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CS 161 HW #6

1. (a) $P(A, B, B)$, $P(x, y, z)$.
$\theta = \{x \backslash A, y \backslash B, z \backslash B\}$
(b) $Q(y, G(A, B))$, $Q(G(x, x), y)$.
There is no possible unifier because x cannot have the value of both A and B
(c) $R(x, A, z)$, $R(B, y, z)$
$\theta = \{x \backslash B, y \backslash A\}$
(d) Older (Father(y), y), Older (Father (x), John).
$\theta = \{x \backslash$ John, $y \backslash$ John $\}$
(e) Knows(Father (y), y), Knows (x, x)
There is no possible unifier because x cannot be both a constant and a function.

2. (a) There exists at most one x such that P(x)
$\forall x \forall y ((P(x) \wedge P(y)) \rightarrow x = y)$
(b) There exists exactly one such x such that P(x).
$\exists x\, P(x) \wedge \forall x \forall y ((P(x) \wedge P(y)) \rightarrow x = y)$
(c) There exists at least two x such that P(x).
$\exists x \exists y ((P(x) \wedge P(y)) \wedge x \neq y)$
(d) There exists at most two x such that P(x).
$\forall x \forall y ((P(x) \wedge P(y)) \rightarrow x \neq y \wedge \forall z (P(z) \rightarrow (z = x \vee z = y)))$
(e) There exists exactly two x such that P(x).
$\exists x \exists y (P(x) \wedge P(y) \wedge x \neq y \wedge \forall z (P(z) \rightarrow (z = x \vee z = y)))$

3. (a) P(A), (E x) (~ P(x)).
Satisfiable because we can have any x != A to satisfy the condition.
(b) P(A), (A x) (~ P (x)).
Unsatisfiable because if x = A, P(A) and ~ P(A) is a contradiction
(c) (A x) (E y) (P(x, y)), (A x) (~ P(x, x)).
Satisfiable because we can pick a y != x to satisfy the condition
(d) (A x) (P(x) => (E x) (P (x))).
Satisfiable because for all x, if you have P(x), this implies that at least one x will be in P(x).

(e) $(A\ x)\ (P(x) => (A\ x)\ (P(x)))$.

? Unsatisfiable because for all x, you cannot guarantee that P(x) will imply that all of x will be in P(x)

4. (a) 1. John likes all kind of food

$(\forall\ x)\ (Food(x) \rightarrow Likes(John, x))$

2. Apples are food

Food (Apples)

3. Chicken is food

Food (Chicken)

4. Anything anyone eats and isn't killed by is food

$(E\ x\ A\ y)\ (Eats(x, y) \wedge \neg Kills(y, x) \rightarrow Food(y))$

5. If you are killed by something, you are not alive.

$(A\ x\ E\ y)\ (Kills(y, x) \rightarrow \neg Alive(x))$

6. Bill eats peanuts and is still alive. *

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

7. Sue eats everything Bill eats.

$(A\ x)\ (Eats(Bill, x) \rightarrow Eats(Sue, x))$

(b) 1. $\neg Food(x) \vee Likes(John, x)$

2. Food (Apples)

3. Food (Chicken)

? 4. $\neg Eats(F(y), y) \vee Kills(y, F(y)) \vee Food(y)$

5. $\neg Kills(F(x), x) \vee \neg Alive(x)$

* 6. $Eats(Bill, Peanuts) \wedge Alive(Bill)$ ☆ Can break thi

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

(c) 8. $\neg Eats(F(y), y) \vee Food(y) \vee \neg Alive(F(y))$ [4,

* 9. Eats (Bill, Peanuts) ☆ Break up 6

* 10. Alive (Bill) ☆ Break up 6

11. $Food(Peanuts) \vee \neg Alive(Bill)$ [8, 9]

$\theta = \{y / Peanuts, F(y) / Bill\}$

12. Food (Peanuts) [10, 11]

13. Likes (John, Peanuts) [11, 1]

$\theta = \{x / Peanuts\}$

Hence, John likes peanuts.

3

(d) "What food does Sue eat?"

14. Eats(Sue, Peanuts) [9, 7]

$\theta = \{x / \text{Peanuts}\}$

Thus, Sue eats peanuts.

(e) Use the following:

1) If you don't eats you die.
2) If you dies you are not alive.
3) Bill is alive.

1) $(\forall x\ \exists y)\ (\neg Eats(x, y) \rightarrow Die(x))$

CNF: $Eats(x, F(x)) \lor Die(x)$

2) $(\forall x)\ (Die(x) \rightarrow \neg Alive(x))$

CNF: $\neg Die(x) \lor \neg Alive(x)$

3) $Alive(Bill)$

CNF: $Alive(Bill)$

Our new knowledge base is as follows:

1. $\neg Food(x) \lor Likes(John, x)$
2. $Food(Apples)$
3. $Food(Chicken)$
4. $\neg Eats(F(y), y) \lor Kills(y, F(y)) \lor Food(y)$
5. $\neg Kills(F(x), x) \lor \neg Alive(x)$
6. $\neg Eats(Bill, x) \lor Eats(Sue, x)$

1) 7. $Eats(x, F(x)) \lor Die(x)$

2) 8. $\neg Die(x) \lor \neg Alive(x)$

3) 9. $Alive(Bill)$

10. $\neg Die(Bill)$ [8, 9]

$\theta = \{x / Bill\}$

11. $Eats(Bill, F(Bill))$ [10, 7]

$\theta = \{x / Bill\}$

12. $Eats(Sue, F(Bill))$ [11, 6]

$\theta = \{x / F(Bill)\}$

This means Sue eats at least what Bill eats.

Since we do not know exactly what Bill eats, we cannot draw conc