Bafna Gold
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Week-8

First Order Logic

Q. Create a knowledge base consisting of first order logic statements & prove the given query using forward reasoning.

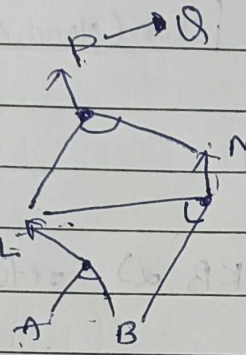
Premises: $P \Rightarrow Q$ → conclusion.

Rules:
- $L \wedge M \Rightarrow P$
- $B \wedge L \Rightarrow M$
- $A \wedge P \Rightarrow L$
- $A \wedge B \Rightarrow L$

Facts:
- A
- B

Prove Q.

⇒



Q. The law says that it is a crime for an American to sell weapons to hostile nations. The country Nono, an enemy of America, has some missiles, & all of its missiles were sold to it by Colonel West who is American. An enemy of America counts as "hostile".
Prove that "West is criminal".

⇒ Rules

① $\forall x, y, z$ American$(x) \wedge$ weapons$(y) \wedge$ sells$(x, y, z) \wedge$ Hostile(z) $\Rightarrow$ criminal(x)

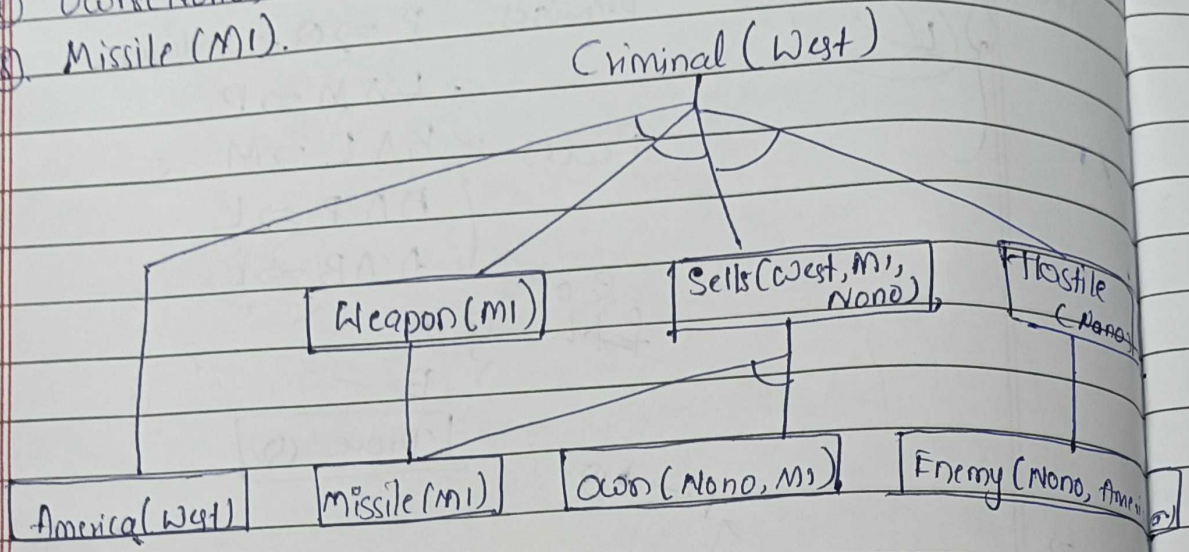
② $\forall x$ Missiles$(x) \wedge$ Owns$(Nono, x) \Rightarrow$ Sells$(West, x, Nono)$

③ $\forall x$ Enemy$(x, America) \Rightarrow$ Hostile(x)

④ $\forall x$ Missle$(x) \Rightarrow$ Weapons(x)

Facts

(5) America(West)
(6) Enemy(Nono, America)
(7) Owns(Nono, M1)
(8) Missile(M1).



Foward Reasoning Algorithm

function FOL-FC-ASK(KB, α) returns a substitution or false

inputs: KB, the knowledge base, a set of first-order definite clauses
α, the query, an atomic sentence
local variables: new, the new sentence inferred on each iteration
repeat until new is empty
new ← {}
for each rule in KB do
(P1 ∧ ... ∧ Pn ⇒ q) ← STANDARDIZE-VARS(rule)
for each θ such that SUBST(θ, P1 ∧ ... ∧ Pn)
= SUBST(θ, P'1 ∧ ... ∧ P'n)
q' ← SUBST(θ, q)
if q' does not unify with some sentence already in KB or new

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Then add q' to new
$\phi \leftarrow$ UNIFY(q', α)
if ϕ is not fail then return ϕ
add new to KB
return false.

Output

Adding fact : American(West)
Adding fact : Enemy(Nono, America)
Adding fact : Missile(M1)
Adding fact : Owns(Nono, M1)
Inferred new fact : Weapon(M1) from ['Missile(M1)'] => Weapon(M1)
Inferred new fact : Sells(West, M1, Nono) from ['Missile(M1)', 'Owns(Nono, M1)'] => Sells(West, M1, Nono)
Inferred new fact : Hostile(Nono) from ['Enemy(Nono, America)'] => Hostile(Nono)
Inferred new fact : Criminal(West) from ['American(West)', 'Weapon(M1)', 'Sells(West, M1, Nono)', 'Hostile(Nono)'] => Criminal(West).
Goal Reached : West is Criminal
True.

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