

2nd Midterm Exam

Thursday April 9

75 minutes == 75 points
open book and notes

1. [10 points]

You are given the English sentence “Only pink objects are in the box.” and different logical expressions:

1. $\exists x \text{ InBox}(x) \Rightarrow \text{Pink}(x)$
2. $\forall x \text{ InBox}(x) \Rightarrow \text{Pink}(x)$
3. $\exists x \text{ InBox}(x) \wedge \text{Pink}(x)$
4. $\forall x \text{ Pink}(x) \Rightarrow \text{InBox}(x)$

1. Is one of the translations from English to logic correct? if yes, which one?
2. For each of the logical sentences that are not a correct translation of the sentence given above, write in English what the logical sentence is actually saying.

2. [5 points]

Convert these English sentences to predicate calculus, using the following predicates: $\text{City}(x) = x$ is a city; $\text{In}(y, x) = x$ is in y ; $\text{FF}(x) = x$ is a fastfood;

1. Every city has at least one fastfood in it.
2. There is at least one city which has a fastfood.
3. Fastfoods are in all cities.

3. [10 points]

Prove using resolution with refutation that the following set of propositional expressions in CNF is unsatisfiable. Show all the steps.

1. $\neg P \vee \neg Q \vee R$
2. $\neg S \vee Z$
3. $\neg Z \vee P$
4. S
5. $\neg R$
6. $\neg S \vee U$
7. $\neg U \vee Q$

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4. [10 points]

Prove using resolution with refutation that $\neg B(C)$ is entailed by this knowledge base expressed in CNF. Capital case letters used as arguments indicate constants, lower case letters are variables.

1. $\neg F(u, x) \vee \neg B(x)$
2. $\neg G(w) \vee \neg F(w, y) \vee F(y, z)$
3. $F(A, B)$
4. $G(A)$

5. [20 points]

1. Write the following sentences using the predicates $mb(x) = x$ is a metal building; $tall(x) = x$ is a tall building; $tower(x) = x$ is a tower; $bridge(x) = x$ is a bridge; $inFrance(x) = x$ is in France. Use Eiffel as a constant, it is the name of a famous tower in Paris.
 1. Some metal buildings are tall.
 2. Every metal building is a bridge or a tower.
 3. The Eiffel tower is not a bridge.
 4. France has many tall buildings.
 5. Tall buildings are made of metal.
 6. The Eiffel tower is tall.
 7. There are no tall metal buildings outside of France.
2. Convert the knowledge base to CNF.
3. Prove using resolution with refutation that “The Eiffel tower is a metal building and is in France.” Show the steps in the proof.

6. [10 points]

Answer these questions about CSP briefly but precisely.

1. Describe briefly one advantage and one disadvantage of backtracking search compared to local search for solving CSPs.
2. When doing CSP, what are the advantages, if any, of including forward checking in backtracking search?

7. [10 points]

Answer these questions about logic briefly but precisely.

1. In propositional logic one way of proving that $KB \models Query$ is to show that $KB \Rightarrow Query$ is a tautology. Explain why.
2. In predicate calculus, if resolution with refutation fails to produce the empty clause, what can you conclude? Is the same true for propositional calculus?