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CS 1555 Assignment 4

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

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1. 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.
    $f_{MAX\ duration}($
    $\sigma_{start\_timestamp>='8\text{-}1\text{-}2019'\ \wedge\ start\_timestamp<'9\text{-}1\text{-}2019'}\ Records \bowtie_{Records.from\_pn\ =\ Directory.pn} (\sigma_{state\ =\ 'Pennsylvania'}\ Directory)$
    $)$
    $Arity = 1$
    $Cardinality_{MAX} = Cardinality_{MIN} = 1$

    b. 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). **[Assuming all payments are due on the last day of the month.]**

$_{\text{zip}}\mathcal{f}_{\text{average amount\_due}}$ (Customers * ($\sigma_{\text{end\_date='11-30-2019'}}$ Statements))

Arity = 2

$\text{Cardinality}_{\text{MAX}}$ = 50 (Every Customer lives in a different zip code)

$\text{Cardinality}_{\text{MIN}}$ = 1 (All Customers live in the same zip code)

c. List the first and last names of customers who have more than one cell phone.

$\Pi_{\text{fname, lname}}$ ($\sigma_{\text{count\_cell\_pn>1}}$ ($_{\text{fname, lname}}\mathcal{f}_{\text{COUNT cell\_pn}}$))

Arity = 3

$\text{Cardinality}_{\text{MAX}}$ = 25 (Every Customer has exactly 2 cell_pn)

$\text{Cardinality}_{\text{MIN}}$ = 0 (Every Customer has only 1 cell_pn)

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. **[Assuming every Customer and their family members are in the directory and everyone in the directory is a customer of a cellphone company]**

Π_{lname} (
$\sigma_{\text{count\_fname=1}}$ ($_{\text{lname}}\mathcal{f}_{\text{COUNT fname}}$ (Customers)) *
$\sigma_{\text{count\_fname>1}}$ ($_{\text{lname}}\mathcal{f}_{\text{COUNT fname}}$ (Directory))
)

Arity = 1

$\text{Cardinality}_{\text{MAX}}$ = 50 (Condition met by every P Mobile customer)

$\text{Cardinality}_{\text{MIN}}$ = 0 (Condition not met by any P Mobile customer)

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).

R1 ← $\sigma_{\text{cell\_pn=4129876543 ^ start\_date>='1-1-2019'}}$ Statements

$\mathcal{F}_{\text{SUM cost}}$ (ρ($\Pi_{\text{total\_minutes*25}}$ ($\sigma_{\text{type = 'call'}}$ R1), cost) U (ρ($\Pi_{\text{total\_SMS*5}}$ ($\sigma_{\text{type = 'SMS'}}$ R1), cost)))

Arity = 1

$\text{Cardinality}_{\text{MAX}}$ = $\text{Cardinality}_{\text{MIN}}$ = 1

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. 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.

R:

A	B	C	D
1	2	3	1
4	5	6	2
7	8	9	3
1	3	5	4
7	9	11	5
0	2	4	6
6	8	10	7
2	3	4	8
7	6	5	9
8	9	10	10
0	9	8	11
5	6	7	12
4	3	2	13

S:

D	E	F
1	4	5
2	7	8
3	0	9
4	7	9
5	13	15
14	99	45
15	12	34

R]⋈[R.D=S.D S:

R.A	R.B	R.C	R.D	S.D	S.E	S.F
1	2	3	1	1	4	5
4	5	6	2	2	7	8
7	8	9	3	3	0	9
1	3	5	4	4	7	9
7	9	11	5	5	13	15
0	2	4	6	NULL	NULL	NULL
6	8	10	7	NULL	NULL	NULL
2	3	4	8	NULL	NULL	NULL
7	6	5	9	NULL	NULL	NULL
8	9	10	10	NULL	NULL	NULL
0	9	8	11	NULL	NULL	NULL
5	6	7	12	NULL	NULL	NULL
4	3	2	13	NULL	NULL	NULL
NULL	NULL	NULL	NULL	14	99	45
NULL	NULL	NULL	NULL	15	12	34