**Database Theory**
**Winter Term 2013/14**
Prof. Dr. W. May

# 2. Unit: Kalkül II

Discussion by 4./11.12.2013

**Exercise 6 (Division: Äquivalenz von Algebra und Kalkül)** For the relational algebra, the division operator has been introduced as a derived operator (cf. lecture "Databases"). Consider the relation schemata $r(A, B)$ and $s(B)$.

$$r \div s = \{\mu \in Tup(A) \mid \{\mu\} \times s \subseteq r\} = \pi[A](r) \setminus \pi[A]((\pi[A](r) \times s) \setminus r).$$

Derive a query in the relational calculus from the left-hand side, and prove the equivalence with the right-hand side.

**Exercise 7 (Kalkül: Gruppierung und Aggregation)** Define a syntactical extension for the relationalen calulus, that allows to use aggregate functions similar to the `GROUP BY` functionality of SQL.

For this, consider only aggregate functions as simple applications over single attributes like max(population), but not more complex expressions like max(population/area).

- What is the result of an aggregate function, and how can it be used in the calculus?
- Which inputs does an aggregate function have?
- how can this input be obtained from the database?

Give a calculus expression for the query "For each country give the name and the total number of people living in its cities".

**Exercise 8 (Algebra→Kalkül)** Consider the relation schemata $R(A, B), S(B, C)$ und $T(A, B, C)$.

a) Give an equivalent safe calculus expresseion for the algebra expression

$$(\pi[A, B]((R \bowtie S) - T)) \cup R$$

b) Simplify it.

c) Give an equivalent safe calculus expresseion for the algebra expression

$$(\pi[A, B]((R \bowtie S) - T)) \cup \pi[A, B](\sigma[A < B](R) \bowtie T)$$

**Exercise 9 (Kalkül→Algebra)** Consider the relation schemata $R(A, B), S(B, C)$ und $T(A, B, C)$.

a) Give an equivalent algebra expression for the following safe relational calculus expression:

$$F_1(X, Y) = T(Y, a, Y) \wedge (R(a, X) \vee S(X, c)) \wedge \neg T(a, X, Y)$$

Proceed as shown in the lecture for the equivalence proof.

b) Simplify the expression.

c) Extend the expression from 8a) to

$$F_2(Y) = \exists X : (F_1(X, Y) \wedge X > 3)$$