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Advanced Database Systems – Exercise Sheet 2

Relational Algebra

Task 1

List and discuss the operators in the relational algebra (RA).

Task 2

Consider a database with the following relations.

Customers

CNo	Name
123	Müller, F
456	Abel, M
789	Schulz, R
109	Jahn, E
403	Meier, T

Products

PNo	Description
45	Butter
56	Cake
11	Milk
67	Orange
13	Potatoes

Sales

RNo	SID	Date	Time	CNo
1	23	2025-09-27	08:13	456
3	20	2025-09-30	09:59	123
5	24	2025-10-18	12:07	789
7	27	2025-10-19	10:43	456
9	27	2025-10-19	21:01	123
17	20	2025-11-03	11:34	403

Stores

SID	Name	Address
27	Aldi	Hüttenholz
23	Netto	Herderstrasse
24	Tegut	Goethepassage
20	Rewe	Mühlgraben

SpecialOffers

SID	PNo
27	13
27	56
23	67
23	13
24	56
27	67
24	67

Receipts

RNo	PNo	Quantity
1	45	2
1	67	10
3	11	2
5	67	5
7	56	1
7	67	11
9	45	1
9	56	3
9	67	7

(a) Give a verbal formulation and the result of the following RA expressions:

- $\pi_{\text{RNo}}(\text{Receipts})$
- $\text{Customers} - \pi_{\text{CNo,Name}}(\text{Customers} \bowtie \text{Sales})$
- $\pi_{\text{SID}}(\text{Stores}) - \pi_{\text{SID}}((\pi_{\text{RNo,SID}}(\text{Sales}) \bowtie \text{Receipts}) \bowtie \text{SpecialOffers})$

(b) Formulate the following queries in RA and SQL:

- List all customer names.
- List all receipts of sales that took place in the morning by their receipt number.
- Which products were bought on "19.10.2025"? List the products based on their description.
- List the names of customers together with their purchased products.
- Which customers have not bought anything? List the customer numbers and names.
- Which stores have the fewest products on sale? List store IDs, names, addresses, and product counts.
- Which store had the earliest sale? List store IDs and names, as well as sales dates and times.

(c) What is the result of a Left Semi-Join and a Right Semi-Join of the relations Customers and Sales? Give a verbal formulation for these expressions.

(d) Provide the results of the following RA expressions:

- $\pi_{\text{Name}}((\text{Customers} \rtimes \text{Sales}) - (\text{Customers} \bowtie \text{Sales}))$
- $\pi_{\text{RNo}}((\text{Customers} \ltimes \text{Sales}) - (\text{Customers} \bowtie \text{Sales}))$
- $\pi_{\text{Name,RNo}}(\text{Customers} \ltimes \text{Sales})$