

## Homework #3: OWL and DL

The following exercises are due at the beginning of class on Thursday, March 7. This will count for 10% of your overall grade.

1. [30 pts.] Consider the following OWL document using the RDF syntax. Draw the equivalent graph. For convenience, you may use QNames for your node and edge labels and you may use relative ids for nodes where no namespace is specified.

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:owl="http://www.w3.org/2002/07/owl#">
  <owl:Ontology rdf:about="" />
  <owl:Class rdf:ID="Person" />
  <owl:Class rdf:ID="Parent">
    <owl:equivalentClass>
      <owl:Restriction>
        <owl:onProperty rdf:resource="#hasChild">
          <owl:someValuesFrom rdf:resource="#Person">
        </owl:Restriction>
      </owl:equivalentClass>
    </owl:Class>
  <owl:Class rdf:ID="Man">
    <rdf:subClassOf>
      <owl:Restriction>
        <owl:onProperty rdf:resource="#hasChild">
          <owl:allValuesFrom rdf:resource="#Person">
        </owl:Restriction>
      </ rdf:subClassOf >
    </owl:Class>
  <owl:ObjectProperty rdf:ID="hasParent">
  <owl:ObjectProperty rdf:ID="hasChild">
    <owl:inverseOf rdf:resource="#hasParent">
  </owl:ObjectProperty>
</rdf:RDF>
```

2. [10 pts.] One way to specify that two classes are disjoint in OWL is to use the `owl:disjointWith` property. However, this property is actually redundant. In the OWL RDF/XML-based syntax, write two different axioms (i.e., they use a different combination of constructors) stating that the classes `Man` and `Woman` are disjoint. Do not use `owl:disjointWith`.
3. [10 pts.] Consider the `swpub.rdf` schema from the last homework (<http://www.cse.lehigh.edu/~heflin/courses/sw-2013/hw2/swpub.rdf>). Using the RDF/XML syntax, write an OWL axiom that states that any **PublishedWork** that has a **publisherLoc** property also has a **publishedBy** property.

4. [15 pts.] Consider an ontology that contains the following triples (written in Turtle):

```

@PREFIX xsd: <http://www.w3.org/2001/XMLSchema#> .
@PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@PREFIX owl: <http://www.w3.org/2002/07/owl#> .
:PublishedWork a owl:Class ;
    rdfs:comment "Any written material that is offered for sale or distribution." .
:InProceedings a owl:Class ;
    rdfs:subClassOf :PublishedWork;
    rdfs:comment "A paper that appears in a conference or workshop." .
:Conference a owl:Class ;
    rdfs:comment "A formal meeting for presentation and discussion of
        scientific work." .
:partOfEvent a owl:ObjectProperty ;
    rdfs:domain InProceedings ;
    rdfs:range Conference ;
    rdfs:comment "Relates a conference paper to the conference that it is
        presented in." .
:venue a owl:DatatypeProperty ;
    rdfs:domain :InProceedings ;
    rdfs:range xsd:string ;
    rdfs:comment "The name of the conference the paper appeared in." .
:confLocation a owl:DatatypeProperty ;
    rdfs:domain :InProceedings ;
    rdfs:range xsd:string ;
    rdfs:comment "The place where the paper was presented." .
:publishedYear a owl:DatatypeProperty ;
    rdfs:domain :PublishedWork ;
    rdfs:range xsd:integer ;
    rdfs:comment "The year that a paper or book was published." .
:confName a owl:DatatypeProperty ;
    rdfs:domain :Conference ;
    rdfs:range xsd:string ;
    rdfs:comment "The name of the conference." .
:location a owl:DatatypeProperty ;
    rdfs:domain :Conference ;
    rdfs:range xsd:string ;
    rdfs:comment "The place where the conference was held." .
:year a owl:DatatypeProperty ;
    rdfs:domain :Conference ;
    rdfs:range xsd:integer ;
    rdfs:comment "The year that the conference was held." .

```

Write a set of OWL2 axioms in Turtle that would allow one to infer a conference paper's venue, location and year from the name, location and year of a conference instance that it is presented in.

5. [20 pts.] Translate the following DL axioms into OWL DL (using the Turtle syntax). Assume that  $A, B, C$ , and  $D$  denote atomic concepts,  $P$  and  $R$  denote atomic roles, and  $a$  an individual.
- $A \equiv B \sqcap (C \sqcup D)$
  - $A \sqsubseteq \exists P^{-}.C$
  - $\neg A \sqsubseteq B \sqcap \exists P.\{a\}$
  - $\forall P.(B \sqcup C) \equiv \leq 2 R$
6. [15 pts.] (Required for CSE 428 students, extra credit for CSE 398 students) Consider the following simple description logic, where  $\cdot^I$  is the interpretation function.

Class Constructor Syntax	Semantics
$C \sqcap D$	$(C \sqcap D)^I = C^I \cap D^I$
$C \sqcup D$	$(C \sqcup D)^I = C^I \cup D^I$
$\forall R.C$	$(\forall R.C)^I = \{x \mid \forall y. \langle x, y \rangle \in R^I \Rightarrow y \in C^I\}$
$\exists R.C$	$(\exists R.C)^I = \{x \mid \exists y. \langle x, y \rangle \in R^I \text{ and } y \in C^I\}$
Axiom Syntax	Semantic Condition
$C \sqsubseteq D$	$C^I \subseteq D^I$

For each of the axioms below, determine which of the three interpretations ( $I_1$ ,  $I_2$ , and  $I_3$ ) in the subsequent table satisfy it (note, zero, one or more interpretations may satisfy any given axiom). Assume  $A, B, C$  and  $D$  are atomic concepts and  $P$  is a role. To receive full credit, show your work.

- $B \sqsubseteq D$
- $A \sqsubseteq B \sqcap \forall P.C$
- $D \sqsubseteq B \sqcup \exists P.C$

Atomic Classes and Roles	Candidate Interpretations ( $\Delta^I = \{a, b, c, d\}$ )		
	$I_1$	$I_2$	$I_3$
$A^I$	$\{\}$	$\{a\}$	$\{b, c\}$
$B^I$	$\{a, b\}$	$\{a\}$	$\{b, c, d\}$
$C^I$	$\{b\}$	$\{b, d\}$	$\{a, b\}$
$D^I$	$\{\}$	$\{a, b\}$	$\{a, b, c, d\}$
$P^I$	$\{\}$	$\{\langle a, b \rangle, \langle a, c \rangle, \langle b, d \rangle\}$	$\{\langle b, a \rangle, \langle b, b \rangle, \langle d, a \rangle\}$