Experiment with the planning algorithms

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Overview

This is a report file for the planning algorithms in AI Nanodegree. In this project, I did an experiment eleven search algorithms on four problems.

Results

Air Cargo Problem 1

Search algorithm	Actions	Expansions	Plan length	Time elapsed (sec)	Optimality
breadth first search	20	43	6	0.0061	True
depth first search	20	21	20	0.0033	False
uniform cost search	20	60	6	0.0106	True
greedy best first with unmet goals	20	7	6	0.0018	True
greedy best first with levelsum	20	6	6	0.3008	True
greedy best first with maxlevel	20	6	6	0.0906	True
greedy best first with setlevel	20	6	6	0.9476	True
A* with unmet goals	20	50	6	0.0100	True
A* with levelsum	20	28	6	0.7552	True
A* with maxlevel	20	43	6	0.3650	True
A* with setlevel	20	33	6	2.4104	True

Air Cargo Problem 2

Search algorithm	Actions	Expansions	Plan length	Time elapsed (sec)	Optimality
breadth first search	72	3343	9	2.0407	True
depth first search	72	624	619	3.1250	False
uniform cost search	72	5154	9	3.4519	True
greedy best first with unmet goals	72	17	9	0.0201	True
greedy best first with levelsum	72	9	9	5.9593	True
greedy best first with maxlevel	72	27	9	3.9277	True

Search algorithm	Actions	Expansions	Plan length	Time elapsed (sec)	Optimality
greedy best first with setlevel	72	9	9	18.9674	True
A* with unmet goals	72	2467	9	2.3587	True
A* with levelsum	72	357	9	156.5190	True
A* with maxlevel	72	2887	9	369.4994	True
A* with setlevel	72	1037	9	1437.0363	True

Air Cargo Problem 3

Search algorithm	Actions	Expansions	Plan length	Time elapsed (sec)	Optimality
breadth first search	88	14663	12	11.0938	True
depth first search	88	408	392	1.1883	False
uniform cost search	88	18510	12	15.2568	True
greedy best first with unmet goals	88	25	15	0.0371	False
greedy best first with levelsum	88	14	14	13.6434	False
greedy best first with maxlevel	88	21	13	5.9953	False
greedy best first with setlevel	88	35	17	96.3056	False
A* with unmet goals	88	7388	12	8.7216	True
A* with levelsum	88	369	12	247.5065	True
A* with maxlevel	88	9580	12	2240.8644	True
A* with setlevel	88	3423	12	6561.5228	True

Air Cargo Problem 4

Search algorithm	Actions	Expansions	Plan length	Time elapsed (sec)	Optimality
breadth first search	104	99736	14	99.6841	True
depth first search	104	25174	24132	-	False
uniform cost search	104	113339	14	117.2805	True
greedy best first with unmet goals	104	29	18	0.0624	False
greedy best first with levelsum	104	17	17	24.7534	False
greedy best first with maxlevel	104	56	17	17.1821	False
greedy best first with setlevel	104	107	23	410.3759	False

Search algorithm	Actions	Expansions	Plan length	Time elapsed (sec)	Optimality
A* with unmet goals	104	34330	14	56.4792	True
A* with levelsum	104	1208	15	1365.6180	False
A* with maxlevel	104	62077	14	-	True
A* with setlevel	104	22606	14	-	True

Analysis

The complexity of problem is getting increased from Problem 1 to Problem 4. Thus, Problem 4 is the most complex one. The simplest one is Problem 1. The more complex problem becomes, the more possible actions problem has. Problem 1 has 20 actions and problem 4 does 104 actions. I can notice that via the prescribed tables and left of chart, the number of expansions increases exponentially repsect to possible actions. Expansions of all uninformed algorithms and A* algorithms are increased exponentially as actions increase. However, greedy best first algorithm has linearity in the relation between expansions and actions. Uniform cost search algorithm produces the most expansions in uninformed algorithms and expansions of A* with max level algorithm dramatically increases among heuristic ones.

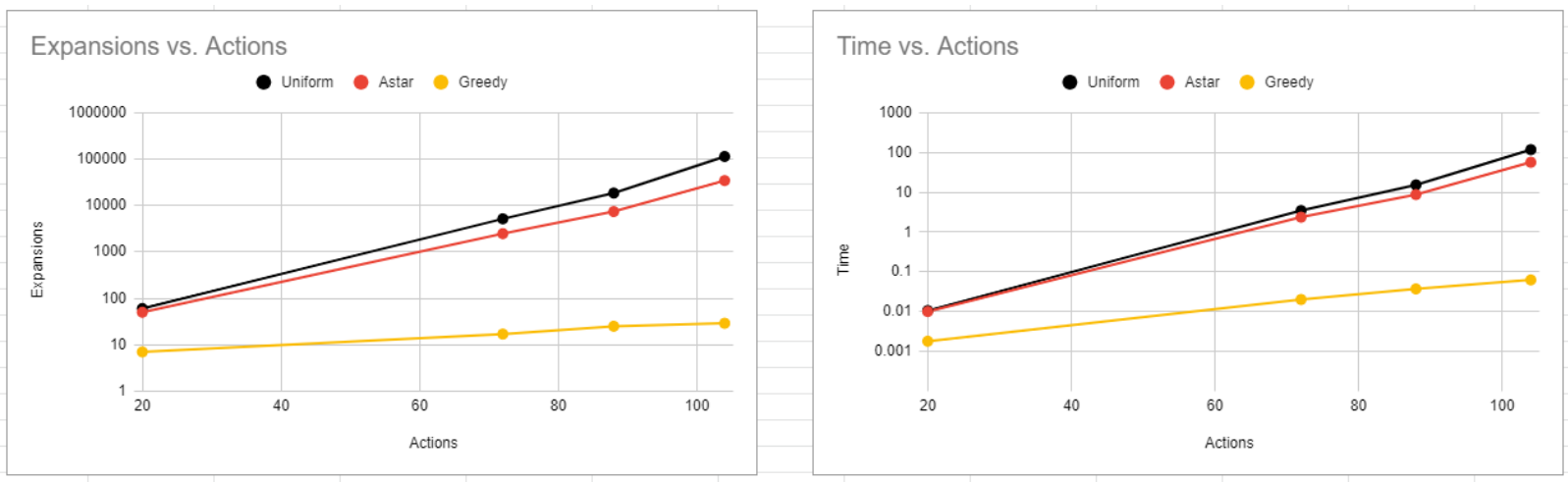

Figure Expansion against the number of Actions

The result of elapsed time is very similar with the previous result (expansions). Time of uninformed algorithms and A* algorithms are exponentially increased. But search time of greedy best first algorithms has the lineary relation against actions. The right chart in the Figure shows the mentioned result.

The optimality column is included to each table of problem. Optimality means that the plan length is optimal for each algorithm. But DFS has no optimal plan length for all problems. BFS and uniform cost search algorithms have optimal plan length for all problems. A* algorithms are optimal except level sum heuristic. Greedy best first algorithms have optimal plan length in problem 1 and 2 but they are not optimal with problem 3 and 4.

Result Answers

- **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 with unmet goals algorithm is the fastest while it has no optimal plan length. Thus, I think it is the most appropriate algorithm in a very restrict 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)?**

  A* with unmet goals is the most appropriate for planning in very large domain. It has the optimal path length for all problems, and its search speed is quite fast.

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

  A* with unmet goals will be the most appropriate to find only optimal plans. It provides the optimal plan for all problems and it is fast than other optimal algorithms.