Experiment with the planning algorithms

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Overview

This is report for a project (Build a Forward-Planning) of Udacity AI Nanodegree program.

Result of experiments

There are 4 problems and 11 search algorithms in this project. I ran all of search algorithms on all 4 problems. below tables are the result of experiments.

Air Cargo Problem 1

Search algorithm	Actions	Expansions	Plan length	Time elapsed (sec)	Optimality
breadth first search	20	43	6	0.0197	True
depth first search	20	21	20	0.0089	False
uniform cost search	20	60	6	0.0250	True
greedy best first w/ unmet goals	20	7	6	0.0040	True
greedy best first w/ levelsum	20	6	6	0.2370	True
greedy best first w/ maxlevel	20	6	6	0.1302	True
greedy best first w/ setlevel	20	6	6	0.5705	True
A* w/ unmet goals	20	50	6	0.0257	True
A* w/ levelsum	20	28	6	0.5072	True

A* w/ maxlevel	20	43	6	0.3431	True
A* w/ setlevel	20	33	6	0.9218	True

Air Cargo Problem 2

Search algorithm	Actions	Expansions	Plan length	Time elapsed (sec)	Optimality
breadth first search	72	3343	9	0.2922	True
depth first search	72	624	619	0.5290	False
uniform cost search	72	5154	9	0.5475	True
greedy best first w/ unmet goals	72	17	9	0.0313	True
greedy best first w/ levelsum	72	9	9	0.8792	True
greedy best first w/ maxlevel	72	27	9	0.7267	True
greedy best first w/ setlevel	72	9	9	2.2096	True
A* w/ unmet goals	72	2467	9	0.6123	True
A* w/ levelsum	72	357	9	11.1267	True
A* w/ maxlevel	72	2887	9	26.4144	True
A* w/ setlevel	72	1037	9	98.1614	True

Air Cargo Problem 3

Search algorithm	Actions	Expansions	Plan length	Time elapsed (sec)	Optimality
breadth first search	88	14663	12	0.8581	True
depth first search	88	408	392	0.2396	False
uniform cost search	88	18510	12	1.2738	True
greedy best first w/ unmet goals	88	25	15	0.0355	False
greedy best first w/ levelsum	88	14	14	1.5522	False

greedy best first w/ maxlevel	88	21	13	0.9403	False
greedy best first w/ setlevel	88	35	17	7.4483	False
A* w/ unmet goals	88	7388	12	0.9595	True
A* w/ levelsum	88	369	12	17.2092	True
A* w/ maxlevel	88	9580	12	153.9378	True
A* w/ setlevel	88	3423	12	427.9282	True

Air Cargo Problem 4

Search algorithm	Actions	Expansions	Plan length	Time elapsed (sec)	Optimality
breadth first search	104	99736	14	4.9436	True
depth first search	104	25174	24132	697.2099	False
uniform cost search	104	113339	14	7.7706	True
greedy best first w/ unmet goals	104	29	18	0.0421	False
greedy best first w/ levelsum	104	17	17	2.2335	False
greedy best first w/ maxlevel	104	56	17	1.8537	False
greedy best first w/ setlevel	104	107	23	28.8522	False
A* w/ unmet goals	104	34330	14	3.8185	True
A* w/ levelsum	104	1208	15	87.0831	False
A* w/ maxlevel	104	62077	14	1677.8133	True
A* w/ setlevel	104	22606	14	4649.6155	True

Analysis

The complexity of problem increases as problem number increases. So, Problem 4 is the most complex one and Problem 1 is the simplest one. As problem gets complex, possible actions increases. Problem 1 has 20 possible actions and problem 4 has 104 possible actions. Above tables and **Figure 1** shows that number of expanded nodes increases as action increase. Expansions of All uninformed algorithms and A* algorithms are increased exponentially as actions increase while expansions of all greedy best first algorithms are increased linearly. Uniform cost search algorithm has the most expansions in uninformed algorithms and Expansions of A* with max level algorithm is dramatically increased among heuristic algorithms.

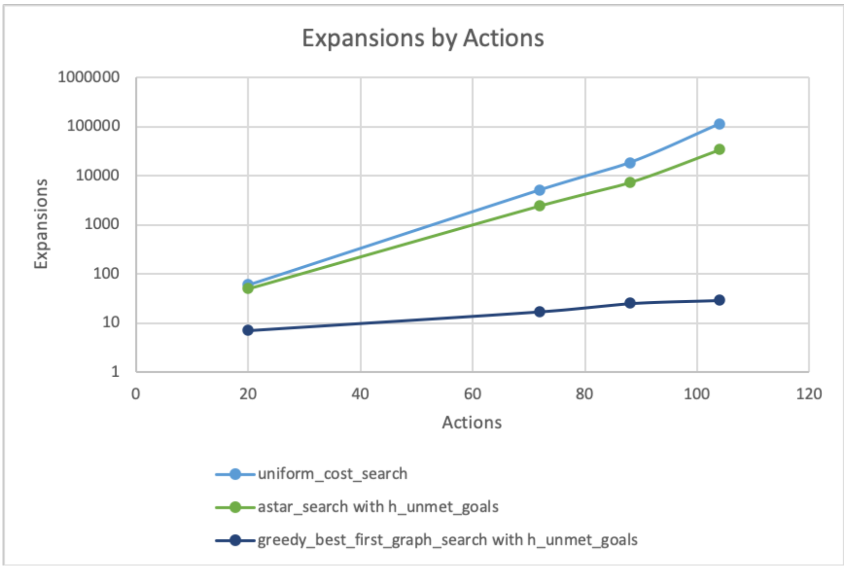

Figure 1. Expansion against the number of Actions

Search time against the number of actions has similar pattern with the case of expansions. Search time of uninformed algorithms and A* algorithms are exponentially increased and search time of greedy best first algorithms is increased linearly against the number of actions. **Figure 2** shows result of three algorithms.

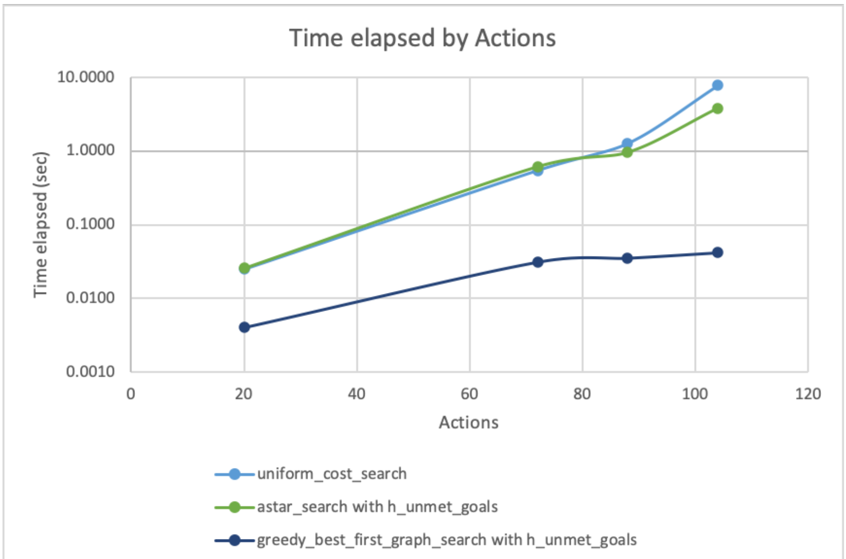

Figure 2. Search time the number of Actions

I added optimality column to each table of problem. Optimality shows that plan length is optimal for each algorithm. Depth first search has no optimal plan length for all problems. Breadth first search and uniform cost search algorithms have optimal plan length for all problems. Above tables show that plan lengths of all A* algorithms except level sum heuristic are optimal. 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?**

  I think greedy best first with unmet goals algorithm is the most appropriate algorithm in very restrict domain. Because it is the fastest and it performed under 0.1 second even though it has no optimal plan length.

- **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)?**

  I think that A* with unmet goals and breadth first search are the most appropriate for planning in very large domain. They have optimal path length for all problems, and They perform much faster than any other algorithms with problem 4.

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

  A* with unmet goals, breadth first search and uniform cost search would be the most appropriate to find only optimal plans. They found the optimal plan for all 4 problems and performs much better than other optimal algorithms.