On-Line Examination

COMP60462

Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

M.Sc. in Advanced Computer Science

The Semantic Web: Ontologies and OWL

Date: Monday 7th June 2010
Time: 14.00 – 16.00

Please answer ALL questions provided and ALL their parts – worth 80 marks in total

This is a CLOSED book examination

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 permitted provided they are not programmable and do not store text
1. **Ontology Engineering**

   a) Describe two techniques that might be used with a domain expert in order to help in determining an initial set of terms and definitions describing a domain. Include one technique that is useful for capturing explicit knowledge, and one which is useful for capturing implicit knowledge.

   (4 marks)

   b) The OntoClean methodology defines meta-properties that are used to evaluate and validate concept hierarchies. According to the OntoClean methodology, what is meant by a property that carries an identity criterion? Give an example of such a property, along with a justification of your choice.

   (2 marks)

   c) Violation of OntoClean constraints does not necessarily lead to logical inconsistency. Discuss why this is the case.

   (2 marks)

2. **DL Reasoning Techniques**

   a) Provide a definition of the term *knowledge base consistency*.  

   (1 mark)

   b) Provide a definition of the term *class unsatisfiability*.  

   (1 mark)

   c) If a knowledge base contains an unsatisfiable class, can it be consistent? Provide an explanation of your answer or a counter-example as appropriate.

   (2 marks)

   d) For the following expression

   I. translate into standard DL notation,

   II. say whether or not the expression is satisfiable, and

   III. show how a tableaux algorithm would be used to prove the (un)satisfiability.

   \((R \text{ some (S some (not C))) and (R only C)}\)  

   (7 marks)
3. **Reasoning with T-Boxes**
   
a) Describe the procedure of *unfolding* a T-Box. Illustrate your answer by unfolding the T Box below.  
   
   \{ \text{A subClass (C and (some R.C)), C equivalentClass (B or D)} \}  
   
   (3 marks)

b) Why would you not be able to successfully repeat the process with the following T-Box?  
   
   \{ \text{A subClass (C and (some R C)), C equivalentClass (A or D)} \}  
   
   (1 mark)

4. **Vocabularies and Ontologies**
   
a) What is the key difference between the broader/narrower hierarchies found in a SKOS vocabulary and the subsumption hierarchies of an OWL ontology?  
   
   (3 marks)

b) SKOS is defined as an OWL ontology. Why is this of benefit? What problems might be introduced due to this?  
   
   (3 marks)

c) "*We are likely to see many more knowledge sources published as SKOS vocabularies than as OWL ontologies*"

   Briefly discuss the above claim. You may agree or disagree with the statement, but should provide arguments for your position.  
   
   (6 marks)

5. **Implementation of OWL**
   
a) Sketch out a design for an application that checks the *profile* (e.g. OWL QL, OWL EL etc) of an ontology. Identify the key features of the OWL API that you would use in doing so. Would reasoning play any role in such an application?  
   
   (5 marks)
6. **Expressivity and Complexity**

   a) Describe (with examples) the tradeoffs between the (logical) expressivity of an ontology language and the *computational* complexity of its key reasoning services. (4 marks)

   b) Describe the relationship (with examples), positive or negative between the computational complexity of an ontology language and its *cognitive* complexity. (4 marks)

   c) Given that we have “practical” implementations of OWL 2 DL, why bother with “tractable” profiles? (3 marks)

7. **Metalogical properties**

   a) Give a case where it is reasonable to use an *unsound* inference procedure and explain why. (3 marks)

   b) Give a case where it is reasonable to use an *incomplete* inference procedure and explain why. (3 marks)

   c) "*If an inference procedure is sound, complete, terminating, and gives me an answer, I can trust that answer.*"

      Is this a reasonable position for an ontology engineer? Why or why not? (4 marks)
8. **Ontology Engineering**

a) Explain the 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.

b) Take the following ontology, O:

1) C SubClassOf (A and D)
2) A SubClassOf (E and B)
3) F SubClassOf (p only A)
4) D SubClassOf (q some Thing)
5) B SubClassOf (not D and (p some D))

Give the justifications(s) for

C SubClassOf Nothing

as a list of lists of numbers (e.g., {{7,8,9},{10, 11}})

(3 marks)

c) Explain when it is, on balance, a good idea to introduce a new datatype into OWL, and what the costs are of doing so.

(3 marks)

9. **SPARQLing Queries**

a) What is the difference between a distinguished and non-distinguished variable?

(2 marks)

b) How is conjunctive query more expressive an ASK language than OWL class expressions? Give an example of the difference.

(3 marks)

c) Describe a service over OWL ontologies that would be helpful and suitable as a DESCRIBE function and justify your design. E.g., given the query:

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
PREFIX owl: <http://www.w3.org/2002/07/owl#>
DESCRIBE ?x ?y
WHERE {?x rdf:subClassOf ?y}
```

What would be useful to return to an ontology engineer? Be sure to detail the circumstances of use in your justification.

(5 marks)