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CS161 – HW5

1.

(a) (Smoke => Fire) => (¬Smoke => ¬Fire)

Smoke	Fire	(Smoke => Fire)	(¬Smoke => ¬Fire)	(Smoke => Fire) => (¬Smoke => ¬Fire)
T	T	T	T	T
T	F	F	T	T
F	T	T	F	F
F	F	T	T	T

It is neither valid nor unsatisfiable.

(b) (Smoke => Fire) => ((Smoke V Heat) => Fire)

Smoke	Fire	Heat	(Smoke => Fire)	((Smoke V Heat) => Fire)	(Smoke => Fire) => ((Smoke V Heat) => Fire)
T	T	T	T	T	T
T	T	F	T	T	T
T	F	T	F	F	T
T	F	F	F	F	T
F	T	T	T	T	T
F	T	F	T	T	T
F	F	T	T	F	F
F	F	F	T	T	T

It is neither valid nor unsatisfiable.

(c) ((Smoke ∧ Heat) ⇒ Fire) ⇔ ((Smoke ⇒ Fire) ∨ (Heat ⇒ Fire))

Smoke	Fire	Heat	((Smoke ∧ Heat) ⇒ Fire) ⇔ ((Smoke ⇒ Fire) ∨ (Heat ⇒ Fire))
T	T	T	T
T	T	F	T
T	F	T	T
T	F	F	T
F	T	T	T
F	T	F	T
F	F	T	T
F	F	F	T

It is valid.

2. Using variables Immortal, Mythical, Mammal, and Horned.

(a)

- Mythical => Immortal
- ¬ Mythical => ¬ Immortal ∧ Mammal
- Immortal V Mammal => Horned
- Horned => Magical

(b) In CNF form, these are

(¬ Mythical V Immortal) ∧
(Mythical V ¬Immortal) ∧ (Mythical V Mammal) ∧
(¬Immortal V Horned) ∧ (¬Mammal V Horned) ∧
(¬Horned V Magical)

(c) First, to prove that it is Horned,

(Mythical V ¬ Mythical) (1)

(Mythical ∧ Immortal)
From point 1 of part (a) (2)

(¬ Mythical ∧ (¬ Immortal ∧ Mammal))
From point 2 of part (a) (3)

(Immortal V (¬ Immortal ∧ Mammal))
From (1) and (2) (4)

(Immortal V ¬ Immortal) ∧ (Immortal V Mammal)
Distributing (3) (5)

(Horned ∧ (Immortal V Mammal))
From point 3 of part (a) (6)

Since,
Left side of (5) is always true and given (6), we can conclude that it is Horned.

Further,
(¬Horned V Magical)
From the CNF form (7)

Thus, we can conclude that it is also magical.

However, it is not possible to prove that it is mythical.

3.
(a) P(A, B ,B), P(x, y, z)
For unifying these,

{x=A, y=B, z=B}

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

For unifying these,

{y=G(x,x), G(A,B)=y}

- ⇨ {y = G(x,x) , y = G(A,B)} => G(x,x) = G(A,B) => x = A and x = B.

However, this isn't possible. Thus, no unification exists.

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

For unifying these,

Older(Father(y), y) = Older(Father(x), John)
- ⇨ { y=John, Father(x) = Father(y)}
- ⇨ {y=John, x=y} => { x = John, y = John}

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

For unifying these,

Knows(Father(y),y) = Knows(x,x)
- ⇨ {x = Father(y) , x=y} => {x=Father(x), y=x}
- ⇨ {x = Father(Father(…))) , y=x}

Since, there is recursion, we don't have a unifier.

4.

(a)
1. A f, Food(f) => Likes(John, f)
2. Food(Apples)
3. Food(Chicken)
4. A f, g, Eats(g, f) ∧ ¬ Killed(f, g) => Food(f)
5. A f, g, Killed(f, g) => ¬Alive(f)
6. Alive(Bill) ∧ Eats(Bill, Peanuts)
7. A f, Eats(Bill, f) => Eats(Sue, f)

(b)

(¬Food(f) V Likes(John, f)) ∧
Food(Apples) ∧
Food(Chicken) ∧
(¬Eats(f, g) V Killed(f, g) ∧ Food(f)) ∧
(¬Killed(f, g) V ¬Alive(f)) ∧
Alive(Bill) ∧

Eats(Bill, Peanuts) ∧
(¬Eats(Bill, f) V Eats(Sue, f))

(c)

For a negated conclusion,

¬Likes(John, Peanuts) (1)

¬Food(Peanuts)
From (1) and (i) (2)

¬Eats(g, Peanuts) ∧ ¬ Killed(Peanuts, g)
From (iv) (3)

¬Eats(Bill, Peanuts) ∧ ¬ Killed(Peanuts, Bill)
From (vii) (4)

¬Eats(Bill, Peanuts) V ¬Alive(Bill)
From (v) (5)

However, (5) is a direct contradiction to (vi).
Hence, (1) is false.

⇨ Likes(John, Peanuts).

(d) For a negated conclusion,

¬Eats(Sue, f)

Eats(Bill, Peanuts)
From (vi) (6)

Eats(Bill, f) => Eats(Sue, f)
From (vii) (7)

Eats(Sue, Peanuts)
From (6) and (7)

Thus, the resolution provides us with a contradiction.

Hence,

A f, Eats(Sue, f), where f could be Peanuts.

(e) The CNF for the new set of Axioms would be as follows:
(¬Food(f) V Likes(John, f)) ∧

Food(Apples) ∧
Food(Chicken) ∧
(¬Eats(f, g) V Killed(f, g) ∧ Food(f)) ∧
(¬Kills(x, y) V ¬Alive(y)) ∧
(Eats(a, b) V Dead(b)) ∧
(¬Dead(c) V ¬Alive(c)) ∧
Alive(Bill) ∧
Eats(Bill, Peanuts) ∧
(¬Eats(Bill, f) V Eats(Sue, f))

Following the same process as above,
For a negated conclusion,

¬Eats(Sue, f)
¬Eats(Bill, f)
¬Alive(Bill)

Clearly this is a contradiction with Alive(Bill)

Thus,
A f, Eats(Sue, f) holds true and she eats whatever Bill does.