| Logics for Data and Knowledge Representation: 12th September 2014 |
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| NAME ………………….. SURNAME ………………….. STUDENT ID………………….. |

**1. [6 PT] Say (mark with an X) whether the following statements are true (T) or false (F).**

| | | |
|---|---|---|
| **a) Venn diagrams cannot be used to prove the satisfiability of a DL ALC formula w.r.t. a TBox.** | **□ T** | **□ F** |
| **b) In syntactic matching a similarity measure between the nodes of the two graphs is computed by comparing their labels** | **□ T** | **□ F** |
| **c) In a lightweight ontology there are is-a and part-of relations** | **□ T** | **□ F** |
| **d) In RDFS, properties are defined with respect to the classes of the resources they can be attached to** | **□ T** | **□ F** |
| **e) SPARQL forbids RDF Literals as the subject of RDF triples** | **□ T** | **□ F** |
| **f) OWL DL is more expressive than OWL Lite while guarantees conclusions and decidability** | **□ T** | **□ F** |

**2. [3 PT] Provide the formal semantics of propositional DL in terms of a class valuation and formally explain what it means for a propositional DL formula to be satisfiable.**

**σ(⊥) = ∅**

**σ(⊤) = U (Universal Class, or Universe)**

**σ(P) ⊆ U, as defined by σ**

**σ(¬P) = {*a* ∈ U | *a* ∉ σ(P)} = *comp*(σ(P)) (Complement)**

**σ(P ⊓ Q) = σ(P) ∩ σ(Q) (Intersection)**

**σ(P ⊔ Q) = σ(P) ∪ σ(Q) (Union)**

**Satisfiability:**

**Let σ be a class-valuation on language L, we define the truth-relation (or class-satisfaction relation) ⊨ and write σ ⊨ P (read: σ satisfies P) iff σ(P) ≠ ∅**

3. **[5 PT] Translate the following natural language sentences in DL language with lowest expressiveness possible (e.g. AL, ALC, FL0…) and say which of the languages you used:**
   a. **A parent is a person having at least one natural child or an adopted child**
   b. **Monkeys are animals which are disjoint from Lions**
   c. **The friend of a policeman cannot be a criminal**
   d. **Facebook users can only post photos about their friends**
   e. **Germans do not have Italian friends and friends having Italian friends**

PARENT ⊑ PERSON ⊓ (∃hasNaturalChild.⊤ ⊔ ∃hasAdoptedChild.⊤) (ALU)

MONKEY ⊑ ANIMAL ⊓ ¬ LION (AL)

POLICEMAN ⊑ ¬ ∃friendOf.Criminal (ALE)

FACEBOOK-USER ⊑ USER ⊓ ∀POST.FRIEND-PHOTO (FL0)

GERMAN ⊑ ∀friendOf. (¬ ITALIAN ⊔ ¬ ∃ friendOf.ITALIAN) (ALCE)

4. **[2 PT] Formally explain the "separation of duties" RelBAC rule with an example in DL**

**See slides**

**5. [3 PT] Formalize the following problem in DL and provide a TBox and ABox as appropriate: "Unicorns are mythical horses having a horn. Pegasus is a unicorn while George is not. Nevertheless, George is a horse". Provide also a formal proof to demonstrate whether the ABox is consistent with the TBox obtained.**

**TBOX T**
**Unicorn ⊑ mythical ⊓ horse ⊓ hasHorn**

**ABOX A**
**Unicorn(Pegasus), ¬Unicorn(George), horse(George)**

**We can check that it is consistent given that the expansion of A w.r.t. T does not contain contradictions. In fact, we have 3 possible expansions of ¬Unicorn(George):**

**¬Unicorn(George) ⇨ ¬ mythical (George) or ¬ horse (George) or ¬ hasHorn(George)**

**Where only the second would generate and contradiction.**

6. [3 PT] Suppose we describe people in an academic environment using DL as follows:

| | |
|---|---|
| Undergraduate | $\sqsubseteq \neg$ Teach |
| Bachelor | $\equiv$ Student $\sqcap$ Undergraduate |
| Master | $\equiv$ Student $\sqcap \neg$ Undergraduate |
| PhD | $\equiv$ Master $\sqcap$ Research |
| Assistant | $\equiv$ PhD $\sqcap$ Teach |

Are assistants undergraduates? Provide a proof to answer.

We need to check whether:

T $\models$ Assistant $\sqsubseteq$ Undergraduate

Assistant $\equiv$ PhD $\sqcap$ Teach $\equiv$ Master $\sqcap$ Research $\sqcap$ Teach $\equiv$
Student $\sqcap \neg$ Undergraduate $\sqcap$ Research $\sqcap$ Teach

Assistants are actually students who are not undergraduates.

7. [2 PT] List and provide a brief description of the four basic ABox reasoning services

See slides

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**8. [3 PT] Given that an RDF model represents information about books and the model is created using standard vocabularies.**

**i) Write a SPARQL query that can return the publishers of the books. Note that books can be represented as URIs.**

**ii) Write a SPARQL query that can return the title and date of publication of the books.**

i)
```
PREFIX dc:    <http://purl.org/dc/elements/1.1/>
    SELECT ?book ?publisher
    WHERE
     { ?book dc:publisher ?publisher }
```

ii)
```
PREFIX dc:    <http://purl.org/dc/elements/1.1/>
    SELECT ?bookTitle ?dateOfPublication
    WHERE
     { ?book dc:date ?dateOfPublication.
       ?book dc:title ?bookTitle
     }
```

**9. [3 PT] What inferences can be drawn from each of the following sets of axioms?**

| | | | |
|---|---|---|---|
| i) | :researcherAt | rdfs:range | :Italian_University |
| | :Benedikt_Elser | :researcherAt | :UniTn |
| ii) | :Researcher | rdfs:subClassOf | :Scientist |
| | :publishedIn | rdfs:domain | :Researcher |
| | :Fausto_Giunchiglia | :publishedIn | :ISWC_2007_Conference |
| iii) | :Italian_University | rdfs:subClassOf | :European_University |
| | :professorshipAt | rdfs:range | :Italian_University |
| | :Fausto_Giunchiglia | :professorshipAt | :UniTn |

| | | | |
|---|---|---|---|
| i) | :UniTn | rdf:type | :Italian_University |
| ii) | :Fausto_Giunchiglia | rdf:type | :Researcher |
| | :Fausto_Giunchiglia | rdf:type | :Scientist |
| iii) | :UniTn | rdf:type | :Italian_University |
| | :UniTn | rdf:type | :European_University |

10. [3 PT] Provide a comparison among OWL 2 profiles EL, QL and RL, which were specified for different kinds of representation and application needs.

See slides