Heuristic Analysis

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Abstract

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1 Optimal Plan

The order of presidence when evaluating an optimal plan is perhaps debatable but I would consider time to find the path be the most essential constraint followed perhaps by the length of the path in the evaluation of a real world problem. Take for instance the actual planning of shipments, the time taken to plan routes is quite critical when it comes to customer satisfaction, but the actual plan itself could, unnecessarily long, result in extreme costs of shipping. Expansions and new nodes are more theoretically interesting it seems to me.

Fortunately given the data presented below, there really isn't much debate to be had about the best plan of action: Breadth First Search is a winner. Greedy Best First Graph Search H1 is a tempting choice if the calculation of the plan is extremely important, but given that it produced a route that was nearly twice as long a Breadth First Search it is doubtful that it would actually be useful in a shipping context.

2 Comparisons

Breadth First Search and Depth First Search have significant differences in results: DFS is extremely quick when it comes to finding a solution. Unfortunately the path that was found was generally an order of magnitude larger than the path found by BFS, leaving DFS as an unlikely candidate.

Breadth First Search and Uniform Cost Search appear to be about on par with one another. They are similar algothrithms so this shouldn't come as a surprise. On all counts BFS is anywhere from moderately to significantly better

than UCS. While their path lengths are the same, time elapsed makes BFS a clear winner.

3 A* Heuristics

- Compare and contrast heuristic search result metrics using A* with the "ignore preconditions" and "level-sum" heuristics for Problems 1, 2, and 3. - What was the best heuristic used in these problems? Was it better than non-heuristic search planning methods for all problems? Why or why not?

4 Data

Zero value data points indicate that a 10 minute timeout was reached.

Time Elapsed (Seconds)

Legend: Problem 1, Problem 2, Problem 3

Algorithm	Problem 1	Problem 2	Problem 3
BreadthFirstSearch	$2.94 \cdot 10^{-2}$	14.39	103.03
BreadthFirstTreeSearch	0.91	0	0
DepthFirstGraphSearch	$1.33 \cdot 10^{-2}$	3.52	1.74
DepthLimitedSearch	$9.73 \cdot 10^{-2}$	0	0
UniformCostSearch	$4.03 \cdot 10^{-2}$	45.29	359.89
RecursiveBestFirstSearchH1	2.74	0	0
GreedyBestFirstGraphSearchH1	$4.89 \cdot 10^{-3}$	7.38	95.51
AstarSearchH1	$3.75 \cdot 10^{-2}$	45.78	356.34
AstarSearchHIgnorePreconditions	$4.79 \cdot 10^{-2}$	40.5	336.01
HPgLevelsum	1.66	177.21	0

Expansions

$\cdot 10^4$

Legend: Problem 1, Problem 2, Problem 3

Algorithm	Problem 1	Problem 2	Problem 3
BreadthFirstSearch	43	3,343	14,663
BreadthFirstTreeSearch	1,458	0	0
DepthFirstGraphSearch	21	624	408
DepthLimitedSearch	101	0	0
UniformCostSearch	55	4,853	18,223
RecursiveBestFirstSearchH1	4,229	0	0
GreedyBestFirstGraphSearchH1	7	998	5,578
AstarSearchH1	55	4,853	18,223
AstarSearchHIgnorePreconditions	45	3,689	14,719
HPgLevelsum	11	86	0

Goal Tests

$\cdot 10^4$

Legend: Problem 1, Problem 2, Problem 3

- BreadthFirstSearch: 56, 4,609, 18,098
- BreadthFirstTreeSearch: 1,459, 0, 0
- DepthFirstGraphSearch: 22, 625, 409
- DepthLimitedSearch: 271, 0, 0
- UniformCostSearch: 57, 4,855, 18,225
- RecursiveBestFirstSearchH1: 4,230, 0, 0
- GreedyBestFirstGraphSearchH1: 9, 1,000, 5,580
- AstarSearchH1: 57, 4,855, 18,225
- AstarSearchHIgnorePreconditions: 47, 3,691, 14,721
- HPgLevelsum: 13, 88, 0

New Nodes

$\cdot 10^5$

Legend: Problem 1, Problem 2, Problem 3

- BreadthFirstSearch: 180, 30,509, $1.3 \cdot 10^5$
- BreadthFirstTreeSearch: 5,960, 0, 0
- DepthFirstGraphSearch: 84, 5,602, 3,364
- DepthLimitedSearch: 414, 0, 0
- UniformCostSearch: 224, 44,041, $1.6 \cdot 10^5$
- RecursiveBestFirstSearchH1: 17,023, 0, 0
- GreedyBestFirstGraphSearchH1: 28, 8,982, 49,150
- AstarSearchH1: 224, 44,041, $1.6 \cdot 10^5$
- AstarSearchHIgnorePreconditions: 188, 33,669, $1.3 \cdot 10^5$
- HPgLevelsum: 50, 841, 0