



MIDSUMMER EXAMINATIONS 2016

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Department	Computer Science
Module Code	CO7216
Module Title	Semantic Web
Exam Duration	Two Hours

CHECK YOU HAVE THE CORRECT QUESTION PAPER

Number of Pages	8
Number of Questions	3
Instructions to Candidates	<p>Please do not remove this paper from the examination hall. Any number of questions may be attempted, but only the best two answers will be taken into account. Full marks may be obtained for answers to two questions.</p> <p>All questions carry equal weight. (50 marks per question). The exam is worth 60% of the total module mark. All relevant namespaces have been provided in the helper sheet.</p>

FOR THIS EXAM YOU ARE ALLOWED TO USE THE FOLLOWING:

Calculators	No
Books/Statutes provided by the University	No
Are students permitted to bring their own Books/Statutes/Notes?	No
Additional Stationery	No



Vehicle Scenario

A vehicle is a mobile machine that transports people or cargo. Vehicles are either powered or unpowered. Bicycles, motor vehicles and railed vehicles are three types of vehicle. Bicycles are human-powered vehicles having two wheels attached to a frame. Motor vehicles are self-propelled road vehicles, having at least one engine, and two or more wheels, and do not operate on rails. Railed vehicles run on a prepared flat surface, and are directionally guided by the tracks on which they run. Motor vehicles can be further classified as passenger cars, buses, trucks and campervans.

A driver is a person who drives a motor or railed vehicle. In the UK, the minimum age to hold a full driving licence is 17. A passenger is a person who travels in a vehicle but not as a driver. A passenger car is a motor vehicle used for the carriage of passengers and comprising not more than eight seats in addition to a driver's seat. A bus is a motor vehicle having more than eight passenger seats. Campervans are motor vehicles that provide both transport and sleeping accommodation. Trucks are motor vehicles used for carrying goods or materials. All vehicles registered in the UK have unique registration numbers.

**Question 1.**

1. (a) The semantic web layer cake is made up of several components and follows a certain hierarchy. Explain and illustrate with the help of a figure. [5 marks]
- (b) Given the following XML document:

```
<?xml version="1.0" encoding="UTF-8"?>
<Companies>
  <Company name="HSBC">
    <Type>Banking</Type>
    <Location>London, Leicester</Location>
    <Employees>
      <Employee id="1">Alice</Employee>
      <Employee id="2">Bob</Employee>
    </Employees>
  </Company>
  <Company name="IBM">
    <Contact>+44 0116 123 0000</Contact>
    <Type>IT</Type>
    <Location>Leicester</Location>
    <Employees>
      <Employee id="3">John</Employee>
    </Employees>
  </Company>
  <Company name="JP_Morgan">
    <Type>Banking</Type>
    <Location>London</Location>
    <Employees>
      <Employee id="3">John</Employee>
    </Employees>
  </Company>
  <Company name="NEXT">
    <Type>Retail</Type>
    <Location>Leicester</Location>
    <Employees>
      <Employee id="4">Kate</Employee>
    </Employees>
  </Company>
</Companies>
```

(Note: a person might work for more than one company; a company can also have branches in different cities)

- i. Write an RDF instance document corresponds to the above XML document using Turtle notation. [6 marks]
- ii. Write an RDF Schema document for the RDF instance document in (i) using RDF/XML syntax. [9 marks]



iii. For each question below, write a SPARQL query to get the specified result:

(1) Select anyone who works for an IT company having a branch in Leicester.

[4 marks]

(2) Get a table consisting of three columns. Each row should contain: the employee's name, the company name and the company's contact telephone number (if given). Limit the result to the first 4 rows.

[4 marks]

(3) Count the number of companies in the banking sector for each city.

[5 marks]

(c) Draw an RDF graph corresponding to the following document:

[5 marks]

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:dc="http://purl.org/dc/elements/1.1/"
  xmlns:ex="http://example.org/stuff/1.0/">
  <rdf:Description rdf:about="http://www.cs.le.ac.uk/films/starwars7"
    dc:title="Star Wars: The Force Awakens">
    <ex:author rdf:nodeID="sw"/>
  </rdf:Description>
  <rdf:Description rdf:nodeID="sw" ex:name="J.J.Abrams">
    <ex:homePage rdf:resource="http://www.imdb.com/name/nm0009190/" />
  </rdf:Description>
</rdf:RDF>
```

(d) Explain the following RDF(S) core classes or properties:

- i. `rdfs:Resource`
- ii. `rdfs:domain`
- iii. `rdfs:range`
- iv. `rdf:Property`
- v. `rdf:type`

[5 marks]

(e) Consider the vehicle scenario.

- Identify six concepts and five properties relevant to the domain. You can write your answer as

Concepts: Concept1, Concept2, ...

Properties: Property1, Property2, ...

- Give an example of the property-subproperty relation between two properties.
- Indicate the hierarchies (subclasses) for at least three top-level concepts. The hierarchies should demonstrate the use of multiple inheritance. You may draw the hierarchies as diagrams or write the ontology in RDF/XML or Turtle syntax. Note: you may add other concepts and it may be necessary to do so to complete this question.

[7 marks]

**Question 2.**

2. (a) What are the OWL 2 profiles? Discuss the choice of profile in practice. [6 marks]
- (b) Briefly explain why OWL is more expressive than RDF Schema with respect to the description of the resources and of their relationships. [4 marks]
- (c) Explain the differences between `owl:inverseOf`, `owl:InverseFunctionalProperty` and `owl:FunctionalProperty`. Use examples from the vehicle scenario to explain each concept. [5 marks]
- (d) Which of the following statements are true? Justify your choices.
- i. A class can not be the subclass of two disjointed classes.
 - ii. A Symmetric or Transitive Property must be an Object Property. `owl:equivalentClass` is a Symmetric, Reflexive and Transitive Property.
 - iii. `hasFather` property is an Asymmetric and Transitive Property.
 - iv. `owl:Restriction` is a subclass of `owl:Class`.
 - v. `owl:complementOf` can be used to indicate that two individuals (instances) are different.
 - vi. Description Logic based reasoner can be used to check the consistency of the OWL ontology.
- [6 marks]
- (e) Consider the vehicle scenario. Write an OWL class expression in RDF/XML that corresponds to the following OWL Functional syntax class expression. [6 marks]
- ```
Declaration(Class(:RailedVehicle))
EquivalentClasses(:RailedVehicle
 ObjectIntersectionOf(ObjectAllValuesFrom(:runOn :Track) :Vehicle))
SubClassOf(:RailedVehicle :Vehicle)
```
- (f) Consider the vehicle scenario. As part of the ontology definition for the scenario, define OWL classes for the entities in (i), (ii) and (iii) below. Use OWL Manchester syntax, OWL Functional syntax or RDF/XML as you wish. Assume all definitions are in the default namespace.
- i. Define an entity demonstrating the construction of an OWL class by using `owl:minCardinality` (or `owl:maxCardinality`) and `owl:someValueFrom`. [5 marks]
  - ii. Define an entity demonstrating the use of `owl:unionOf`. [5 marks]
  - iii. Define an entity demonstrating the use of `owl:cardinality` and `owl:hasValue`. [5 marks]
- (g) Consider the vehicle scenario. Give four examples of properties specific to the domain. Properties types may be chosen from transitive, symmetric, asymmetric, reflexive, irreflexive or disjoint respectively. Do not give more than one example of each property type. In the case of disjoint, note the property for which this is disjoint. Define the domain and range restrictions for the properties. [8 marks]

**Question 3.**

3. (a) Consider the following HTML code.

```
<html>
<head>Top Gear</head>
<body>
<div>
<p>
Top Gear is a BBC television series about motor vehicles,
primarily cars, and the most widely watched factual television
programme in the world. The programme has received acclaim for
its visual style and presentation as well as criticism for its
content. It is undergoing a major reconstruction since former
presenter Jeremy Clarkson left in 2015.
</p>
</div>
</body>
</html>
```

Markup the HTML code in RDFa using the following properties and classes defined in the dc, foaf and po namespaces respectively:

- dc:title and dc:year
- foaf:primaryTopic, foaf:name and foaf:Person
- po:Programme and po:BroadcasterOrganisation.

[9 marks]

- (b) Within the context of linked data, discuss the advantages and disadvantages of two different strategies for dereferencing URIs. [5 marks]
- (c) Enumerate four tags used to annotate web pages using Microdata. Briefly explain each of them. [6 marks]
- (d) For each statement below, write a reasoning rule using SWRL or Jena rule syntax:
- If person A is a friend of B then B is also a friend of A (use only `Person(?)` and `isFriendOf(?,?)` to express this rule).
  - Property `isYoungerThan` is transitive.
  - An individual *a* is linked to another individual *b* via property *p1*. If *p1* is a sub property of *p2* then *a* is also linked to *b* via property *p2*.
  - Given an RDF triple statement  $\langle s, p, o \rangle$ , if the domain of the property (predicate) *p* is class *C* then *s* must be an instance of *C*.

[10 marks]

- (e) Given the OWL class definition and instance data below, explain why the Statement 1 can be deduced by the Description Logic reasoner but not the Statement 2. [6 marks]



Class: Vegetarian

EquivalentTo: Person and (eat only Vegetable)

Class: NonVegetarian

EquivalentTo: Person and (eat some Meat)

Individual: person1

Types: Person

Facts:

eat beef\_steak

Individual: person2

Types: Person

Facts:

eat potato

**Statement 1:** person1 is a NonVegetarian.

**Statement 2:** person2 is a Vegetarian.

(Assume potato and beef\_steak are different instances. potato is an instance of Vegetable, beef\_steak is an instance of Meat)

- (f) Describe the five steps to publish linked data. Write two predicates that can be used for linking data sets. [7 marks]
- (g) Which of the following statements are true?
- i. London is a subclass of England.
  - ii. Both RDFa and Microdata can be used to annotate HTML and to create typed links.
  - iii. Every URL is also a URI, but there are URIs which are not URLs.

[4 marks]

- (h) Explain the differences between TBox and ABox.

[3 marks]



## Namespaces

```
base="http://www.cs.le.ac.uk/co7216/exam/#"
rdfs="http://www.w3.org/2000/01/rdf-schema#"
owl="http://www.w3.org/2002/07/owl#"
xsd="http://www.w3.org/2001/XMLSchema#"
rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
foaf="http://xmlns.com/foaf/0.1/"
dc="http://purl.org/dc/elements/1.1/"
po="http://purl.org/ontology/po"
```

Default namespace:

```
http://www.cs.le.ac.uk/co7216/exam/#
```