

Heuristics Analysis

Uninformed Search Strategies

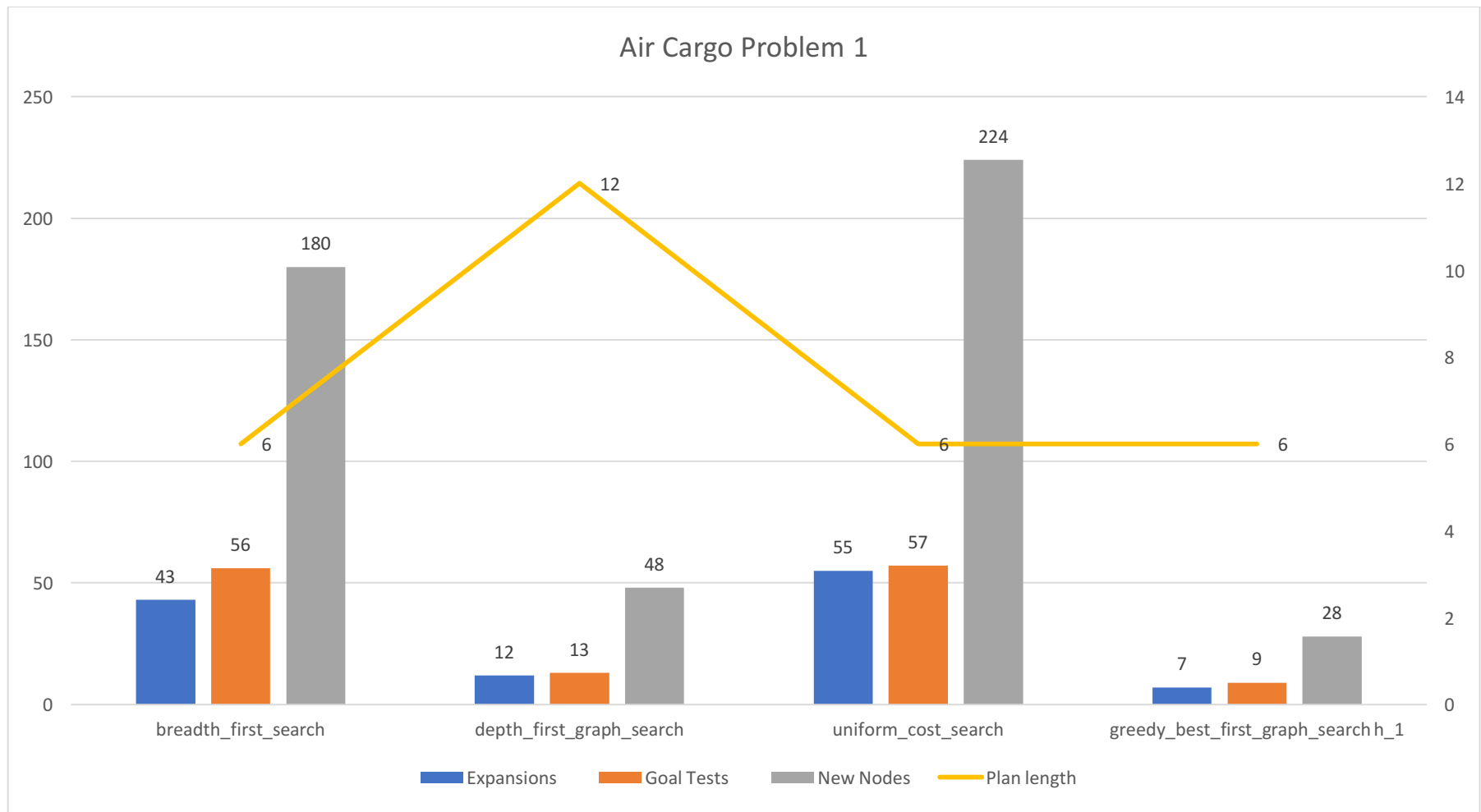
The summary of the non-heuristic search results are presented here. In my search I considered the breadth_first_search, depth_first_graph_search, uniform_cost_search, greedy_best_first_graph_search h_1 for all the three cargo problems.

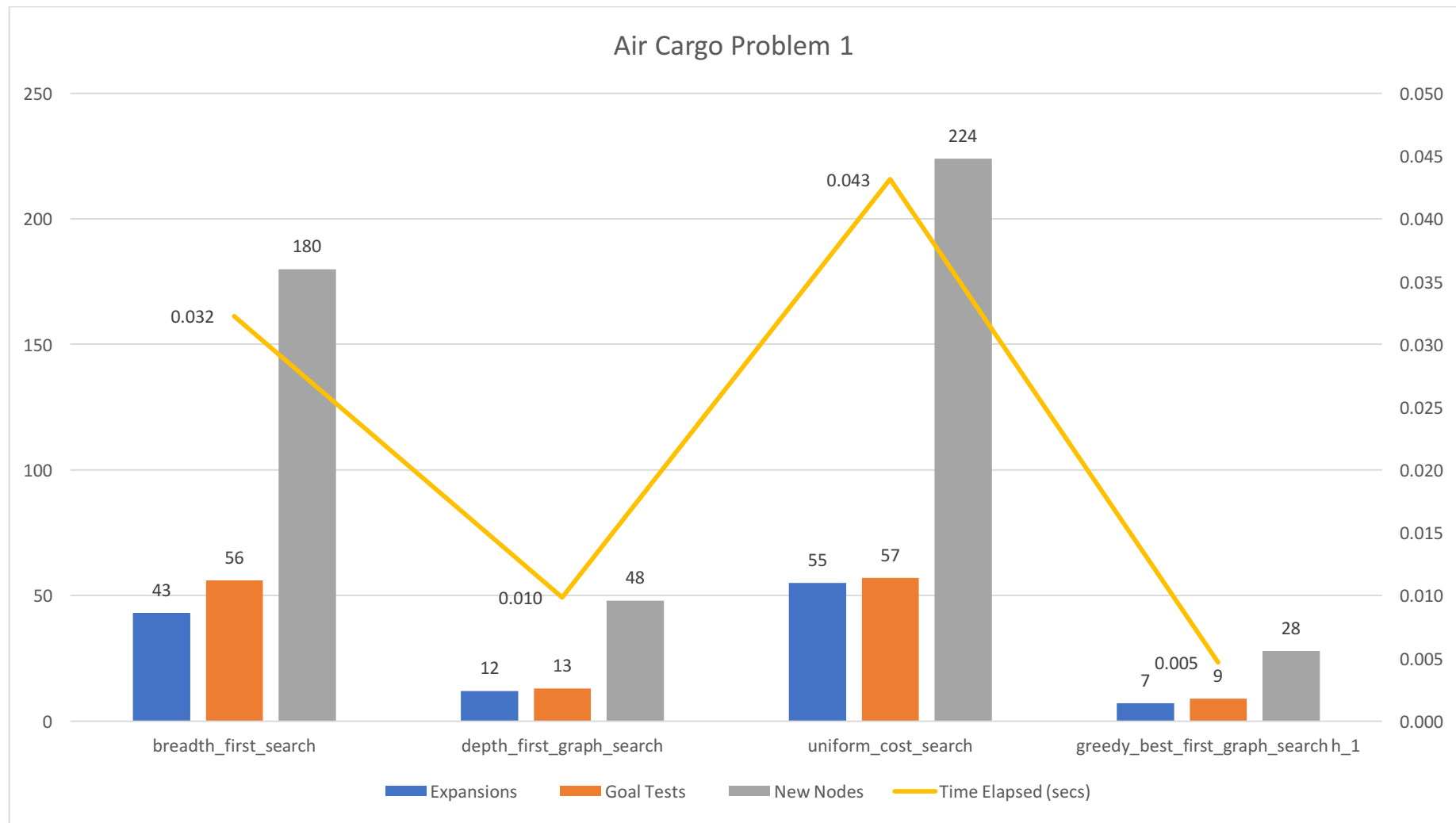
Cargo	Test	Expansions	Goal Tests	New Nodes	Plan length	Time Elapsed (secs)
Air Cargo Problem 1	breadth_first_search	43	56	180	6	0.032
Air Cargo Problem 1	depth_first_graph_search	12	13	48	12	0.010
Air Cargo Problem 1	uniform_cost_search	55	57	224	6	0.043
Air Cargo Problem 1	greedy_best_first_graph_search h_1	7	9	28	6	0.005
Air Cargo Problem 2	breadth_first_search	3343	4609	30509	9	8.071
Air Cargo Problem 2	depth_first_graph_search	476	477	4253	466	2.209
Air Cargo Problem 2	uniform_cost_search	4853	4855	44041	9	11.475
Air Cargo Problem 2	greedy_best_first_graph_search h_1	998	1000	8982	17	2.539
Air Cargo Problem 3	breadth_first_search	14663	18098	129631	12	42.372
Air Cargo Problem 3	depth_first_graph_search	1511	1512	12611	1442	12.765
Air Cargo Problem 3	uniform_cost_search	18162	18164	159218	12	51.930
Air Cargo Problem 3	greedy_best_first_graph_search h_1	5380	5382	47545	26	15.673

Air Cargo Problem 1

Cargo	Test	Expansions	Goal Tests	New Nodes	Plan length	Time Elapsed (secs)
Air Cargo Problem 1	breadth_first_search	43	56	180	6	0.032

Air Cargo Problem 1	depth_first_graph_search	12	13	48	12	0.010
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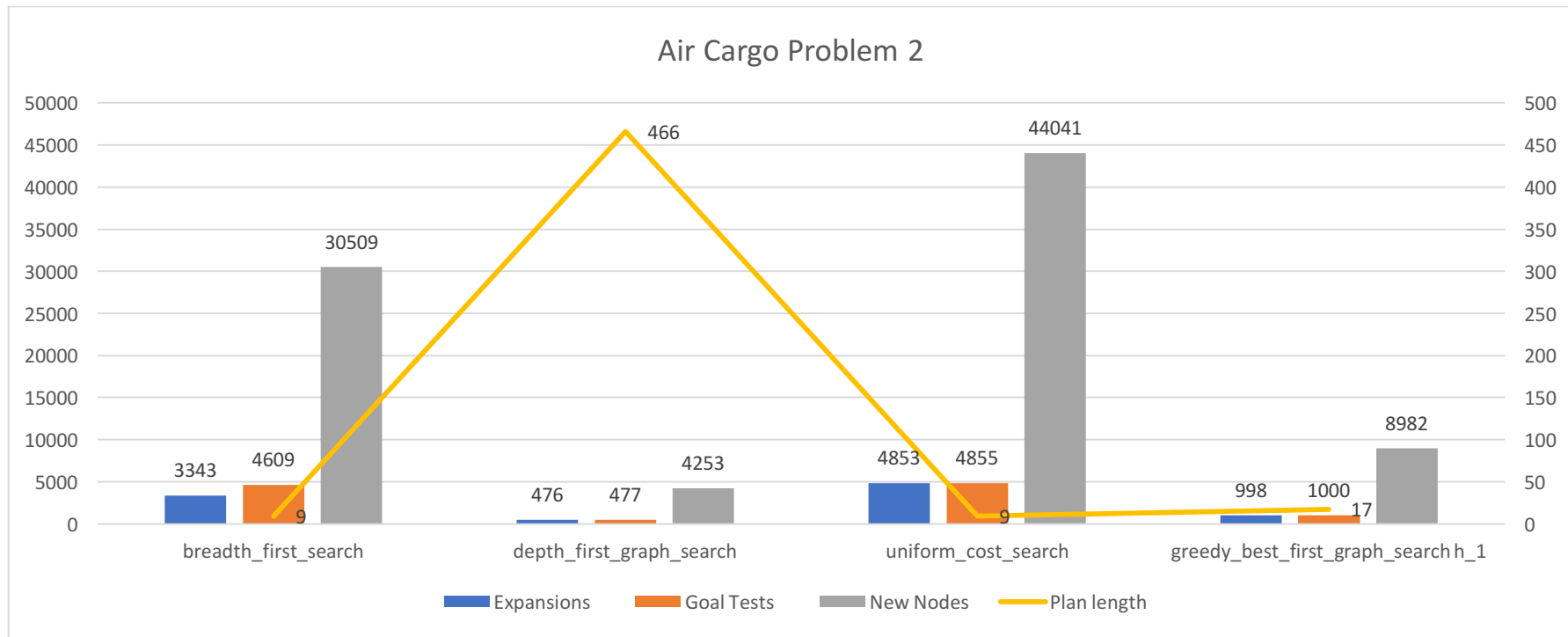




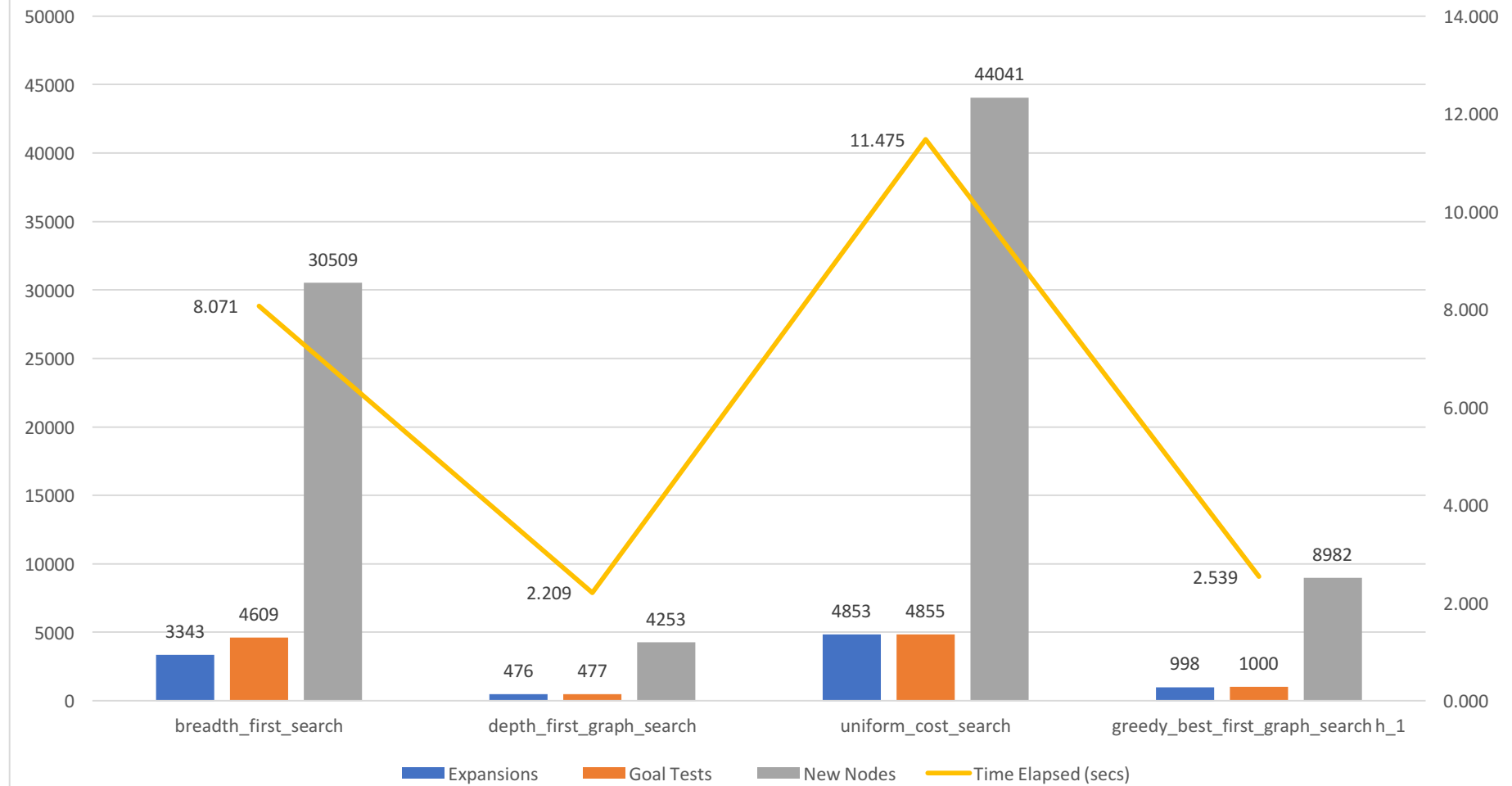
The test results clearly demonstrate that the path length for all the methods are constant at 6 but the greedy best first search method performs the best in terms of time elapsed. It is by far the fastest at 0.005 secs and even though breadth first search also is a close second with 0.03 secs, I would recommend the greedy best first search for this problem.

Air Cargo Problem 2

Cargo	Test	Expansions	Goal Tests	New Nodes	Plan length	Time Elapsed (secs)
Air Cargo Problem 2	breadth_first_search	3343	4609	30509	9	8.071
Air Cargo Problem 2	depth_first_graph_search	476	477	4253	466	2.209
Air Cargo Problem 2	uniform_cost_search	4853	4855	44041	9	11.475
Air Cargo Problem 2	greedy_best_first_graph_search h_1	998	1000	8982	17	2.539



Air Cargo Problem 2

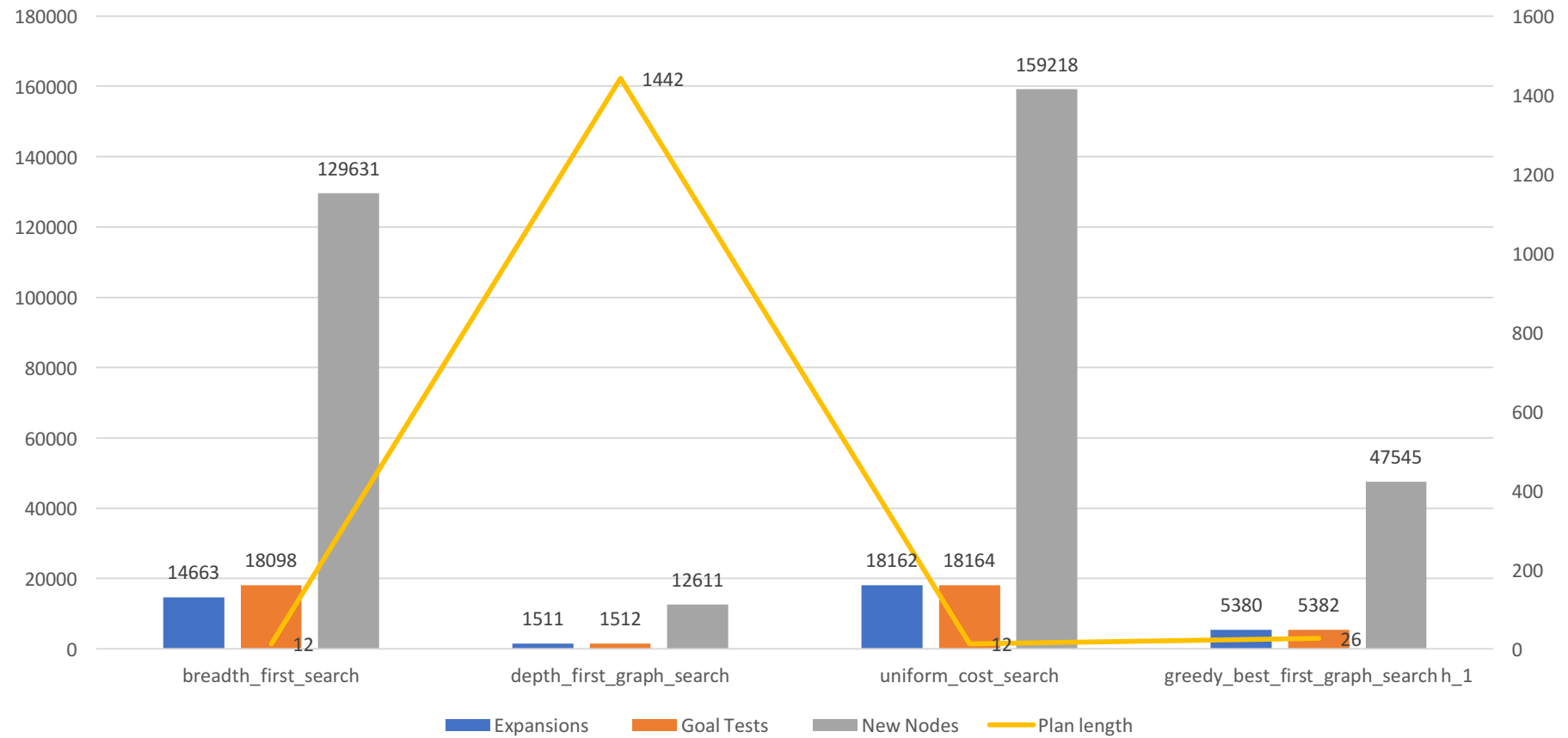


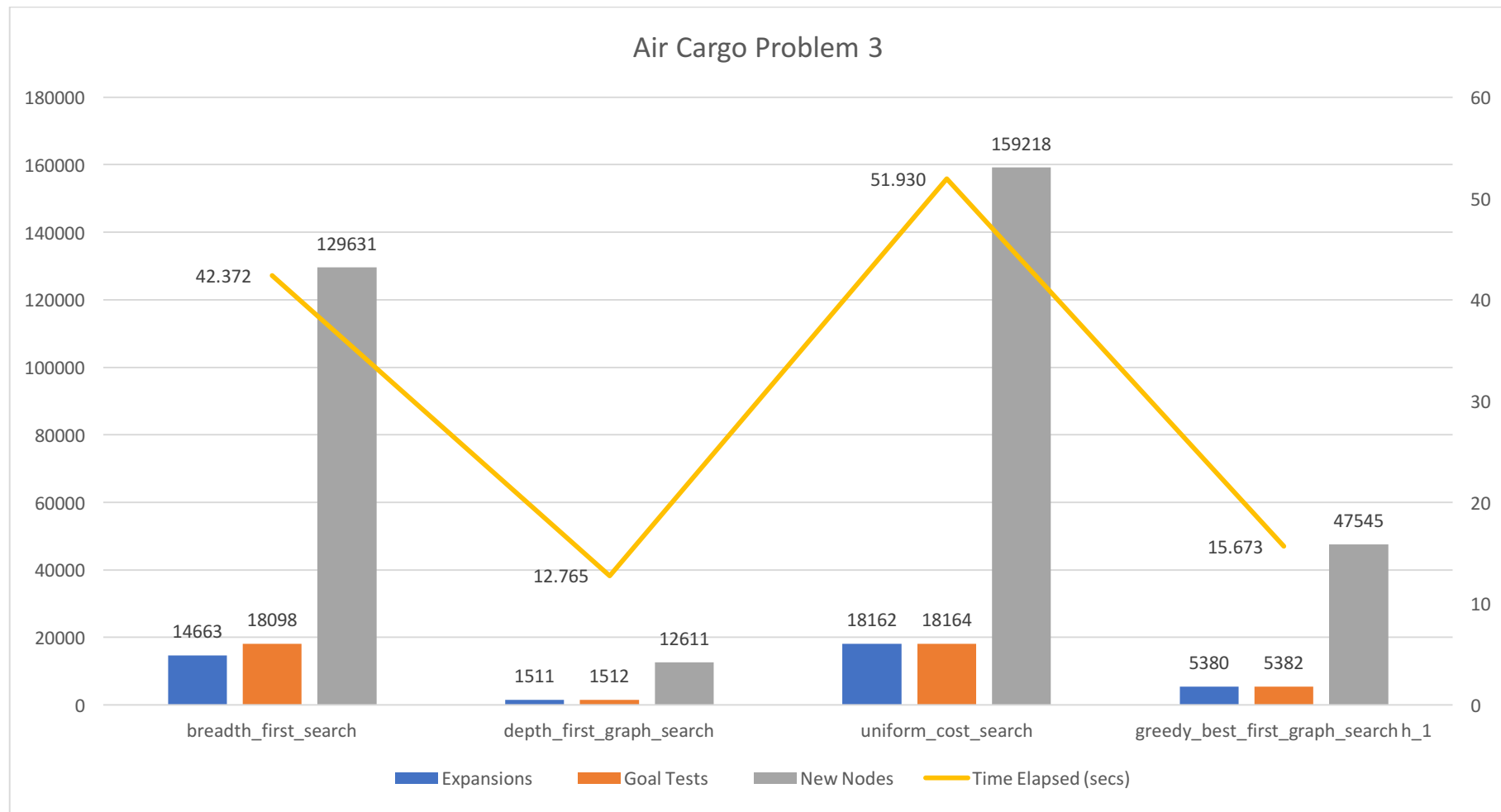
The test results clearly demonstrate that the two best methods are breadth first search and uniform cost search with both their path lengths at 9. But the breadth first search method performs the best in terms of time elapsed. It is by far the fastest at 8.071 secs with the uniform cost search performing at a time elapsed of 11.475 secs. Even though the depth first graph search performs the best in terms of time elapsed with 2.209 secs, the plan length is a staggering 466 which suggests that it is not the optimal one. The greedy best first graph search performs with a time of 2.539 secs but has a plan length of 17 which is longer than the 9 given by breadth first search and uniform cost search.

Air Cargo Problem 3

Cargo	Test	Expansions	Goal Tests	New Nodes	Plan length	Time Elapsed (secs)
Air Cargo Problem 3	breadth_first_search	14663	18098	129631	12	42.372
Air Cargo Problem 3	depth_first_graph_search	1511	1512	12611	1442	12.765
Air Cargo Problem 3	uniform_cost_search	18162	18164	159218	12	51.930
Air Cargo Problem 3	greedy_best_first_graph_search h_1	5380	5382	47545	26	15.673

Air Cargo Problem 3





This is similar to the test results for Cargo Problem 2. The two best methods are breadth first search and uniform cost search with both their path lengths at 12. The breadth first search method performs the best in terms of time elapsed (42.372 secs) compared to the uniform cost search performing at a time elapsed of 51.930 secs. Again the depth first graph search performs the best in terms of time elapsed with 12.765

secs, the plan length is a staggering 1442 which suggests that it is not the optimal one. The greedy best first graph search performs with a time of 15.673 secs but has a plan length of 26 which is longer than the 12 given by breadth first search and uniform cost search.

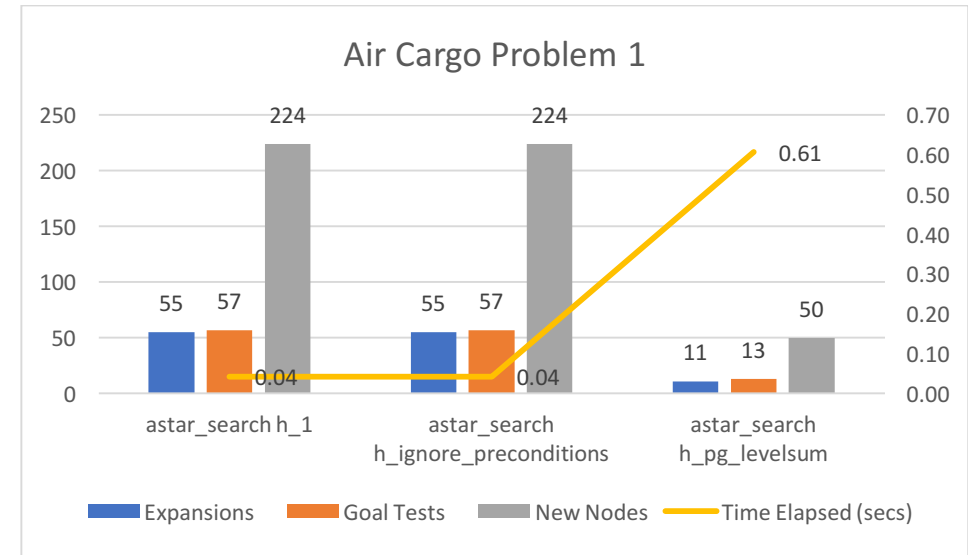
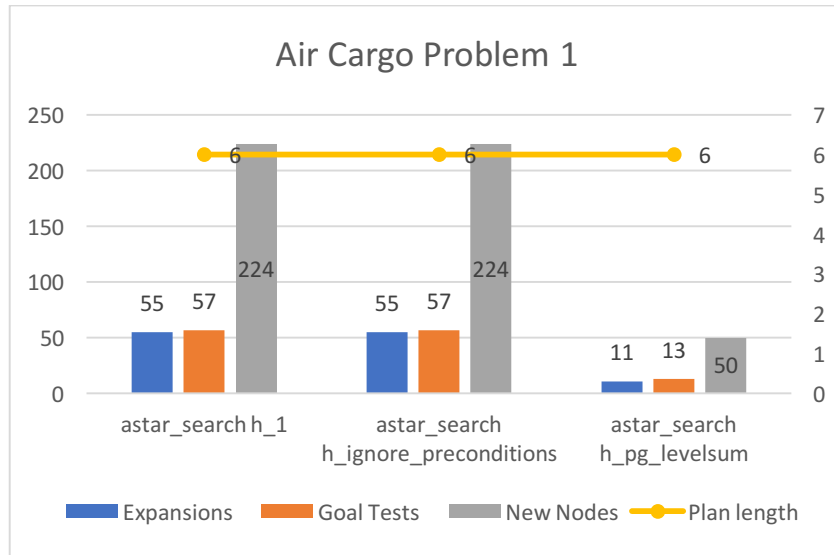
Informed Search Strategies

The summary of the heuristics search results are presented here. In my search I considered the astar_search h_1, astar_search h_ignore_preconditions and astar_search h_pg_levelsum for all the three cargo problems.

Cargo	Test	Expansions	Goal Tests	New Nodes	Plan length	Time Elapsed (secs)
Air Cargo Problem 1	astar_search h_1	55	57	224	6	0.04
Air Cargo Problem 1	astar_search h_ignore_preconditions	55	57	224	6	0.04
Air Cargo Problem 1	astar_search h_pg_levelsum	11	13	50	6	0.61
Air Cargo Problem 2	astar_search h_1	4853	4855	44041	9	11.55
Air Cargo Problem 2	astar_search h_ignore_preconditions	4853	4855	44041	9	11.82
Air Cargo Problem 2	astar_search h_pg_levelsum	86	88	841	9	55.78
Air Cargo Problem 3	astar_search h_1	18162	18164	159128	12	52.20
Air Cargo Problem 3	astar_search h_ignore_preconditions	18162	18164	159128	12	52.49
Air Cargo Problem 3	astar_search h_pg_levelsum	316	318	2914	12	276.20

Air Cargo Problem 1

Cargo	Test	Expansions	Goal Tests	New Nodes	Plan length	Time Elapsed (secs)
Air Cargo Problem 1	astar_search h_1	55	57	224	6	0.04
Air Cargo Problem 1	astar_search h_ignore_preconditions	55	57	224	6	0.04
Air Cargo Problem 1	astar_search h_pg_levelsum	11	13	50	6	0.61

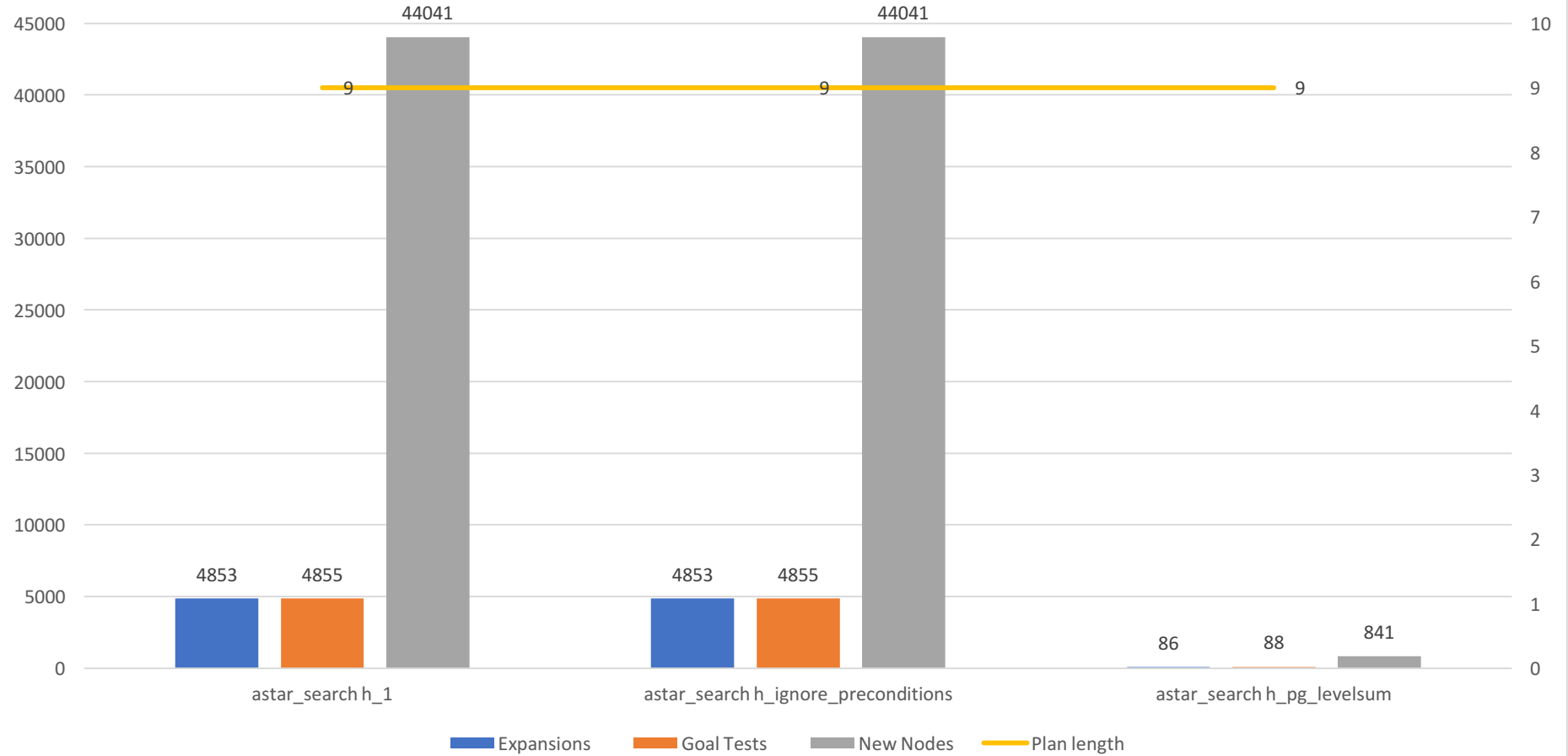


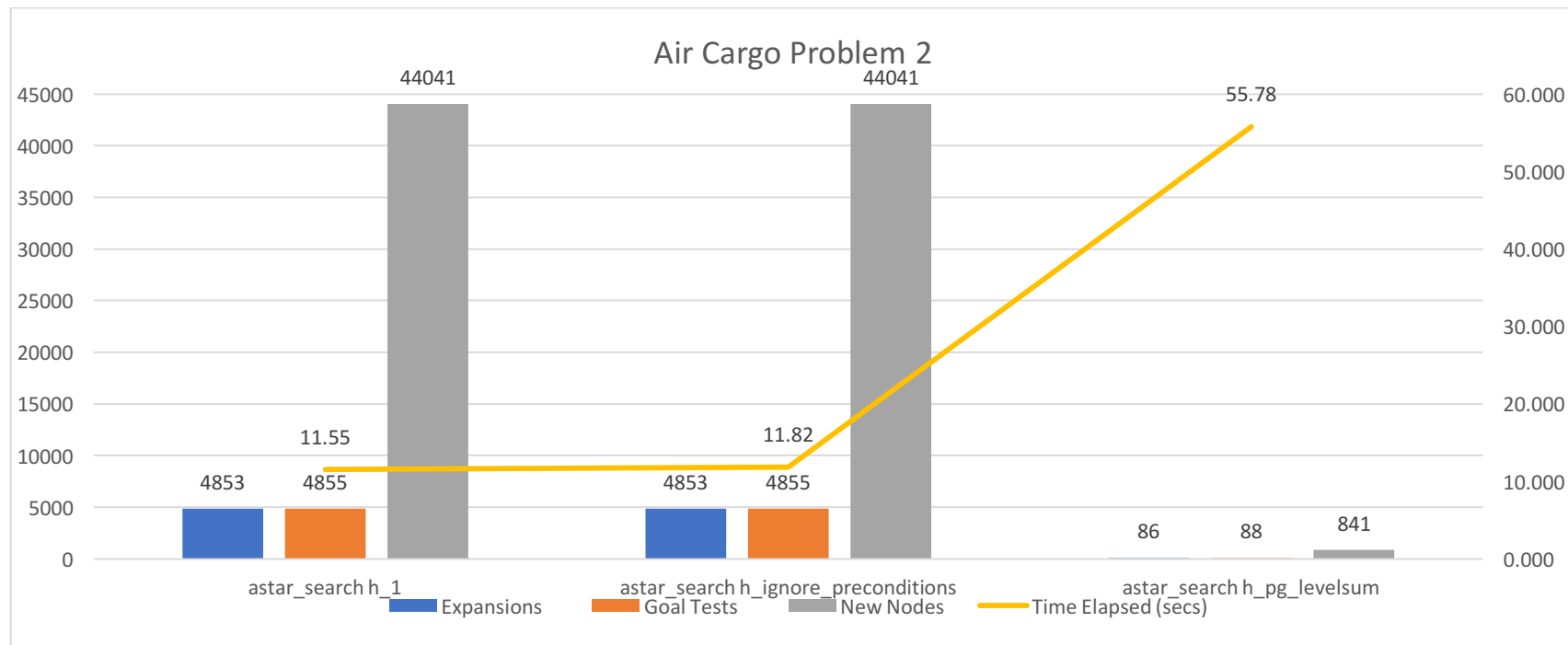
As is evident from the results for Cargo 1, the `astar_search_h_1` and `astar_search_h_ignore_preconditions` perform the best considering the optimal plan length and the time elapsed. Plan Length for both are at 6 and time elapsed is 0.04 secs whereas for `astar_search_h_pg_levelsum` method the plan is 6 but the time elapsed is 0.61 secs.

Air Cargo Problem 2

Cargo	Test	Expansions	Goal Tests	New Nodes	Plan length	Time Elapsed (secs)
Air Cargo Problem 2	astar_search h_1	4853	4855	44041	9	11.55
Air Cargo Problem 2	astar_search h_ignore_preconditions	4853	4855	44041	9	11.82
Air Cargo Problem 2	astar_search h_pg_levelsum	86	88	841	9	55.78

Air Cargo Problem 2



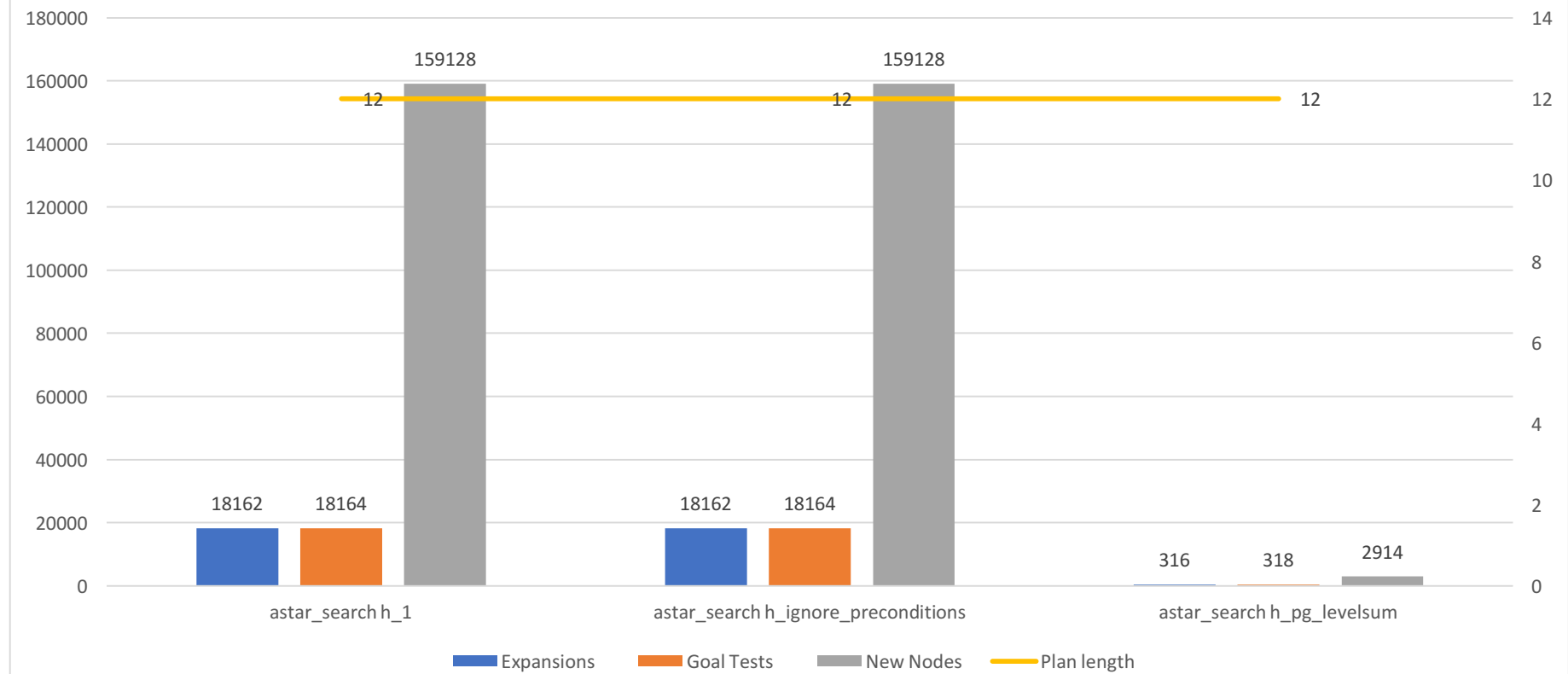


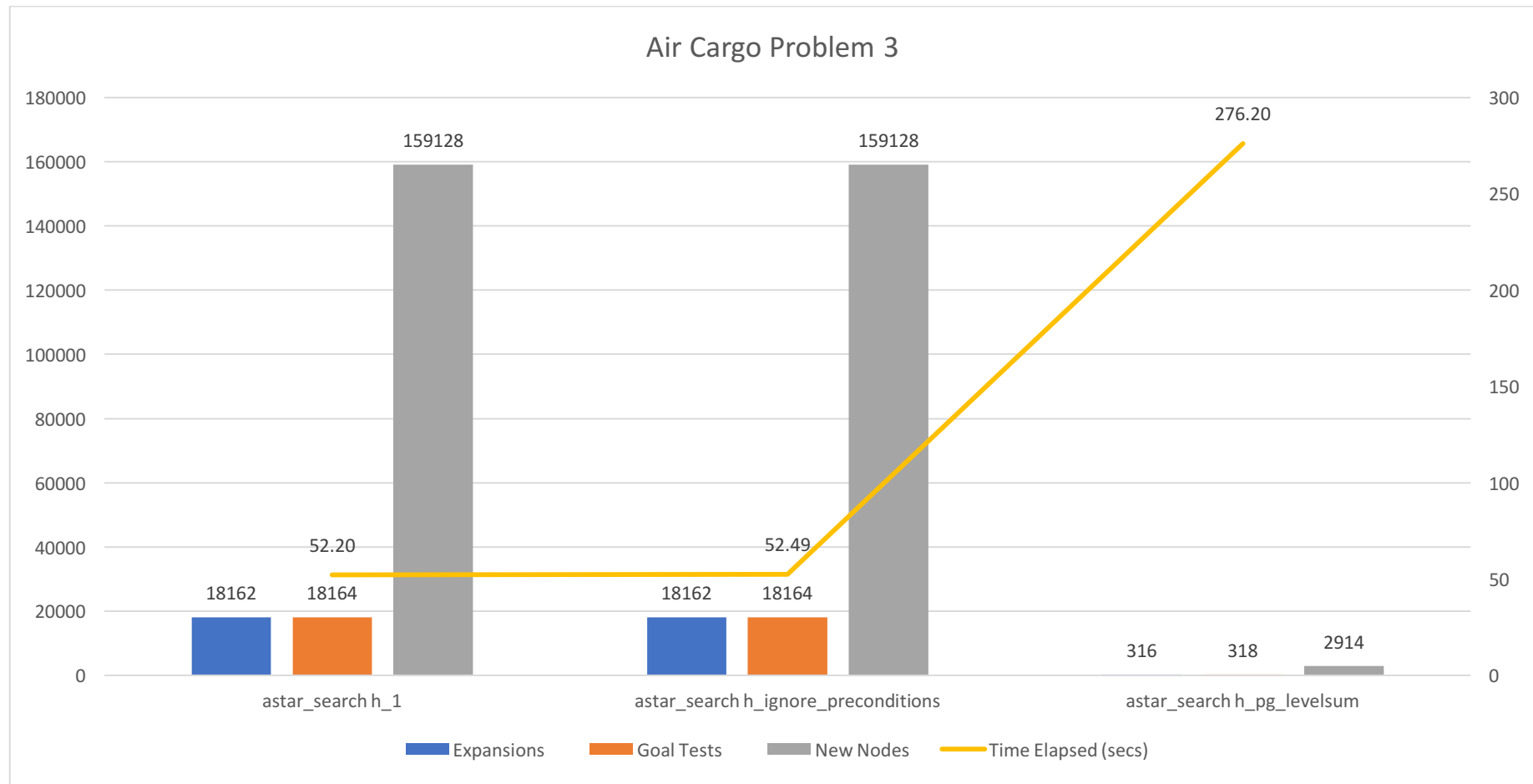
The results for Cargo 2 show that the `astar_search_h_1` and `astar_search_h_ignore_preconditions` perform the best considering the optimal plan length and the time elapsed. Plan Length for both are at 9 and time elapsed is 11.55 secs / 11.82 secs whereas for `astar_search_h_pg_levelsum` method the plan is 6 but the time elapsed is 55.78 secs.

Air Cargo Problem 3

Cargo	Test	Expansions	Goal Tests	New Nodes	Plan length	Time Elapsed (secs)
Air Cargo Problem 3	astar_search_h_1	18162	18164	159128	12	52.20
Air Cargo Problem 3	astar_search_h_ignore_preconditions	18162	18164	159128	12	52.49
Air Cargo Problem 3	astar_search_h_pg_levelsum	316	318	2914	12	276.20

Air Cargo Problem 3





The results for Cargo 3 show that the `astar_search_h_1` and `astar_search_h_ignore_preconditions` perform the best considering the optimal plan length and the time elapsed. Plan Length for both are at 12 and time elapsed is 52.20 secs / 52.49 secs whereas for `astar_search_h_pg_levelsum` method the plan is 12 but the time elapsed is 276.20 secs.

Conclusion

Cargo	Test	Expansions	Goal Tests	New Nodes	Plan length	Time Elapsed (secs)
Air Cargo Problem 1	breadth_first_search	43	56	180	6	0.032
Air Cargo Problem 1	uniform_cost_search	55	57	224	6	0.043
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Air Cargo Problem 1	astar_search h_1	55	57	224	6	0.04
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Air Cargo Problem 1	astar_search h_pg_levelsum	11	13	50	6	0.61

Cargo	Test	Expansions	Goal Tests	New Nodes	Plan length	Time Elapsed (secs)
Air Cargo Problem 2	breadth_first_search	3343	4609	30509	9	8.071
Air Cargo Problem 2	uniform_cost_search	4853	4855	44041	9	11.475
Air Cargo Problem 2	astar_search h_1	4853	4855	44041	9	11.55
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Based on the search strategies and the observations of the results, the uninformed search strategies performed better than the informed search strategies in terms of time elapsed. But the informed search strategies performed well in terms of more expansions, nodes and goal tests being explored. The path lengths of the best search methods were the same in both the cases. The best methods for uninformed was breadth first search and for informed it was as the astar_search_h_1.