Heuristic Analysis - Experiment and document metrics for non-heuristic planning solution searches

*Yellow highlight is the lowest value
** Optimality - #1 is the best

1. Air Cargo Problem 1					
	1. BFS	2. BFTS	3. DFS	9. A* h ignore preconditions	10. A* search h pg levelsum
Expansions	43	1458	12	41	55
Goal Tests	56	1459	13	43	57
New Nodes	180	5960	48	170	224
Plan length	6	6	12	6	6
Time elapsed (Seconds)	0.03015911	0.849372333	0.007581946	0.033878473	2.2154512
**Optimality	2			1	

Comments:

From the number we can observe the following:

- Even though BFS and BFTS give the same path length (6), the time spent on coming up with such path by BFTS is significantly higher than that of BFS. Therefore in this case, BFS gives a better result than BFTS.
- If we compare BFS and DFS, BFS went through a lot of “path” and “goals” as demonstrated in a high amount of expansions and goal test. And the number is much higher than that of DFS.
- Even though the time spent to find a path in DFS is much faster than BFS, if we look at the number, DFS touches less number of goals and expansion, which result in a plan of length of 12.
- Now look at A* ignore condition, the expansions, goal tested and new loaded are slightly lower than BFS. The time spent is also very similar, and most importantly, it gets the same goal result (6) as BFS
- We therefore conculded that A* ignore condition is the optimal algorithm for P1, and BFS is the second best.

Solving Air Cargo Problem 2

2. Air Cargo Problem 2					
	1. BFS	2. BFTS	3. DFS	9. A* h ignore preconditions	10. A* search h pg levelsum
Expansions	3343	N/A	582	1450	4853
Goal Tests	4609	N/A	583	1452	4855
New Nodes	30509	N/A	5211	13303	44041
Plan length	9	N/A	575	9	9
Time elapsed (Seconds)	35.86497058	N/A	9.741080466	12.93473728	3625.030473
Optimality	2			1	

Comments:

- There is no error trackback in my running for BFTS.
- This time when I am running BFTS, the time it takes is too long and therefore I can only terminate the process.
- In other words, since BFS and DFS give result but BFTS didn't, we don't have enough evidence to prove that BFTS is the most optimal algorithm.
- The time spent to get the result by BFS is 3x - 4x more than DFS
- However, even if that the result from BFS looks promising than DFS, the reason why is that the number of expansions and goals tests are higher than DFS, which means more paths are tested in order to get an optimal plan
- The length of plan by BFS and DFS also prove that BFS is much better in this case.
- BFS length of plan is 9, while DFS is 575, which is significantly shorter.
- From the `shortest path` point of view, BFS, A* ignore pre-condition and A* pg levelsum gaves the same result (9).
- But if we look at the time spent on it, A* ignore condition is better than BFS for 3x faster.
- The expansions, goal tested and new nodes touched by A* ignore condition is also 2x lower than BFS, which means that A* ignore conditions is more "goal oriented" that it touches less nodes, and takes less time to get to the goal.
- So in this case, I still pick A* ignore condition as the optimal search algorithm, and BFS the second.

Solving Air Cargo Problem 3

3. Air Cargo Problem 3					
	1. BFS	2. BFTS	3. DFS	9. A* h ignore preconditions	10. A* search h pg levelsum
Expansions	14663	N/A	627	4951	18233
Goal Tests	18098	N/A	628	4953	18235
New Nodes	129631	N/A	5176	44051	159697
Plan length	12	N/A	596	12	12
Time elapsed (Seconds)	213.6010253	N/A	10.01481998	41.58506535	15570.457288128999
Optimality	2			1	

Comments:

- Again, just like Problem 2, BFTS take too long to run and I terminate the process.
- We cannot conclude that BFTS is the optimal algorithm, compared to other algorithms, which return results.
- A* search h pg levelsum takes more than 4 hours to get the result.
- DFS is fast because it goes from start to the end, which is therefore faster than BFS to get to the goal
- However, as a result of above, the plan length is also higher than BFS, A* h pg levelsum and ignore precondition
- The second fast algorithm is A* h ignore preconditions, which is also 4x - 5x faster than BFS, and return an optimal result of 12
- The expansions, goal tests and new nodes are also smaller compared to BFS and pg levelsum.
- It means that A* ignore precondition is more “goal oriented” and less distracted from other expansions. Hence it is faster.