Heuristics Analysis for Planning Search Project:

The following are the comparison data obtained by running run_search.py

Problem 1:

Algorithm	Heuristic	Expansions	Goal Test	New Nodes	Plan length	Time Elapsed
BFS		43	56	180	6	0.039970412
DFS		21	22	84	20	0.017707876
A* h_ignore_preconditions	Ignore Preconditions	41	43	170	6	0.033396061
A* h_pg_levelsum	level Sum	55	57	224	6	0.979801461

Problem 2:

Algorithm	Heuristic	Expansions	Goal Test	New Nodes	Plan length	Time Elapsed
BFS		3343	4609	30509	9	6.525102123
DFS		624	625	5602	619	2.770552488
A* h_ignore_preconditions	Ignore Preconditions	1450	1452	13303	9	3.63289276
A* h_pg_levelsum	level Sum	4853	4855	44041	9	620.4492995

Problem 3:

Algorithm	Heuristic	Expansions	Goal Test	New Nodes	Plan length	Time Elapsed
BFS		14663	18098	129631	12	34.34664737
DFS		408	409	3364	392	1.464425275
A* h_ignore_preconditions	Ignore Preconditions	5038	5040	44926	12	13.16569374
A* h_pg_levelsum	level Sum	-	-	-	-	-

Comparison: As can be noted from the tables above, for problem 1, A* Ignore preconditions is the optimal algorithm for all the three problems. BFS does better than DFS with fewer plan lengths and time elapsed. As stated in the reference TextBook by Russell and Norvig, DFS is not an optimal solution since there is more than one goal. Compared to BFS, A* ignore Preconditions has the same plan length as BFS but is more optimal as the time elapsed is lower.

The following is the plan length and sequence of actions for the various algorithms:

Problem 1:

Algorithm	Plan length	Sequence of Actions
BFS	6	Load(C1, P1, SFO) Load(C2, P2, JFK) Fly(P2, JFK, SFO) Unload(C2, P2, SFO) Fly(P1, SFO, JFK) Unload(C1, P1, JFK)
DFS	20	Fly(P1, SFO, JFK) Fly(P2, JFK, SFO) Load(C2, P1, JFK) Fly(P1, JFK, SFO) Fly(P2, SFO, JFK) Unload(C2, P1, SFO) Fly(P1, SFO, JFK) Fly(P2, JFK, SFO) Load(C2, P2, SFO) Fly(P1, JFK, SFO) Load(C1, P2, SFO) Fly(P2, SFO, JFK) Fly(P1, SFO, JFK) Unload(C2, P2, JFK) Unload(C1, P2, JFK) Fly(P2, JFK, SFO) Load(C2, P1, JFK) Fly(P1, JFK, SFO) Fly(P2, SFO, JFK) Unload(C2, P1, SFO)
A* h_ignore_preconditions	6	Load(C1, P1, SFO) Fly(P1, SFO, JFK) Unload(C1, P1, JFK) Load(C2, P2, JFK) Fly(P2, JFK, SFO) Unload(C2, P2, SFO)
A* h_pg_levelsum	6	Load(C1, P1, SFO) Load(C2, P2, JFK) Fly(P1, SFO, JFK) Fly(P2, JFK, SFO) Unload(C1, P1, JFK) Unload(C2, P2, SFO)

For problem 1, BFS, A* Ignore Preconditions and A* level sum have same plan lengths.

Problem 2:

Algorithm	Plan length	Sequence of Actions
BFS	9	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)
DFS	619	Fly(P3, ATL, SFO) Fly(P1, SFO, ATL) Fly(P3, SFO, JFK) Fly(P1, ATL, JFK) Fly(P2, JFK, ATL) Fly(P3, JFK, ATL) Fly(P2, ATL, SFO) Fly(P3, ATL, SFO) Load(C2, P1, JFK) Fly(P2, SFO, ATL) Fly(P1, JFK, ATL)……
A* h_ignore_preconditions	9	Load(C1, P1, SFO) Load(C2, P2, JFK) Load(C3, P3, ATL) Fly(P1, SFO, JFK) Fly(P2, JFK, SFO) Fly(P3, ATL, SFO) Unload(C1, P1, JFK) Unload(C2, P2, SFO) Unload(C3, P3, SFO)
A* h_pg_levelsum	9	Load(C1, P1, SFO) Load(C2, P2, JFK) Load(C3, P3, ATL) Fly(P1, SFO, JFK) Fly(P2, JFK, SFO) Fly(P3, ATL, SFO) Unload(C1, P1, JFK) Unload(C2, P2, SFO) Unload(C3, P3, SFO)

For problem 2, BFS, A* Ignore preconditions and A* level sum have same plan lengths

Problem 3:

Algorithm	Plan length	Sequence of Actions
BFS	12	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)
DFS	392	Fly(P1, SFO, ORD) Fly(P2, JFK, ORD) Fly(P1, ORD, ATL) Fly(P2, ORD, ATL) Fly(P1, ATL, JFK) Fly(P2, ATL, SFO) Load(C2, P1, JFK)…..
A* h_ignore_preconditions	12	Load(C1, P1, SFO) Fly(P1, SFO, ATL) Load(C3, P1, ATL) Fly(P1, ATL, JFK) Unload(C1, P1, JFK) Load(C2, P2, JFK) Fly(P2, JFK, ORD) Load(C4, P2, ORD) Fly(P2, ORD, SFO) Unload(C2, P2, SFO) Unload(C3, P1, JFK) Unload(C4, P2, SFO)
A* h_pg_levelsum	-	-

As can be seen from the tables, for Problem 3, level sum algorithm is not a good fit as it takes for ever to complete. Ignore preconditions and BFS are similar in the plan lengths

Justification: As can be noted from reference textbook, DFS will not provide an optimal solutions since there is more than one goal. A* level sum is not a suitable algorithm as it fails to complete. Compared to BFS, A* ignore preconditions is faster with the same plan length. So A* Ignore preconditions will be the best fit for our problems.