COMP 5112: Data Structures and Database Systems
Assignment 2
Prof. Ken Yiu and Dr. Kevin Yuen

Deadline: 14:00 on 4 Dec 2024   (no further extension)

Guidelines
- Please refer to `course_info.pdf` for the late submission policy.
- All questions are written questions.
- Please write your solution in a document,
  then convert it to PDF with the filename `A2_<studentID>.pdf`,
  then **submit** it to learn.polyu.edu.hk.

Question 1. [15 marks]

Convert the following ER diagram to relational schemas.
Explain your decisions briefly.
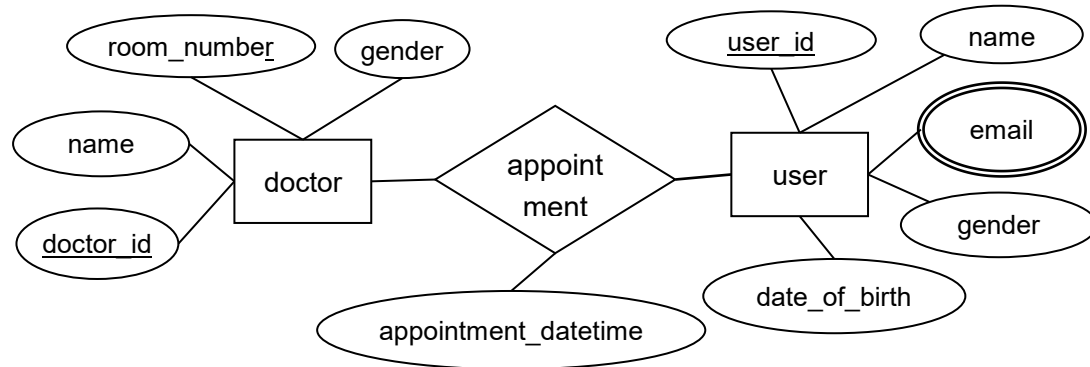
Question 2. [20 marks]

Suppose that a relation R(A,B,C,D,E) satisfies the following functional dependencies:
- A → C
- A → E
- B → D
- CD → A
- CD → B
- CD → E

Check whether this relation in BCNF.
If it is not in BCNF, **decompose** it into BCNF.
Show your steps.

Question 3. [15 marks]

You are given the following information:
- The available memory contains 55 blocks.
- Relations `branch` and `account` are stored as sequential files in the hard disk.
- `branch` and `account` occupy 2200 and 250000 blocks, respectively.
- `branch` and `account` have 110000 and 10000000 tuples, respectively.

Estimate the cost of using Block Nested-Loop Join to compute: Branch ⋈ Account.
Express the cost in terms of the number of block transfers.
Hint: There are two ways to perform Block Nested-Loop Join.

Question 4.   **[50 marks]**

A relational database schema consists of four relation schemas for a fast-food enterprise with many branches.

- The STAFF relation stores the personal data of every staff member.
- The BRANCH relation stores the address data of every branch.
- Each staff works in one branch. The WORKIN relation stores the salary and the branch of every staff.
- Each staff has at most one supervisor. The MANAGE relation stores every pair of subordinate and supervisor. Both MemberID and ManagerID are foreign keys referencing STAFF.StaffID.

Relation	Schema	Sample tuple
STAFF	(StaffID, StaffName, Street, City)	(13579,'Chan Tai', 'Cat Street','Tokyo')
BRANCH	(BranchName, Street, City)	('Tokyo02', 'Otome Road','Tokyo')
WORKIN	(StaffID, BranchName, Salary)	(13579,'Tokyo02',8000)
MANAGE	(MemberID, ManagerID)	(13579,2357)

In each sub-question **4(a)-(f)**, please convert each English statement into
(i) one relational algebra expression and
(ii) one SQL statement.

4(a)   **[8 marks]**
Use *Natural Join / Inner Join* to find the staff names, staff cities, and salaries of all employees who work in the branch named 'B1' and earn more than $26,000.

4(b)   **[8 marks]**
Use *Cartesian Product* to find the staff names, staff cities, and salaries of all employees who work in the branch named 'B1' and earn more than $26,000.

4(c)   **[8 marks]**
Find the staff names, branch streets, and branch cities for all employees who work in the same cities where they live.

4(d)   **[8 marks]**
Find the names and salaries of all employees from the branch named 'B1', who earn more than the average salary of all employees in the enterprise.

4(e)   **[8 marks]**

Find all staff names with their branch names, who are not in the role of manager.
You are not allowed to use "in" or "not in" operators/keywords in relational algebra expressions and SQL statements.

4(f)   **[10 marks]**

Find all pairs of subordinate names and manager names, who live in the same city.