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Foundations of Query Languages
Summer semester 2010
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11. Exercise Set: Datalog

Exercise 1
Complete the proof of Lemma ($*_1$), i.e. define the function $r2d$ from the lecture slides for the case of atomic selection operations.

Exercise 2
Consider the following Datalog programs:

- $P(x) \leftarrow P_0(x)$
  $P(x) \leftarrow R(x, y), P(y)$
  $R(x, y) \leftarrow S(x), S(y)$

- $greenPath(x, y) \leftarrow green(x, y)$
  $greenPath(x, y) \leftarrow greenPath(x, z), greenPath(z, y)$
  $bingo(x, y) \leftarrow red(x, y), \neg greenPath(x, y)$

- $win(x) \leftarrow move(x, y), \neg win(y)$

Are these programs stratified? If so, give the stratification of the respective grogram.

Exercise 3
- Consider the schema $R[A, B, C], S[C, D]$. Transform the following expression into an equivalent non-recursive Datalog$^\neg$ program:
  $\pi_A(\sigma_{A=D}(R \bowtie \rho_{A,B\to E,F} R \bowtie S)) \cup \pi_A R \cup \pi_A(\rho_{C,D\to A,B}(\rho_{A,B\to C,D}(\pi_{A,B}(R)) - S))$.
- Transform the program
  $P(x) \leftarrow P_0(x)$
  $P(x) \leftarrow R(x, y), P(y)$
  $R(x, y) \leftarrow S(x), S(y)$

  into an equivalent relational algebra query (P is the ditinguished query predicate). You may define the schema of the extensional relations yourself.

Exercise 4

- Look up the definition of an isomorphism (between two relational structures over the same set of predicate symbols) in an arbitrary textbook on mathematical logic.
- Consider the definition of a partial isomorphism below. Explain this definition.
- Give two finite relational structures $\mathcal{A}$ and $\mathcal{B}$ such that $\mathcal{A}$ and $\mathcal{B}$ are not isomorphic but there is a partial isomorphism between them.

Definition (Partial Isomorphism):

- $\mathcal{A}|_S$: Restriction of a structure $\mathcal{A}$ to the subdomain $S \subseteq |\mathcal{A}|$. Same schema; for each relation $R^{\mathcal{A}}$:

$$R^{\mathcal{A}|_S} := \{(a_1, \ldots, a_k) \in R^{\mathcal{A}} \mid a_1, \ldots, a_k \in S\}.$$

- θ is a partial isomorphism if and only if

$$\theta : \mathcal{A}|_{\mathrm{dom}(\theta)} \to \mathcal{B}|_{\mathrm{rng}(\theta)}$$

  is an isomorphism.
- This definition assumes that the schema of $\mathcal{A}$ does not contain any constants but is purely relational.

Due by: July 14, 2010 before the tutorial starts.