

ORDRE DES INGÉNIEURS DU QUÉBEC  
MAI 2017 SESSION

Open-book examination

Calculators : only authorized models

Duration : 3 hours

### 14-IF-B3 Data Bases and File Systems

1. [10 points]  
What are the three major steps of the database design (data modelling) process? Give a brief description of each step.
2. [10 points]  
What types of participation constraints can you have in an E-R model? Give a brief description of each participation constraint.
3. [10 points]  
Given relation  $R(A, B, C, D, E)$  where  $(A,B)$  is the key, and the functional dependencies  $(A, B) \rightarrow (C, D, E)$  and  $B \rightarrow D$ , is  $R$  in Boyce-Codd Normal Form (BCNF)? Justify your answer with one sentence.
4. [10 points]  
What is referential integrity? How do you represent it in relational model?
5. [10 points]  
What is the difference between logical data independence and physical data independence?
6. [10 points]  
What are insertion, deletion, and update anomalies?
7. [10 points]  
Given relation  $R(A, B, C, D, E, F, G)$  and the set of functional dependencies  $F=\{BCD \rightarrow A, BC \rightarrow E, A \rightarrow F, F \rightarrow G, C \rightarrow D, A \rightarrow G\}$ , decompose  $R$  into 3NF. Show your steps. Is this decomposition also BCNF? Why or why not?  
Note : This requires you to first determine the key(s) of  $R$ .
8. [10 points]  
Consider histories  $H1$  and  $H2$  given below :

$$H1 = r1(x), r2(z), r1(z), r3(x), r3(y), w1(x), w3(y), r2(y), w2(z), w2(y)$$

$$H2 = r1(x), r2(z), r3(x), r1(z), r2(y), r3(y), w1(x), w2(z), w3(y), w2(y)$$

These histories are generated by the following transactions :

$$T1 = r1(x), r1(z), w1(x)$$

$$T2 = r2(z), r2(y), w2(z), w2(y)$$

$$T3 = r3(x), r3(y), w3(y)$$

- (a) Draw the serialization graph for H1 and state whether or not it is serializable. If it is serializable, give the equivalent serial history.
- (b) Draw the serialization graph for H2 and state whether or not it is serializable. If it is serializable, give the equivalent serial history.

9. [10 points]

You are designing a database for HS Humane Society. The result is the following set of relations where the type of each relations attribute is given following the attribute (e.g., ID : integer) :

Animals(ID : integer, Name : string, PrevOwner : string, DateAdmitted : date, Type : string)

Adopter(SIN : integer, Name : string, Address : string, OtherAnimals :integer)

Adoption(AnimalID : integer, SIN : integer, AdoptDate : date, chipNo : integer)

where

- (a) The primary keys are underlined.
- (b) Animals stores information about the animals currently at the Humane Society. Each is given an ID, and their names together with the SIN of their previous owners (attribute PrevOwner), and their date of admission is recorded. Type refers to the type of animal (dog, cat, etc).
- (c) Adopter is the relation that holds information about animal adopters. The attributes are self-descriptive, except OtherAnimals which records the number of other animals that the adopter currently has at home.
- (d) AnimalID in Adoption refers to the ID of Animals. Similarly, SIN in Adoption refers to the SIN of Adopter. Attribute chipNo stores the number on the microchip that is implanted on the animal for tracking. Owner in Animals refers to the SIN of Adopter (in this case the previous adopter).

Formulate the following queries in SQL ;

- (a) Retrieve the total number of dogs that were brought to the Humane Society on 18 April 2000.
- (b) List the name of the adopter who has adopted every type of animal.
- (c) For each animal type, list the animal type and total number of adoptions on 14 June 1999.

- (d) List the types of animals who have not had any adoptions.
- (e) For each adopter who has made at least two adoptions, list their names and addresses.

10. [10 points]

In the following expressions of relational algebra, the relations are  $R(a, b)$  and  $S(b, c)$

$$Q_1 : \pi_{a,b}(R \bowtie S)$$

$$Q_2 : R \cap (\rho_{R(a)}(\pi_c(S)) \times \pi_b(S))$$

Indicate the correct answer(s), and give a justification :

- (a)  $Q_1$  and  $Q_2$  produce the same answer.
- (b) The answer to  $Q_1$  is always contained in the answer to  $Q_2$ .
- (c) The answer to  $Q_2$  is always contained in the answer to  $Q_1$ .
- (d)  $Q_1$  and  $Q_2$  produce different answers.

Fin de l'examen.