Tutorial 5

1.Find the different departments in School of Computing.

Table: department(faculty, department)

SELECT d.department

FROM department d

WHERE d.faculty = ‘School of Computing’

2. Let us check the integrity of the data. Find the emails of the students who borrowed or lent a copy of a book before they joined the university. There should not be any

```
SELECT DISTINCT s . email
FROM student s, loan l
WHERE (s. email = l. borrower AND l. borrowed < s. year )
OR (s. email = l . owner AND l. borrowed < s. year );
```

3.Print the emails of the students who borrowed but did not lend a copy of a book on the day that they joined the university.

$\exists T1\ \exists T2\ (T1 \in student \wedge T2 \in loan \wedge T1.email = T2.borrower \wedge T2.borrowed =$

$T1.year \Rightarrow$ student who borrowed on the day they joined

$\exists T1\ \exists T3\ (T1 \in student \wedge T3 \in loan \wedge T1.email = T2.owner \wedge T2.borrowed =$

$T1.year \Rightarrow$ student who lend on the day they joined

{T | ∃T1 ∃T2 (T1 ∈ student∧T2 ∈ loan ∧ T1.email = T2.borrower ∧ T2.borrowed = T1.year ∧ ¬(∃T3 (T3 ∈ loan ∧ T1.email = T3.owner ∧ T3.borrowed = T1.year)) ∧ T.email = T1.email)}

Apply rule **¬(∃X F(x)) = ∀x ¬(F(x))**

{T | ∃T1 ∃T2 ∀T3 (T1 ∈ student ∧ T2 ∈ loan ∧ T1.email = T2.borrower ∧ T2.borrowed = T1.year ∧ ¬(T3 ∈ loan ∧ T1.email = T3.borrower ∧ T3.borrowed = T1.year) ∧ T.email = T1.email)}

Apply rule **¬(A ∧ B) = ¬A ∨ ¬B**

$$\{T \mid \exists T_1\ \exists T_2\ \forall T3\ (T_1 \in student \wedge T_2 \in loan \wedge T_1.email = T_2.borrower \wedge T_2.borrowed = T_1.year \wedge (T_3 \notin loan \vee T_1.email \neq T_3.borrower \vee T_3.borrowed \neq T_1.year) \wedge T.email = T_1.email)\}$$

4. Find the ISBN13 of the books that have been borrowed by all the students in the computer science department.

Solution: $\{T \mid \exists T_1 (T_1 \in book \wedge \forall T_2 ((T_2 \in student \wedge T_2.department = 'Computer\ Science') \rightarrow (\exists T_3 (T_3 \in loan \wedge T_2.email = T_3.borrower \wedge T_1.isbn13 = T_3.book)) \wedge T.isbn13 = T_1.isbn13)\}$

Apply rule: p -> q = ¬p V q + ¬(∃ X F(x)) = ∀x ¬(F(x))

$\{T \mid \exists T_1 (T_1 \in book \wedge \neg(\exists T_2 (T_2 \in student \wedge T_2.department = 'Computer\ Science' \wedge \neg(\exists T_3 (T_3 \in loan \wedge T_2.email = T_3.borrower \wedge T_1.isbn13 = T_3.book)))) \wedge T.isbn13 = T_1.isbn13)\}$

This translates into SQL as follows.

```
SELECT    b.isbn13
FROM book b
WHERE NOT EXISTS(
     SELECT  *
     FROM student s
     WHERE s.department = 'Computer Science'
          AND NOT EXISTS(
          SELECT  *
          FROM loan l
          WHERE s.email = l.borrower
          AND b.isbn13 = l.book));
```

Relational Algebra

Selection	σ
Projection	π
Renaming	ρ
Union	$\cup$
Intersection	$\cap$
Difference	$-$
Cartesian product	$\times$
Join	$\bowtie$
Logical AND	$\wedge$
Logical OR	$\vee$
Logical NOT	$\sim$

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$$\pi_{s.email}(\sigma_{(s.email=l.borrower \ \vee \ s.email=l.owner) \ \wedge \ l.borrowed<s.year}(\rho(student, s) \times \rho(loan, l)))$$

$$\pi_{s.email}(\rho(student, s) \bowtie_{(s.email=l.borrower \ \vee \ s.email=l.owner) \ \wedge \ l.borrowed<s.year} \rho(loan, l))$$

or as

$$\pi_{s_1.email}(\sigma_{s_1.email=l_1.borrower \ \wedge \ l_1.borrowed<s_1.year}(\rho(student, s_1) \times \rho(loan, l_1)))$$

$$\cup$$

$$\pi_{s_2.email}(\sigma_{s_2.email=l_2.owner \ \wedge \ l_2.borrowed<s_2.year}(\rho(student, s_2) \times \rho(loan, l_2)))$$

3. Print the emails of the students who borrowed but did not lend a copy of a book on the day that they joined the university

$$\pi_{s_1.email}(\sigma_{s_1.email=l_1.borrower \wedge l_1.borrowed=s_1.year}(\rho(student, s_1) \times \rho(loan, l_1)))$$
$$\setminus$$
$$\pi_{s_2.email}(\sigma_{s_2.email=l_2.owner \wedge l_2.borrowed=s_2.year}(\rho(student, s_2) \times \rho(loan, l_2)))$$