Exercise 7 "Implementation of Databases"
Due until 10 Dec, 2008 (before exercises)  

7.1 Standardization of Queries (7 pt.)

a) Transform the following query into DPNF by applying the four transformation steps introduced in the lecture. Please distinguish the following cases:

- no relation is empty,
- only the papers relation is empty,
- only the courses relation is empty.

\[
\text{[EACH } e \text{ IN EMPL: } e.\text{name}=\text{´Simpson´AND (NOT (SOME p IN PAPERS (p.year=2002 AND p.eno=e.eno)) OR SOME c IN COURSES (c.level=´Undergraduate´AND SOME t IN TIMETABLE (t.cno=c.cno AND t.eno=e.eno)))]}
\]

b) Translate the resulting tuple calculus expressions from (a) into domain relational calculus expressions.

7.2 Tableau Containment (5 pt.)

Given are the following tableaux:

<table>
<thead>
<tr>
<th>T₁:</th>
<th>T₂:</th>
<th>T₃:</th>
</tr>
</thead>
<tbody>
<tr>
<td>a₁</td>
<td>a₁</td>
<td>a₁</td>
</tr>
<tr>
<td>a₁</td>
<td>b₁</td>
<td>a₁</td>
</tr>
<tr>
<td>b₂</td>
<td>a₂</td>
<td>b₂</td>
</tr>
<tr>
<td>b₁</td>
<td>b₃</td>
<td>b₁</td>
</tr>
<tr>
<td>b₃</td>
<td>b₂</td>
<td>x</td>
</tr>
</tbody>
</table>

a) Define the queries corresponding to T₁, T₂ and T₃ as expressions in the domain relational calculus (c is a constant).

b) Find out if Tᵢ⊆Tⱼ resp. Tᵢ≡Tⱼ for i≠j, i,j ∈ {1,2,3}.
The Semi-Join is defined as follows:

$\text{If } r \in \text{Rel}(R), s \in \text{Rel}(S) \text{ then } r \ltimes s := \Pi_R(r \ltimes s)$

a) Explain the advantage of evaluating semi-joins ($\ltimes$) opposite to joins ($\bowtie$).

b) Show for $r \in \text{Rel}(R), s \in \text{Rel}(S)$:

- $r \ltimes s = (r \ltimes s) \ltimes s$
- $r \ltimes s = r \ltimes \Pi_{R \cap S}(s)$
- if $r' := r \ltimes s, s' := s \ltimes r'$, then: $r \ltimes s = r' \ltimes s'$