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UNIVERSITY OF OSLO

Faculty of Mathematics and Natural Sciences

Examination in INF3580/INF4580

Day of examination: 15. June 2017
Examination hours: 9:00–13:00
Place: Sal D Silurveien 2

Permitted aids: Any printed or written course material

The exam consists of 5 sections with equal weight.

i **Section 1: RDF and R2RML**

Section 1: RDF and R2RML

1 **RDF, triples and prefixes**

Here are some triples with long, hard to read URIs. Write the same triples in Turtle notation, introducing some prefixes. (You can use standard prefixes, or invent your own.)

<http://dbpedia.org/ontology/TelevisionShow> <http://www.w3.org/2000/01/rdf-schema#subClassOf> <http://dbpedia.org/ontology/Work> .

<http://dbpedia.org/resource/How_I_Met_Your_Mother> <http://www.w3.org/1999/02/22-rdf-syntax-ns#type> <http://dbpedia.org/ontology/TelevisionShow> .

<http://dbpedia.org/resource/How_I_Met_Your_Mother> <http://www.w3.org/2000/01/rdf-schema#label> "How I Met Your Mother"^^<http://www.w3.org/2001/XMLSchema#string> .

<http://dbpedia.org/resource/How_I_Met_Your_Mother> <http://www.w3.org/2002/07/owl#sameAs> <http://yago-knowledge.org/resource/How_I_Met_Your_Mother> .

<http://dbpedia.org/resource/How_I_Met_Your_Mother> <http://dbpedia.org/ontology/starring> <http://yago-knowledge.org/resource/Alyson_Hannigan> .

<http://dbpedia.org/resource/How_I_Met_Your_Mother> <http://xmlns.com/foaf/name> "How I Met Your Mother"^^<http://www.w3.org/2001/XMLSchema#string> .

Fill in your answer here

```
1
```

Maximum marks: 4

2   Triples for R2RML mapping

Given the following table in a relational database:

Table **SERIES**

Title	Genre	Seasons	Episodes
How_I_Met_Your_Mother	Romantic_Comedy	9	208
Modern_Family	Sitcom	7	159

And the following mapping definition (we assume missing prefixes have been already defined):

```
<TriplesMap1> a rr:TriplesMap;
  rr:logicalTable  [rr:SQLQuery  "Select * from SERIES" ];
  rr:subjectMap
  [
    rr:template  "http://dbpedia.org/resource/{Title}";
    rr:class  <http://dbpedia.org/ontology/TelevisionShow>;
  ] ;
  rr:predicateObjectMap
  [
    rr:predicate  <http://dbpedia.org/ontology/numberOfEpisodes>;
    rr:objectMap  [ rr:column  "Episodes";  rr:datatype  xsd:integer; ]
  ] .
  rr:predicateObjectMap
  [
    rr:predicate  <http://dbpedia.org/ontology/numberOfSeasons>;
    rr:objectMap  [ rr:column  "Seasons";  rr:datatype  xsd:integer; ]
  ] .
  rr:predicateObjectMap
  [
    rr:predicate  <http://dbpedia.org/ontology/genre>;
    rr:objectMap  [ rr:template  "http://dbpedia.org/resource/{Genre}" ]
  ] .
```

Write down the triples generated by the mapping applied to the table "SERIES".

Fill in your answer here

1	

Maximum marks: 6

3   R2RML mapping from triples

Give the following database table:

Table **PLAYED-ROLE**

Actor	Role
Alyson_Hannigan	Lily_Aldrin
Joshua_Radnor	Ted_Mosby

Define an R2RML mapping that generates the following triples:

<http://dbpedia.org/resource/Alyson_Hannigan> <http://dbpedia.org/ontology/playRole>
<http://dbpedia.org/resource/Lily_Aldrin> .

<http://dbpedia.org/resource/Joshua_Radnor> <http://dbpedia.org/ontology/playRole>
<http://dbpedia.org/resource/Ted_Mosby> .

Fill in your answer here

```
1
```

Maximum marks: 6

4   Blank nodes

In this question, wrong answers will give 0 points.

Which of these are true and which false?

	False	True
Blank nodes can be used in the predicate position	○	○
Blank nodes can be used only in the subject position	○	○
Blank nodes have URIs	○	○
Blank nodes represent resources	○	○
Blank nodes do not have a global identifier	○	○

Maximum marks: 4

ℹ   **Section 2: SPARQL**

Section 2: SPARQL

Assume we have the following prefixes:

dbo - http://dbpedia.org/ontology/
dbr - http://dbpedia.org/resource/
xsd - http://www.w3.org/2001/XMLSchema
foaf - http://xmlns.com/foaf/

and the following RDFS classes and properties based on dbpedia:

dbo:Actor - The class of all actors
dbo:Person - The class of all people
dbo:TelevisionShow - The class of all TV shows
dbo:TelevisionEpisode - The class of all TV episodes

dbo:showName - Relationship between a TV show and a string denoting the TV show name
dbo:title - Relationship between a TV episode and a string denoting the episode's title
foaf:name - Relationship between a person and a string denoting the person name
dbo:starring - Relationship between a TV show or film and an actor
dbo:guest - Relationship between a TV episode and a person
dbo:releaseDate - Relationship between a TV show or TV episode and a date (xsd:date) representing the date the TV show/episode was first aired
dbo:completionDate - Relationship between a TV show and a date (xsd:date) representing the date the TV show was last aired
dbo:numSeasons - Relationship between a TV show and a integer literal denoting the number of seasons of the TV show
dbo:numEpisodes - Relationship between a TV show and a integer literal denoting the number of episodes of the TV show

Below are some example triples:

dbr:How_I_Met_Your_Mother	a	dbo:TelevisionShow ;
	dbo:showName	"How I Met Your Mother"^^xsd:string ;
	dbo:releaseDate	"2005-09-19"^^xsd:date ;
	dbo:starring	dbr:Josh_Radnor ;
	dbo:numSeasons	9^^xsd:integer ;
	dbo:numEpisodes	208^^xsd:integer .

dbr:Josh_Radnor	a	dbo:Actor ;
	foaf:name	Josh Radnor .

dbr:The_Stamp_Tramp	a	dbo:TelevisionEpisode ;
	dbo:series	dbr:How_I_Met_Your_Mother ;
	dbo:guest	dbr:Joe_Manganiello .

dbr:Joe_Manganiello	a	dbo:Actor ;
	foaf:name	Joe Manganiello .

5 TV Shows in 2016

Write a SPARQL query that lists the names of TV shows with episodes during 2016.

Fill in your answer here

1	

Maximum marks: 4

6 Shows with many guests

Write a SPARQL query that lists the TV episodes and number of guests, for the episodes with more than 10 guests.

Fill in your answer here

1	

Maximum marks: 4

7 Ongoing TV Shows

Write a SPARQL query that constructs an RDF-graph with triples of the form < x rdf:type dbo:OngoingTVShow> for every TV show "x" that does not have a completion date.

Fill in your answer here

1	

Maximum marks: 4

8 Long running shows

Write a SPARQL query that lists the TV shows that either have more than 200 episodes or were on air for more than 15 years. You can use the function year(…) in a FILTER to get the year from a xsd:date.

Fill in your answer here

1	

Maximum marks: 4

9   SPARQL Entailment regimes

Consider the following subgraph from dbpedia:

dbr:Josh_Radnor   owl:sameAs   freebase:Josh Radnor .

dbo:Actor   rdfs:subClassOf   dbo:Person .

dbo:starring   rdfs:range   dbo:Actor .

dbo:guest   rdfs:range   dbo:Person .

dbr:How_I_Met_Your_Mother   dbo:starring   dbr:Alyson_Hannigan .

dbr:How_I_Met_Your_Mother   dbo:guest   dbr:Joe_Manganiello .

Write the result of running the following SPARQL query over the above graph using: (a) Simple entailment, (b) RDF entailment, (c) RDF Schema entailment, and (d) OWL 2 Direct Semantics entailment.

SELECT ?person WHERE { ?person rdf:type dbo:Person }

Fill in your answer here

Format ▾	B	*I*	U	x₂	x²								Ω			Σ	

Words: 0

Maximum marks: 4

Section 3: RDFS inference

Section 3: RDFS inference

Assume we have the following prefixes

@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .

@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .

@prefix : <http://www.ifi.uio.no/banking#> .

and let Γ be the following set of triples:

(1)	:Account	rdfs:subClassOf	:BankService .
(2)	:SavingsAccount	rdfs:subClassOf	:Account .
(3)	:DebitAccount	rdfs:subClassOf	:Account .
(4)	:hasAccount	rdfs:domain	:Customer .
(5)	:hasAccount	rdfs:range	:Account .
(6)	:hasAccount	rdfs:subPropertyOf	:hasService .
(7)	:hasSavingsAccount	rdfs:subPropertyOf	:hasAccount .

(8)		:hasDebitAccount rdfs:subPropertyOf :hasAccount .	
(9)	:sa	rdf:type	:SavingsAccount .
(10)	:sandra	:hasSavingsAccount :sa .	
(11)	:peter	:hasAccount	:ba .
(12)	_:x	:hasService	:service .

You can use the numbers in the left-most column to reference the triples in your derivations in the following exercises.

10   Type of :sa

For the triple

:sa   rdf:type   :BankService .

either give a derivation from Γ using the rules of RDFS and simple entailment or explain why this is not possible if no such derivation exists. Also indicate whether the triple is entailed by Γ or not.

Fill in your answer here

Format	B I U x₂ x²				Ω ⊞	Σ	ᴬᴮꟲ	✕

Words: 0

Maximum marks: 3

11   Type of :peter

For the triple

:peter   rdf:type   :Customer .

either give a derivation from Γ using the rules of RDFS and simple entailment or explain why this is not possible if no such derivation exists. Also indicate whether the triple is entailed by Γ or not.

Fill in your answer here

Words: 0

Maximum marks: 3

12 _:y has service

For the triple

_:y   :hasService   _:y .

either give a derivation from Γ using the rules of RDFS and simple entailment or explain why this is not possible if no such derivation exists. Also indicate whether the triple is entailed by Γ or not.

Fill in your answer here

Words: 0

Maximum marks: 4

13   Entailed but not derivable

Write down a triple that is entailed by Γ but which is impossible to derive
using the rules of RDFS and simple entailment and explain why it is entailed but not derivable.

Fill in your answer here

Format ▾	B	I	U	x₂	x²	Iₓ	⎘	⎘	↰	↱	⟲	≔	≔	Ω	⊞	✎	Σ	ᴬᴮᶜ✔	⛶

Words: 0

Maximum marks: 5

14   :sandra has account

Assume we have the same prefixes as before, and let Γ' be the set of triples

(1)	:hasPrivateLoan	rdfs:subPropertyOf	_:r .
(2)	:hasCorporateLoan	rdfs:subPropertyOf	_:r .
(3)	_:r	rdfs:subPropertyOf	:hasService .
(4)	:sandra	:hasPrivateLoan	:loan .

For the triple

:sandra   :hasService   :loan .

either give a derivation from Γ' using the rules of RDFS and simple entailment or explain why this is not possible if no such derivation exists.

Fill in your answer here

| Format ▾ | **B** | *I* | U | x₂ | x² | T_x | ⎘ | ⎘ | ↩ | ↪ | ⟳ | ≔ | ≔ | Ω | ⊞ | ✎ | Σ | ABC | ⛶ |

Words: 0

Maximum marks: 5

ⓘ **Section 4: Description Logic and OWL**

Section 4: Description Logic and OWL

In the following exercises you can use Manchester syntax to write DL-axioms. The conversion between DL-syntax and Manchester syntax is given in the following table:

Constructor	DL-syntax	Manchester syntax
Bottom	$\perp$	Nothing
Top	$\top$	Thing
Intersection	$C \sqcap D$	C and D
Union	$C \sqcup D$	C or D
Complement	$\neg C$	not C
Closed class	$\{a, b, c\}$	$\{a, b, c\}$
Existential restriction	$\exists R.C$	R some C
Universal restriction	$\forall R.C$	R only C
Min. cardinality restriction	$\geq n\,R.C$	R min $n\,C$
Max. cardinality restriction	$\leq n\,R.C$	R max $n\,C$
Eq. cardinality restriction	$= n\,R.C$	R exactly $n\,C$
Self restriction	$\exists R.\text{Self}$	R Self
Property chain	$R \circ P$	$R\,o\,P$
Inverse property	R^-	inverse R
Property complement	$\neg R$	not R

Axiom	DL-syntax	Manchester syntax
Subclass of	$C \sqsubseteq D$	C SubClassOf D
Equivalent class	$C \equiv D$	C EquivalentTo D
Subproperty of	$R \sqsubseteq P$	C SubPropertyOf D
Equivalent property	$R \equiv P$	R EquivalentTo P

ⓘ **Classes, properties and individuals**

In the following exercises, use this vocabulary:

<u>Classes:</u>

- **Computer**
- **SuperComputer**
- **CPU**
- **Core**
- **RAM**
- **Motherboard**

<u>Properties:</u>

- **hasPart**
- **hasCore**
- **isConnectedTo**

<u>Individuals:</u>

- *superCPU*

A computer can e.g. have a CPU as part, and a CPU can have cores. A CPU can e.g. be connected to a motherboard. But CPUs are not parts of motherboards, they are connected to motherboards.

15   Computer, CPU

Write a DL-axiom stating that a computer is precisely something that has a CPU.

Fill in your answer here

Format ▾	B	I	U	x₂	x²													

Words: 0

Maximum marks: 2

16   Parts of computer

Write a DL-axiom stating that all parts of a computer are either motherboards or things connected to motherboards.

Fill in your answer here

| Format ▾ | **B** *I* U x₂ x² Iₓ | ⎙ ⎘ | ↰ ↱ ⟲ | ☰ ☷ | Ω ⊞ | ✎ | Σ | ABC | ⤢ |

Words: 0

Maximum marks: 4

17   Super-computer

Write a DL-axiom stating that if a computer either has more than 2 CPUs or a CPU with more than 8 cores, then it is a super-computer.

Fill in your answer here

| Format ▾ | **B** *I* U x₂ x² Iₓ | ⎙ ⎘ | ↰ ↱ ⟲ | ☰ ☷ | Ω ⊞ | ✎ | Σ | ABC | ⤢ |

Words: 0

Maximum marks: 4

18   myCPU

Write a DL-axiom asserting that *myCPU* is a CPU that is part of a super-computer.

Fill in your answer here

Format ▾	B	I	U	x₂	x²	Iₓ		Ω			Σ	ABC	

Words: 0

Maximum marks: 3

19 Connected to itself

Write a DL-axiom stating that nothing is connected to itself.

Fill in your answer here

Format ▾	B	I	U	x₂	x²	Iₓ		Ω			Σ	ABC	

Words: 0

Maximum marks: 3

20 Not having parts

Write a DL-axiom stating that if a thing x has a CPU with a core y, then x has y as a core.

Fill in your answer here

| Format ▾ | **B** | *I* | U | x₂ | x² | I̶ₓ | ⎙ | ⎘ | ⬅ | ➡ | ⟲ | ≔ | ≔ | Ω | ⊞ | ✎ | Σ | ᴬᴮꟲ | ⤫ |

Words: 0

Maximum marks: 4

ℹ **Section 5: RDF and OWL semantics**

Section 5: RDF and OWL semantics

For writing OWL or DL expressions, please use the Manchester syntax, see the table in Section 4.

21 Blank node semantics

Let I be the following interpretation:

Δ^I = {robert, cersei, jaime, joffrey}

Man^I = {robert, jaime, joffrey}

$Woman^I$ = {cersei}

$King^I$ = {robert}

$marriedTo^I$ = {<cersei,robert>}

$hasFather^I$ = {<joffrey,jaime>}

$hasMother^I$ = {<joffrey, cersei>}

Let A be the set of triples
{ _:b :hasFather _:c, _:c rdf:type King }
or in DL notation:
{ hasFather(_:b,_:c), King(_:c) }

Is it the case that $I \models A$, i.e. A is true in I?

Please explain your answer, using the simplified RDFS model semantics from the course.

Fill in your answer here

Format ▾	**B**	*I*	<u>U</u>	x₂	x²															

Words: 0

Maximum marks: 7

22 OWL Concept semantics

Let I be the **same interpretation as before,** repeated here for convenience.

Δ^I = {robert, cersei, jaime, joffrey}

Man^I = {robert, jaime, joffrey}

$Woman^I$ = {cersei}

$King^I$ = {robert}

$marriedTo^I$ = {<cersei,robert>, <robert,cersei>}

$hasFather^I$ = {<joffrey,jaime>}

$hasMother^I$ = {<joffrey, cersei>}

Please give the interpretation of the OWL concepts

a) King **or** marriedTo **some** King

(In DL syntax: $King \sqcup \exists marriedTo . King$)

b) King **or** marriedTo **only** King

(In DL syntax: $King \sqcup \forall marriedTo . King$)

Please explain your answer, using the OWL model semantics from the course.

Fill in your answer here

Format ▾	**B**	*I*	<u>U</u>	x₂	x²	...	...

Words: 0

Maximum marks: 6

23 OWL Axiom semantics

Let I be the **same interpretation as before,** repeated here for convenience.

Δ^I = {robert, cersei, jaime, joffrey}

Man^I = {robert, jaime, joffrey}

$Woman^I$ = {cersei}

$King^I$ = {robert}

$marriedTo^I$ = {<cersei,robert>, <robert,cersei>}

$hasFather^I$ = {<joffrey,jaime>}

$hasMother^I$ = {<joffrey, cersei>}

Do the following OWL axioms hold in I?

a) King **subClassOf** marriedTo **only** Woman

DL Syntax: $King \sqsubseteq \forall marriedTo \,.\, Woman$

b) King **subClassOf** marriedTo **only** owl:Thing

DL Syntax: $King \sqsubseteq \forall marriedTo \,.\, \top$

Is each of these an OWL tautology, i.e. does it hold in *any* interpretation?

Fill in your answer here

| Format ▾ | B | I | U | x₂ | x² | I_x | 📋 | 📋 | ↰ | ↱ | ⟲ | ☰ | ☰ | Ω | ⊞ | ✏ | Σ | ABC | ⛶ |

Words: 0

Maximum marks: 7