# UNIVERSITY OF LONDON

# GOLDSMITHS COLLEGE

## B. Sc. Examination 2008

## COMPUTING AND INFORMATION SYSTEMS

## IS53019A (CIS344) The Semantic Web

**Duration: 2 hours 15 minutes**

**Date and time:**

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*There are five questions in this paper. You should answer no more than THREE questions. Full marks will be awarded for complete answers to a total of THREE questions. Each question carries 25 marks. The marks for each part of a question are indicated at the end of the part in [.] brackets.*

*There are 75 marks available on this paper.*

*No calculators should be used.*

**THIS PAPER MUST NOT BE REMOVED FROM THE EXAMINATION ROOM**

## Question 1: Concepts, Tools and Applications

(a) Explain **in your own words** what is meant by an **ontology** and how ontologies can be useful in the context of the Semantic Web. Why is **reasoning support** important for ontology languages?

[8 marks]

(b) Write notes on **one** of the following technologies for constructing and/or querying Semantic Web documents, describing its capabilities and limitations: [7 marks]

- Protégé
- OilEd
- SPARQL
- GRDDL

(c) Compare the following statements:

> "The Semantic Web will bring structure to the meaningful content of Web pages, creating an environment where software agents roaming from page to page can readily carry out sophisticated tasks for users".
>
> Berners-Lee, Hendler and Lassila, *Scientific American*, 2001.
>
> "Because we haven't yet delivered large-scale, agent-based mediation, some commentators argue that the Semantic Web has failed to deliver".
>
> Shadbolt, Hall and Berners-Lee, *IEEE Intelligent Systems*, 2006.

Do you think it reasonable to say that the Semantic Web has failed to meet expectations or should it be regarded as a work-in-progress which has already a degree of success? If the latter, what factors other than the "infrastructure" of Semantic Web languages and ontologies will be critical to the success of the enterprise? Justify your answers.

[10 marks]

## Question 2: Ontologies

Noy and McGuinness (Ontology Development 101) outline a "simple knowledge engineering methodology" including the tasks listed below, which will be applied in this question to the task of designing an ontology in the general subject area of **Food and Drink**. Any examples you give should be drawn from this subject area. You are free to specialise as you think appropriate.

(a) **Determine the domain and scope of the ontology**.

(i) Explain what is meant by "domain" and "scope" in this context.
(ii) Describe a heuristic technique that can be used in the initial design and subsequent testing to make sure an ontology is suitable for its intended use. Give concrete examples

[6 marks]

(b) **Consider reuse.** What kinds of information sources could you exploit in designing your ontology? What automated or semi-automated techniques could you use?

[6 marks]

(c )
(i) **Enumerate important items in the ontology**. Write down an unstructured list of 10 – 20 terms.
(ii) **Define the classes, class hierarchy,and properties of classes**. Give **two** examples of **classes**, **properties/slots** and **facets** from your above list, or new examples if the list does not include suitable examples
(iii) Give examples of simple class and property hierarchies (no more than three levels) preferably using the terminology you have defined in (i – ii) above.

[7 marks]

(d) Discuss the statement that

> … an ontology is really a definition of the business rules associated with a vocabulary. In other words, ontologies are business models.
>
> Shelley Powers, *Practical RDF*.

[6 marks]

## Question 3: RDF

(a) Describe the essential constituents of a **statement** in RDF and explain the function of URIs (Universal Resource Identifiers) in RDF statements. [5 marks]

(b) Consider the following RDF document and answer questions (i – iii) following:

```
<?xml version = "1.0" ?>
<rdf:RDF
        xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
        xmlns:ac="http://www.mydomain.org/ac-ns">
<rdf:Description>
            <ac:courseTitle>Medieval Shipbuilding</ac:courseTitle>
            <ac:courseID>MED237</ac:courseID>
            <ac:isTaughtBy>
                  <rdf:Description>
                        <ac:name>James Dixon</ac:name>
                        <ac:title>Visiting Lecturer</ac:title>
                  </rdf:Description>
            </ac:isTaughtBy>
</rdf:Description>
</rdf:RDF>
```

(i) In ordinary English, what information is conveyed in this document?
(ii) Draw a graphical representation of the content of this document as might be generated by the W3C's RDF Validator.
(iii) In this example the description of James Dixon is nested inside another description. What disadvantages could this have, and what alternative techniques are available for encoding the same content in RDF/XML?

[8 marks]

(c) Discuss the difference between the following statements:

(i) The motion was supported by Smith; the motion was supported by Brown; the motion was supported by Jones.
(ii) The motion was supported by the group of Smith, Brown and Jones.

Draw a graph to illustrate the difference. What kind of RDF element could you use to express statement (ii)?

[9 marks]

(d) Antoniou and van Harmelen (Semantic Web Primer, 2004) state that:

> RDF Schema is quite primitive as a modelling language for the Web. Many desirable modelling primitives are missing. Therefore we need an ontology layer on top of RDF/RDFS.

Describe **two** examples of features which are missing from RDF/RDFS but are implemented in the OWL language.

[6 marks]

## Question 4: Logic and Reasoning

(a)

(i) Explain the difference between **object properties** and **data type properties** in the OWL language.

(ii) Explain in ordinary English what the following OWL statements say about the properties `partOf` and `hasChild`:

```
<owl:ObjectProperty rdf:ID="partOf">
      <rdf:type rdf:resource="&owl;FunctionalProperty" />
</owl:ObjectProperty>
<owl:ObjectProperty rdf:ID="hasChild">
      <rdf:type rdf:resource="&owl;InverseFunctionalProperty" />
      <owl:inverseOf rdf:resource="partOf" />
</owl:ObjectProperty>
```

(iii) Do you think it is reasonable to define the `partOf` property as **transitive**? If so, what implications would this have for the definitions in (ii) above?

(iv) Which of the following properties are **transitive**? Justify your answers.

- "taller than"
- "brother of"
- "cousin of"

[10 marks]

(b) Show using truth tables whether:

(i) (P v Q) → R **implies** P → (Q v R);

(ii) (P & Q) → R **is equivalent to** (P → R) & (Q → R)

[8 marks]

(c) The following is an excerpt from an OWL document, coded in RDF/XML. Explain the use of `subClassOf` with `Restriction`, and express the content both in ordinary English and as a formula of **predicate calculus**. [7 marks]

```
<owl:Class rdf:ID="giraffe">
      <rdfs:subClassOf rdf:type="#herbivore"/>
      <rdfs:subClassOf>
            <owl:Restriction>
                  <owl:onProperty rdf:resource="#eats"/>
                  <owl:allValuesFrom rdf:resource="#leaf"/>
            </owl:Restriction>
      </rdfs:subClassOf>
</owl:Class>
```

(Antoniou and van Harmelen, A Semantic Web Primer, 2004, pp 131-2.)

## Question 5: XML

(a) What does it mean for an XML document to be *well-formed* and *valid*? How can you check a document for well-formedness and validity? [4 marks]

(b) Suppose you want to create an XML document using two separately defined vocabularies which include some elements with the same names. For example, a database of academic contacts in a particular subject area might include both UK and US staff with the title "Professor", although this has different meanings in the two communities. Explain how you can ensure that the various uses of this term are properly disambiguated when the document is processed. [4 marks]

(c ) Describe three different ways an XML document can be displayed in a web browser. [3 marks]

(d)Consider the XML Schema shown below and answer questions (i – iii) following:

```
<?xml version = "1.0"?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema">
<xsd:element name = "Cust-List" type = "custListType"/>
<xsd:complexType name = "custListType">
<xsd:sequence>
<xsd:element name = "Cust" type = "custType" maxOccurs =
"unbounded"/>
</xsd:sequence>
</xsd:complexType>
<xsd:complexType name = "custType">
<xsd:sequence>
<xsd:element name = "ID" maxOccurs = "1" minOccurs = "1" type =
“xsd:integer”/>
<xsd:element name = "Title" maxOccurs = "1" minOccurs = "1" type =
“xsd:string”/>
<xsd:element name = "Firstname" type = "xsd:string"/>
<xsd:element name = "Lastname" type = "xsd:string"/>
<xsd:element name = "HouseNumber" type = "xsd:integer"/>
<xsd:element name = "Street" type = "xsd:string"/>
<xsd:element name = "Town" type = "xsd:string" maxOccurs = "1"
minOccurs = "0"/>
<xsd:element name = "Phone" type = "xsd:string"/>
</xsd:sequence>
</xsd:complexType>
</xsd:schema>
```

(i) Explain the difference between simple and complex types, with reference to examples in the above schema.

(ii) Construct an example of an XML document that conforms to the schema. Which elements are obligatory and which are optional?

(iii) Explain how the schema could be modified so that:

- "Title" must be one of "Mr", "Mrs", "Miss", "Ms", "Dr" or "Prof";
- "House Name" may be specified as an alternative to "House Number".

[14 marks]