Data and Knowledge Representation Languages: September 7, 2015

NAME …….. SURNAME …….. STUDENT ID……..

1. [5 PT] Say (mark with an X) whether the following statements are true (T) or false (F).

a) In formal logics, a model of a theory is an interpretation function which satisfies all the facts in the theory	**□ T □ F**
b) In Description Logic (DL) languages, instance checking is the ABox service that finds all the instances of a concept C	**□ T □ F**
c) Databases are limited w.r.t. DL in that databases represent a single model and inference is just instance retrieval or model checking.	**□ T □ F**
d) Venn diagrams cannot be used to prove the satisfiability of a DL ALC formula w.r.t. a TBox.	**□ T □ F**
e) The problem of automatic classification of documents in a lightweight ontology corresponds to reason about subsumption between the concepts at labels and the concepts of the documents	**□ T □ F**
f) S-Match is a semantic matching tool where the three steps are the following: (1) Compute concepts for labels; (2) Compute concepts for each node; (3) Compute semantic relations between concepts.	**□ T □ F**
g) The RelBAC general access control rule S $\sqsubseteq \exists$ P.O means that the subject S is allowed to access permission P over object O.	**□ T □ F**
h) Producing 2-star data requires the Open Data to be made available in non-proprietary structured format in order to make it machine readable	**□ T □ F**
i) While OWL Full trades expressivity for efficiency, OWL Lite trades computational completeness for expressivity.	**□ T □ F**
j) Synonymy indicates the linguistic phenomenon in which multiple words correspond to the same meaning	**□ T □ F**

2. [2 PT] Explain the relation between the notion of *correctness* and of *decidability* in a formal language.

A language is decidable if we can come up with an algorithm to check the correctness of a formula given the formation rules of the language.

3. [6 PT] Define a TBOX and ABOX for the following problem: "A father is a male person having at least a child. A happy father is a father whose children are all doctors or lawyers". John is a happy father given that her child Mary is a doctor". Finally, define a domain D and provide a class valuation σ which satisfies them.

TBOX

$Father \equiv Male \sqcap Person \sqcap \exists Child$

$HappyFather \equiv Father \sqcap \forall Child.(Doctor \sqcup Lawyer)$

ABOX
HappyFather(John)
Child(John, Mary)
Doctor(Mary)

CLASS VALUATION
D = {John, Mary, Stuart}
σ (Person) = {John, Mary, Stuart}
σ (Male) = {John, Stuart}
σ (Father) = {John}
σ (HappyFather) = {John}
σ (Doctor) = {Mary}
σ (Lawyer) = {Stuart}
σ (Child) = {(John, Mary)}

Data and Knowledge Representation Languages: September 7, 2015

NAME …….. SURNAME …….. STUDENT ID……..

4. [4 PT] For each of the following DL sentences, say which DL language with lowest expressiveness possible (e.g. AL, ALC, FL0…) has been used and translate them in natural language.

DL sentence	DL language	Natural language sentence
Policeman ⊑ Officer ⊓ ∀access.(Document ⊓ Restricted)	FL0	Policemen are officers that can access restricted documents only
CloseFriend ⊑ Friend ⊓ ∀access.myPhotos	FL0	Close friends are friends that can access my photos only

5. [2 PT] Provide an example of inconsistent ABox w.r.t. a non-empty TBox.

For instance:
TBox = { Male ⊑ ¬Female}
ABox = {Male(John), Female(John)}

6. [4 PT] Define the RelBAC rules necessary for the following problem: "In a controlled storage for music there are two types of songs: Purchased Songs and Unlicensed Songs. Purchased Songs can be played by everyone. Unlicensed Songs can be played at most 5 times by Standard Users and an unlimited number of times by Premium Users.

StandardUser ⊑∃ Play.PurchasedSong
PremiumUser ⊑∃ Play.PurchasedSong

StandardUser ⊑ ≤5 Play.UnlicensedSong
PremiumUser ⊑∃ Play.UnlicensedSong

7. **[2 PT] Provide an example of query, both in natural language and in DL language, and a corresponding non-empty answer on top of the following TBox and ABox:**

TBox = {Person ⊑ Female ⊔ Male}
ABox = {Child(John, Mary), Child(Eva, Mary), Child(Eva, Luc), Female(Mary), Male(Luc)}

For instance:
NL query: Find all individuals having only female children

DL Query: T, A ⊨ ∀Child.Female
Answer: {John}

8. **[3 PT] Applications that use RDF data from multiple sources need to overcome the issue of managing terminology. Suppose that one source uses the term analyst and another one uses the term researcher. How can you represent in RDF the fact that:**
   a) **researcher is a special case of analyst?**
   b) **researcher and analyst may overlap?**
   c) **researcher and analyst are equivalent?**

a) If a researcher is a special case of analyst, then all researchers are also analysts:

:Researcher	**rdfs:subClassOf**	**:Analyst**

b) We can define a new class and express the fact that both classes specialize it (so they may overlap):

:Researcher	**rdfs:subClassOf**	**:Investigator**
:Analyst	**rdfs:subClassOf**	**:Investigator**

c) RDFS does not provide a primitive construct for expressing class equivalence. It can be represented using rdfs:subClassOf:

:Analyst	**rdfs:subClassOf**	**:Researcher**
:Researcher	**rdfs:subClassOf**	**:Analyst**

9. [3 PT] Suppose you have a RDF model that represents information about books, created using standard vocabularies (i.e. Dublin Core). Write a SPARQL query that returns in descending order the authors of the books whose title starts with "Harry Potter".

```
PREFIX dc: <http://purl.org/dc/elements/1.1/>
SELECT ?bookTitle ?author
WHERE
    {  ?book dc:creator ?author.
       ?book dc:title ?bookTitle.
       FILTER regex(?bookTitle, "^Harry Potter") }
ORDER BY DESC (?author)
```

10. [2 PT] The picture below provides the hyponyms of the term "mountain" taken from WordNet. (a) Provide the proper nouns (denoting individual entities), and (b) Provide common nouns whose definition contains a genus that (according to the guidelines of the DERA methodology) is not consistent with the position in the hierarchy.

S: (n) **mountain**, mount (a land mass that projects well above its surroundings; higher than a hill)
- ***direct hyponym*** / *full hyponym*
  - S: (n) alp (any high mountain)
  - S: (n) ben (a mountain or tall hill) *"they were climbing the ben"*
  - S: (n) seamount (an underwater mountain rising above the ocean floor)
  - S: (n) volcano (a mountain formed by volcanic material)
  - S: (n) Black Hills (mountains in western South Dakota and northeastern Wyoming)

(a) Black Hills

(b) ben (because of the "or")