UNIVERSITY OF OSLO

Faculty of mathematics and natural sciences

Examination in	INF3580/INF4580 — Semantic Technologies
Day of examination:	4 June 2015
Examination hours:	09:00 – 13:00
This problem set consists of 6 pages.	
Appendices:	None
Permitted aids:	Any printed or written course material

Please make sure that your copy of the problem set is complete before you attempt to answer anything.

The exam consists of 5 questions with equal weight.

Problem 1 RDF (20 %)

The Norwegian Business Registry in Brønnøysund keeps information about "units" such as companies, organisations, etc. that are active in Norway. Every unit in the register is uniquely identified by a 9 digit "organisation number." The dataset is very large, it contains over 1 million units.

Assume that the Brønnøysund registry now wants to make the information about these units available as RDF data.

(a) There has to be a URI for every unit, and data should be published using linked open data (LOD) principles, such that the URI for a unit can be used to retrieve basic information about that unit. Which of the following suggestions for the URI is better, and why?

1. `http://brreg.no/enheter/`⟨*org.nr.*⟩
2. `http://brreg.no/enheter#`⟨*org.nr.*⟩

(b) What is "HTTP 303" redirection, and what is its purpose in the context of LOD?

(c) Consider the following HTML + RDFa 1.0 file:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML+RDFa 1.0//EN"
  "http://www.w3.org/MarkUp/DTD/xhtml-rdfa-1.dtd">
```

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```
<html xmlns="http://www.w3.org/1999/xhtml"
      xmlns:v="http://rdf.data-vocabulary.org/#"
      xmlns:brreg="http://brreg.no/vocab#">
  <head>
    <title>UNIVERSITETET I OSLO</title>
  </head>

  <body about="http://brreg.no/enheter/971035854" typeof="brreg:Enhet">

    <h1>Information about
      <span property="v:name">UNIVERSITETET I OSLO</span></h1>

    <p>Organisation Number
      <span property="brreg:orgNr">971035854</span></p>

    <p>Address:</p>
    <div rel="v:address">
      <address typeof="v:Address">
<span property="v:street-address">Postboks 1072 Blindern</span><br/>
<span property="v:postal-code">0316</span>
<span property="v:locality">OSLO</span>
      </address>
    </div>
  </body>
</html>
```

Please write the triples included in this file in Turtle format.

Problem 2 SPARQL (20 %)

Assume we have the two vocabularies `wth` and `mov` that describe weather and movies at movie theatres respectively. In `wth` we have the following defined URIs:

wth:DailyForecast (class) is the class of daily forecasts.

wth:dateTime (data property) gives the date as an `xsd:dateTime` string of the form "yyyy-mm-dd" for a a forecast.

wth:forecast (data property) states the actual weather forecast as a string for a given forecast. The forecast can be one of the literals "clear", "cloudy", "light rain", and "heavy rain".

In the `mov` vocabulary, we have the following URIs:

mov:Movie (class) the movies that can be shown in movie theatres.

mov:MovieTheatre (class) the movie theatres that show movies.

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mov:Screening (class) is all movie screenings. A movie screening is one display of a movie at a specific theatre at a specific date.

mov:theatre (object property) relates a movie screening to the theatre it runs at.

mov:shownMovie (object property) the movie shown in a screening.

mov:dateTime (data property) the date of a screening, which is an `xsd:dateTime` string on the form "yyyy-mm-dd".

mov:name (data property) relates movies to their title and movie theatres to their names.

Here are some example triples of the above vocabulary:

```
@prefix xsd: <http://www.w3.org/2001/XMLSchema#>
@prefix wht: <http://www.ifi.uio.no/weather#>
@prefix mov: <http://www.ifi.uio.no/movies#>

wht:fc1 a wht:DailyForecast;
  wth:dateTime "2015-05-07"^^xsd:dateTime;
  wht:forecast "light rain" .

mov:hobbitScreening a mov:Screening;
  mov:dateTime "2015-01-02"^^xsd:dateTime;
  mov:theater mov:colosseum;
  mov:shownMovie mov:hobbit .

mov:colosseum a mov:MovieTheater;
  mov:name "Colosseum" .

mov:hobbit a mov:Movie;
  mov:name "The Hobbit: The Battle of the Five Armies" .
```

(a) Write a SPARQL query that retrieves all dates where the forecast is cloudy .

(b) Write a SPARQL query returns *true* if there exists a date after 1. January 2015 where the forecast is cloudy and *false* otherwise (you can assume that `xsd:dateTime` is ordered chronologically by (<)).

(c) Assume that the weather station is somewhat unstable in your area, and that there might be days where there is no forecast. Write a SPARQL query that lists all movies on dates where, there is no forecast, or *if* there is a forecast, it should be heavy rain.

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(d) Write a SPARQL query that finds all dates where there is a screening of a movie that has a title that starts with the string "The Hobbit:" or where the forecast is clear.

(e) Write a SPARQL query that finds the theatres that have more than 5 screenings on a rainy day (either light or heavy rain). The query should output both the theatre, the date and the number of screenings.

Problem 3 RDFS Reasoning (20 %)

Consider the following triples about movies using the same vocabulary as the previous Problem:

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs:<http://www.w3.org/2000/01/rdf-schema#> .
@prefix foaf:<http://xmlns.com/foaf/0.1/> .
@prefix p: <http://example.org/people/> .
@prefix : <http://www.ifi.uio.no/movies#> .
(1) :hasDirector rdfs:domain :Movie .
(2) :hasActor rdfs:range :Actor .
(3) :hasMaleLead rdfs:range :Man .
(4) :hasMaleLead rdfs:subPropertyOf :hasActor .
(5) :hasFemaleLead rdfs:range :Woman .
(6) :hasFemaleLead rdfs:subPropertyOf :hasActor .
(7) :Actor rdfs:subClassOf :Person .
(8) :hobbit :hasDirector _:1 .
(9) _:1 foaf:name "Peter Jackson" .
(10) :hobbit :hasMaleLead p:martin .
(11) p:martin foaf:name "Martin Freeman" .
```

For each of the following triples (or sets of triples, in (e)), either give a derivation using the rules of RDFS and simple entailment, or give a short explanation of why such a derivation does not exist. If no derivation exists, also indicate whether the statement is entailed or not (under the simplified RDF/RDFS semantics used in the course).

(a) `:hobbit a :Movie .`

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(b)
```
p:martin a :Person .
```

(c)
```
:hasMaleLead rdfs:range :Person .
```

(d)
```
:hasFemaleLead rdfs:domain :Movie .
```

(e)
```
_:x :hasActor _:y .
_:x :hasDirector _:y .
```

Problem 4 Description logics/OWL (20 %)

Assume we have the following classes:

Postman, Route, Mail, PriorityMail, RegularMail

the following properties:

hasRoute, containsAddress, deliversToAddress, mailTo

and the following individuals:

king, pat

denoting the King and the person Pat respectively.

The property hasRoute is a relation between postmen and their routes, containsAddress is a relation between routes and the addresses on that route, deliversToAddress is a relation between postmen and the addresses they deliver mail to, and mailTo is a relationship between mail and the address the mail is for.

Express the following sentences as DL axioms:

(a) All postmen have a route.

(b) Pat is not a postman.

(c) All mail is either priority mail or regular mail, but never both.

(d) Postmen have between one and five routes.

(e) If something/someone has a route and that route contains an address, then that something/someone delivers mail to that address.

(f) All mail to the King is priority mail.

(Continued on page 6.)

Problem 5 RDF and OWL semantics (20 %)

In this problem, A, B, C and D are class names, a and b are individual names, and R is a role name.

(a) Let $\mathcal{I}$ be a DL-interpretation with $\mathcal{I} \models C \sqsubseteq D$. Show that also $\mathcal{I} \models \forall R.C \sqsubseteq \forall R.D$.

Note: This fact can be useful for the following questions!

(b) Given the following set $\mathcal{T}$ of TBox axioms:

$$\mathcal{T} = \{ \begin{array}{rl} A \sqcap B & \sqsubseteq \bot, \\ B & \sqsubseteq \forall R.\bot, \\ \forall R.D & \sqsubseteq A \end{array} \}$$

Are the axioms in $\mathcal{T}$ consistent with the ABox assertion $A(a)$? If yes, give an interpretation satisfying the three axioms and the assertion. If no, give a short explanation why, based on DL semantics.

(c) Are the axioms in $\mathcal{T}$ consistent with the ABox assertion $B(b)$? If yes, give an interpretation satisfying the three axioms and the assertion. If no, give a short explanation why, based on DL semantics.