

Name:

ID:

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Total (max 31 points)
Points								

Knowledge Representation and Reasoning – Mod. 2

Mock Test 2022

RDF, RDFS, XSD & OWL Cheatsheet

- `rdf:type`
- `rdf:Statement`
- `rdf:subject`
- `rdf:predicate`
- `rdf:object`
- `rdfs:subClassOf`
- `rdfs:subPropertyOf`
- `rdfs:label`
- `rdfs:domain`
- `rdfs:range`
- `xsd:string`
- `xsd:integer`
- `xsd:decimal`
- `owl:equivalentClass`
- `owl:disjointWith`
- `owl:sameAs`
- `owl:differentFrom`
- `owl:Class`
- `owl:ObjectProperty`
- `owl:DatatypeProperty`
- `owl:NamedIndividual`
- `owl:Restriction`
- `owl:onProperty`
- `owl:allValuesFrom`
- `owl:someValuesFrom`
- `owl:cardinality`
- `owl:minCardinality`
- `owl:minQualifiedCardinality`
- `owl:maxCardinality`
- `owl:maxQualifiedCardinality`
- `owl:onClass`

Question 1. RDF

5 P.

According to the semantics of *simple interpretations*:

1. Does the graph G_1 entail the graph G_2 ? Justify your answer (provide a valid blank node assignment or a counterexample)¹. 2.5 P
2. Does the graph G_1 entail the graph G_3 ? Justify your answer (provide a valid blank node assignment or a counterexample). 2.5 P

G_1	G_2	G_3
<div> <div>ex:alice ex:parent ex:bob</div> <div>ex:bob ex:parent ex:carol</div> </div>	<div> <div><u>_</u>:x ex:parent <u>_</u>:y</div> <div><u>_</u>:z ex:parent <u>_</u>:x</div> </div>	<div> <div><u>_</u>:x ex:parent ex:bob</div> <div>ex:bob ex:parent <u>_</u>:x</div> </div>

Remark: prefix definitions are omitted; notation is Turtle.

Another example for Question 1

5 P.

Express the following using the Turtle syntax² and, where relevant, typed literals:

1. Alice knows Bob who is a person
2. Alice knows Mary, who is a Teacher and is 28 years old
3. Alice knows Bob's sister, who is 28 years old
4. Alice knows that Bob is 28 years old
5. Bob wants to prevent Alice from studying Law

```

@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns##> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema##> .
@prefix owl: <http://www.w3.org/2002/07/owl##> .
@prefix ex: <http://example.org/> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
## continue here

```

¹In a real exam, the hint written within parentheses may be omitted

²You can use prefixes, and, in particular ex: as a prefix

Question 1. RDF

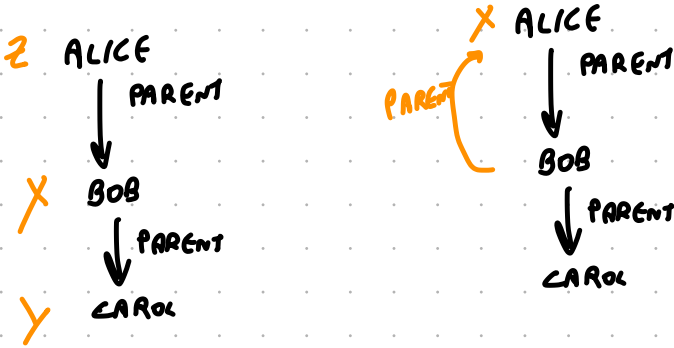
5 P.

According to the semantics of *simple interpretations*:

1. Does the graph G_1 entail the graph G_2 ? Justify your answer (provide a valid blank node assignment or a counterexample)¹.
2.5 P
2. Does the graph G_1 entail the graph G_3 ? Justify your answer (provide a valid blank node assignment or a counterexample).
2.5 P

G_1	G_2	G_3
ex:alice ex:parent ex:bob ex:bob ex:parent ex:carol	_:x ex:parent _:y _:z ex:parent _:x	_:x ex:parent ex:bob ex:bob ex:parent _:x

Remark: prefix definitions are omitted; notation is Turtle.



Another example for Question 1

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Express the following using the Turtle syntax² and, where relevant, typed literals:

1. Alice knows Bob who is a person
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@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
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@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix ex: <http://example.org/> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
## continue here
```

1) ex:ALICE foaf:knows ex:BOB.
ex:BOB rdfs:type ex:PERSON.

ex:ALICE foaf:knows [ex:BOB rdfs:type ex:PERSON]
???

2) ex:ALICE foaf:knows ex:MARY.
ex:MARY rdfs:type ex:PERSON;
rdfs:occupation ex:TEACHER;
ex:YEARSOLD 28.

3) ex:ALICE foaf:knows _:x.
_:x foaf:sister ex:BOB;
ex:YEARSOLD 28.

4) ex:ALICE ex:knows [rdfs:type ex:STATEMENT;
rdfs:subject ex:BOB;
rdfs:predicate ex:YEARSOLD;
rdfs:object 28],

5) ex: Bob ex: want to prevent

??

Question 2. SPARQL

5 P.

Consider the following RDF graph:

```
@prefix : <http://example.org/> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .

:A rdfs:subClassOf :B .
:B rdfs:subClassOf :C .
:p rdfs:domain :A ; rdfs:range :C .
:q rdfs:domain :B .

:a rdf:type :A . :b rdf:type :B . :c rdf:type :C .
:c :p :d . :d :q :e .
```

1. What are the results of the following queries?

2 P

- `select * where { ?x a ?y }`
- `select * where { ?x rdfs:subClassOf ?y } LIMIT 1`

2. Write the following queries and their results:

3 P

- Retrieve all ?x and ?y such that ?x and ?y are related by :p or by :q.
- Construct a graph containing the results of the following inference: if
 - ?c is the domain of the property ?p,
 - ?c is a subclass of ?d, and
 - ?x and ?y are related by ?pthen ?x is an instance of ?d

Question 2. SPARQL

5 P.

Consider the following RDF graph:

```
@prefix : <http://example.org/> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns##> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema##> .
@prefix owl: <http://www.w3.org/2002/07/owl##> .

:A rdfs:subClassOf :B .
:B rdfs:subClassOf :C .
:p rdfs:domain :A ; rdfs:range :C .
:q rdfs:domain :B .

:a rdf:type :A . :b rdf:type :B . :c rdf:type :C .
:c :p :d . :d :q :e .
```

1. What are the results of the following queries?

2 P

- `select * where { ?x a ?y }`
- `select * where { ?x rdfs:subClassOf ?y } LIMIT 1`

1. A) (:a ; :A) , (:b ; :B) , (:c ; :C)
 (:a ; :B) , (:a ; :C) , (:b ;
1. B) (:A ; :B)

Question 3. RDFS

3 P.

Model (only) with RDFS syntax a schema that is compliant with the following constraints:

- Musicians and Bands are Music Artists;
- Musicians are associated with Bands;
- Musicians that sing in a band are associated with that band;
- Singles and Albums are Music Works;
- Singles are included in Albums;
- Singles have titles, and Albums have titles too;
- Titles are denoted with strings;
- Musicians and Bands make Singles and Albums;

and that guarantees the following inferences:

- If it is known that Paul McCartney (PM) makes Waterfalls, infer that PM is a Music Artist and Waterfalls is a Music Work;
- If a literal value v is a title of a Music Work, infer that it is a String;
- If it is known that PM sings in The Beatles, infer that PM is a Musician and The Beatles is a band;
- If it is known that Waterfalls is included in McCartney II, infer that Waterfalls is a Single and McCartney II is an Album.

You can skip the prefix section and use `ex:` as prefix for resources that are not classes or properties, and `onto:` as prefix for classes and properties (obvious exceptions apply to classes and properties defined in the `rdf`, `rdfs`, and `xsd` vocabularies). Also you can draw a graph where nodes are classes and edges are properties in addition to writing the statements.

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Question 4. Modeling Knowledge with Description Logics (OWL)

5 P.

1. Express the following using the Description Logic syntax: 3 P
 - a) Carol is a Math student who attends the Algebra course. Alice is a student who attends the Algebra and Algorithms courses. The latter is a CS course.
 - b) Students are people who attend at least one course.
 - c) Organized students are students who attend exactly 2 courses.
 - d) Specify which classes (resp., properties) are subclasses (subproperties) of which; specify the domain and range of each property.
 - e) Math students attend only Math courses, and CS students attend only CS courses.
2. What can be inferred in the Abox about Alice, Carol, and the Algebra and Algorithm courses, if anything (justify your answer)? 2 P

$$\underline{MT} = \exists \text{ATTEND. MC}$$

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Question 5. Datalog

5 P.

1. Provide the most general unifier of the following pair of terms, if it exists. Justify your answer.

$p(a, B, C, d, B) \quad p(X, y, X, Z, X).$

2. Consider the following KB:

$r(a). \quad r(e).$
 $p(c).$
 $q(b).$
 $s(a, b). \quad s(d, b). \quad s(e, d).$
 $p(X) :- q(X), r(X).$
 $q(X) :- s(X, Y), q(Y).$

Show that $KB \vdash p(e)$ by proceeding bottom-up.

Question 6. Disjunctive and Nonmonotonic Reasoning in ASP

5 P.

1. Consider the following program:

```
q v -r v p :- not p.  
d :- not r.  
-q.
```

- a) Explain why p cannot be in any answer set 1.5 P
- b) Provide the answer sets of the program, if any. Justify your answer 1.5 P
2. Write a program that implements the guess and check methodology in ASP according to the following specifications. 2 P

You have several socks of three colors and you want to organize them by assigning each sock to exactly one of three boxes:

- Use the following predicates (and possibly more if you need):
 - `white_sock(X)`, `grey_sock(X)` and `black_sock(X)` if X is, respectively, a white, grey, or black sock.
 - `assign(X, Y)` means that the sock X is assigned to the box Y , where Y must be one of `white_box`, `grey_box` and `black_box`.
- The organization must satisfy the following:
 - Grey socks can only be assigned to the grey box;
 - White socks can be assigned to the white box or the grey box;
 - Black socks can be assigned to the grey box or the black box;
 - You cannot put white and black socks in the same box.

Additional question (not needed to get the full 2 points): How many possible ways to organize your socks (i.e., how many answer sets) are there if you have the following socks?

```
white_sock(w).  grey_sock(g).  black_sock(b).
```

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Question 7. Open Question

3 P.

Explain the differences between *lexical ontologies*, *taxonomies*, and *axiomatic ontologies*.