Heuristic Analysis

In this report, relevant analysis and optimal plans of three planning questions are presented. First, optimal plans and their lengths in shown in table 1. From this table, we know the plan length of three problems are 6, 9, and 12 respectively.

Table 2, 3, and 4 represents the results of analyses of three problems. I choose three different uniformed planning algorithms, including uniform_cost_search (UCS), breadth_first_search (BFS), and depth_first_graph_search (DFGS) for comparison. From the video lectures, we learned that depth first search cannot guarantee a shortest path, which did not identify the optimal plan for the planning problems as well. Therefore, although DFGS requires the least expansion and time for computations in all of three problems it cannot be considered as a feasible approach. By comparing the performance of UCS and BFS in three problem, I notice that both approaches found optimal plans. However, BFS requires less expansion and time for computation, thus, I will consider BFS is the best algorithm among these three.

For the comparison of heuristic functions with A* search, I choose ignore preconditions and level-sum functions. Level-sum function took too much time for problem 3, therefore, I didn't provide the relevant result. From the observation on three tables, ignore preconditions function require less time for computation, but level-sum function needs less expansions. Due to the trade-off between the computation time and the performance, I would assume that there is no obvious winner between these two heuristic functions.

	Problem 1	Problem 2	Problem 3
Plan Length	6	9	12
Optimal Plan	Load(C1, P1, SFO) Load(C2, P2, JFK) Fly(P2, JFK, SFO) Unload(C2, P2, SFO) Fly(P1, SFO, JFK) Unload(C1, P1, JFK)	Load(C1, P1, SFO) Load(C2, P2, JFK) Load(C3, P3, ATL) Fly(P2, JFK, SFO) Unload(C2, P2, SFO) Fly(P1, SFO, JFK) Unload(C1, P1, JFK) Fly(P3, ATL, SFO) Unload(C3, P3, SFO)	Load(C1, P1, SFO) Load(C2, P2, JFK) Fly(P2, JFK, ORD) Load(C4, P2, ORD) Fly(P1, SFO, ATL) Load(C3, P1, ATL) Fly(P1, ATL, JFK) Unload(C1, P1, JFK) Unload(C3, P1, JFK) Fly(P2, ORD, SFO) Unload(C2, P2, SFO) Unload(C4, P2, SFO)

Table 1 Optimal plans of three problmes

Algorithm	Expansions	Goal Tests	New Nodes	Time	Length	Optimality
UCS	55	57	224	0.04	6	Yes
BFS	43	56	180	0.03	6	Yes
DFGS	21	22	84	0.015	20	No
Ignore	41	43	170	0.052	6	Yes
levelsum	41	43	170	2.75	6	Yes

Table 2 Analysis of problem 1

Algorithm	Expansions	Goal Tests	New Nodes	Time	Length	Optimality
UCS	4780	4782	43381	42.62	9	Yes
BFS	3343	4609	30509	13.26	9	Yes
DFGS	624	625	5602	3.31	619	No
Ignore	1506	1508	13820	14	9	Yes
levelsum	1245	1247	11307	1447.94	9	Yes

Table 3 Analysis of problem 2

Algorithm	Expansions	Goal Tests	New Nodes	Time	Length	Optimality
UCS	18151	18153	159038	377.96	12	Yes
BFS	14663	18098	129631	106.07	12	Yes
DFGS	408	409	3364	1.9	392	No
Ignore	5118	5120	45650	84.46	12	Yes
levelsum	NA	NA	NA	NA	NA	NA

Table 4 Analysis of problem 3