Concordia University
Department of Computer Science and Software Engineering
Comp 353 - Databases
Summer 2025

Assignment 3
Submission through Moodle is due by August 1st, 2025 at 23:55

Heads-Up

- All assignments must be completed and submitted individually.
- You must submit the answers to all the questions. However, only one or more questions, possibly chosen at random, will be corrected and will be evaluated to the full 50 marks.

1. **(6 Points)** For each of the following relations with the set of FDs, find the keys of the relation.

   (a) S (A, B, C, D, E, F, G, H) with the FDs
   F = {AH → B, B → A, C → AE, D → C, F→ E, G → A}
   (b) T (A, B, C, D, E, F, G, H) with the FDs
   F = {ABEG → D, BFD → E, CDE → A, AC → BH}

2. **(3 Points)** Consider the relation schema R(A, B, C, D, E, F) with the following set of functional dependencies FDs F = {ABC → E, DE → A, ACE → D, BC → A, BD → E}. Is the decomposition of R into R into R_1(A, B, C, E), R_2(B, C, D) and R_3(B, D, F) a lossless decomposition? (Explain)

3. **(16 Points)** Consider a relation schema R (A, B, C, D, E, F, G, H) with the following set of functional dependencies
   FDs F = {AB → D, D → A, E → C, C → E, F → BG, BC → AD, H → CF, B→ A}.

   (a) Find all keys of R. [3 Points]
   (b) If F is not minimal, then find a minimal basis (also called canonical cover) of F [7 Points].
   (c) If R is not in 3NF with respect to F, find a lossless-join, dependency preserving decomposition of R into 3NF relations. [3 Points]
   (d) If your decomposition in (c) is not in BCNF, identify any of the resulting relations that is not in BCNF, and decompose further to be in BCNF. Is your decomposition dependency preserving? [3 Points]

4. **(25 Points)** You are provided below a design of a relational database for a Humane Society Organization (HSO). The database contains information about Centers, Animals, Adopters and Adoptions for the HSO.

   HSO_Location is the relation that holds information about the HSO location ID, Name and address of the location.

   Animals is the relation that holds information about the animals that have been taken by the organization. Each animal is given an ID. The animal type such as dog, cat etc. is recorded. The gender of the animal such as Male or Female is recorded. Also, a chip number associated with each animal is recorded in this relation. The chip No stores the number on the microchip that is implanted on the animal for tracking.

   Admission is the relation that holds information about the animals that have been taken by each center. It stores the location ID of the center where the animal is admitted, the ID of the animal that is admitted, the date of the admission and the SIN of the previous owner of the admitted animal.

   Adopter is the relation that holds information about animal adopters. The SIN, name, address, phone and the total number of other animals that the adopter currently have are recorded in the Adopter relation.
   Adoption is the relation that holds information about the Animal_ID, the SIN of the adopter of the animal and the date that the animal is adopted.

   Some information about how this organization runs:
   - An adopter can adopt many animals.
   - An animal can be adopted by the same owner only once.

   The database schema is as follows, where the underlined attribute(s) in each relation collectively form the primary key of that relation:

   1. HSO_Location (<u>locID</u>, locName, address*, city, postal code, province)
   2. Animals (<u>aID</u>, type, gender, chipNo)
   3. Admission (<u>animalID, dateAdmitted, locID,</u> prevOwnerSIN)
   4. Adopter (<u>SIN</u>, name, address*, city, postal code, province, phone, animalCount)
   5. Adoption (<u>animalID, SIN</u>, adoptDate)

   * address consists of civic number.

Express the following queries in **RA (Relational Algebra):**
(Note: You are not allowed to use Grouping in RA queries)

a) Provide the Animal type, Animal gender, Location Name, name of the adopter of all the animals that have been adopted in 2024 and have been admitted in 2025. [5 points]

b) Provide the animal id, type, gender and chip number of animals that have been admitted at least at three different dates. [5 points]

c) Provide the name and phone number of adopters that they adopted at least one animal from locations that are located in different provinces that they reside in and have never adopted any animal from locations that are located in the same province that they reside in. [5 points]

d) Provide the name and phone of adopters that they adopted only male animals. (They have never adopted female animals) [5 points]

e) Provide the name and phone of adopters that they adopted at least one animal from every HSO location that is located in the city of Montréal. [5 points]