CS 1555 – Database Management Systems (Spring 2020)
Dept. of Computer Science, University of Pittsburgh

Assignment #4: More Relational Algebra

Release: Feb. 6th, 2020 Due: 8:00pm Feb. 12th, 2020

Goal

More practice on Relational Algebra. We will continue with the *P_Mobile* Database Schema of Assignment #2.

Description

- Assume the following relational database schema along with its cardinalities that supports a cell phone company, *P_Mobile*. Refer to HW2 for more details on the schema (e.g., constraints such as primary key, foreign key, unique, and not null):

  - CUSTOMERS = (SSN, fname, lname, cell_pn, home_pn, street, city, zip, state, free_min, DOB, free_SMS)
  - RECORDS (from_pn, to_pn, start_timestamp, duration, type)
  - STATEMENTS (cell_pn, start_date, end_date, total_minutes, total_SMS, amount_due)
  - PAYMENTS (cell_pn, paid_on, amount_paid)
  - DIRECTORY (pn, fname, lname, street, city, zip, state)

  - Cardinalities of the relations:
    | r(CUSTOMERS) | = 50
    | r(RECORDS) | = 500
    | r(STATEMENTS) | = 120
    | r(PAYMENTS) | = 150
    | r(DIRECTORY) | = 1000

- Answer the following questions [for a total of 100 points]:

  1. [14 points each; last two queries with ⋆ are optional and carry no points] Write the arity, expected min cardinality, expected max cardinality, and the *relational algebra* expression to answer each of the following queries:
     (a) Calculate the *max* duration of phone calls in August 2019, that were originated from Pennsylvania.
     (b) Calculate the *average* amount of payments due for the month of November 2019 for each zipcode (i.e., sum up all customers on the same zip code into a single amount for that zip code).
     (c) List the first and last names of customers who have more than one cell phone.

(d) List the last names of customers whom none of their family members is a customer of P_Mobile. That is, customers whose family members are customers in other companies. Recall that people with the same last name are relatives that belong to the same family.

(e) Find the charges of the customer whose cell phone number is 412-987-6543 in the period between January 1st 2019 until now, assuming a flat rate of 25 cents per minute and 5 cents per SMS (without adding any tax or plan fees).

(f) ⋆ List the first name, last name and phone number of all customers who owe more than $90. Note that people may have skipped more than one payment.

(g) ⋆ Find the first and last name of the customer who made the longest phone call between June 1st, 2019 and August 31st 2019.

2. [10 points each] Given relation R with attributes A, B, C, D and relation S with attributes D, E, F provide:
   - an instance of relation R with 13 tuples,
   - an instance of relation S with 7 tuples, and
   - an instance of relation *R full-outer-join(*R.D = S.D*) S*,

   such that relation *R * S* has 5 tuples, and relation *R right-outer-join(*R.D = S.D) S has 7 tuples.

   Feel free to assume any type for attributes A, B, C, D, E, F in your relation instances/examples. You do not need to provide *R * S* or *R right-outer-join(*R.D = S.D*) S*.

To submit your assignment:

1. Create a single file named `hw4-<username>` in PDF (.pdf) or Microsoft Word (.doc) format, containing your answers to all questions. **Do not forget to include your name and username (account name) in the file**.
2. Submit your assignments through the Web-base submission interface you have used for homework #1. **It is your responsibility to make sure the assignment was properly submitted.**
3. Submit your assignment by the due date (8:00pm February 12th, 2020). **There is no late submission.**
4. If you have trouble generating any of the relational algebra symbols, for example R $\bowtie_{A=B}$ S, use a descriptive word, e.g., R Join(A=B) S.

Academic Honesty

The work in this assignment is to be done *independently*. Discussions with other students on the assignment should be limited to understanding the statement of the problem. Cheating in any way, including giving your work to someone else will result in an F for the course and a report to the appropriate University authority.