CSE 636: Test #2 (due 12/13/11)

Submit all the answers as a **single pdf file**, using `submit_cse636`. This is **individual work**. Duplicate solutions will be considered violations of academic integrity. Please write your name and the text **"The submitted solutions are my individual work."** at the beginning of the submitted file.

Problem 1 (10 pts)

Two databases, DA and DB, are defined as follows:

- **DA:** There are two relations *EmpName(SSN,Name,Addr)* and *EmpDept(SSN,DeptName)*, with *SSN* being the key in both.
- **DB:** There are as many relations as there are departments. Each of them has a schema of the form *X(SSN,Name)*. A tuple *(s,n)* is in the relation *X* if and only if a tuple *(s,n,a)* is in *EmpName* for some *a*, and the tuple *(s,X)* is in *EmpDept*. The first attribute is the key in both relations.

To do:

- Define in FISQL the mappings between the databases DA and DB (in both directions).
- **Extra credit:** Show a database C containing a single relation in which there is a column for every department. This column assumes *true* values for the employees working in that department; otherwise it is *null*. Define in FISQL the mappings between the databases DB and DC (in both directions).

Problem 2 (10 pts)

The source database has 3 relations:

- *Faculty(EmpSSN,EmpName,Rank)*;
- *Staff(EmpSSN,EmpName,Level)*;
- *Dependent(EmpSSN,DepSSN,DepName,Status)* where *Status* is equal to 1 for the spouse and 2 for a child.

The target database has 2 relations:

- *EmpSpouse(EmpSSN,EmpName,SpouseName)*;
- *EmpChildren(EmpSSN,ChildName,Age)*,

and 2 integrity constraints:

- *EmpSpouse: EmpSSN* $\rightarrow$ *EmpName SpouseName*;
- *EmpChildren: EmpSSN is a foreign key referencing EmpSpouse(SSN).*

1. Define the appropriate source-to-target dependencies.
2. You are given a source instance consisting of the following facts: *Faculty(123,mark,full), Staff(456,frank,11), Dependent(123,999,julie,1), Dependent(333,321,bill,2)*:
   - Compute a corresponding universal target instance.
   - What are the certain answers for the following queries: (a) $EmpSpouse(x, y, z)$, (b) $\exists y, z.EmpSpouse(x, y, z)$?
3. Show a source instance for which there is no corresponding universal target instance.

Problem 3 (10 pts)

Suppose you are given a relation $R(A, B)$.

1. Write down the integrity constraint stating that R *is symmetric* in logical notation.
2. Rewrite the query $Q = R(x, y)$ to a query that computes all the consistent answers to Q.
3. Consider the instance $r = \{(1, 2), (2, 3), (3, 2)\}$ of R. What are the repairs of r with respect to the given integrity constraint? What is the set of consistent answers to Q w.r.t. the constraint in r?
4. **Extra credit.** Consider the same questions if, additionally, there is a key constraint on A.

Problem 4 (20 pts)

Definitions:

- A knowledge base KB (TBox + ABox) is *satisfiable* if there is an interpretation that satisfies it.
- A knowledge KB *implies* an assertion A if every interpretation that satisfies KB also satisfies A.

(A) You have the following ontology:

> There are two kinds of entities: movies and persons, mutually disjoint. Movies are directed by (single) persons and star zero or more actors.

1. Express this ontology as a satisfiable description logic knowledge-base KB. Explain why it is satisfiable.
2. Which axioms of KB can be expressed in (a) RDF/RDFS, (b) DL-Lite?
3. Define the following notions in description logics:
   - *actor*, *director*;
   - *actor that starred only in movies directed by Spielberg*;
   - *movie in which Orson Welles was both actor and director.*
4. Add axioms and assertions to KB to make the resulting knowledge-base unsatisfiable.
5. Using the assertions in KB, rewrite the following query:

$$q_0(x) \leftarrow Person(x).$$

Extra credit. Express KB using first-order logic.
Extra credit: Consider the knowledge base consisting of the following Description Logic ABox:

$$Inherits(eve, mark).$$
$$Inherits(mark, jean).$$
$$Inherits(eve, jean).$$
$$Inherits(jean, marie).$$
$$French(mark).$$
$$\neg French(marie).$$

Does this knowledge base imply the following fact:

$$eve \in (\exists Inherits.(French \sqcap \exists Inherits.\neg French))?$$

Explain your answers in detail using the formal semantics of description logics.