AI Homework 6

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1. Given each pair of atomic sentences, find their most general unifier if it exists:

a. P(A,B,C), P(x,y,z)

$\{A \mapsto x, B \mapsto y, C \mapsto z\}$

b. Q(y, G(A,B)), Q(G(x,x), y)

Unifier doesn't exist;

$\{y \mapsto G(x,x)\}$ becomes
$Q(G(x,x), G(A,B)), Q(G(x,x), G(x,x))$
$\{x \mapsto A\}$ becomes
$Q(G(A,A), G(A,B))$, $Q(G(A,A), G(A,A))$

A can't unify with B (constants can't unify)

c. Older(Father(y), x), Older(Father(x), John)

$\{Father(y) \mapsto Father(x), x \mapsto John\}$

d. Knows(Father(y), y), Knows(x,x)

unifier doesn't exist; after $x \mapsto y$,can't unify y with $Father(y)$

2. Write down a logical representation for the following sentences, suitable for use with the Generalized Modus Ponens rule:

a. Horses, cows, and pigs are animals.

b. An offspring of a horse is a horse.

c. Bluebeard is a horse.

d. Bluebeard is Charlie's parent.

e. Offspring and parent are inverse relations.

f. Every mammal has a parent.

g. Every mammal is an animal

$Animal(a)$ **[a is an animal]**

$Horse(h)$ **[h is a horse]**

$IsOffspring(c,p)$ **[c is a child of p]**

$IsParent(p,c)$ **[p is the parent of c]**

$Bluebeard, Charlie$ **[enumerate constants] [0]**

$Animal(Horse) \land Animal(Cow) \land Animal(Pig)$ **[1]**

$\forall h \forall c\, Horse(h) \land IsOffspring(c,h) \Rightarrow Horse(c)$ **[2]**

$Horse(Bluebeard)$ **[3]**

$IsParent(Bluebeard, Charlie)$ **[4]**

$\forall p \forall c\, IsOffspring(c,p) \Rightarrow IsParent(p,c)$ **[5]**

$\forall p \forall c\, IsParent(p,c) \Rightarrow IsOffspring(c,p)$ **[6]**

$\forall m\, Mammal(m) \Rightarrow\ IsChild(p,m)$ **[7]**

$\forall m\, Mammal(m) \Rightarrow Animal(m)$ **[8]**

Prove that Charlie is a horse and is an offspring of Bluebeard using the GMP rule.

$$Bluebeard, Charlie(0)$$

$$Horse(Bluebeard)(3)$$

$$IsParent(Bluebeard, Charlie)(4)$$

$$IsParent(p, c) \Rightarrow IsOffspring(c, p)(6)$$

$$\{Bluebeard \hookleftarrow p, Charlie \hookleftarrow c\}()$$

$$IsParent(Bluebeard, Charlie) \Rightarrow IsOffspring(Charlie, Bluebeard)(4, 6)$$

$$\vDash IsOffspring(Charlie, Bluebeard)$$

$$Horse(h) \wedge IsOffspring(c, h) \Rightarrow Horse(c)(2)$$

$$\{Bluebeard \hookleftarrow h, Charlie \hookleftarrow c\}()$$

$$Horse(Bluebeard) \wedge IsOffspring(Charlie, Bluebeard) \Rightarrow Horse(Charlie)(2, 3, 6)$$

$$\models Horse(Charlie)$$

What is the answer to the question "is Charlie a cow?"

Charlie is not a cow.

3. How can we use the resolution algorithm to prove that a ground sentence is valid? Unsatisfiable?

The first step to utilizing the resolution algorithm is converting the KB to Conjunctive Normal Form. To prove a sentence is unsatisfable, we attempt to prove a contradiction by resolving our ground sentence to the empty clause. This is done by resolving premises one at a time, making substitutions as appropriate to eliminate complementary literals each equivalent sentence. If applying resolution repeatedly results in the empty clause, we can conclude the initial ground sentence is unsatisfiable. Then, "resolution proves that $KB \models \alpha$by proving $KB \wedge \neg\alpha$, that is, by deriving the empty clause." 9.5.3, pg 347.