Heuristic Analysis of Search Algorithms and Planning Graphs

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Problem 1

Below is a table with information regarding problem 1. Of the non-heuristic searches, DFS was the fastest and expanded the fewest nodes. Of the heuristic searches with A*, `ignore_preconditions` was faster, but `levelsum` expanded fewer nodes.

	Problem 1				
	Expansions	Goal tests	New nodes	Plan length	Time
BFS	**43**	**56**	**180**	**6**	**0.3546833866**
DFS	**21**	**22**	**84**	**20**	**0.1343715547**
A* (constant heuristic)	**55**	**57**	**224**	**6**	**0.335447558**
A* (ignore_precond)	**41**	**43**	**170**	**6**	**0.2820590539**
A* (levelsum)	**11**	**13**	**50**	**6**	**0.8867961899**

Problem 2

Below is a table with information regarding problem 2. Of the non-heuristic searches, DFS was the fastest and expanded the fewest nodes. Of the heuristic searches with A*, `ignore_preconditions` was faster, but `levelsum` expanded fewer nodes.

	Problem 2				
	Expansions	Goal tests	New nodes	Plan length	Time
BFS	**1923**	**2672**	**15352**	**9**	**45.97717874**
DFS	**82**	**83**	**511**	**77**	**1.903286081**
A* (constant heuristic)	**2723**	**2725**	**21368**	**9**	**60.72963981**
A* (ignore_precond	**876**	**878**	**7199**	**9**	**20.16962518**

)					
A* (levelsum)	**238**	**240**	**1911**	**9**	**87.25437523**

Problem 3

Below is a table with information regarding problem 3. Of the non-heuristic searches, DFS was the fastest and expanded the fewest nodes. Of the heuristic searches with A*, `ignore_preconditions` was faster, but `levelsum` expanded fewer nodes.

	Problem 3				
	Expansions	Goal tests	New nodes	Plan length	Time
BFS	**14663**	**18098**	**129631**	**12**	**513.2798851**
DFS	**408**	**409**	**3364**	**392**	**11.24713236**
A* (constant heuristic)	**18235**	**18237**	**159716**	**12**	**494.1599941**
A* (ignore_precond)	**5040**	**5042**	**44944**	**12**	**134.0663204**
A* (levelsum)	**325**	**327**	**3002**	**12**	**359.1089114**

Conclusions

For each of these problems, depth-first search found a solutions extremely quickly; it outperformed every other method I evaluated. However, the resulting plan lengths from depth-first search are unreasonably long to serve as practical solutions to the problems. The best solution to these problems was found using A* with the `ignore_preconditions` heuristic, which found the solution faster than A* with `levelsum`. The latter search performed fewer expansions, goal tests, and expanded fewer new nodes. As described in Norvig and Russell's book, the `ignore_preconditions` heuristic adds more edges the to the graph, making it easier to solve (and reduces the computation time).