CS1571
Fall 2019
10/9 In-Class Worksheet

Name: ____________________________

Where were you sitting in class today: ____________________________

A. Pre-Reflection

On a scale of 1-5, with 5 being most confident, how well do you think you could execute these learning objectives:

10.1 Compare model checking, theorem proving, and resolution as ways of inferring new knowledge from a knowledge base. ____

10.3 Prove that a KB entails a sentence alpha through resolution. ____

11.3 Compare first-order logic to propositional logic. ____

11.4 Translate English sentences into first order logic. ____

B. Theorem Proving with Resolution

1. Let's go back to the Wumpus world. Suppose our KB is currently:
   $(B_{1,1} \Leftrightarrow (P_{1,2} \lor P_{2,1})) \land \neg B_{1,1}$

We want to prove that KB |= α, where α says "there's no pit in Room 1,2" ($\neg P_{1,2}$)

First, figure out the CNF for:

$(B_{1,1} \Leftrightarrow (P_{1,2}\ v\ P_{2,1})) \land \neg B_{1,1}$

Step 1: Remove the biconditional using biconditional elimination.

$((B_{1,1} \text{->} (P_{1,2}\ V\ P_{2,1}))\ \text{^}\ ((P_{1,2}\ V\ P_{2,1}) \text{->} B_{1,1})\text{^}\ \neg B_{1,1})$

Step 2: Remove the implication using implication elimination.

$(\neg B_{1,1}\ V\ (P_{1,2}\ v\ P_{2,1}))\ \text{^}\ (\neg(P_{1,2}\ V\ P_{2,1}) \lor B_{1,1})\ \text{^}\ \neg B_{1,1}$

Step 3: Move ¬ inwards using de Morgan's rules and double-negation ($\neg(\neg P) \Leftrightarrow P$):

$(\neg B_{1,1} \vee (P_{1,2} \vee P_{2,1})) \wedge ((\neg P_{1,2} \wedge \neg P_{2,1}) \vee B_{1,1}) \wedge \neg B_{1,1}$

Step 4: Apply distributivity law to get conjunctions of disjunctions.

$(\neg B_{1,1} \vee P_{1,2} \vee P_{2,1}) \wedge (\neg P_{1,2} \vee B_{1,1}) \wedge (\neg P_{2,1} \vee B_{1,1}) \wedge \neg B_{1,1}$

Step 5: To prove by contradiction with resolution, we need to negate the sentence we want to prove and add it to the KB. So KB $\wedge \neg\alpha$ is

$(\neg B_{1,1} \vee P_{1,2} \vee P_{2,1}) \wedge (\neg P_{1,2} \vee B_{1,1}) \wedge (\neg P_{2,1} \vee B_{1,1}) \wedge \neg B_{1,1} \wedge P_{1,2}$

Step 6: Apply the resolution rule to create new clauses until you get a contradiction. You can use the table to track your work.

Clause #	Clause	Clauses Used
1	$(\neg B_{1,1} \vee P_{1,2} \vee P_{2,1})$	
2	$(\neg P_{1,2} \vee B_{1,1})$	
3	$(\neg P_{2,1} \vee B_{1,1})$	
4	$\neg B_{1,1}$	
5	$P_{1,2}$	
6	$\neg P_{1,2}$	2, 4
7		

2. (P^Q) ^ (P => R) ^ [(Q^R) => S] , Prove S

(P^Q) ^ (¬P V R) ^ [¬(Q^R) V S]

(P^Q) ^ (¬P V R) ^ [¬Q V ¬R V S]

(P^Q) ^ (¬P V R) ^ [¬Q V ¬R V S] ^ ¬S

R

~R V S

S

End at: S ^ ~S == contradiction

C. First-Order Logic

You are all experts in something. Express something about what you know in First-Order Logic. I will be using these answers (non-anonymized) as discussion items next class.

X = plays the piano

For all x, if x is a piano, then there exists a person Y that can play it

∀ x Piano(X) ^ ∃y(Person(Y), X)

D. Post-Reflection

On a scale of 1-5, with 5 being most confident, how well do you think you could execute these learning objectives:

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