EXAM OF FUNDAMENTALS OF AI – FIRST MODULE
20/12/2019
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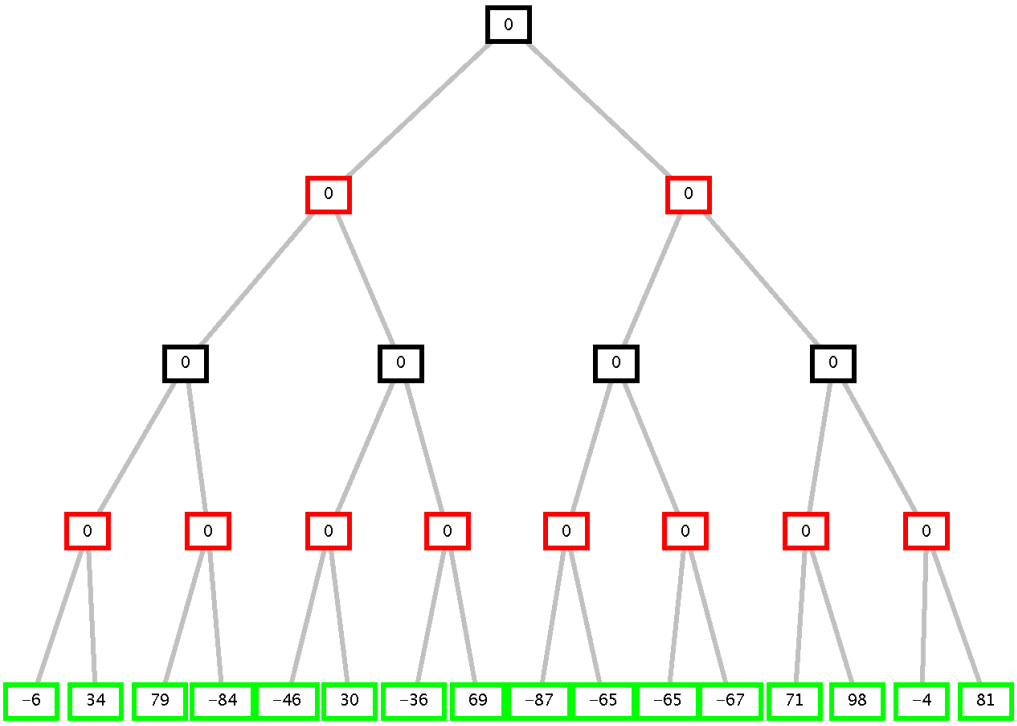
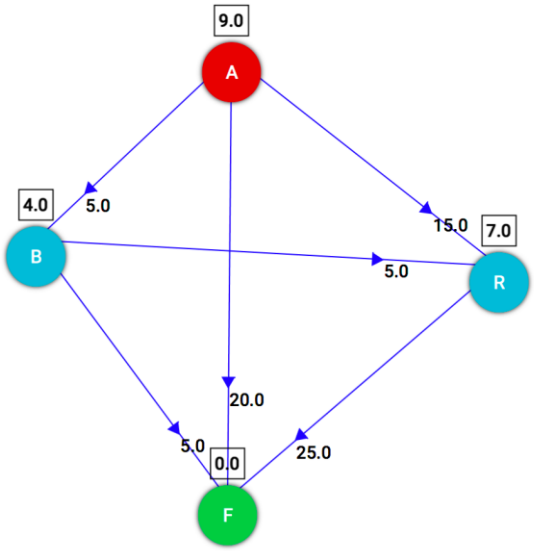
Exercise 1 (5 points)
Consider the following game tree where the first player is *MAX*. Show how the *min-max* algorithm works and show the *alfa-beta* cuts. Also, show which is the proposed move for the first player.



Exercise 2 (6 points)
Consider the following graph, where A is the starting node and F the goal node. The number on each arc is the cost of the operator for the move. Close to each node there is the heuristic evaluation of the node itself, namely its estimated distance from the goal:



a) Show the search tree generated first Best-First and then by the A* algorithm along with the order of expansion of nodes. In case of ties, choose the node to expand in alphabetical order. Consider as the heuristic h(n) the one indicated in the square close to each node in the figure.
a) Is the heuristic admissible?
b) Which is the cost of the path found by Best-First and by A*?

Exercise 3 (5 Points)
Given the following CSP:

A::[4, 5, 6, 7, 8, 9, 10]
B::[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
C::[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
D::[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]

A>B-5
C>B-7
A=D+3
B=D+2

Find the first solution through tree search, by applying forward checking, using alphabetical order of variables and lexicographic order of values.

Exercise 4 (8 Points)
Given the following initial state, where a truck is in location '2' with cement bags loaded. In Location '3' there are bricks. Loc '2' and Loc '3' are connected to '1'; and actions modeled as follows:

unload(C,M,Loc)
PREC: on(C,M), in(C,Loc)
EFFECT: ¬on(C,M), in(M,Loc)

load(C,M,Loc)
PREC: in(C,Loc), in(M,Loc)
EFFECT: on(C,M), ¬in(M,Loc)

move(C,Loc1,Loc2)
PREC: in(C,Loc1), connected(Loc1,Loc2)
EFFECT: in(C,Loc2), ¬in(C,Loc1)

Initial state

in(truck,2), connected(1,2), connected(2,1), connected(1,3), connected(3,1), in(cement,2), on(truck,cement), in(bricks,3), connected(3,2), connected(2,3)

Goal: **in(truck,1), in(cement,1), in(bricks,1)**

Solve the problem with the POP algorithm, identifying threats and their solution during the process.

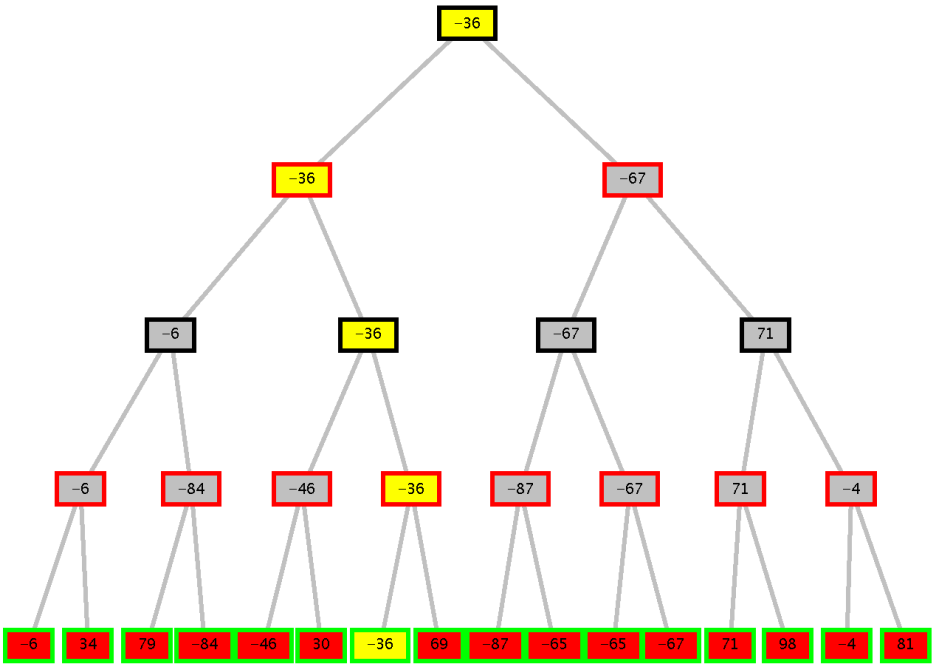
Exercise 5 (7 points)

1) Model the action **move** (preconditions, effects and frame axioms), and the initial state of the exercise 4 using the Kowalsky formulation
2) Show two levels of graph plan when applied to exercise 4.
3) What are the main features of a swarm intelligence algorithm?
4) What is conditional planning and which are its main features?
5) What is modal truth criterion and why it has been defined.

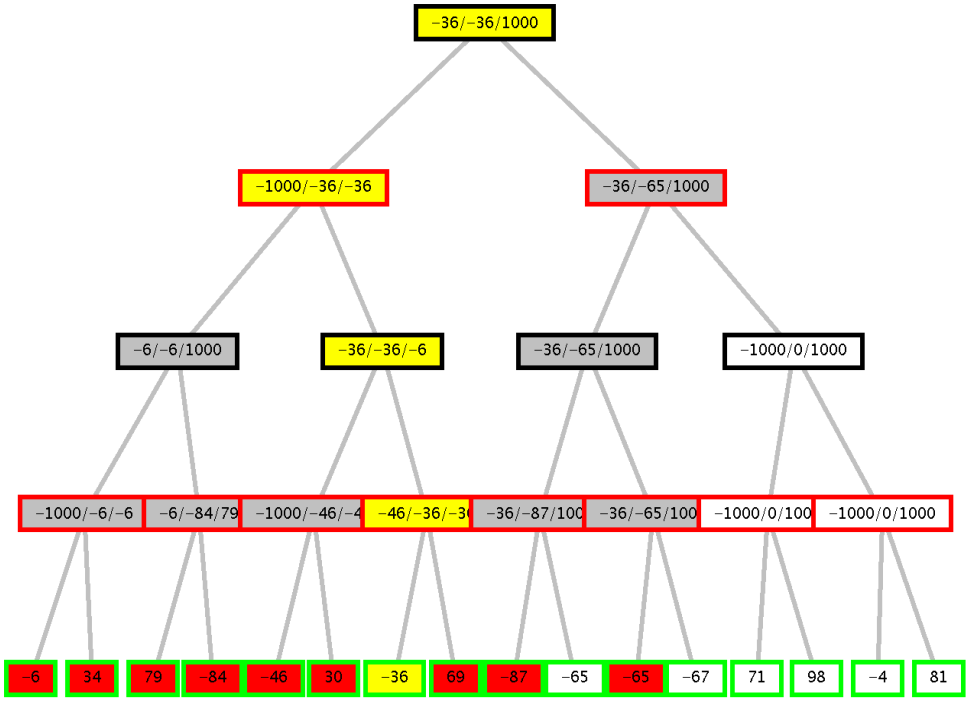
Solution

Exercise 1

Min-max

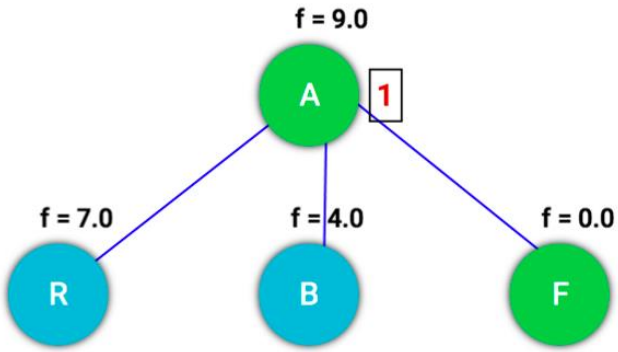


Alfa-beta :

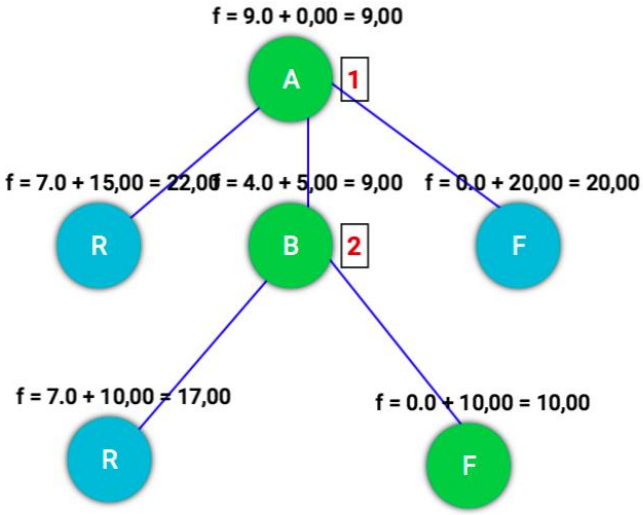


Exercise 2

Best-first (cost of the path: 20)



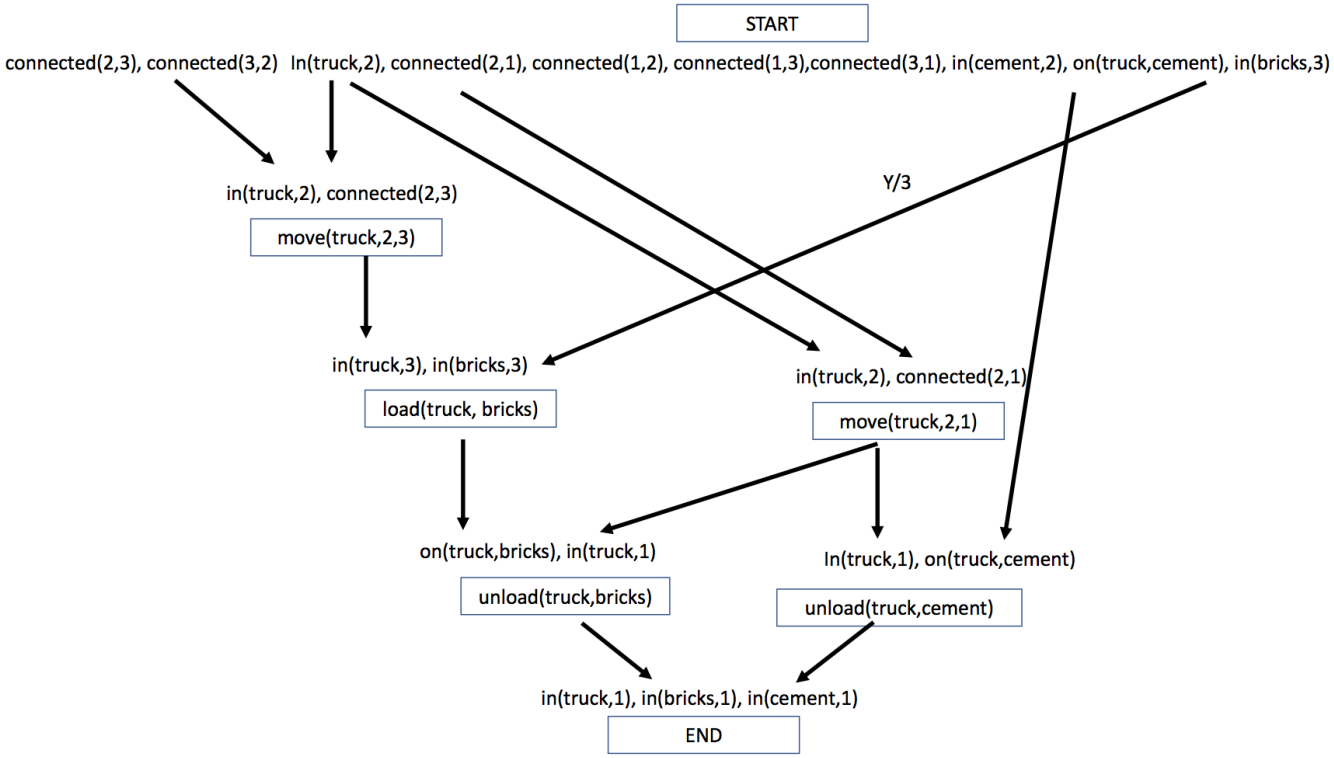
A* (Admissible heuristics because it never overestimates the cost of reaching the goal, regardless of which node of the graph you consider as starting point. Cost of the path: 10)

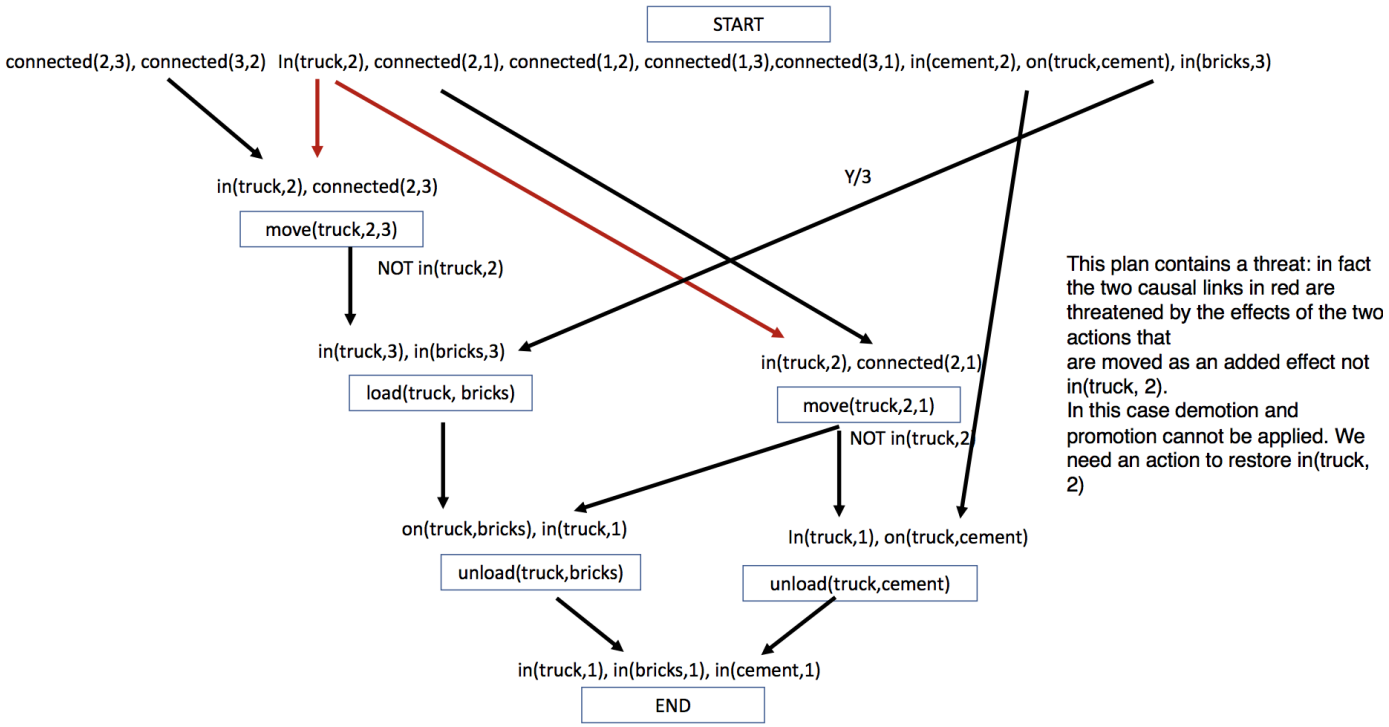


Exercise 3

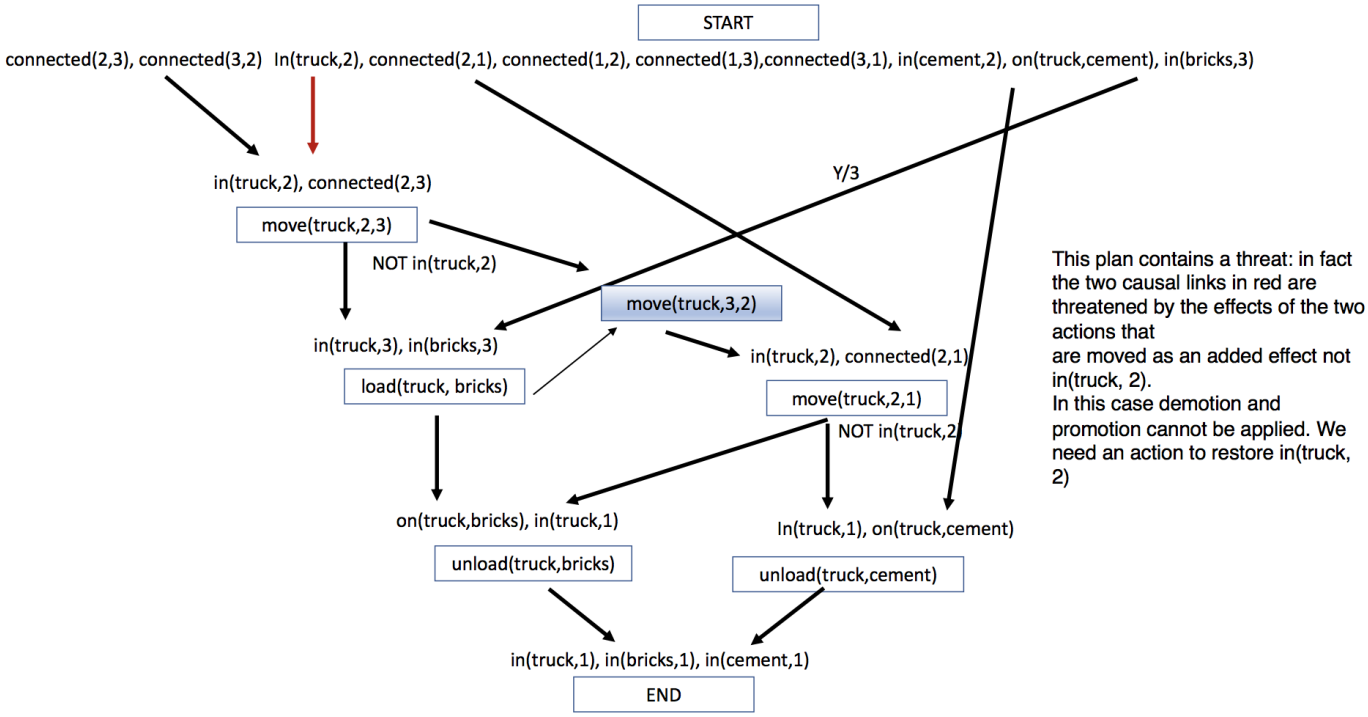
	A	B	C	D
Labeling e FC	A=4	[1...8]	[1...10]	[1...10]
Labeling e FC	A=4	[1...8]	[1...10]	[1]
Backtracking	A=4	B=1	[1...10]	***Fail***
Backtracking	A=4	B=2	[1...10]	***Fail***
Labeling e FC	A=4	B=3	[1...10]	[1]
Labeling e FC	A=4	B=3	C=1	[1]
Labeling e FC	A=4	B=3	C=1	D=1

Exercise 4





This plan contains a threat: in fact the two causal links in red are threatened by the effects of the two actions that
are moved as an added effect not in(truck, 2).
In this case demotion and promotion cannot be applied. We need an action to restore in(truck, 2)



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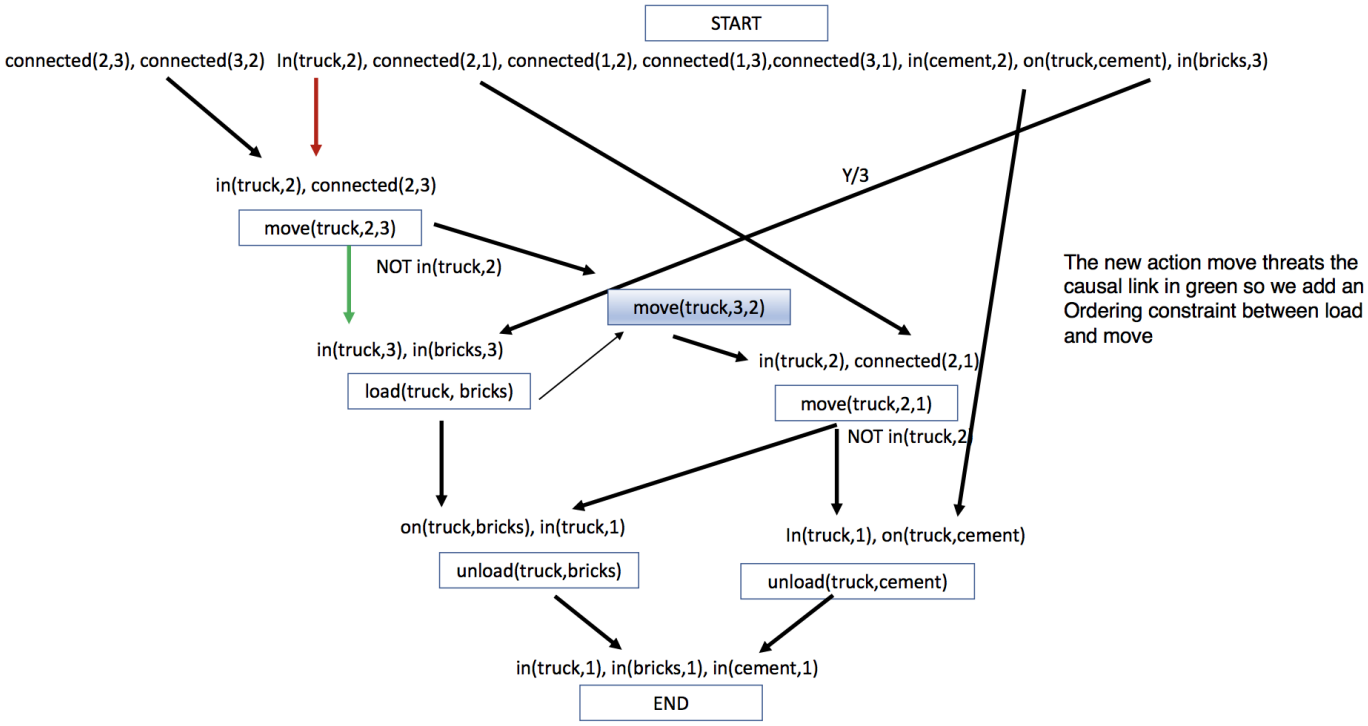
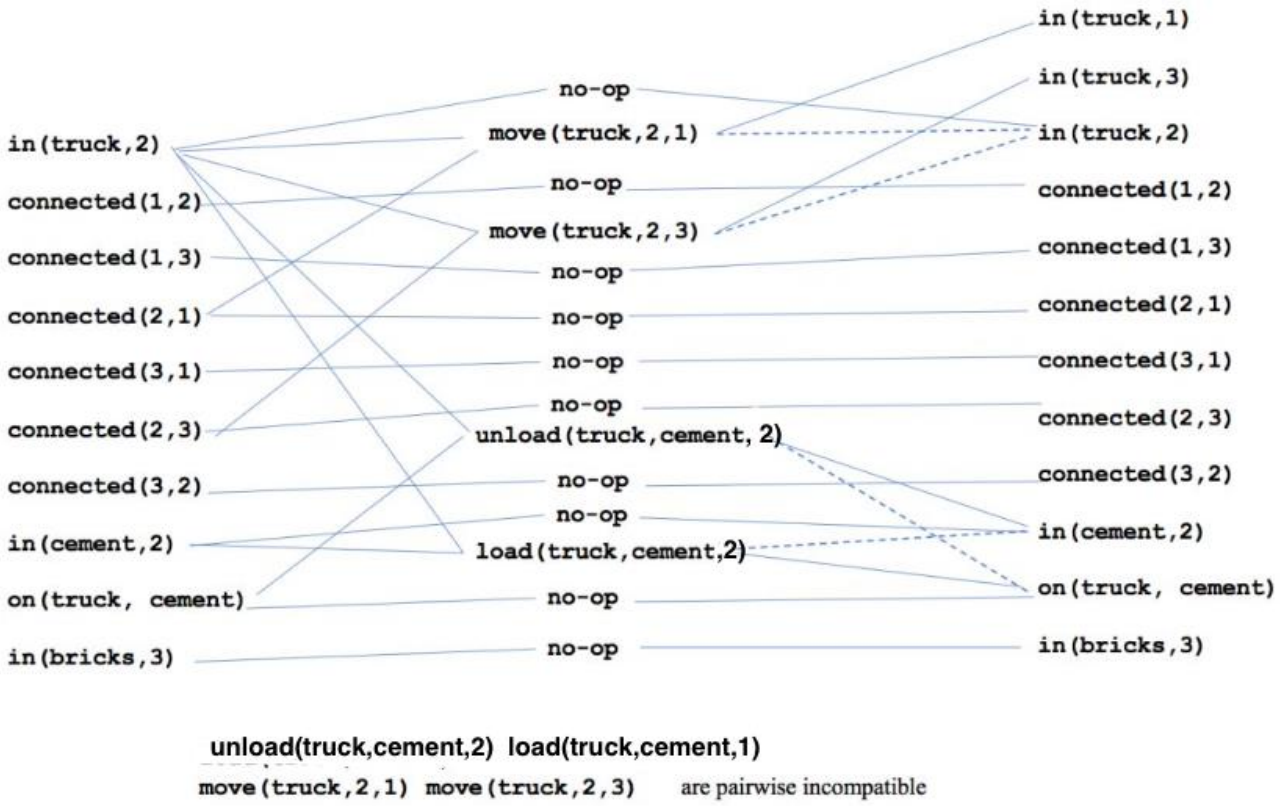


Exercise 5

1) holds(in(truck,2),s0).
holds(connected(1,2), s0).
holds(connected(2,1), s0).
holds(connected(1,3), s0).
holds(connected(3,1), s0).
holds(in(cement,2),s0).
holds(on(truck,cement),s0).
holds(in(bricks,3),s0).

holds(in(C,Loc2), do(move(C,Loc1,Loc2),S))
pact(move(C,Loc1,Loc2),S):- holds(in(C,Loc1), S), holds(connected(Loc1,Loc2),S).
holds(V,do(move(C,Loc1,Loc2),S)):- holds(V,S), V\=in(C,Loc1).

2)



The following pairs of proposition are inconsistent: in(truck,1)-in(truck,2), in(truck,1)-in(truck,3), in(truck,3)-in(truck,2), in(cement,2)-on(truck,cement