First Examination
Intelligent Systems

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Code : INFOIS   Datum : 2 Maart 2015   Time : 13:30-15:30

Dit examen bevat ? vragen. De antwoorden schrijf je in de vakken die daar voor gegeven zijn. Gebruik het extra kladpapier om eerste bedenksels op te schrijven. Het cijfer van het tentamen wordt bepaalt door de som van de punten van de vragen plus 10 punten waar je mee begint. Het resultaat van dit deeltentamen weegt mee in het totaalcijfer als het gewogen gemiddelde er beter van wordt.

vraag1	vraag2	vraag3	vraag4	vraag5	vraag6
15pt	20pt	10pt	15pt	15pt	15pt

FOL = First Order Logic   KB = Knowledge Base

1. (a) We kunnen vier categorien van definities voor AI geven. Geef aan voor welke categorie de Turing test een goede test is.

   (b) Beschrijf mbv. PEAS componenten een robotstofzuiger.

   (c) Geef aan of de omgeving van het voetbalspel *observable, deterministic, dynamic, discrete, episodic* is. Geef ook kort aan waarom (niet).

(d) Maak een waarheidstabel voor de propositionele formule $(p \wedge \neg q) \rightarrow r$. Geef aan waar je in de waarheidstabel de Syntax, de Modellen en de Interpretatie functie kunt vinden.

2. Determine for each of the following FOL structures whether or not it satisfies the formula: $\forall x \exists y \exists z : P(x,y) \wedge P(x,z) \wedge \neg P(z,y) \wedge \neg P(y,z)$. Explain your answer!

   (a) Domain $= \mathbb{Z}$ (i.e., the integers),
   Relation $P = \{(m, m+1) \mid m \in \mathbb{N}\}$

   (b) Domain $= 2^{\mathbb{N}}$ (i.e., the set of subsets of the natural numbers),
   Relation $P = \{(A, B) \mid A, B \in 2^{\mathbb{N}} \text{ en } A \subseteq B\}$

   (c) Domain $= \mathbb{Q}$ (i.e., the rational numbers),
   Relation $P = \{(m, n) \mid m, n \in \mathbb{Q} \text{ en } m \leq n\}$

3. Translate the following sentences into FOL. Use a member predicate to denote that points belong to lines or circles. So, points, lines and circles are all seen as objects and membership relations are denoted by a membership predicate relating these objects. You are not allowed to assume unique names assumptions for points, lines and circles.

   (a) Parallel lines do not have any point in common.

   (b) Two circles are identical if they have at least three different points in common.

4. Which of the following pairs of predicates can be unified? Give the substitutions in case unification succeeds. In these formulas $Brother$, $Sister$ and $Mother$ are functions, and $dislikes$, $loves$ and old are predicates.

   (a) $dislikes(Sister(Piet), y)$ and $dislikes(x, Piet)$

   (b) $old(Mother(Mother(x))$ and $old(Mother(x))$

   (c) $loves(Brother(Piet), Jan)$ and $loves(x, Brother(y))$

5. We assume that to move in the wumpus world, an agent only has the possibility to GoEast and GoNorth. Apart from that, the agent can perform the actions GrabGold and Shoot, both with the effect suggested by their name. The formula below represents an initial attempt to formulate a successor state axioma based on the fluent $At(Agent, x, y, s)$, where the x and the y are place coordinates (as usual for the situation calculus, all variables are implicitly universally quantified). Finish the formula by substituting a correct formula for the '...'.

$$Poss(a, s) \rightarrow [At(Agent, x, y, Result(a, s)) \Leftrightarrow (\ldots)]$$

6. If there is something wrong with the following reasoning, then explain where the mistake is: "FOL is complete. So, for every formula that follows from a FOL knowledge base there is a derivation. This means that if we ask a FOL knowledge base to find an answer to the question if a given formula follows from it, we will always get an answer. "

7. We have seen two ways to interpret negation. Let us assume the formula $\neg p(Obj) \rightarrow q(Obj)$ is part of a knowledge base KB. Now first explain the classical logic interpretation of the negation, by explaining how $q(Obj)$ could follow from the KB under this interpretation of the negation in the formula. Then explain 'negation as failure' by explaining how $q(Obj)$ could follow from the KB under this alternative interpretation of the negation in the formula.