

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		Products		Sales				
CNo	Name	PNo	Description	RNo	SID	Date	Time	CNo
123	Müller, F.	45	Butter	1	23	2025-09-27	08:13	456
456	Abel, M.	56	Cake	3	20	2025-09-30	09:59	123
789	Schulz, R.	11	Milk	5	24	2025-10-18	12:07	789
109	Jahn, E.	67	Orange	7	27	2025-10-19	10:43	456
403	Meier, T.	13	Potatoes	9	27	2025-10-19	21:01	123
				17	20	2025-11-03	11:34	403

Stores			SpecialOffers		Receipts		
SID	Name	Address	SID	PNo	RNo	PNo	Quantity
27	Aldi	Hüttenholz	27	13	1	45	2
23	Netto	Herderstrasse	27	56	1	67	10
24	Tegut	Goethepassage	23	67	3	11	2
20	Rewe	Mühlgraben	23	13	5	67	5
			24	56	7	56	1
			27	67	7	67	11
			27	67	9	45	1
			24	67	9	56	3
					9	67	7

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

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

(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:

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