

## Optimal Plan

Problem1	Problem2	Problem3
Load(C1, P1, SFO) Fly(P1, SFO, JFK) Load(C2, P2, JFK) Fly(P2, JFK, SFO) Unload(C1, P1, JFK) Unload(C2, P2, SFO)	Load(C1, P1, SFO) Fly(P1, SFO, JFK) Load(C2, P2, JFK) Fly(P2, JFK, SFO) Load(C3, P3, ATL) Fly(P3, ATL, SFO) Unload(C1, P1, JFK) Unload(C2, P2, SFO) Unload(C3, P3, SFO)	Load(C2, P2, JFK) Fly(P2, JFK, ORD) Load(C4, P2, ORD) Fly(P2, ORD, SFO) Load(C1, P1, SFO) Fly(P1, SFO, ATL) Load(C3, P1, ATL) Fly(P1, ATL, JFK) Unload(C1, P1, JFK) Unload(C2, P2, SFO) Unload(C3, P1, JFK) Unload(C4, P2, SFO)

## Compare Non-Heuristic Results

Search	Metric	Problem1	Problem2	Problem3
Breadth First				
	optimality	Plan length: 6	Plan length: 9	Plan length: 12
	time elapsed	0.0310175910126418	14.222846562042832	101.1185695250751
	expansions	43	3343	14663
Depth First				
	optimality	Plan length: 12	Plan length: 575	Plan length: 596
	time elapsed	0.0086758499965072	3.2981188980629668	3.633390802075155
	expansions	12	582	627
Uniform Cost				
	optimality	Plan length: 6	Plan length: 9	Plan length: 12
	time elapsed	0.03749071701895447	12.874966609058902	57.42416402092203
	expansions	55	4604	16963

We can notice from the algorithm results that Depth First Search[1] does not guarantee to find the optimal path because it is start search from the bottom and stop when find the first goal but in the other hand it is fastest to find the gola if it is near to the bottom which is the case with all problem testing.

## Compare Heuristic Results

Search	Metric	Problem1	Problem2	Problem3
ignore preconditions	optimality	Plan length: 6	Plan length: 9	Plan length: 12
	time elapsed	0.036432395107112825	3.8029578829882666	14.65875636402052
	expansions	41	1310	4444
level-sum	optimality	Plan length: 6	Plan length: 9	Plan length: 12
	time elapsed	0.8546273149549961	291.9521953499643	1082.386400689953
	expansions	45	1456	2568

## Best Heuristic

*What was the best heuristic used in these problems?*

Heuristic search algorithm depend on the heuristic function to find the optimal path with good time, if the function implemented correctly it will find the goal faster and grantee to find the optimal path.

The best heuristic regarding time is (ignore preconditions) in this case because it find the optimal path in less time that level-sum which is more complicated.

*Was it better than non-heuristic search planning methods for all problems? Why or why not?*

None-heuristic search like breadth first search[1] and uniform search grantee to find the shortest level path but it take much time than heuristic search that use good heuristic function[2].

As we noticed the (ignore preconditions) found the optimal path in only (14.6) seconds while other non-heuristic functions took at least (57.4) seconds.

## Resources:

- **[1]** DFS algorithm does not guarantee to find optimal path (Lesson 8 - Quiz: Search Comparison)
- **[2]** BFS algorithm is optimal (Lesson 8 - Quiz: Search Comparison)
- **[3]** good function is the one where  $h(s) < \text{true cost}$  (Lesson 8 - Optimistic Heuristic)