1 Resolution

Resolution

Algorithm Overview

function PL-RESOLUTION?(KB, α) returns true or false

We want to prove that KB entails α

In other words, we want to prove that we cannot satisfy (KB and **not** α)

1. Start with a set of CNF clauses, including the KB as well as $\neg\alpha$
2. Keep resolving pairs of clauses until
   A. You resolve the empty clause
      Contradiction found!
      KB $\wedge \neg\alpha$ cannot be satisfied
      Return true, KB entails α
   B. No new clauses added
      Return false, KB does not entail α

From the knowledge base below, show $\neg$A must be true.

$D \vee B$	$\neg A \vee B \vee \neg C$	$C \vee \neg D$	$A \vee C$	$\neg B$

2 Forward chaining

In this section, we will be proving a statement using forward chaining.

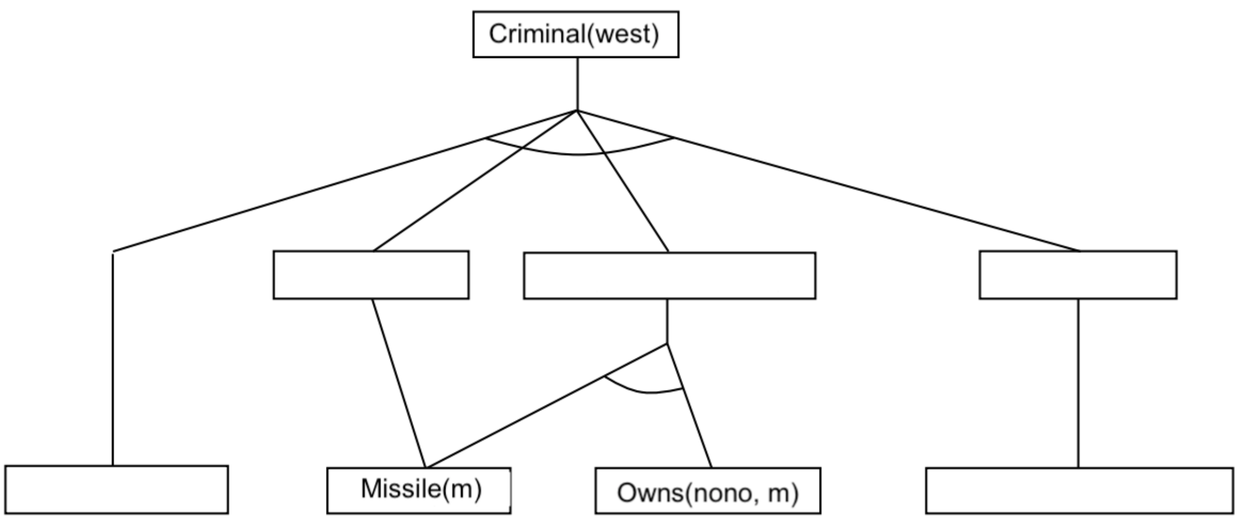
There is currently a war going on and the United States is desperate to round up all the criminals. We want to determine whether Colonel West is a criminal. Let's start with what we know.

We know that it is a crime for an American to sell weapons to hostile nations. The country Nono is an enemy of America. Furthermore, we know that Nono has some missiles, all of which were sold to it by Colonel West, who is American.

(a) Represent your knowledge base using first order logic. You can use the following function predicates: American(x), Criminal(x), Hostile(x), Missile(x), Weapon(x), Enemy(x,y), Owns(x,y), Sells(x,y,z).

1. ________ $\wedge$ ________ $\wedge$ ________ $\wedge$ ________ $\Rightarrow$ Criminal(x)
2. Missile(x) $\Rightarrow$ ________
3. Missile(m)
4. Owns(nono, m)
5. Missile(x) $\wedge$ ________ $\Rightarrow$ Sells(west, x, nono)
6. Enemy(x, america) $\Rightarrow$ ________
7. ________
8. ________

(b) Fill in the blanks below using your knowledge base to prove that Colonel West is a criminal.



3 First-Order Logic

(a) Write in first-order logic the assertion that every key will eventually be lost forever, using only the following vocabulary:

- $Key(x), x$ is a key
- $Sock(x), x$ is a sock
- $Pair(x, y), x$ and y are a pair
- Now is the current time
- $Before(t_1, t_2)$ represents that time t_1 comes before t_2
- $Lost(x, t)$ represents that object x is lost at time t

(b) Write in first-order logic the assertion that at least one of every pair of socks will eventually be lost forever.

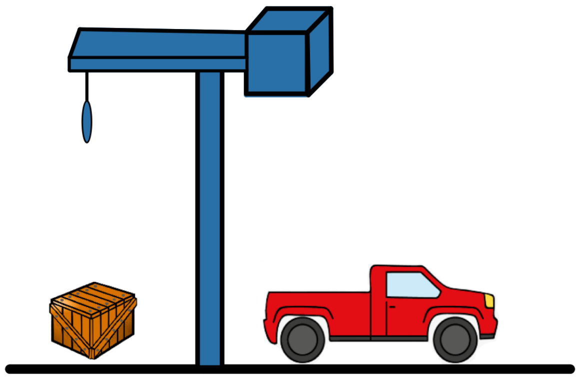
(c) Write out the vocabulary you would use to represent the following sentence in first-order logic.

- Everyone who takes 15-281 loves Pacman.

4 Symbolic Planning - Crate Problem

In the Crane problem, you are given a crane, a package and a truck. The package starts on the left, the truck on the right, and the crane faces the left. The goal of this is to load the package onto the truck and have the crane be facing the left.

The crane can swing between left and right, with or without a payload, and it can pick up the crate if it is on the same side. The crate can only be loaded onto the truck using the crane.



(a) Conceptual Question: What is the difference between linear and non-linear planning? When are they the same?

(b) Draw the planning graph for the first 3 moves. You may use pictures instead of propositions.

(c) Formulate the crate problem as a symbolic plan.

(d) Draw the first two levels of the Graph Plan graph.

(e) Identify the exclusive actions in your graph and determine which type of mutex each is.