Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Knowledge Representation

Date: Friday 4th June 2010
Time: 14.00 – 16.00

Please answer ALL Questions

The exam will be taken on line.
This is the paper format, which will be available as a backup

The use of electronic calculators is NOT permitted
Section A

1. Knowledge Acquisition and Modelling

   a) What is the "20 questions" technique? What kind of knowledge would it be good for acquiring? (2 marks)

   b) You have been asked to build an ontology to be used in an application that supports management of a university information system.

   The first stage of the Knowledge Acquisition Process has identified the following collection of terms (in no particular order):

<table>
<thead>
<tr>
<th>University</th>
<th>Module</th>
<th>Lecture</th>
<th>Lab Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam</td>
<td>Examples Class</td>
<td>Person</td>
<td>Student</td>
</tr>
<tr>
<td>Academic</td>
<td>Lecturer</td>
<td>Teaching Assistant</td>
<td>PhD Student</td>
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<tr>
<td>MSc Student</td>
<td>Undergraduate Student</td>
<td>Senior Lecturer</td>
<td>Professor</td>
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<tr>
<td>Lecture Theatre</td>
<td>1st Year Module</td>
<td>2nd Year Module</td>
<td>3rd Year Module</td>
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<tr>
<td>Lab</td>
<td>Common Room</td>
<td>Collab Space</td>
<td>MSc Degree</td>
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<tr>
<td>Postgraduate Degree</td>
<td>BSc Degree</td>
<td>PhD Degree</td>
<td>1st Year</td>
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<td>2nd Year</td>
<td>3rd Year</td>
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   Sketch out a preliminary hierarchy of concepts, based on the terms given. For each concept in the hierarchy, indicate whether it is:

   i) Selfstanding (S)
   ii) Modifier (M)
   iii) Definable (D)

   You may introduce abstractions or additional terms into the hierarchy where necessary. If concepts are definable, provide some brief natural language definitions, with discussion of any points you feel are particularly interesting or contentious. You should also introduce any relations used in the definitions.
(Question 1 continues from the previous page)

There is no need to draw out the hierarchy as a diagram – an indented list is sufficient, e.g.

Fruit

+ Soft Fruit (Fruit that grows on bushes and is generally soft to the touch) D S
  ++ Strawberry S
  ++ Redcurrant S
+ Top Fruit (Fruit that grows on trees) D S
  ++ Apple S

Use explicit characters (such as + above) to represent hierarchy and indentation. (7 marks)

2. **OntoClean**

   a) The OntoClean methodology supports analysis of concept hierarchies in order to identify potential modelling misnomers. Provide a brief description of the property of **Rigidity**. (1 mark)

   b) The following subclass axiom occurs in an ontology being developed to describe popular music. Identify a potential problem with this axiom, using OntoClean properties to justify your answer.

      Band SubClassOf GroupOfPeople (3 marks)

3. **SKOS and Vocabularies**

   If I was building a catalogue of articles describing a particular subject area of life sciences, what would be the pros and cons of using an OWL ontology or a SKOS vocabulary? Illustrate your answer through discussion of the key differences between OWL and SKOS. (6 marks)
4. **Logic**

a) In First Order Predicate Logic (FOL), what do we mean by a valid formula? (1 mark)

b) What do soundness and completeness results tell us about the relationships between a proof theory and a semantics for a logic? (2 marks)

c) Describe one reasoning service and one extra-logical service, and discuss how they might be used in tools supporting ontology engineering. (4 marks)

d) Describe two characteristics of the Web Ontology Language (OWL) that make it a suitable representation language for use in the Semantic Web. Justify your choices. (4 marks)
Section B

5. Conceptual Foundations
   a) Briefly describe each of the three foci of KR discussed during the module. (6 marks)
   b) Why is a KR not a data structure (illustrate with an example)? (3 marks)
   c) Compare the fourth and fifth roles of a KR. Focus particularly on where they tend to work together and where they tend to work at cross purposes. (3 marks)

6. Logic Engineering
   a) Explicate the trade off between the expressivity and computational complexity of a KR formalism. (3 marks)
   b) Represent the following statements in OWL (using Manchester syntax or DL syntax). Distinguish TBox from ABox axioms.

      Anything that is a woman and burns is a witch. Ann is a woman. If something is made of wood, then it burns. If something is made of wood, it floats. Quackers is a duck and floats. Ann is Quackers.

      (6 marks)

7. Commonsense
   Briefly explain (with an example) what it is for a representation to be “elaboration tolerant”. (4 marks)

8. Ontology Engineering
   a) Explain 2 benefits of using a (logic-based) ontology to represent a terminology. Distinguish the cases where the ontology is used at development time only and also at runtime. (3 marks)
   b) Explain how classes in OWL are similar to/different from classes in programming languages. (2 marks)

END OF EXAMINATION