

Birkbeck
(University of London)

MSc and MRes Examination for Internal Students
MSc in Advanced Information Systems
MSc in Web Information Management
MRes in Computer Science

School of Computer Science and Information Systems

Knowledge Representation and Reasoning (COIY027P)

Date of examination: 30/05/2008

Duration of paper: (14:30–16:30)

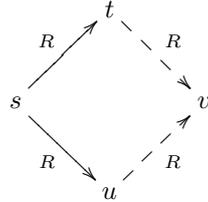
There are 5 questions on this paper. Candidates should attempt any FOUR of them. Calculators are not permitted.

1. Consider the following argument. “If I am clever, then I pass the exam, or if I do the homeworks, then I pass the exam. Therefore, if I am clever or I do the homeworks, then I pass the exam.”
 - (a) Formalise the above argument using propositional logic. (10 marks)
 - (b) Using the semantic tableaux method determine whether the argument is valid. (15 marks)

2. A frame $\mathcal{F} = (W, R)$ is called *directed* if

$$\forall s \forall t \forall u ((sRt \wedge sRu) \rightarrow \exists v (tRv \wedge uRv)),$$

see the picture:



Consider the following formula:

$$\text{DIRECTED: } \diamond \Box \varphi \rightarrow \Box \diamond \varphi$$

- (a) Prove that the formula DIRECTED is valid in directed frames. (15 marks)
- (b) Show that the formula DIRECTED is not valid in general. (10 marks)

3. Consider the formula α of modal logic:

$$\Box(\varphi \wedge \Box(\varphi \rightarrow \psi)) \rightarrow \Box\psi.$$

- (a) Determine whether α is valid. (10 marks)
- (b) Determine whether that version of α where we replace all occurrences of \Box with the epistemic modality E in the definition of α is valid in epistemic logic. (15 marks)

4. Consider the following variant of the muddy children puzzle. The father’s (true) public announcement is:

“The number of muddy children and the number of clean children are different.”

Assume that there are four (healthy, intelligent and truthful) children.

- (a) Draw a model representing the children’s knowledge after the father’s announcement. (5 marks)
- (b) Determine what happens in the first and second rounds when the father asks: “Raise your hand if you know whether you are muddy.” (Note that your answer should depend on the number of muddy children.) (20 marks)

5. Consider the following facts. “Bob and Carl are each other’s neighbours, and both of them are friends of Alice.”

- (a) Design a knowledge base Σ in description logic expressing the above facts. (5 marks)
- (b) Decide whether the following are true:

$$\begin{aligned} \Sigma &\models \exists \text{hasFriend} . (\text{Clever} \rightarrow \exists \text{hasNeighbour} . (\exists \text{hasNeighbour} . \text{Clever})) (\text{ALICE}) \\ \Sigma &\models \exists \text{hasFriend} . (\exists \text{hasNeighbour} . (\exists \text{hasNeighbour} . \text{Clever}) \rightarrow \text{Clever}) (\text{ALICE}) \end{aligned}$$

(20 marks)