In this project, there are 3 planning problems. The project has been setup with 3 stages:

1. Represent the planning problems using propositional logic. Planning and domain definition language is used to represent the planning problems
2. Define the domain independent heuristics. The heuristic functions will add the intelligence component to the search algorithm
3. Experiment different search algorithms to reach the solution state

Air Cargo Problem 1

The table below provides the results of applying various search algorithms to first planning problem.

#	Algorithm	Optimal	Expansions	Goal Tests	New Nodes	Plan Length	Time Elapsed (ms)
1	breadth_first_search	Yes	43	56	180	6	43.1
2	breadth_first_tree_search	Yes	1458	1459	5960	6	1095.2
3	depth_first_graph_search	No	12	13	48	12	9.89
4	depth_limited_search	No	101	271	414	50	108.04
5	uniform_cost_search	Yes	55	57	224	6	40.1
6	recursive_best_first_search	Yes	4229	4230	17029	6	3056.3
7	greedy_best_first_graph_search	Yes	7	9	28	6	5.225
8	astar_search with h_1	Yes	55	57	224	6	51.2
9	astar_search with h_ignore_preconditions	Yes	41	43	170	6	44.3
10	astar_search with h_pg_levelsum	Yes	55	57	224	6	1809

Key Takeaways

1. Optimal plans have length of 6 in the table above
2. Except for depth_first_graph_search and depth_limited_search, all other search algorithms generates and optimal plan with path length of 6
3. Of all the optimal plans, uniform_cost_search has the least execution time and the recursive_best_first_search has the maximum execution time
4. For this problem, uniformed search algorithm ‘uniform_cost_search’ and informed search algorithm ‘astart_search_with_h_ignore_preconditions’ are the best candidates for search algorithm

Air Cargo Problem 2

The table below provides the results of applying various search algorithms to first planning problem.

#	Algorithm	Optimal	Expansions	Goal Tests	New Nodes	Plan Length	Time Elapsed (ms)
1	breadth_first_search	Yes	3346	4612	30534	9	15862.3
2	breadth_first_tree_search		--	--	--	--	--
3	depth_first_graph_search	No	1124	1125	10017	1085	10205.9
4	depth_limited_search		--	--	--	--	--
5	uniform_cost_search	Yes	4853	4855	44041	9	14684.5
6	recursive_best_first_search		--	--	--	--	--
7	greedy_best_first_graph_search	No	895	897	8009	21	2910.6
8	astar_search with h_1	Yes	4853	4855	44041	9	14891.7
9	astar_search with h_ignore_preconditions	Yes	1450	1452	13303	9	4701.9
10	astar_search with h_pg_levelsum		--	--	--	--	--

Key Takeaways

1. Optimal plans have length of 9 in the table above
2. Only 4 search algorithms yields a result to problem with optimal length. The 4 algorithms are breadth_first_search, uniform_cost_search, astar_search_search_h_1 and astar_search_with_h_ignore_preconditions
3. Although greedy_best_first_graph_search has lowest execution time, the algorithm does not provide and optimal plan in terms of plan length
4. For this problem, informed search algorithm 'astart_search_with_h_ignore_preconditions' is the best candidates for search algorithmin terms of optimal length and execution time

Air Cargo Problem 3

The table below provides the results of applying various search algorithms to first planning problem.

#	Algorithm	Optimal	Expansions	Goal Tests	New Nodes	Plan Length	Time Elapsed (ms)
1	breadth_first_search	Yes	14120	17673	124926	12	119599.9
2	breadth_first_tree_search		--	--	--	--	--
3	depth_first_graph_search	No	677	678	5608	660	4256.7
4	depth_limited_search		--	--	--	--	--
5	uniform_cost_search	Yes	18233	18235	159697	12	96591.8
6	recursive_best_first_search		--	--	--	--	--
7	greedy_best_first_graph_search	Yes	5165	5167	45611	22	17032.4
8	astar_search with h_1	Yes	18233	18235	159697	12	1230866
9	astar_search with h_ignore_preconditions	Yes	4951	4953	44051	12	16617
10	astar_search with h_pg_levelsum		--	--	--	--	--

Key Takeaways

1. Optimal plans have length of 12 in the table above
2. Only 4 search algorithms yields a result to problem with optimal length. The 4 algorithms are breadth_first_search, uniform_cost_search, astar_search_search_h_1 and astar_search_with_h_ignore_preconditions
3. Although depth_first_graph_search has lowest execution time, the algorithm does not provide and optimal plan in terms of plan length
4. For this problem, informed search algorithm 'astart_search_with_h_ignore_preconditions' is the best candidates for search algorithmin terms of optimal length and execution time