The University of Waikato
Department of Computer Science
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THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

COMP 340-08B

Reasoning about Programs

Assignment 1

Exercise 1   (5 marks)

Determine for each of the following strings whether they represent well-formed formulas (wffs) of propositional logic. If they do not, explain briefly why this is the case.

a) p

b) $\oplus q$

c) $p \leftrightarrow (q \wedge r) \rightarrow p \leftrightarrow q$

d) $p \leftrightarrow (q \rightarrow p \leftarrow q)$

e) $p \wedge \neg p$

Exercise 2   (1+2+2 marks)

Use truth tables to determine for each of the following well-formed formulas whether they are valid, satisfiable but not valid, or unsatisfiable. Show your working clearly.

a) $(p \rightarrow q) \leftrightarrow (\neg q \rightarrow \neg p)$

b) $((p \rightarrow q) \rightarrow r) \leftrightarrow (p \rightarrow (q \rightarrow r))$

c) $((p \wedge q) \rightarrow r) \leftrightarrow (p \rightarrow (q \rightarrow r))$

Exercise 3   (1+1+1+2 marks)

Use the laws of equivalence to obtain a conjunctive normal form for each of the following well-formed formulas. Write down each transformation step in a line of its own, and indicate the law of equivalence that you have used.

a) $p \rightarrow (q \rightarrow r \vee s)$

b) $p \leftrightarrow q$

c) $p \vee q \leftrightarrow r \wedge s$

d) $((p \rightarrow q) \rightarrow r) \leftrightarrow (p \rightarrow (q \rightarrow r))$

Exercise 4   (5 marks)

Write an explanation in plain English (without using any logic symbols whatsoever), making clear why the following argument is correct. Explain your reasoning clearly, referring to the English text below whenever necessary.

Wolves, foxes, birds, caterpillars, and snails are all animals, and there are some of each of them; also there are some kiwifruit, and kiwifruit are plants. Every animal likes to eat all plants, or all animals much smaller than itself that like to eat some plants. Caterpillars and snails are much smaller than birds, which are much smaller than foxes, which in turn are much smaller than wolves. Wolves do not like to eat foxes or kiwifruit, while birds like to eat caterpillars but not snails. Caterpillars and snails like to eat some plants.

Therefore, there is an animal that likes to eat a kiwifruit-eating animal.

Submission

Please put your written answers into the box marked **COMP340B** in front of room G 1.15 before the due date.

Due date: Wednesday, 23 July 2008, 17:00