Foundations of Information Systems

Winter Semester 2024–25, Exercise 12

For discussion on Tuesday, February 4, 2024

1. You are given the following relational database schema:

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STUDENT(SNO, NAME)
ENROLL(CNO, SNO, GRADE)
COURSE(CNO, DEPT)
```

   (a) Underline the primary keys and dashed-underline all foreign keys.

   (b) Write the following queries in relational algebra and SQL.

      i. Find the names of all students failing a course (`GRADE='F'`).

      ii. Find the names of all students taking a course in the Math Department (`DEPT='MATH'`).

2. Consider the following bank customer database with relations "Customers", "Accounts", and "Branch".

Customers			
CustomerID	Name	Address	Phone
001	John Doe	123 Elm Street	555-1234
002	Jane Smith	456 Pine Street	555-5678
003	Bob Brown	789 Oak Street	555-9012

Accounts				
AccountNumber	CustomerID	BranchID	Balance	Type
A0001	001	B01	$5,000	Checking
A0002	002	B02	$8,000	Savings
A0003	003	B01	$2,500	Savings
A0004	003	B01	$3,500	Checking

Branches			
BranchID	BranchName	Manager	Location
B01	Downtown	Alice Johnson	123 City Square
B02	Uptown	Gary White	456 Suburb Road

State the relations returned by the following relational algebra expressions, as a table.

(a) $\pi_{\text{Type}}(\text{Accounts})$

(b) $\sigma_{\text{BranchID='B01'}}(\text{Accounts})$

(c) $\text{Customers} \bowtie \text{Accounts}$

(d) $\pi_{(\text{Name,BranchName})}(\text{Customers} \bowtie \text{Accounts} \bowtie \text{Branches})$

3. Prove the following:

(a) If given relations $r(R)$, $s(S)$, and $t(T)$, then

$$r \bowtie (s \bowtie t) = (r \bowtie s) \bowtie t\,.$$

(b) Given relations $r(R)$ and $s(S)$, and attributes $N, M \in R$, then

$$\sigma_{N=M}(r \bowtie s) = \sigma_{N=M}(r) \bowtie s\,.$$