Udacity AI Nanodegree - Build a Forward Planning Agent

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For each table comparison, I have used light yellow color to mark the best result. Below is the list of method with its abbreviation. Note that some data in the cell is missing is because my computer crashed during running the method.

Method (abbreviation):
breadth_first_search (BFS),
depth_first_graph_search (DFS),
uniform_cost_search (UCS),
greedy_best_first_graph_search:h_unmet_goals (UNMET),
greedy_best_first_graph_search:h_pg_levelsum (LEVEL-SUM),
greedy_best_first_graph_search:h_pg_maxlevel (MAX-LEVEL),
greedy_best_first_graph_search:h_pg_setlevel (SET-LEVEL),
astar_search:h_unmet_goals (A*-UNMET),
astar_search:h_pg_levelsum (A*-LEVEL-SUM),
astar_search:h_pg_maxlevel (A*-MAX-LEVEL),
astar_search:h_pg_setlevel (A*-SET-LEVEL)

Use a table or chart to analyze the number of nodes expanded against number of actions in the domain

Air Cargo Problem 1 (20 actions)

Method	Expansions	Goal Tests	New Nodes
BFS	43	56	178
DFS	21	22	84
UCS	60	62	240
UNMET	7	9	29
LEVEL-SUM	6	8	28
MAX-LEVEL	9	11	34
SET-LEVEL	6	8	28
A*-UNMET	50	52	206
A*-LEVEL-SUM	28	30	122
A*-MAX-LEVEL	58	60	236

A*-SET-LEVEL	33	35	138

Air Cargo Problem 2 (72 actions)

Method	Expansions	Goal Tests	New Nodes
BFS	3343	4609	30503
DFS	624	625	5602
UCS	5154	5156	46618
UNMET	17	19	170
LEVEL-SUM	9	11	86
MAX-LEVEL	192	194	1719
SET-LEVEL	9	11	84
A*-UNMET	2467	2469	22522
A*-LEVEL-SUM	357	359	3426
A*-MAX-LEVEL	4087	4089	37406
A*-SET-LEVEL	1037	1039	9605

Air Cargo Problem 3 (88 actions)

Method	Expansions	Goal Tests	New Nodes
BFS	14663	18098	129625
DFS	408	409	3364
UCS	18510	18512	161936
UNMET	25	27	230
LEVEL-SUM	14	16	126
MAX-LEVEL	80	82	719
SET-LEVEL	35	37	345
A*-UNMET	7388	7390	65711

A*-LEVEL-SUM	369	371	3403
A*-MAX-LEVEL			
A*-SET-LEVEL			

Air Cargo Problem 4 (104 actions)

Method	Expansions	Goal Tests	New Nodes
BFS	99736	114953	944130
DFS			
UCS	113339	113341	1066413
UNMET	29	31	280
LEVEL-SUM	17	19	165
MAX-LEVEL	162	164	1630
SET-LEVEL			
A*-UNMET	34330	34332	328509
A*-LEVEL-SUM	1208	1210	12210
A*-MAX-LEVEL			
A*-SET-LEVEL			

Use a table or chart to analyze the search time against the number of actions in the domain

Air Cargo Problem 1 (20 actions)

Method	Time (s)
BFS	0.006697536999126896
DFS	0.0035539750024327077
UCS	0.010331427998607978
UNMET	0.0016326279946952127
LEVEL-SUM	0.20433458399929805

MAX-LEVEL	0.176889840993681
SET-LEVEL	0.552647762997367
A*-UNMET	0.00927632799721323
A*-LEVEL-SUM	0.4931658410059754
A*-MAX-LEVEL	0.5329839670012007
A*-SET-LEVEL	1.2896715609967941

Air Cargo Problem 2 (72 actions)

Method	Time (s)
BFS	2.027142085004016
DFS	2.728364321999834
UCS	3.505613667999569
UNMET	0.02317860500625102
LEVEL-SUM	4.595474061999994
MAX-LEVEL	32.43900434499665
SET-LEVEL	15.702857955999207
A*-UNMET	2.525891618002788
A*-LEVEL-SUM	130.2074804349977
A*-MAX-LEVEL	515.145605194
A*-SET-LEVEL	739.3634918629999

Air Cargo Problem 3 (88 actions)

Method	Time (s)
BFS	12.2021766090038
DFS	1.2103442229999928
UCS	16.643950690006022
UNMET	0.046514554996974766

LEVEL-SUM	11.467603153003438
MAX-LEVEL	25.544983306994254
SET-LEVEL	84.959572148
A*-UNMET	10.461943615002383
A*-LEVEL-SUM	276.34614961300394
A*-MAX-LEVEL	
A*-SET-LEVEL	

Air Cargo Problem 4 (88 actions)

Method	Time (s)
BFS	105.52977758299676
DFS	
UCS	143.28691585499473
UNMET	0.061190678003185894
LEVEL-SUM	19.35269542799506
MAX-LEVEL	76.06717380700138
SET-LEVEL	
A*-UNMET	63.82519042000058
A*-LEVEL-SUM	1389.151862634004
A*-MAX-LEVEL	
A*-SET-LEVEL	

Use a table or chart to analyze the length of the plans returned by each algorithm on all search problems

Air Cargo Problem 1 (20 actions)

Method	Plan Length
BFS	6

DFS	20
UCS	6
UNMET	6
LEVEL-SUM	6
MAX-LEVEL	7
SET-LEVEL	6
A*-UNMET	6
A*-LEVEL-SUM	6
A*-MAX-LEVEL	6
A*-SET-LEVEL	6

Air Cargo Problem 2 (72 actions)

Method	Plan Length
BFS	9
DFS	619
UCS	9
UNMET	9
LEVEL-SUM	9
MAX-LEVEL	12
SET-LEVEL	9
A*-UNMET	9
A*-LEVEL-SUM	9
A*-MAX-LEVEL	9
A*-SET-LEVEL	9

Air Cargo Problem 3 (88 actions)

Method	Plan Length
BFS	12
DFS	392
UCS	12
UNMET	15
LEVEL-SUM	14
MAX-LEVEL	14
SET-LEVEL	17
A*-UNMET	12
A*-LEVEL-SUM	12
A*-MAX-LEVEL	
A*-SET-LEVEL	

Air Cargo Problem 4 (88 actions)

Method	Plan Length
BFS	14
DFS	
UCS	14
UNMET	18
LEVEL-SUM	17
MAX-LEVEL	18
SET-LEVEL	
A*-UNMET	14
A*-LEVEL-SUM	15
A*-MAX-LEVEL	

A*-SET-LEVEL	

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?

Based on the experiment results, given few actions and execution time, Breadth first search (BFS), Uniform Cost Search (UCS), Greedy Best First Graph Search with h_unmet_goals heuristic (UNMET) would be the most appropriate algorithms for planning in a very restricted domain. They have similar usage time in scale.

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)

To find the goal in very large domains, Greedy Best First Graph Search with h_unmet_goals heuristic (UNMET) would be appropriate to quickly find a goal.

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

Breadth first search (BFS) is the most appropriate approach to find optimal plans efficiently.