The University of Waikato
Department of Computer Science
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COMP 340-08B

Reasoning about Programs

Assignment 2

Exercise 1 (5 marks)

Given a predicate logic signature that includes

- constant symbols leo and africa;
- unary function symbol $\mathsf{home\text{-}of}$;
- unary predicate symbols lion and zebra;
- binary predicate symbols eats and $\mathsf{lives\text{-}in}$;

determine for each of the following strings whether they represent well-formed formulas of predicate logic. If they do not, explain briefly why not.

a) $\mathsf{leo}(\mathsf{lion}) \vee \mathsf{leo}(\mathsf{zebra})$

b) $\exists\, \mathsf{leo}\ \mathsf{lion}(\mathsf{leo})$

c) $\forall x \forall y\ \mathsf{eats}(\mathsf{lion}(x), \mathsf{zebra}(y))$

d) $\exists x\ \mathsf{home\text{-}of}(\mathsf{leo}, x)$

e) $\forall x\, (\mathsf{lion}(x) \vee \mathsf{zebra}(x) \rightarrow \mathsf{lives\text{-}in}(x, \mathsf{home\text{-}of}(\mathsf{leo})))$

Exercise 2 (5 marks)

Using only the function and predicate symbols given in exercise 1, translate the following English sentences into well-formed formulas of predicate logic.

a) Leo is a lion or a zebra.

b) Every zebra lives in Africa.

c) Some lions do not live in Africa.

d) Lions like to eat zebras.

e) Some lions like to eat everything that lives in Africa except lions.

Exercise 3 (5 marks)

Translate each of the following English sentences into a well-formed formula of predicate logic, using only the unary predicate symbol being, the binary predicate symbol elder, and the unary function symbol father.

a) No being is elder than its father.

b) The father of every being also is a being.

c) The father of every being is elder than that being.

d) There exists a being that is elder than all beings.

e) If something is elder than all beings, then it is not a being.

Exercise 4 (1+2+2 marks)

Transform the following predicate logic formulas into Skolem Normal Form. Show your working clearly, writing each step in a line of its own and indicating how it was obtained.

a) $\forall x\,((\mathsf{woman}(x) \lor \mathsf{man}(x)) \land \exists y\ \mathsf{loves}(x, y) \to \mathsf{happy}(x))$

b) $\forall x\,(\mathsf{man}(x) \to \exists y\,(\mathsf{woman}(y) \land \mathsf{loves}(x, y)))$

c) $(\exists y\ \mathsf{lt}(0, y) \land \forall x\,(\exists y\ \mathsf{lt}(x, y) \to \exists y\ \mathsf{lt}(\mathsf{s}(x), y))) \to \forall x\,\exists y\ \mathsf{lt}(x, y)$

Submission

Please put your written answers into the box marked **COMP340** in front of room G 1.15 before the due date.

Due date: Wednesday, 30 July 2008, 17:00