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CS 1555

Assignment #4: More Relational Algebra

* 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

1. Write the arity, expected min cardinality, expected max cardinality, and the relational algebra expression to answer each of the following queries:
   1. Calculate the max duration of phone calls in August 2019, that were originated from Pennsylvania.
      1. A1 🡨 RECORDS ⋈ STATEMENTS ⋈ CUSTOMERS
      2. A2 🡨 πDURATION(σSTART\_DATE = ‘AUGUST 2019’ ∧ STATE = ‘PENNSYLVANIA’(A1))
      3. A3 🡨 FMAX DURATION (A2)
      4. Arity: 1
      5. Expected Min Cardinality: 0
      6. Expected Max Cardinality: 1
   2. Calculate the average amount of payments due for the month of November 2019 for each zip code (i.e., sum up all customers on the same zip code into a single amount for that zip code).
      1. B1 🡨 PAYMENTS ⋈ CUSTOMERS ⋈ STATEMENTS
      2. B2 🡨 πZIP, AMOUNT\_PAID(σSTART\_DATE = ‘NOVEMBER 2019 (B1))
      3. B3 🡨 ZIP FSUM AMOUNT\_PAID (B2)
      4. B4 🡨 ZIP FAVG AMOUNT\_PAID (B3)
      5. Arity: 3
      6. Expected Min Cardinality: 0
      7. Expected Max Cardinality: | r(ZIP) |
   3. List the first and last names of customers who have more than one cell phone.
   4. 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.
   5. 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 at rate of 25 cents per minute and 5 cents per SMS (without adding any tax or plan fees).
2. 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.

R

|  |  |  |  |
| --- | --- | --- | --- |
| A | B | C | D |
| 1 | 1 | 1 | 2 |
| 1 | 1 | 1 | 2 |
| 1 | 1 | 1 | 2 |
| 1 | 1 | 1 | 2 |
| 1 | 1 | 1 | 2 |
| 1 | 1 | 1 | 2 |
| 2 | 2 | 2 | 5 |
| 2 | 2 | 2 | 5 |
| 2 | 2 | 2 | 5 |
| 3 | 3 | 3 | 5 |
| 3 | 3 | 3 | 5 |
| 4 | 4 | 4 | 5 |
| 5 | 5 | 5 | 5 |

S

|  |  |  |
| --- | --- | --- |
| D | E | F |
| 5 | 2 | 2 |
| 5 | 2 | 2 |
| 5 | 2 | 2 |
| 5 | 3 | 3 |
| 5 | 3 | 3 |
| 5 | 4 | 4 |
| 5 | 5 | 5 |

R full-outer-join(R.D = S.D) S

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| A | B | C | D | E | F |
| 2 | 2 | 2 | 5 | 2 | 2 |
| 2 | 2 | 2 | 5 | 2 | 2 |
| 2 | 2 | 2 | 5 | 2 | 2 |
| 3 | 3 | 3 | 5 | 3 | 3 |
| 3 | 3 | 3 | 5 | 3 | 3 |
| 4 | 4 | 4 | 5 | 4 | 4 |
| 5 | 5 | 5 | 5 | 5 | 5 |