CS 161 Assignment 5

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1

a

~~Smoke Fire ¬Smoke⇒¬Fire Smoke~~

S	F	① S→F	② ¬S→¬F	①→②
0	0	1	1	1
0	1	1	0	0
1	0	0	1	1
1	1	1	1	1

S=Smoke
F=Fire
H=Heat

(S→F)⇒(¬S→¬F)

Neither (Not Valid, Satisfiable)

b

S	F	H	① S→F	② S∨H	③ ②→F	①→③
0	0	0	1	0	0	1
0	0	1	1	1	0	1
0	1	0	1	1	0	1
0	1	1	1	1	0	1
1	0	0	0	0	1	1
1	0	1	0	1	0	0
1	1	0	1	1	0	1
1	1	1	1	1	0	1

(S→F)→((S∨H)→F)

Neither
(Not Valid, Satisfiable)

c

S	F	H	① S∧H	①→F	③ S→F	④ H→F	③∨④	②↔⑤
0	0	0	0	1	1	1	1	1
0	0	1	0	1	1	0	1	1
0	1	0	0	1	1	1	1	1
0	1	1	0	1	1	0	1	1
1	0	0	0	1	0	1	1	1
1	0	1	0	0	0	0	0	0
1	1	0	0	1	1	1	1	1
1	1	1	1	1	1	1	1	1

((S∧H)→F)⟷((S→F)∨(H→F))

Valid (and Satisfiable)

2

a

① Mythical → ¬ Mortal
② ¬Mythical → (Mortal ∧ Mammal)
③ (¬Mortal ∨ Mammal) → Horned
④ Horned → Magical

b

① ¬Mythical ∨ ¬Mortal
② Mythical ∨ (Mortal ∧ Mammal) ≡
③ ¬(¬Mortal ∨ Mammal) ∨ Horned ≡
④ ¬Horned ∨ Magical

CNF

¬Mythical ∨ ¬Mortal
(Mythical ∨ Mortal) ∧ (Mythical ∨ Mammal)
(Mortal ∨ Horned) ∧ (Mammal ∨ Horned)
¬Horned ∨ Magical

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2 c

① ¬Mythical ∨ ¬Mortal, ② Mythical ∨ (Mortal ∧ Mammal)

⑤ ¬Mortal ∨ (Mortal ∧ Mammal) ≡ (¬Mortal ∨ Mammal)

③ (Mortal ∨ Mammal) ∨ Horned, ⑤ (¬Mortal ∨ Mammal)

⑥ Horned

④ ¬Horned ∨ Magical, ⑥ Horned

⑦ Magical

Derived Rules
⑤ (¬Mortal ∨ Mammal)
⑥ Horned
⑦ Magical

We can prove that the unicorn is Horned and Magical, but we can't prove that it is Mythical.

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3 a $\theta = \{x/A, y/B, z/B\}$

b No Unification; x cannot be both A & B.

c $\theta = \{y/John, x/John\}$

d No Unification; x cannot be both y & Father(y).

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4 a ① $\forall x\ (Food(x) \rightarrow Likes(John, x))$

② Food(Apples)

③ Food(Chicken)

④ $\forall x \forall y\ (Eats(y,x) \wedge \neg Kill(x,y)) \rightarrow Food(x))$

⑤ $\forall x\ (\exists y\ Kill(y,x) \rightarrow \neg Alive(x))$

⑥ $Eats(Bill, Peanuts) \wedge Alive(Bill)$

⑦ $\forall x\ (Eats(Bill,x) \rightarrow Eats(Sue,x))$

b ① $\neg Food(x) \vee Likes(John,x)$

② Food(Apples) ③ Food(Chicken)

④ $\neg Eats(K(y),y) \vee Kill(y, K(y)) \vee Food(y)$

⑤ $\neg Kill(K(x),x) \vee \neg Alive(x)$

⑥ $Eats(Bill, Peanuts) \wedge Alive(Bill) \Rightarrow$ ⑥a $Eats(Bill, Peanuts)$, ⑥b $Alive(Bill)$

⑦ $\neg Eats(Bill,x) \vee Eats(Sue,x)$

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4 c

(6a) Eats(Bill, Peanuts), (4) $\theta = \{y/\text{Peanuts}, K(y)/\text{Bill}\}$ $\neg\text{Eats}(\text{Bill}, \text{Peanuts}) \vee \text{Kill}(\text{Peanuts}, \text{Bill}) \vee \text{Food}(\text{Peanuts})$

(8) $\text{Kill}(\text{Peanuts}, \text{Bill}) \vee \text{Food}(\text{Peanuts})$

(8) $\text{Kill}(\text{Peanuts}, \text{Bill}) \vee \text{Food}(\text{Peanuts})$, (5) $\theta = \{K(x)/\text{Peanuts}, x/\text{Bill}\}$ $\neg\text{Kill}(\text{Peanuts}, \text{Bill}) \vee \neg\text{Alive}(\text{Bill})$

(9) $\text{Food}(\text{Peanuts}) \vee \neg\text{Alive}(\text{Bill})$

(9) $\text{Food}(\text{Peanuts}) \vee \neg\text{Alive}(\text{Bill})$, (6b) $\text{Alive}(\text{Bill})$

(10) $\text{Food}(\text{Peanuts})$

(1) $\theta = \{x/\text{Peanuts}\}$ $\neg\text{Food}(\text{Peanuts}) \vee \text{Likes}(\text{John}, \text{Peanuts})$, (10) $\text{Food}(\text{Peanuts})$

(11) $\text{Likes}(\text{John}, \text{Peanuts})$

John likes Peanuts

d

(6a) $\text{Eats}(\text{Bill}, \text{Peanuts})$, (7) $\theta = \{x/\text{Peanuts}\}$ $\neg\text{Eats}(\text{Bill}, \text{Peanuts}) \vee \text{Eats}(\text{Sue}, \text{Peanuts})$

$\text{Eats}(\text{Sue}, \text{Peanuts})$

Sue eats peanuts.

e

KB

(1) $\neg\text{Food}(x) \vee \text{Likes}(\text{John}, x)$

(2) $\text{Food}(\text{Apples})$

(3) $\text{Food}(\text{Chicken})$

(4) $\neg\text{Eats}(K(y), y) \vee \text{Kill}(y, K(y)) \vee \text{Food}(y)$

(5) $\neg\text{Kill}(K(x), x) \vee \neg\text{Alive}(x)$

(6a) $\text{Eats}(x, K(x)) \vee \text{Die}(x)$

(6b) $\neg\text{Die}(x) \vee \neg\text{Alive}(x)$

(6c) $\text{Alive}(\text{Bill})$

(7) $\neg\text{Eats}(\text{Bill}, X) \vee \text{Eats}(\text{Sue}, x)$

(6c) + (6B), $\theta = \{x/\text{Bill}\}$

(8) $\neg\text{Die}(\text{Bill})$

(7) + (9), $\theta = \{x/K(\text{Bill})\}$

(10) $\text{Eats}(\text{Sue}, K(\text{Bill}))$

(6a) + (8), $\theta = \{x/\text{Bill}\}$

(9) $\text{Eats}(\text{Bill}, K(\text{Bill}))$

Sue eats what Bill eats; already in KB, cannot specify further.