Foundations of Databases

Exercises – Relational Query Languages

February 22, 2005

1. Try to express the queries on the slides 12-13

   Database schema $\mathbf{C} = \{$ `Account, Movie, Schedule` $\}$,

   ```
   Account:  number, branch, customerId
   Movie:  title, director, actor
   Schedule:  theater, title
   ```

   (a) Find titles of current movies
   (b) Find theaters showing movies directed by Polanski
   (c) Find theaters showing movies featuring Nicholson
   (d) Find all directors who acted themselves
   (e) Find directors whose movies are playing in all theaters
   (f) Find theaters that only show movies featuring Nicholson

   (a) as rule-based conjunctive queries,
   (b) in SPC Algebra in unnamed case,
   (c) in SPJR Algebra,
   (d) in SQL without nesting.

   If a query can not be expressed, argue why. Evaluate the rule-based conjunctive queries according to the formal semantics.

2. Show that for any rule-based conjunctive query q and any database instance $\mathbf{I}$, $q(\mathbf{I})$ is finite.

3. Show that rule-based conjunctive queries are monotonic.

4. In the unnamed case, sometimes a more general projection operator is defined: For a list of positions $i_1, \ldots, i_k \leq n$ (where not necessarily all i_{j_1} and i_{j_2} are distinct), and any set of tuples $r \subseteq \mathbf{dom}^n$, let $\pi_{i_1,\ldots,i_k}(r)$ denote the set of all tuples t constructed from a tuple t' in r by concatenating $t'(j_1)$, $\ldots$, $t'(j_k)$.

   - Give a formal definition of this operator.
   - Does this operator add expressivity to the one where all $i_1, \ldots, i_k$ are distinct? Argue why.

5. Express renaming $\rho_{A_1,\ldots,A_m \leftarrow B_1,\ldots,B_m}$, for distinct $A_1, \ldots, A_m$ resp. B_1, $\ldots, B_m$ in terms of basic renaming $\rho_{B \leftarrow A}$.

6. Show that SPJ queries $\subset$ Algebra with $\sigma, \pi, \bowtie$, i.e., not every query expressible with $\sigma, \pi, \bowtie$ can be equivalently expressed by a query of the form
$$\pi_{A_1,\ldots,A_n}(\sigma_c(R_1 \bowtie \cdots \bowtie R_m))$$

7. Show: SQL + Nesting with IN does not add expressiveness over SQL without nesting

8. Demonstrate the normal form result for the SPC Algebra (unnamed case): Every expression of the SPC Algebra is equivalent to an expression of the form
$$\pi_{A_1,\ldots,A_n}(\sigma_c(R_1 \times \cdots \times R_m))$$
   (Hint: Induction on the structure of the expression)

9. Consider variants of rule-based conjunctive queries, and assess whether they have the same / less / higher expressiveness:

   - Suppose we allow that constants occur in rule heads.
   - Suppose we allow repetitions of variables in the head.
   - Suppose we disallow inequality in rule bodies.
   - Suppose we disallow equality in rule bodies.
   - Suppose we disallow equality and inequality in rule bodies.

10. Give conditions under which we can eliminate an equality atom in the body of a conjunctive query rule.

11. Satisfiability of rule-based conjunctive queries q:

- Show that q is satisfiable, provided that '=' and '$\neq$' do not occur in q.
- Describe a method to decide whether a given rule-based conjunctive query is satisfiable. Is this problem solvable in polynomial time?

12. Give a formal proof that Union of SPC queries = SPCU queries
13. Detail the mapping from simple SPC to SQL and demonstrate its correctness.
14. Demonstrate the correctness of the mapping from SQL to SPC.
15. Describe a mapping from SPC to rule-based conjunctive queries