Universität Freiburg
Institut für Informatik
Prof. Dr. G. Lausen
Michael Schmidt

Georges-Köhler Allee, Geb. 51
D-79110 Freiburg
Tel. (0761) 203-8120
Tel. (0761) 203-8127

**Formal Foundations of Information Systems**
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# 5. Exercise Set: RDF and SPARQL

**Exercise 17 (Auswertung von SPARQL Anfragen, 1+1+2+2+2=8 Punkte)**
Consider the RDF database

$D$ := { (_:P1,rdf:type,Person), (_:P1,name,"Pete"), (_:P1,age,"17"), (_:P1,email,"pete@abc.com"),
(_:P2,rdf:type,Person), (_:P2,name,"John"), (_:P2,email,"john@abc.com"),
(_:P3,rdf:type,Person), (_:P3,name,"Sue"), (_:P3,age,"21"),
(_:P1,knows,_:P2), (_:P1,knows,_P3), (_:P2,knows,_:P1), (_:P2,knows,_:P3) }.

Draw the RDF graph. Evaluate the following SPARQL graph patterns step by step according to the semantics introduced in the lecture and phrase their semantics in words.

a) `((?p,rdf:type,Person) AND (?p,age,?age)) FILTER (?age>20)`
b) `((?p,rdf:type,Person) AND (?p,name,?name)) OPT (?p,age,?age)`
c) `((?p,rdf:type,Person) AND (?p,age,?age)) UNION ((?p,rdf:type,Person) AND (?p,email,?email))`
d) `((?p,rdf:type,Person) OPT (?p,email,?email)) FILTER (!bound(?email))`

Verify your results using the ARQ SPARQL engine. A short installation instruction, the above RDF document $D$, and example query a) are provided at the exercise page of the lecture homepage.

**Exercise 18 (SPARQL Anfragen, 1+1+1+2+2=7 Punkte)**
Consider the RDF database $D$ from the previous exercise. Specify the following requests as SPARQL queries and indicate the final results obtained when evaluating them on document $D$.

a) All pairs of distinct persons that have a common friend (i.e., it must hold that the intersection of persons they know is non-empty).
b) The names of all persons that know at least one person or are younger than 20 years. If present, the email address and, also if present, the age of this person should be included in the result.
c) Construct a new graph using the `CONSTRUCT` form that contains all persons (including their names) that know at least two persons.
d) Write a SPARQL `ASK` query that – given any document $D$ as input – returns *yes* if and only if the constraint

$$\forall p(D(p, rdf{:}type, Person) \rightarrow \exists n\, D(p, name, n))$$

is violated (we interprete the RDF database $D$ here as a ternary relation $D(subject, predicate, object)$ that contains all RDF triples).

e) Write a SPARQL `ASK` query that – given any document $D$ as input – returns *yes* if and only if the constraint

$\forall p_1, p_2, n\ (D(p_1, \textit{rdf:type}, \textit{Person}), D(p_2, \textit{rdf:type}, \textit{Person}), D(p_1, \textit{foaf:name}, n), D(p_2, \textit{foaf:name}, n) \rightarrow p_1 = p_2)$

is violated (we interprete the RDF database $D$ here as a ternary relation $D(\textit{subject}, \textit{predicate}, \textit{object})$ that contains all RDF triples).

Verify your results using the ARQ engine.

**Exercise 19 (Auswertung von SPARQL Anfragen, 1+1+1+2=6 Punkte)**
We write $P_1 \equiv P_2$ for two graph patterns $P_1$, $P_2$ if and only if $P_1$ and $P_2$ yield the same result on every possible RDF document $D$, i.e. if $[\![P_1]\!]_D = [\![P_2]\!]_D$ holds for every document $D$.

Let $A$, $B$, and $C$ be SPARQL graph patterns. For each of the following equivalences either prove that it holds or show – by counterexample – that the equivalence does not hold.

a) $A$ Union $A \equiv A$

b) $A$ Opt $A \equiv A$

c) $A$ And $A \equiv A$

d) $A$ Union ($B$ And $C$) $\equiv$ ($A$ Union $B$) And ($A$ Union $C$)

**Exercise 20 (Modellierung mit RDF, 3 Punkte)**
Encode the following scenario in RDF.

*The elementary school of Freiburg has three employees: the two teachers Mr. Maier and Mrs. Schmidt, and the schoolmaster Mrs. Koster. In addition to their administrative duties, Mrs. Koster also does some teaching. In particular, Mr. Maier is assigned to the first-graders, while Mrs. Schmidt and Mrs. Koster together teach the second-, third-, and fourth-graders. Mr. Maier has specialized in sports and therefore is assigned to physical education for all four grades of school. Each grade has a class representative and at least one pupil. Actually, Marie is a fourth-grader. Her favourite subjects in school are physical education, painting, and mathematics.*

Use URIs, Blank Nodes, Literals, and RDF containers in your RDF graph. Whenever it makes sense, also use the `rdfs` vocabulary, in particular `rdfs:subClassOf`, `rdfs:subPropertyOf`, `rdfs:domain`, and `rdfs:range`. Finally list the facts that can be derived from your graph according to the RDFS semantics.

**Exercise 21 (Relationale Speicherung von RDF Daten, 1+1+4=6 Punkte)**
We consider the RDF database $D$ from Exercise 17.

a) Provide the relational database instance that stores the RDF graph $D$ according to the Triple Table scheme with dictionary encoding.

b) Provide the relational database instance that stores the RDF graph $D$ according to the Vertical Partitioning scheme without dictionary encoding.

c) Translate the queries from Exercise 17a)-d) into SQL queries over the vertically partitioned scheme from part b).

Due by: 16.06.2009