

Analyzing the search complexity as a function of domain size, search algorithm, and heuristic

problem #1 Data

	Number of nodes expanded	Number of domain actions
breadth_first_search	178	20
depth_first_graph_search	84	20
uniform_cost_search	240	20
greedy_best_first_graph_search with h_unmet_goals	29	20
greedy_best_first_graph_search with h_pg_levelsum	28	20
greedy_best_first_graph_search with h_pg_maxlevel	24	20
greedy_best_first_graph_search with h_pg_setlevel	28	20
astar_search with h_unmet_goals	206	20
astar_search with h_pg_levelsum	122	20
astar_search with h_pg_maxlevel	180	20
astar_search with h_pg_setlevel	138	20

problem #2 Data

	Number of nodes expanded	Number of domain actions
breadth_first_search	30503	72
depth_first_graph_search	5602	72
uniform_cost_search	46618	72
greedy_best_first_graph_search with h_unmet_goals	170	72
greedy_best_first_graph_search with h_pg_levelsum	86	72
greedy_best_first_graph_search with h_pg_maxlevel	249	72
greedy_best_first_graph_search with h_pg_setlevel	84	72
astar_search with h_unmet_goals	22522	72
astar_search with h_pg_levelsum	3426	72

astar_search with h_pg_maxlevel	26594	72
astar_search with h_pg_setlevel	9605	72

problem 3 Data

	Number of nodes expanded	Number of domain actions
breadth_first_search	129625	88
greedy_best_first_graph_search with h_unmet_goals	230	88
greedy_best_first_graph_search with h_pg_levelsum	126	88
astar_search with h_unmet_goals	65711	88
astar_search with h_pg_levelsum	3403	88

problem 4 Data

	Number of nodes expanded	Number of domain actions
breadth_first_search	944130	104
greedy_best_first_graph_search with h_unmet_goals	280	104
greedy_best_first_graph_search with h_pg_levelsum	165	104
astar_search with h_unmet_goals	328509	104
astar_search with h_pg_levelsum	12210	104

it is quite obvious that as the domain size increases, the number of nodes to be expanded will increase as well. Uninformed search generally will need more nodes than the two other categories. Greedy best first searches need less nodes than a star searchres. The max level heuristic then unmet goals require more nodes than the other heuristic in both a star and greedy search methods.

Analyzing search time as a function of domain size, search algorithm, and heuristic.

problem #1 Data

	Search time needed	Number of domain actions
breadth_first_search	0.004	20
depth_first_graph_search	0.004	20
uniform_cost_search	0.01	20
greedy_best_first_graph_search with h_unmet_goals	0.001	20
greedy_best_first_graph_search with h_pg_levelsum	0.319	20
greedy_best_first_graph_search with h_pg_maxlevel	0.237	20
greedy_best_first_graph_search with h_pg_setlevel	0.875	20
astar_search with h_unmet_goals	0.007	20
astar_search with h_pg_levelsum	0.824	20
astar_search with h_pg_maxlevel	0.824	20
astar_search with h_pg_setlevel	2.216	20

problem #2 Data

	Search time needed	Number of domain actions
breadth_first_search	1.42	72
depth_first_graph_search	2.253	72
uniform_cost_search	2.54	72
greedy_best_first_graph_search with h_unmet_goals	0.02	72
greedy_best_first_graph_search with h_pg_levelsum	8.36	72
greedy_best_first_graph_search with h_pg_maxlevel	16.9	72
greedy_best_first_graph_search with h_pg_setlevel	19.58	72
astar_search with h_unmet_goals	1.55	72
astar_search with h_pg_levelsum	189	72

astar_search with h_pg_maxlevel	1064	72
astar_search with h_pg_setlevel	1526	72

problem 3 Data

	Search time needed	Number of domain actions
breadth_first_search	6.72	104
greedy_best_first_graph_search with h_unmet_goals	0.03	104
greedy_best_first_graph_search with h_pg_levelsum	17.76	104
astar_search with h_unmet_goals	5.88	104
astar_search with h_pg_levelsum	305.66	104

problem 4 Data

	Search time needed	Number of domain actions
breadth_first_search	59.7	104
greedy_best_first_graph_search with h_unmet_goals	0.04	104
greedy_best_first_graph_search with h_pg_levelsum	31.46	104
astar_search with h_unmet_goals	35.33	104
astar_search with h_pg_levelsum	1723	104

as the problem size increases, the time needed for search will increase accordingly. Of all search algorithm, greedy best first graph search with h unmet goals exhibit the fastest algorithm. Uninformed search sometime output a fast search but it happen accidentally as it depend on the position of the goal in the tree. A star with unmet goals output stable search time in the sense that it doesn't necessarily be the second after the greedy with unmet but it come close to the second it isn't.

Analyzing the optimality of solution as a function of domain size, search algorithm, and heuristic.

problem #1 Data

	Length of plan	Number of domain actions
breadth_first_search	6	20
depth_first_graph_search	20	20
uniform_cost_search	6	20
greedy_best_first_graph_search with h_unmet_goals	6	20
greedy_best_first_graph_search with h_pg_levelsum	6	20
greedy_best_first_graph_search with h_pg_maxlevel	6	20
greedy_best_first_graph_search with h_pg_setlevel	6	20
astar_search with h_unmet_goals	6	20
astar_search with h_pg_levelsum	6	20
astar_search with h_pg_maxlevel	6	20
astar_search with h_pg_setlevel	6	20

problem #2 Data

	Length of plan	Number of domain actions
breadth_first_search	9	72
depth_first_graph_search	619	72
uniform_cost_search	9	72
greedy_best_first_graph_search with h_unmet_goals	9	72
greedy_best_first_graph_search with h_pg_levelsum	9	72
greedy_best_first_graph_search with h_pg_maxlevel	9	72
greedy_best_first_graph_search with h_pg_setlevel	9	72
astar_search with h_unmet_goals	9	72
astar_search with h_pg_levelsum	9	72

astar_search with h_pg_maxlevel	9	72
astar_search with h_pg_setlevel	9	72

problem 3 Data

	Length of plan	Number of domain actions
breadth_first_search	12	88
greedy_best_first_graph_search with h_unmet_goals	15	88
greedy_best_first_graph_search with h_pg_levelsum	14	88
astar_search with h_unmet_goals	12	88
astar_search with h_pg_levelsum	12	88

problem 4 Data

	Length of plan	Number of domain actions
breadth_first_search	14	104
greedy_best_first_graph_search with h_unmet_goals	18	104
greedy_best_first_graph_search with h_pg_levelsum	17	104
astar_search with h_unmet_goals	14	104
astar_search with h_pg_levelsum	15	104

if we considered plan length criteria, we shall see that breadth first search always got the minimum plan. Astar searches with heuristics will get the minimum plan always with unmet goal heuristic but not necessarily all heuristics or at least level sum heuristic. On the other hand greedy best first searches will get minimum plan for small scale problems. But, for large scale problems it won't.

Answers to questions:

1. greedy_best_first_graph_search with h_unmet_goals for its fast results in small scale applications as well as less memory requirement (# of nodes).
2. astar searches with unmet goals will output results fast as well as minimum plan length.
3. breadth first search as well as astar searches with unmet goals as they always result minimum plans while neglecting other factors