

Q1. You should run **all** of the search algorithms on the first two problems and record the following information for each combination:

- number of actions in the domain
- number of new node expansions
- time to complete the plan search

Problem 1:

Solving Air Cargo Problem 1 using breadth\_first\_search...

# Actions	Expansions	Goal Tests	New Nodes
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20	43	56	178
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Plan length: 6 Time elapsed in seconds: 0.004974200000000001

Load(C1, P1, SFO)

Load(C2, P2, JFK)

Fly(P2, JFK, SFO)

Unload(C2, P2, SFO)

Fly(P1, SFO, JFK)

Unload(C1, P1, JFK)

Solving Air Cargo Problem 1 using depth\_first\_graph\_search...

# Actions	Expansions	Goal Tests	New Nodes
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20	21	22	84
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Plan length: 20 Time elapsed in seconds: 0.0027377

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)

Solving Air Cargo Problem 1 using uniform\_cost\_search...

# Actions	Expansions	Goal Tests	New Nodes
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20	60	62	240
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Plan length: 6 Time elapsed in seconds: 0.0076784

Load(C2, P2, JFK)  
Fly(P2, JFK, SFO)  
Load(C1, P2, SFO)

Unload(C2, P2, SFO)

Fly(P2, SFO, JFK)

Unload(C1, P2, JFK)

Solving Air Cargo Problem 1 using greedy\_best\_first\_graph\_search with h\_unmet\_goals...

# Actions	Expansions	Goal Tests	New Nodes
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20	7	9	29
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Plan length: 6 Time elapsed in seconds: 0.0013483000000000002

Load(C1, P1, SFO)

Load(C2, P2, JFK)

Fly(P2, JFK, SFO)

Unload(C2, P2, SFO)

Fly(P1, SFO, JFK)

Unload(C1, P1, JFK)

Solving Air Cargo Problem 1 using greedy\_best\_first\_graph\_search with h\_pg\_levelsum...

# Actions	Expansions	Goal Tests	New Nodes
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20	6	8	28
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Plan length: 6 Time elapsed in seconds: 0.3340624

Load(C1, P1, SFO)

Fly(P1, SFO, JFK)

Unload(C1, P1, JFK)

Load(C2, P2, JFK)

Fly(P2, JFK, SFO)

Unload(C2, P2, SFO)

Solving Air Cargo Problem 1 using greedy\_best\_first\_graph\_search with h\_pg\_maxlevel...

# Actions	Expansions	Goal Tests	New Nodes
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20	6	8	24
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Plan length: 6 Time elapsed in seconds: 0.37013029999999997

Load(C1, P1, SFO)

Load(C2, P2, JFK)

Fly(P2, JFK, SFO)

Fly(P1, SFO, JFK)

Unload(C2, P2, SFO)

Unload(C1, P1, JFK)

Solving Air Cargo Problem 1 using greedy\_best\_first\_graph\_search with h\_pg\_setlevel...

# Actions	Expansions	Goal Tests	New Nodes
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20	6	8	28
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Plan length: 6 Time elapsed in seconds: 0.458494

Load(C1, P1, SFO)

Fly(P1, SFO, JFK)

Unload(C1, P1, JFK)

Load(C2, P2, JFK)

Fly(P2, JFK, SFO)

Unload(C2, P2, SFO)

Solving Air Cargo Problem 1 using astar\_search with h\_unmet\_goals...

# Actions	Expansions	Goal Tests	New Nodes
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20	50	52	206
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Plan length: 6 Time elapsed in seconds: 0.0075125

Load(C2, P2, JFK)

Fly(P2, JFK, SFO)

Unload(C2, P2, SFO)

Load(C1, P2, SFO)

Fly(P2, SFO, JFK)

Unload(C1, P2, JFK)

Solving Air Cargo Problem 1 using astar\_search with h\_pg\_levelsum...

# Actions	Expansions	Goal Tests	New Nodes
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20	28	30	122
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Plan length: 6 Time elapsed in seconds: 0.8186332000000001

Load(C2, P2, JFK)

Fly(P2, JFK, SFO)

Unload(C2, P2, SFO)

Load(C1, P2, SFO)

Fly(P2, SFO, JFK)

Unload(C1, P2, JFK)

Solving Air Cargo Problem 1 using astar\_search with h\_pg\_maxlevel...

# Actions	Expansions	Goal Tests	New Nodes
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20	43	45	180
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Plan length: 6 Time elapsed in seconds: 0.9075542

Load(C2, P2, JFK)

Fly(P2, JFK, SFO)

Load(C1, P2, SFO)

Unload(C2, P2, SFO)

Fly(P2, SFO, JFK)

Unload(C1, P2, JFK)

Solving Air Cargo Problem 1 using astar\_search with h\_pg\_setlevel...

# Actions	Expansions	Goal Tests	New Nodes
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20	33	35	138
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Plan length: 6 Time elapsed in seconds: 0.986248

Load(C2, P2, JFK)

Fly(P2, JFK, SFO)

Unload(C2, P2, SFO)

Load(C1, P2, SFO)

Fly(P2, SFO, JFK)

Unload(C1, P2, JFK)

## Problem 2:

Solving Air Cargo Problem 2 using breadth\_first\_search...

# Actions	Expansions	Goal Tests	New Nodes
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72	3343	4609	30503
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Plan length: 9 Time elapsed in seconds: 1.5728233

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)

Solving Air Cargo Problem 2 using depth\_first\_graph\_search...

# Actions	Expansions	Goal Tests	New Nodes
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72	624	625	5602
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Plan length: 619 Time elapsed in seconds: 2.1440848

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)  
Fly(P2, ATL, JFK)  
Fly(P1, ATL, SFO)  
Fly(P3, SFO, ATL)  
Fly(P1, SFO, JFK)  
Load(C3, P3, ATL)  
Fly(P3, ATL, SFO)  
Fly(P2, JFK, ATL)  
Fly(P3, SFO, JFK)  
Fly(P2, ATL, SFO)  
Fly(P1, JFK, ATL)  
Fly(P2, SFO, JFK)  
Fly(P1, ATL, SFO)  
Unload(C3, P3, JFK)  
Fly(P1, SFO, JFK)  
Fly(P3, JFK, ATL)  
Fly(P2, JFK, ATL)  
Fly(P3, ATL, SFO)  
Fly(P2, ATL, SFO)  
Fly(P1, JFK, ATL)  
Fly(P3, SFO, ATL)  
Fly(P1, ATL, SFO)



Unload(C2, P1, SFO)

Fly(P3, ATL, SFO)

Fly(P2, SFO, ATL)

Fly(P1, SFO, ATL)

Fly(P2, ATL, JFK)

Fly(P1, ATL, JFK)

Fly(P3, SFO, ATL)

Fly(P2, JFK, ATL)

Fly(P3, ATL, JFK)

Fly(P2, ATL, SFO)

Fly(P1, JFK, ATL)

Load(C3, P3, JFK)

Fly(P1, ATL, SFO)

Fly(P2, SFO, ATL)

Fly(P3, JFK, ATL)

Fly(P2, ATL, JFK)

Fly(P3, ATL, SFO)

Fly(P1, SFO, ATL)

Fly(P2, JFK, ATL)

Fly(P1, ATL, JFK)

Fly(P2, ATL, SFO)

Fly(P3, SFO, ATL)

Unload(C3, P3, ATL)

Fly(P3, ATL, SFO)

Fly(P2, SFO, ATL)

Fly(P3, SFO, JFK)

Fly(P2, ATL, JFK)

Fly(P1, JFK, ATL)

Fly(P3, JFK, ATL)

Fly(P2, JFK, ATL)  
Load(C3, P2, ATL)  
Fly(P3, ATL, SFO)  
Fly(P2, ATL, SFO)  
Fly(P1, ATL, SFO)  
Fly(P3, SFO, ATL)  
Fly(P2, SFO, JFK)  
Fly(P3, ATL, JFK)  
Fly(P1, SFO, JFK)  
Fly(P2, JFK, SFO)  
Unload(C3, P2, SFO)  
Fly(P2, SFO, ATL)  
Fly(P3, JFK, ATL)  
Fly(P2, ATL, JFK)  
Fly(P3, ATL, SFO)  
Load(C2, P3, SFO)  
Fly(P3, SFO, ATL)  
Fly(P2, JFK, ATL)  
Fly(P3, ATL, JFK)  
Fly(P2, ATL, SFO)  
Fly(P1, JFK, ATL)  
Fly(P2, SFO, JFK)  
Fly(P1, ATL, SFO)  
Unload(C2, P3, JFK)  
Fly(P1, SFO, JFK)  
Fly(P3, JFK, ATL)  
Fly(P2, JFK, ATL)  
Fly(P3, ATL, SFO)  
Fly(P2, ATL, SFO)

Fly(P1, JFK, ATL)  
Fly(P3, SFO, ATL)  
Fly(P1, ATL, SFO)  
Load(C3, P2, SFO)  
Fly(P3, ATL, SFO)  
Fly(P2, SFO, ATL)  
Fly(P1, SFO, ATL)  
Fly(P2, ATL, JFK)  
Fly(P1, ATL, JFK)  
Fly(P3, SFO, ATL)  
Load(C2, P2, JFK)  
Fly(P3, ATL, JFK)  
Fly(P2, JFK, ATL)  
Fly(P1, JFK, ATL)  
Fly(P2, ATL, SFO)  
Fly(P1, ATL, SFO)  
Unload(C3, P2, SFO)  
Fly(P2, SFO, ATL)  
Fly(P1, SFO, ATL)  
Fly(P2, ATL, JFK)  
Fly(P3, JFK, ATL)  
Fly(P1, ATL, SFO)  
Fly(P3, ATL, SFO)  
Fly(P1, SFO, JFK)  
Fly(P2, JFK, ATL)  
Fly(P3, SFO, ATL)  
Fly(P2, ATL, SFO)  
Load(C1, P2, SFO)  
Fly(P3, ATL, SFO)

Fly(P2, SFO, ATL)  
Fly(P3, SFO, JFK)  
Fly(P2, ATL, JFK)  
Fly(P1, JFK, ATL)  
Fly(P3, JFK, ATL)  
Fly(P1, ATL, SFO)  
Fly(P3, ATL, SFO)  
Unload(C2, P2, JFK)  
Fly(P1, SFO, ATL)  
Fly(P2, JFK, ATL)  
Fly(P1, ATL, JFK)  
Fly(P3, SFO, ATL)  
Fly(P2, ATL, SFO)  
Fly(P3, ATL, JFK)  
Fly(P1, JFK, ATL)  
Load(C3, P2, SFO)  
Fly(P1, ATL, SFO)  
Fly(P2, SFO, ATL)  
Fly(P1, SFO, JFK)  
Fly(P2, ATL, JFK)  
Fly(P3, JFK, ATL)  
Fly(P1, JFK, ATL)  
Fly(P3, ATL, SFO)  
Fly(P1, ATL, SFO)  
Unload(C3, P2, JFK)  
Fly(P3, SFO, ATL)  
Fly(P2, JFK, ATL)  
Fly(P3, ATL, JFK)  
Fly(P2, ATL, SFO)

Fly(P1, SFO, ATL)  
Fly(P2, SFO, JFK)  
Unload(C1, P2, JFK)  
Fly(P1, ATL, SFO)  
Fly(P2, JFK, ATL)  
Fly(P1, SFO, JFK)  
Fly(P2, ATL, SFO)  
Fly(P3, JFK, ATL)  
Fly(P2, SFO, JFK)  
Fly(P3, ATL, SFO)  
Load(C3, P2, JFK)  
Fly(P2, JFK, ATL)  
Fly(P3, SFO, ATL)  
Fly(P2, ATL, SFO)  
Fly(P3, ATL, JFK)  
Fly(P1, JFK, ATL)  
Fly(P2, SFO, ATL)  
Fly(P1, ATL, SFO)  
Unload(C3, P2, ATL)  
Fly(P2, ATL, SFO)  
Fly(P1, SFO, ATL)  
Fly(P2, SFO, JFK)  
Fly(P1, ATL, JFK)  
Fly(P3, JFK, ATL)  
Fly(P2, JFK, SFO)  
Fly(P3, ATL, SFO)  
Load(C2, P1, JFK)  
Fly(P2, SFO, ATL)  
Fly(P3, SFO, ATL)

Fly(P1, JFK, ATL)  
Fly(P2, ATL, SFO)  
Fly(P1, ATL, SFO)  
Fly(P3, ATL, JFK)  
Fly(P2, SFO, ATL)  
Unload(C2, P1, SFO)  
Fly(P2, ATL, JFK)  
Fly(P1, SFO, ATL)  
Fly(P3, JFK, ATL)  
Fly(P1, ATL, JFK)  
Fly(P3, ATL, SFO)  
Fly(P2, JFK, ATL)  
Fly(P1, JFK, ATL)  
Fly(P2, ATL, SFO)  
Fly(P1, ATL, SFO)  
Load(C2, P3, SFO)  
Fly(P3, SFO, ATL)  
Fly(P2, SFO, ATL)  
Fly(P1, SFO, ATL)  
Fly(P3, ATL, JFK)  
Fly(P1, ATL, JFK)  
Fly(P2, ATL, SFO)  
Load(C1, P3, JFK)  
Fly(P2, SFO, JFK)  
Fly(P3, JFK, ATL)  
Fly(P2, JFK, ATL)  
Fly(P3, ATL, SFO)  
Fly(P1, JFK, ATL)  
Fly(P2, ATL, SFO)

Fly(P1, ATL, SFO)  
Fly(P3, SFO, ATL)  
Unload(C2, P3, ATL)  
Fly(P3, ATL, SFO)  
Fly(P2, SFO, ATL)  
Fly(P1, SFO, ATL)  
Fly(P2, ATL, JFK)  
Fly(P1, ATL, JFK)  
Fly(P3, SFO, JFK)  
Fly(P2, JFK, ATL)  
Unload(C1, P3, JFK)  
Fly(P2, ATL, SFO)  
Fly(P3, JFK, ATL)  
Fly(P2, SFO, JFK)  
Fly(P3, ATL, SFO)  
Fly(P1, JFK, ATL)  
Fly(P3, SFO, JFK)  
Fly(P1, ATL, SFO)  
Load(C1, P2, JFK)  
Fly(P1, SFO, JFK)  
Fly(P2, JFK, ATL)  
Fly(P3, JFK, ATL)  
Fly(P2, ATL, SFO)  
Fly(P3, ATL, SFO)  
Fly(P1, JFK, ATL)  
Fly(P2, SFO, ATL)  
Fly(P1, ATL, SFO)  
Unload(C1, P2, ATL)  
Fly(P2, ATL, SFO)

Fly(P1, SFO, ATL)  
Fly(P3, SFO, ATL)  
Fly(P1, ATL, JFK)  
Fly(P3, ATL, JFK)  
Fly(P2, SFO, JFK)  
Fly(P1, JFK, ATL)  
Fly(P2, JFK, ATL)  
Load(C3, P2, ATL)  
Fly(P2, ATL, SFO)  
Fly(P1, ATL, SFO)  
Fly(P2, SFO, JFK)  
Fly(P1, SFO, JFK)  
Fly(P3, JFK, ATL)  
Fly(P2, JFK, ATL)  
Fly(P3, ATL, SFO)  
Fly(P2, ATL, SFO)  
Unload(C3, P2, SFO)  
Fly(P3, SFO, ATL)  
Fly(P2, SFO, ATL)  
Fly(P3, ATL, JFK)  
Fly(P2, ATL, JFK)  
Fly(P1, JFK, ATL)  
Fly(P3, JFK, ATL)  
Fly(P1, ATL, SFO)  
Fly(P3, ATL, SFO)  
Fly(P2, JFK, ATL)  
Fly(P1, SFO, ATL)  
Load(C3, P3, SFO)  
Fly(P2, ATL, SFO)



Fly(P1, ATL, SFO)  
Fly(P3, SFO, ATL)  
Fly(P2, SFO, ATL)  
Fly(P3, ATL, JFK)  
Fly(P2, ATL, JFK)  
Fly(P1, SFO, ATL)  
Fly(P3, JFK, ATL)  
Fly(P1, ATL, JFK)  
Load(C2, P3, ATL)  
Fly(P3, ATL, SFO)  
Fly(P2, JFK, ATL)  
Fly(P3, SFO, JFK)  
Fly(P2, ATL, SFO)  
Fly(P1, JFK, ATL)  
Fly(P2, SFO, JFK)  
Fly(P1, ATL, SFO)  
Unload(C3, P3, JFK)  
Fly(P1, SFO, JFK)  
Fly(P3, JFK, ATL)  
Fly(P2, JFK, ATL)  
Fly(P3, ATL, SFO)  
Fly(P2, ATL, SFO)  
Fly(P1, JFK, ATL)  
Fly(P3, SFO, ATL)  
Fly(P1, ATL, SFO)  
Unload(C2, P3, ATL)  
Fly(P3, ATL, SFO)  
Fly(P2, SFO, ATL)  
Fly(P1, SFO, ATL)

Fly(P2, ATL, JFK)  
Fly(P1, ATL, JFK)  
Load(C3, P1, JFK)  
Fly(P3, SFO, ATL)  
Fly(P2, JFK, ATL)  
Fly(P3, ATL, JFK)  
Fly(P2, ATL, SFO)  
Fly(P1, JFK, ATL)  
Load(C2, P1, ATL)  
Fly(P1, ATL, SFO)  
Fly(P2, SFO, ATL)  
Fly(P1, SFO, JFK)  
Fly(P2, ATL, JFK)  
Fly(P3, JFK, ATL)  
Fly(P1, JFK, ATL)  
Fly(P3, ATL, SFO)  
Fly(P1, ATL, SFO)  
Unload(C3, P1, SFO)  
Fly(P3, SFO, ATL)  
Fly(P1, SFO, JFK)  
Fly(P3, ATL, JFK)  
Fly(P2, JFK, ATL)  
Fly(P1, JFK, ATL)  
Fly(P2, ATL, SFO)  
Fly(P3, JFK, ATL)  
Load(C3, P2, SFO)  
Fly(P3, ATL, SFO)  
Fly(P1, ATL, SFO)  
Fly(P2, SFO, ATL)

Fly(P3, SFO, ATL)  
Fly(P2, ATL, JFK)  
Fly(P3, ATL, JFK)  
Fly(P1, SFO, ATL)  
Unload(C3, P2, JFK)  
Fly(P3, JFK, ATL)  
Fly(P2, JFK, ATL)  
Fly(P1, ATL, SFO)  
Fly(P3, ATL, SFO)  
Fly(P2, ATL, SFO)  
Fly(P1, SFO, ATL)  
Load(C1, P1, ATL)  
Fly(P1, ATL, SFO)  
Fly(P2, SFO, ATL)  
Fly(P3, SFO, ATL)  
Fly(P2, ATL, JFK)  
Fly(P1, SFO, JFK)  
Fly(P3, ATL, SFO)  
Load(C3, P2, JFK)  
Fly(P3, SFO, JFK)  
Fly(P2, JFK, ATL)  
Fly(P3, JFK, ATL)  
Fly(P2, ATL, SFO)  
Fly(P1, JFK, SFO)  
Fly(P3, ATL, SFO)  
Fly(P2, SFO, ATL)  
Fly(P1, SFO, ATL)  
Unload(C3, P2, ATL)  
Fly(P2, ATL, SFO)

Fly(P1, ATL, SFO)  
Fly(P3, SFO, ATL)  
Fly(P2, SFO, ATL)  
Fly(P3, ATL, JFK)  
Fly(P2, ATL, JFK)  
Fly(P1, SFO, ATL)  
Fly(P3, JFK, ATL)  
Fly(P1, ATL, JFK)  
Fly(P3, ATL, SFO)  
Unload(C2, P1, JFK)  
Fly(P2, JFK, ATL)  
Fly(P3, SFO, ATL)  
Fly(P1, JFK, ATL)  
Fly(P2, ATL, SFO)  
Fly(P3, ATL, SFO)  
Fly(P1, ATL, SFO)  
Fly(P3, SFO, JFK)  
Fly(P2, SFO, ATL)  
Load(C3, P2, ATL)  
Fly(P2, ATL, SFO)  
Fly(P1, SFO, ATL)  
Fly(P2, SFO, JFK)  
Fly(P3, JFK, ATL)  
Fly(P1, ATL, SFO)  
Fly(P3, ATL, SFO)  
Unload(C3, P2, JFK)  
Fly(P1, SFO, ATL)  
Fly(P2, JFK, ATL)  
Fly(P1, ATL, JFK)

Fly(P2, ATL, SFO)  
Load(C3, P1, JFK)  
Fly(P3, SFO, ATL)  
Fly(P2, SFO, ATL)  
Fly(P3, ATL, JFK)  
Fly(P2, ATL, JFK)  
Fly(P1, JFK, ATL)  
Fly(P3, JFK, ATL)  
Fly(P1, ATL, SFO)  
Fly(P3, ATL, SFO)  
Fly(P2, JFK, ATL)  
Fly(P1, SFO, ATL)  
Unload(C1, P1, ATL)  
Fly(P2, ATL, SFO)  
Fly(P1, ATL, SFO)  
Fly(P3, SFO, ATL)  
Fly(P2, SFO, ATL)  
Fly(P3, ATL, JFK)  
Fly(P2, ATL, JFK)  
Unload(C3, P1, SFO)  
Fly(P1, SFO, ATL)  
Fly(P3, JFK, ATL)  
Fly(P2, JFK, ATL)  
Load(C1, P3, ATL)  
Fly(P3, ATL, SFO)  
Fly(P1, ATL, SFO)  
Fly(P2, ATL, SFO)  
Fly(P3, SFO, ATL)  
Fly(P2, SFO, JFK)

Fly(P3, ATL, JFK)  
Fly(P1, SFO, ATL)  
Fly(P2, JFK, SFO)  
Fly(P1, ATL, JFK)  
Fly(P2, SFO, ATL)  
Unload(C1, P3, JFK)  
Fly(P2, ATL, JFK)  
Fly(P3, JFK, ATL)  
Fly(P1, JFK, ATL)  
Fly(P2, JFK, ATL)  
Fly(P3, ATL, SFO)  
Fly(P2, ATL, SFO)  
Fly(P1, ATL, SFO)  
Fly(P3, SFO, ATL)  
Load(C3, P1, SFO)  
Fly(P3, ATL, JFK)  
Fly(P2, SFO, ATL)  
Fly(P1, SFO, ATL)  
Fly(P3, JFK, ATL)  
Fly(P2, ATL, JFK)  
Fly(P3, ATL, SFO)  
Fly(P1, ATL, SFO)  
Load(C2, P2, JFK)  
Fly(P3, SFO, ATL)  
Fly(P1, SFO, JFK)  
Fly(P3, ATL, JFK)  
Fly(P2, JFK, ATL)  
Fly(P1, JFK, ATL)  
Fly(P2, ATL, SFO)

Fly(P1, ATL, SFO)  
Unload(C3, P1, SFO)  
Fly(P2, SFO, ATL)  
Fly(P1, SFO, ATL)  
Fly(P3, JFK, ATL)  
Fly(P2, ATL, SFO)  
Fly(P3, ATL, SFO)  
Fly(P1, ATL, JFK)  
Fly(P2, SFO, ATL)  
Unload(C2, P2, ATL)  
Fly(P2, ATL, SFO)  
Fly(P3, SFO, ATL)  
Fly(P2, SFO, JFK)  
Fly(P3, ATL, JFK)  
Fly(P1, JFK, ATL)  
Fly(P3, JFK, SFO)  
Fly(P1, ATL, SFO)  
Load(C3, P3, SFO)  
Fly(P3, SFO, ATL)  
Fly(P1, SFO, ATL)  
Fly(P3, ATL, JFK)  
Fly(P1, ATL, JFK)  
Fly(P2, JFK, ATL)  
Fly(P3, JFK, ATL)  
Load(C2, P3, ATL)  
Fly(P3, ATL, SFO)  
Fly(P2, ATL, SFO)  
Fly(P3, SFO, JFK)  
Fly(P2, SFO, JFK)

Fly(P1, JFK, ATL)  
Fly(P2, JFK, ATL)  
Fly(P1, ATL, SFO)  
Load(C1, P3, JFK)  
Fly(P2, ATL, SFO)  
Fly(P1, SFO, ATL)  
Fly(P3, JFK, ATL)  
Fly(P1, ATL, JFK)  
Fly(P3, ATL, SFO)  
Fly(P2, SFO, ATL)  
Fly(P1, JFK, ATL)  
Fly(P2, ATL, JFK)  
Fly(P1, ATL, SFO)  
Fly(P3, SFO, ATL)  
Unload(C2, P3, ATL)  
Fly(P3, ATL, SFO)  
Fly(P1, SFO, ATL)  
Fly(P2, JFK, ATL)  
Fly(P1, ATL, JFK)  
Fly(P2, ATL, SFO)  
Fly(P3, SFO, JFK)  
Fly(P1, JFK, ATL)  
Unload(C3, P3, JFK)  
Fly(P1, ATL, SFO)  
Fly(P2, SFO, ATL)  
Fly(P1, SFO, JFK)  
Fly(P2, ATL, JFK)  
Fly(P3, JFK, ATL)  
Fly(P1, JFK, ATL)



Fly(P3, ATL, SFO)  
Fly(P1, ATL, SFO)  
Unload(C1, P3, SFO)  
Fly(P3, SFO, ATL)  
Fly(P1, SFO, ATL)  
Fly(P3, ATL, JFK)  
Fly(P1, ATL, JFK)  
Fly(P2, JFK, ATL)  
Fly(P3, JFK, ATL)  
Fly(P2, ATL, SFO)  
Fly(P3, ATL, SFO)  
Load(C3, P1, JFK)  
Fly(P2, SFO, ATL)  
Fly(P1, JFK, ATL)  
Fly(P2, ATL, JFK)  
Fly(P1, ATL, SFO)  
Fly(P3, SFO, ATL)  
Fly(P1, SFO, JFK)  
Load(C2, P3, ATL)  
Fly(P3, ATL, SFO)  
Fly(P2, JFK, ATL)  
Fly(P3, SFO, JFK)  
Fly(P2, ATL, SFO)  
Fly(P1, JFK, ATL)  
Fly(P3, JFK, ATL)  
Fly(P1, ATL, SFO)  
Fly(P3, ATL, SFO)  
Unload(C3, P1, SFO)  
Fly(P2, SFO, ATL)

Unload(C2, P3, SFO)

Load(C3, P1, SFO)

Fly(P2, ATL, JFK)

Fly(P3, SFO, ATL)

Fly(P2, JFK, SFO)

Fly(P3, ATL, JFK)

Fly(P1, SFO, ATL)

Fly(P3, JFK, SFO)

Fly(P1, ATL, JFK)

Load(C2, P2, SFO)

Fly(P3, SFO, ATL)

Fly(P2, SFO, ATL)

Fly(P3, ATL, JFK)

Fly(P2, ATL, JFK)

Fly(P1, JFK, ATL)

Fly(P3, JFK, ATL)

Unload(C3, P1, ATL)

Fly(P1, ATL, JFK)

Fly(P3, ATL, SFO)

Fly(P2, JFK, ATL)

Fly(P1, JFK, ATL)

Fly(P2, ATL, SFO)

Fly(P1, ATL, SFO)

Fly(P3, SFO, ATL)

Fly(P2, SFO, ATL)

Fly(P3, ATL, JFK)

Fly(P2, ATL, JFK)

Load(C1, P1, SFO)

Fly(P1, SFO, ATL)

Fly(P3, JFK, ATL)  
Fly(P1, ATL, JFK)  
Fly(P2, JFK, ATL)  
Fly(P3, ATL, SFO)  
Fly(P2, ATL, SFO)  
Fly(P3, SFO, JFK)  
Unload(C2, P2, SFO)  
Fly(P2, SFO, ATL)  
Fly(P3, JFK, ATL)  
Fly(P1, JFK, ATL)  
Fly(P3, ATL, SFO)  
Fly(P2, ATL, SFO)  
Unload(C1, P1, ATL)  
Fly(P1, ATL, SFO)  
Fly(P3, SFO, ATL)  
Fly(P2, SFO, ATL)  
Fly(P3, ATL, JFK)  
Fly(P2, ATL, JFK)  
Fly(P1, SFO, ATL)  
Fly(P3, JFK, ATL)  
Fly(P1, ATL, JFK)  
Fly(P3, ATL, SFO)  
Fly(P2, JFK, ATL)  
Load(C3, P2, ATL)  
Fly(P2, ATL, SFO)  
Fly(P3, SFO, ATL)  
Fly(P2, SFO, JFK)  
Fly(P3, ATL, JFK)  
Fly(P1, JFK, ATL)

Fly(P2, JFK, ATL)  
Fly(P3, JFK, ATL)  
Load(C1, P3, ATL)  
Fly(P2, ATL, SFO)  
Fly(P1, ATL, SFO)  
Fly(P3, ATL, JFK)  
Fly(P2, SFO, ATL)  
Fly(P1, SFO, JFK)  
Fly(P2, ATL, JFK)  
Fly(P1, JFK, ATL)  
Fly(P3, JFK, SFO)  
Fly(P1, ATL, SFO)  
Unload(C3, P2, JFK)  
Fly(P3, SFO, ATL)  
Fly(P1, SFO, ATL)  
Fly(P2, JFK, ATL)  
Fly(P3, ATL, JFK)  
Fly(P2, ATL, SFO)  
Fly(P1, ATL, SFO)  
Unload(C1, P3, JFK)  
Fly(P2, SFO, ATL)  
Fly(P1, SFO, JFK)  
Fly(P2, ATL, JFK)  
Fly(P3, JFK, ATL)  
Fly(P1, JFK, ATL)  
Fly(P3, ATL, SFO)  
Fly(P1, ATL, SFO)  
Load(C3, P2, JFK)  
Fly(P3, SFO, ATL)

Fly(P2, JFK, ATL)  
Fly(P1, SFO, ATL)  
Fly(P2, ATL, SFO)  
Fly(P3, ATL, SFO)  
Fly(P1, ATL, JFK)  
Fly(P3, SFO, JFK)  
Unload(C3, P2, SFO)

Solving Air Cargo Problem 2 using uniform\_cost\_search...

# Actions	Expansions	Goal Tests	New Nodes
72	5154	5156	46618

Plan length: 9 Time elapsed in seconds: 2.7484074

Load(C3, P3, ATL)  
Fly(P3, ATL, SFO)  
Load(C1, P3, SFO)  
Load(C2, P2, JFK)  
Fly(P2, JFK, SFO)  
Unload(C3, P3, SFO)  
Fly(P3, SFO, JFK)  
Unload(C2, P2, SFO)  
Unload(C1, P3, JFK)

Solving Air Cargo Problem 2 using greedy\_best\_first\_graph\_search with h\_unmet\_goals...

# Actions	Expansions	Goal Tests	New Nodes
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72      17      19      170

Plan length: 9 Time elapsed in seconds: 0.031599300000000004

Load(C1, P1, SFO)

Load(C2, P2, JFK)

Load(C3, P3, ATL)

Fly(P2, JFK, SFO)

Unload(C2, P2, SFO)

Fly(P3, ATL, SFO)

Unload(C3, P3, SFO)

Fly(P1, SFO, JFK)

Unload(C1, P1, JFK)

Solving Air Cargo Problem 2 using greedy\_best\_first\_graph\_search with h\_pg\_levelsum...

# Actions	Expansions	Goal Tests	New Nodes
-----------	------------	------------	-----------

72	9	11	86
----	---	----	----

Plan length: 9 Time elapsed in seconds: 6.6956124

Load(C1, P1, SFO)

Fly(P1, SFO, JFK)

Unload(C1, P1, JFK)

Load(C2, P2, JFK)

Fly(P2, JFK, SFO)

Unload(C2, P2, SFO)

Load(C3, P3, ATL)

Fly(P3, ATL, SFO)

Unload(C3, P3, SFO)

Solving Air Cargo Problem 2 using greedy\_best\_first\_graph\_search with h\_pg\_maxlevel...

# Actions	Expansions	Goal Tests	New Nodes
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72	27	29	249
----	----	----	-----

Plan length: 9 Time elapsed in seconds: 13.697749

Load(C1, P1, SFO)

Load(C2, P2, JFK)

Load(C3, P3, ATL)

Fly(P2, JFK, SFO)

Fly(P3, ATL, SFO)

Fly(P1, SFO, JFK)

Unload(C3, P3, SFO)

Unload(C2, P2, SFO)

Unload(C1, P1, JFK)

Solving Air Cargo Problem 2 using greedy\_best\_first\_graph\_search with h\_pg\_setlevel...

# Actions	Expansions	Goal Tests	New Nodes
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72	9	11	84
----	---	----	----

Plan length: 9 Time elapsed in seconds: 9.8989795

Load(C1, P1, SFO)

Load(C2, P2, JFK)

Load(C3, P3, ATL)

Fly(P2, JFK, SFO)

Fly(P3, ATL, SFO)

Fly(P1, SFO, JFK)

Unload(C3, P3, SFO)

Unload(C2, P2, SFO)

Unload(C1, P1, JFK)

Solving Air Cargo Problem 2 using astar\_search with h\_unmet\_goals...

# Actions	Expansions	Goal Tests	New Nodes
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72	2467	2469	22522
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Plan length: 9 Time elapsed in seconds: 1.7004968

Load(C3, P3, ATL)

Fly(P3, ATL, SFO)

Unload(C3, P3, SFO)

Load(C2, P2, JFK)

Fly(P2, JFK, SFO)

Unload(C2, P2, SFO)

Load(C1, P3, SFO)

Fly(P3, SFO, JFK)

Unload(C1, P3, JFK)

Solving Air Cargo Problem 2 using astar\_search with h\_pg\_levelsum...

Plan length: 9 Time elapsed in seconds: 400,000



Q2. Use the results from the first two problems to determine whether any of the uninformed search algorithms should be excluded for problems 3 and 4. You must run **at least** one uninformed search, two heuristics with greedy best first search, and two heuristics with A\* on problems 3 and 4.

Yes uninformed search should be excluded as it be slower for larger domains. We should prefer A\* search with heuristics or informed search for better performance.

Q4. Which algorithm or algorithms would be most appropriate for planning in a very restricted domain (i.e., one that has only a few actions) and needs to operate in real time?

The below algorithms based on runtimes would work best for this situations

astar\_search h\_pg\_levelsum

astar\_search h\_pg\_maxlevel

Q5. Which algorithm or algorithms would be most appropriate for planning in very large domains (e.g., planning delivery routes for all UPS drivers in the U.S. on a given day) ?

The below algorithms based on runtimes would work best for this situations

astar\_search h\_pg\_levelsum

astar\_search h\_pg\_maxlevel

Which algorithm or algorithms would be most appropriate for planning problems where it is important to find only optimal plans?

A\* search only if the heuristic is admissible otherwise use uninformed search such as Uniform Cost Search.