the 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?

Time elapsed:

It appears that the `greedy_best_first_graph_search h_unmet_goals` and the `depth_first_graph_search` performed the best when the number of actions were twenty with elapsed times of : 0.00175989499985007 and 0.00362794000178459 respectively.

Overall, `greedy_best_first_graph_search h_unmet_goals` is the most efficient when processing needs to occur in real time.

Node Expansions:

As far as Node Expansions, the following:

- greedy_best_first_graph_search h_pg_levelsum
- greedy_best_first_graph_search h_pg_maxlevel
- greedy_best_first_graph_search h_pg_setlevel

Have the most optimal outcomes over `greedy_best_first_graph_search h_unmet_goals`.

New Nodes:

The following also outperformed `greedy_best_first_graph_search h_unmet_goals`. When it comes to New Nodes created:

- greedy_best_first_graph_search h_pg_levelsum
- greedy_best_first_graph_search h_pg_maxlevel
- greedy_best_first_graph_search h_pg_setlevel

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

It seems as though the `a* search algorithms are the most appropriate because they are the most optimal.

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

When looking for the most appropriate algorithm for planning problems where it is only appropriate to find the most optimal planning, in order of most to least optimal:

- Breadth first Search
- A* Search
- Uniform Cost Search

The above three maintain the lowest **Plan length** even though they maintain a longer time to execute.