



Artificial Intelligence

Assignment 12

This Assignment will not be graded.

Question 1 Resolution

- (a) Prove by resolution that Naomi and Zack were the hackers in the hacking case task in the last assignment. Use the following statements for the knowledge base:
- (i) Except for Eva, Naomi, and Zack, nobody is able to do it.
 - (ii) Naomi never does anything without Zack's help.
 - (iii) If Eva was a hacker, then she was not alone. The same goes for Zack.
 - (iv) If Naomi is a hacker, Eva is innocent.
 - (v) If Eva is a hacker, Zack is innocent
- (b) Prove using unit resolution that the following sentence entails A :
- $$(G \vee C) \wedge (\neg G \vee B) \wedge (\neg C \vee F) \wedge (\neg B \vee A) \wedge (\neg F \vee A)$$
- (c) Suggest a knowledge base with a minimum number of clauses which can prove the sentence
- $$(\neg C \wedge E \wedge \neg A) \vee (A \wedge E \wedge B)$$

Question 2 Clauses

Students attend the lecture "Artificial Intelligence" and the professor has established that a person who is a university student (S) is allowed to present the final exam (E) if he/she submitted at least five assignments (A) but otherwise is not allowed.

- (a) Which of the following are correct representations of what the professor said?
- (i) $(S \wedge A) \Rightarrow E$
 - (ii) $(E \Rightarrow A) \Rightarrow S$
 - (iii) $(S \Rightarrow \neg A) \Rightarrow \neg E$
- (b) Write the sentences given in (a) as a conjunction of clauses (CNF).

Question 3 First order logic

- (a) Consider a vocabulary with the following predicates:

- $Student(x)$: x is a student
- $Takes(x, c)$: student x takes course c
- $Passes(x, c)$: student x passes course c

Constants denoting courses are: *English*, *German*, *French*. Constants denoting students are: *Alex* and *James*. Use these symbols to write the following assertions in first order logic:

- Students who take French cannot take German.
- If there is a student who took English and failed it, then it must be *James* who failed it.

- If and only if Alex fails German, he can take French.

(b) Consider a vocabulary with the following predicates:

- $Person(x)$: x is a person
- $Born(x, c)$: person x is born in country c
- $Parent(x, y)$: person x is a parent of y
- $Citizen(x, c)$: person x is a citizen of country c
- $Resident(x, c)$: person x is a resident of country c

Use these symbols to write the following assertions in first order logic:

- A person born inside the UK, both of whose parents are not UK citizens, is not a UK citizen.
- A person born outside the US, both of whose parents are US citizens but not US residents, is not a US citizen.

Question 4 Resolution in First-Order-Logic

Prove the statement $A(x) \wedge B(y, f(x))$ by using resolution from the following knowledge base. For each step, also give the numbers of the clauses used and the unifier (the substitution) θ .

1. $B(x_1, f(x_2)) \vee \neg A(x_1) \vee \neg C(x_2)$
2. $\neg D(y_1, y_2) \vee A(f(y_2))$
3. $C(f(G))$
4. $D(z_1, G)$