Artificial Intelligence
Partial Exam I Version B

Course code 192140302

7 May 2012

Name and student number

Name: ....

Student number: ....

Introduction

This partial examination consists of multiple-choice questions. It is a closed book exam. You have 1 hour and 30 minutes. At the end of the exam you must hand in this question form with your answers written on it. This question form consists of four pages and has ten questions.

Each correct answer counts for 4 points.

Tips:

- Read each question carefully keeping the possible answers covered.
- Try to answer the question yourself, before you look at the answers you are given to choose from. Make a note of your first thoughts and calculations on a scribbling-paper ("kladpapier").
- Beware of double negations (negatives) as these can be confusing.
- Do not stay on any one question too long. If you do not know the answer and have spent more than 10 minutes on the question, move on to the next question and come back to this one later.
- If you have any time left at the end, check your answers.
- Fill in your answers on this question form!

Good luck!

1. This question is about producing CNF from a sentence in propositional or first-order logic. Of the following four statements, three are true while one is false. Which one is false?

   (a) Every syntactically correct sentence in propositional logic can be turned into CNF.

   (b) The algorithm that turns a syntactically correct sentence in first-order logic into CNF is undecidable in certain cases. (*)

   (c) Every syntactically correct sentence in first-order logic can be turned into CNF.

   (d) The algorithm that turns a syntactically correct sentence in propositional or first-order logic into CNF has a step that may lead to an exponential increase of the number of conjuncts.

2. We want to Skolemise the following sentence in first-order logic:

   $$\forall x \exists y \forall z\ A(x,y) \wedge B(y) \Rightarrow C(x,y,z)$$

   Of the following four substitutions, only one produces a correct Skolemisation. Which one?

   (a) $\{y/S\}$

   (b) $\{y/S(x)\}$ (*)

   (c) $\{y/S(z)\}$

   (d) $\{y/S(x,z)\}$

3. We are given the following premisses:

   - $(P \vee Q) \wedge (P \vee R)$
   - $(Q \wedge R) \Rightarrow (V \Rightarrow W)$
   - $\neg[(R \Rightarrow S) \Rightarrow \neg(S \Rightarrow W)]$

   The question is whether we can prove $V \Rightarrow S$ from these premisses. Which of the following answers is correct?

   (a) Yes, the conclusion follows.

   (b) No, the conclusion does not follow, but if you add the premiss $\neg S$ the conclusion can be derived.

   (c) No, the conclusion does not follow, but if you add the premiss V the conclusion can be derived.

   (d) No, the conclusion does not follow, but if you add the premiss $\neg W$ the conclusion can be derived. (*)

4. We are given the following premisses:

   - $(A \vee B) \Rightarrow (C \wedge D)$
   - $\neg(\neg A \vee \neg C)$
   - $\neg(A \Rightarrow \neg D) \Rightarrow E$

   The question is whether we can prove E from these premisses. Which of the following answers is correct?

   (a) Yes, the conclusion follows. (*)

   (b) No, the conclusion does not follow, but if you add the premiss A the conclusion can be derived.

   (c) No, the conclusion does not follow, but if you add the premiss $\neg B$ the conclusion can be derived.

   (d) No, the conclusion does not follow, but if you add the premiss C the conclusion can be derived.

5. Consider the proposition:

   $$K \Rightarrow [(L \vee M) \Rightarrow R]$$

   How many models are there for this proposition?

   (a) 11

   (b) 12

   (c) 13 (*)

   (d) 14

6. This question is about resolution in propositional logic. Of the following four statements, three are true while one is false. Which one is false?

   (a) Resolution always terminates.

   (b) Resolution can be used to find out whether one sentence can be inferred from another.

   (c) It is not guaranteed that resolution always terminates. (*)

   (d) Resolution can be used to find out whether one sentence entails another.

7. Consider the proposition:

   $$R \Rightarrow (\neg Q \Rightarrow W)$$

   How many models are there for this proposition?

   (a) 4

   (b) 5

   (c) 6

   (d) 7 (*)

8. Given is the following statement: “No painting made by Rembrandt is ugly”. Also given are the following predicates:

   - $Painting(x)$: x is a painting.
   - $MadeBy(x, y)$: (painting) x is painted by (painter) y.
   - $Ugly(x)$: x is ugly.

   We are further given the term constant *Rembrandt* which stands for Rembrandt.

   Two possible formalisations of the statement in first-order logic are:

   I. $\forall x\ Painting(x) \wedge MadeBy(x, Rembrandt) \Rightarrow \neg Ugly(x)$
   II. $\neg\exists x\ Painting(x) \wedge MadeBy(x, Rembrandt) \wedge Ugly(x)$

   The question is whether there is an entailment relation between these two sentences. We write $P \vDash R$ for “P entails R” and $P \nvDash R$ for “P does not entail R”.Only one of the following is true; which one?

   (a) I $\vDash$ II and II $\vDash$ I. (*)
   (b) I $\vDash$ II but II $\nvDash$ I.
   (c) I $\nvDash$ II but II $\vDash$ I.
   (d) I $\nvDash$ II and II $\nvDash$ I.

9. Given is the following statement: “All Germans speak the same language”. Of the following four formalisations in first-order logic, one is correct while the others are incorrect. The predicates used in the formalisation are:

   - $German(x)$: x is a German.
   - $Speaks(x, y)$: x speaks language y.

   Which formalisation is correct?

   (a) $\forall x \exists y\ German(x) \Rightarrow Speaks(x, y)$
   (b) $\forall x, y, l\ German(x) \wedge German(y) \wedge Speaks(x, l) \Rightarrow Speaks(y, l)$ (*)
   (c) $\forall x, y \exists l\ German(x) \wedge German(y) \Rightarrow Speaks(x, l) \wedge Speaks(y, l)$ (*)
   (d) $\forall x, y\ German(x) \Rightarrow Speaks(x, y)$

10. We apply unification with the occurs-check on pairs of literals. Of the following four pairs, only one pair can be unified. Which one?

    (a) $Frustrates(Wilders, Rutte)$ and $Frustrates(Wilders, PrimeMinisterOf(x))$
    (b) $Frustrates(Wilders, Rutte)$ and $Frustrates(x, y)$ (*)
    (c) $Frustrates(Wilders, Rutte)$ and $Frustrates(x, PrimeMinisterOf(x))$
    (d) $Frustrates(Wilders, Rutte)$ and $Frustrates(x, x)$