CS1571 HW 3 Written

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1. **Entailment**
   $(A \vee C) \wedge (B \vee (\neg C))$

A	B	C	$A \vee C$	$\neg C$	$B \vee (\neg C)$	$(A \vee C) \wedge (B \vee (\neg C))$	$A \vee B$
True	True	True	True	False	True	False	True
True	**True**	**False**	**True**	**True**	**True**	**True**	**True**
True	False	True	True	False	False	False	True
True	**False**	**False**	**True**	**True**	**True**	**True**	**True**
False	**True**	**True**	**True**	**False**	**True**	**True**	**True**
False	True	False	False	True	True	False	True
False	False	True	True	False	False	False	False
False	False	False	False	True	True	False	False

2. **Resolution - Propositional**
   Knowledge Base:
   $(P \wedge Q) \vee (Q \wedge R)$
   Rules:
   $R \Rightarrow S$
   $S \Rightarrow P$
   $(P \wedge Q) \Rightarrow G$
   Goal: G

   (a) (a) $(P \wedge Q) \vee (Q \wedge R)$
   $\equiv ((P \wedge Q) \vee Q) \wedge ((P \wedge Q) \vee R)$
   $\equiv ((P \vee Q) \wedge (Q \vee Q)) \wedge ((P \vee R) \wedge (Q \vee R))$
   $\equiv Q \wedge (P \vee R) \wedge (Q \vee R)$
   $\equiv Q \wedge (P \vee R)$

   (b) $R \Rightarrow S$
   $\equiv \neg R \vee S$

   (c) $S \Rightarrow P$
   $\equiv \neg S \vee P$

   (d) $(P \wedge Q) \Rightarrow G$
   $\equiv \neg(P \wedge Q) \vee G$
   $\equiv (\neg P \vee \neg Q) \vee G$
   $\equiv \neg P \vee \neg Q \vee G$

(b)

Step	Formula	Derivation
1	Q	Given
2	$P \vee R$	Given
3	$\neg R \vee S$	Given
4	$\neg S \vee P$	Given
5	$\neg P \vee \neg Q \vee G$	Given
6	$\neg G$	Negated conclusion
7	$P \vee S$	2,3
8	P	4,7
9	$\neg Q \vee G$	5,8
10	G	1,9
11	$\bullet$	6,10

3. **FOL Translation for Forward and Backward Chaining**
   GameX says it is criminal for a programmer to provide emulators to people. My friends don't have a GameX, but they use software EMULATOR1 that runs GameX games on their PC, which is written by SuperProgrammer, who is a programmer.

   1. **It is criminal for a programmer to provide emulators to people.**
      $\forall x \forall y \forall z (Programmer(x) \wedge Emulator(y) \wedge Provide(x, y, z) \wedge People(z) \Rightarrow Criminal(x))$
   2. **My Friends use emulator called EMULATOR1.**
      $Use(MyFriends, EMULATOR1) \wedge Emulator(EMULATOR1)$
   3. **Emulator used by my friends is provided by SuperProgrammer.**
      $\exists x (Emulator(x) \wedge Use(MyFriends, x) \Rightarrow Provide(SuperProgrammer, x, MyFriends))$
   4. **My friends are people.**
      $People(MyFriends)$
   5. **SuperProgrammer is a programmer.**
      $Programmer(SuperProgrammer)$

4. **Unification**

   (a) **P(A,B,B), P(x,y,z)**
   {x/A,y/B,z/B}

   (b) **Q(y,G(A,B)), Q(G(x,x),y)**
   Fail

   (c) **Older(Father(y),y), Older(Father(x),John)**
   {x/John,y/John}

   (d) **Knows(Father(y),y), Knows(x,x)**
   Fail

5. **Resolution - FOL**

(a) (a) $\forall x(pass(x, History) \wedge win(x, Lottery) \Rightarrow happy(x))$
$\equiv \neg(pass(x, History) \wedge win(x, Lottery)) \vee happy(x)$
$\equiv (\neg pass(x, History) \vee \neg win(x, Lottery)) \vee happy(x)$
$\equiv \neg pass(x, History) \vee \neg win(x, Lottery) \vee happy(x)$

(b) $\forall x \forall y(study(x) \vee lucky(x) \Rightarrow pass(x, y))$
$\equiv \neg(study(x) \vee lucky(x)) \vee pass(x, y)$
$\equiv (\neg study(x) \wedge \neg lucky(x)) \vee pass(x, y)$
$\equiv (\neg study(x) \vee pass(x, y)) \wedge (\neg lucky(x) \vee pass(x, y))$

(c) $\neg study(John) \wedge lucky(John)$

(d) $\forall x(lucky(x) \Rightarrow win(x, Lottery))$
$\equiv \neg lucky(x) \vee win(x, Lottery)$

(e) $\exists x(wealthy(x))$
$\equiv wealthy(F(x))$

(b)

Step	Formula	Derivation
1	$\neg pass(x, History) \vee \neg win(x, Lottery) \vee happy(x)$	Given
2	$\neg study(x) \vee pass(x, y)$	Given
3	$\neg lucky(x) \vee pass(x, y)$	Given
4	$\neg study(John)$	Given
5	$lucky(John)$	Given
6	$\neg lucky(x) \vee win(x, Lottery)$	Given
7	$\neg wealthy(F(x))$	Given
8	$\neg happy(John)$	Negated conclusion
9	$win(John, Lottery)$	5,6
10	$pass(John, y)$	3,5
11	$\neg pass(John, History) \vee happy(John)$	1,9
12	$happy(John)$	10,11
13	$\bullet$	8,12