# DATABASE SYSTEMS

## Tutorial 2

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**Database schema.** Consider the following schema:

CUSTOMER : *ID*, *Name*, *City*

where *ID* is the primary key.

ACCOUNT : *Number*, *Branch*, *CustID*, *Balance*

where *Number* is the primary key and *CustID* is a foreign key referencing CUSTOMER on *ID*.

**Problem 1.** Write the following queries in relational algebra:

(1) "ID and name of customers who own an account in a branch in their city."

(2) "ID and name of customers who do **not** own any account."

(3) "ID and name of customers who own an account in **every** branch."

(4) "ID and name of customers who own an account with a balance which is no less than the balance of any other account."

[ *Try to write the queries directly in relational algebra, without translating from relational calculus* ]

**Problem 2.** Can query (4) of Problem 1 ever return more than one tuple? If yes, come up with a database (over the given schema) on which that happens; otherwise, explain why it cannot happen.

**Problem 3.** Write queries (1), (2) and (4) of Problem 1 in relational calculus.
[ *Try to write the queries directly in relational calculus, without translating from relational algebra* ]

**Problem 4.** Write query (1) of Problem 1 in SQL.

**Problem 5.** Given the database below

CUSTOMER

| ID | Name | City |
|---|---|---|
| 1 | John | London |
| 2 | Mary | Edinburgh |
| 3 | Jeff | London |
| 4 | Jane | Cardiff |

ACCOUNT

| Number | Branch | CustID | Balance |
|---|---|---|---|
| 111 | London | 1 | 120 |
| 222 | Edinburgh | 1 | 62 |
| 333 | London | 3 | 76 |
| 444 | London | 2 | 200 |

compute the answer to the query

$$\text{CUSTOMER} \bowtie \left(\pi_{\text{ID,City}}(\text{CUSTOMER}) \cap \rho_{\text{CustID}\to\text{ID},\,\text{Branch}\to\text{City}}\left(\pi_{\text{Branch,CustID}}(\text{ACCOUNT})\right)\right)$$