CSC3170 Introduction to Database Systems (Fall 2020)

Assignment 2

Please answer all the questions below (total 100 marks) and submit your solution to the blackboard before **11:59 pm November 7, 2020.**
Note: Write the following queries in relational algebra. **Note that some of these queries may not be expressible in standard relational algebra taught in the lectures. For such queries, explain why they cannot be expressed.**

Part 1 Consider a database:
Customer (sid, name, career)
Commodity (cid, title)
Price (sid, cid, HKD)
Details:
• Sid of Price is a foreign key referring to sid of Customer.
• Cid of Price is a foreign key referring to cid of Commodity.

1. (5 marks) Find the name of customers who have bought the commodity with cid "c1".

$\Pi_{name}(\sigma_{cid="c1"}(Price) \bowtie Customer)$

2. (5 marks) Find the sid of customers who have bought the commodity entitled "milk".

$\Pi_{sid}(Price \bowtie \sigma_{title="milk"}(Commodity))$

3. (5 marks) Find the sid of customers who have bought two hamburgers.

N/A. This query cannot be expressed since there is no operator for "count".

4. (10 marks) Find the sid of customers who have bought both the commodity entitled "milk" and the commodity entitled "bread".

$\Pi_{sid}(Price \bowtie \sigma_{title="milk"}(Commodity)) \cap \Pi_{sid}(Price \bowtie \sigma_{title="bread"}(Commodity))$

5. (10 marks) Find the sid of customers who have bought the commodity entitled "milk" or the commodity entitled "hamburger".

$\Pi_{sid}(Price \bowtie \sigma_{title="milk" \text{ or } title="hamburger"}(Commodity))$

6. (10 marks) Find the sid and names of customers who did not buy the commodity entitled "milk".

$\Pi_{sid,name}(Customer) - \Pi_{sid,name}(Customer) \bowtie \Pi_{sid}(Price \bowtie \sigma_{title="milk"}(Commodity))$

Part 2 Consider a database:
Creature (name, category, status)
FoodChain (predator, food, percentage)
Details:

- The values of status in Creature can be:
  Carnivores,
  Herbivores,
  Omnivorous,
  Saprophagous.
- Predator of FoodChain is a foreign key referring to name of Creature.
- Food of FoodChain is a foreign key referring to name of Creature.

1. (5 marks) Find the predator(s) whose foods are all known in Creature.(For a predator if the percentages of its foods sum up to 100%, we say that its foods are all known.)
N/A. This query cannot be expressed since there is no operator for "sum" .

2. (10 marks) List the name of each creature which eats any of the predators of the creature "frog".
$\rho\ (F(predator \rightarrow food),\ \Pi_{predator}\ (\sigma_{food=\text{"frog"}}(FoodChain)))$
$\Pi_{predator}(\Pi_{predator,food}(FoodChain) \bowtie F)$

3. (10 marks) List the name of each creature which eats all the predators of the creature "bird".
$\Pi_{predator,food}(FoodChain)\ /$
$\rho\ (P(predator \rightarrow food),\ \Pi_{predator}\ (\sigma_{food=\text{"bird"}}(FoodChain)))$

4. (15 marks) Find food(s) which are eaten by exactly three predators.
$\rho\ (A(predator \rightarrow p, food \rightarrow f), FoodChain)\ ,\ \rho(B, A)\ ,\ \rho(C, A)\ ,\ \rho(\mathrm{D}, A)$
$\rho\ (D, \sigma(A.f{=}B.f) \wedge (B.f{=}C.f) \wedge (\mathrm{C}.f{=}\mathrm{D}.f) \wedge ((A.p{\neq}B.p) \wedge (B.p{\neq}C.p) \wedge (\mathrm{C}.p{\neq}\mathrm{D}.p) \wedge$
$(A.p{\neq}\mathrm{C}.p) \wedge (A.p{\neq}\mathrm{D}.p) \wedge (B.p{\neq}\mathrm{D}.p))((A \times B \times C \times \mathrm{D}))$
$\rho\ (E, \sigma(A.f{=}B.f) \wedge (B.f{=}C.f) \wedge (A.p{\neq}B.p) \wedge (B.p{\neq}C.p) \wedge (A.p{\neq}C.p)(A \times B \times C))$
$\Pi A.f(\mathrm{E}) - \Pi A.f(\mathrm{D})$

5. (15 marks) List the name of each predator which eats all creatures except itself.
$\rho(P(\text{name} \rightarrow predator),\ \Pi_{name}\ (Creature))$
$\rho(F(\text{name} \rightarrow food),\ \Pi_{name}\ (Creature))$
$\rho\ (A,\ \sigma_{\text{predator=food}}(P \times F))$
$\rho\ (C,\ (A \cup \Pi_{predator,food}(FoodChain))\ /\ \rho(B(name \rightarrow food),\ \Pi_{name}(Creature)))$
$\mathrm{C} - \Pi_{predator}\ (\sigma_{predator=food}(FoodChain))$