CS 348 - Homework 2

Relational Algebra (RA), Tuple Relational Calculus (TRC), and
Domain Relational Calculus (DRC)
(100 Points)

Fall 2019

Answers

1. (40 points) Consider the following schema with the details about a theater complex.

   MOVIES(***mid:*** `int`, *mname:* `string`, *screenedfrom:* `date`, *screenedtill:* `date`)
   SCREENS(***sid***: `int`, *theatername:* `string`, *stype:* `string`, *ssize:* `int`)
   PROJECTIONISTS(***pid***: `int`, *pname:* `string`, *salary:* `int`)
   TRAINED(***pid:*** `int`, ***sid:*** `int`)

   Note that every projectionist is trained to operate some specific type of screen (IMAX, 3D, etc.) Write the following queries in RA, TRC, and DRC. They key field are underlined.

   A. (10 points) Find the *pname*s of projectionists who is trained to operate IMAX screen type.

   - **RA**:
     $\pi_{pname}(\sigma_{sname='IMAX'}(SCREENS \bowtie TRAINED \bowtie PROJECTIONISTS))$

   - **TRC**:
     $\{P.pname \mid P \in PROJECTIONISTS \wedge \exists T \in TRAINED$
     $(\exists S \in SCREENS(S.sid = T.sid \wedge S.stype = \text{'IMAX'} \wedge P.pid = T.pid))\}$

   - **DRC**:
     $\{\langle PN\rangle \mid \langle Pid, PN, PS\rangle \in PROJECTIONISTS \wedge$
     $\exists Tpid, Tsid(\langle Tpid, Tsid\rangle \in TRAINED \wedge$
     $\exists Sid, SN, SR(\langle Sid, SN, SR\rangle \exists SCREENS \wedge$
     $Sid = Tid \wedge SN = \text{'IMAX'} \wedge Pid = Tid)\}$

B. (10 points) Identify the *pid*s of projectionists who make the highest income.

- **RA**:
  Let us find all the projectionists who do not get the highest income. Subtract the result from the original list of porjectionists. Thus remaining projectionists are the highest paid.
  $\rho(P1, PROJECTIONISTS)$
  $\rho(P2, PROJECTIONISTS)$
  $\rho(P3, \pi_{P2.pid}(P1 \bowtie_{P1.salary > P2.salary} P2))$
  $(\pi_{pid} P1) - P3$

- **TRC**:
  $\{P1.pid \mid P1 \in PROJECTIONISTS \wedge \neg(\exists P2 \in PROJECTIONISTS(P2.salary > P1.salary))\}$

- **DRC**:
  $\{\langle Pid \rangle \mid \langle Pid1, PN1, PS1 \rangle PROJECTIONISTS \wedge$
  $\neg(\exists Pid2, PN2, PS2(\langle Pid2, PN2, PS2 \rangle \in PROJECTIONISTS \wedge PS2 > PS1))\}$

C. (20 points) Find the *pname*s of projectionists who are trained to operate screens capable of projecting flim strip size (*ssize*) greater than 35mm but are not trained on IMAX screen type.

- **RA**:
  $\rho(R1, \pi_{pid}(\sigma_{ssize>35}(SCREENS \bowtie TRAINED)))$
  $\pi_{pname}(PROJECTIONISTS \bowtie (R1 - \pi_{pid}(\sigma_{stype='IMAX'}(SCREENS \bowtie TRAINED))))$

- **TRC**:
  $\{P.pname \mid P \in PROJECTIONISTS \wedge \exists T \in TRAINED(\exists S \in SCREENS$
  $(T.sid = T.tid \wedge P.pid = T.pid \wedge S.ssize > 35)) \wedge$
  $\neg(\exists T2 \in TRAINED(\exists S2 \in SCREENS(S2.stype =' IMAX' \wedge T2.sid = S2.sid \wedge T2.pid = P.pid))\}$

- **DRC**:
  $\{\langle PN \rangle \mid \langle Pid, PN, PS \rangle \in PROJECTIONISTS \wedge$
  $\exists Tpid, Tsid(\langle Tpid, Tsid \rangle \in TRAINED \wedge$
  $\exists Sid, SN, SR(\langle Sid, SN, SR \rangle \in SCREENS \wedge$
  $Sid = Tsid \wedge Pid = Tpid \wedge SR > 35)) \wedge$
  $\neg(\exists Sid2, AN2, SR2(\langle Sid2, SN2, SR2 \rangle \in SCREENS \wedge$
  $\exists Tpid2, Tsid2(\langle Tpid2, Tsid2 \rangle \in TRAINED \wedge$
  $Sid2 = Tsid2 \wedge Pid = Tpid2 \wedge SN2 =' IMAX')))\}$

2. (20 points) Write tuple calculus and domain calculus expressions for the following RA operations.

   A. (10 points) `SELECT P=r (R(P, Q, R))`:

   tuple calculus: $\{t \mid R(t) AND\ t.P = r\}$
   domain calculus: $\{abc \mid R(abc) AND\ a = r\}$

   B. (10 points) `PROJECT <P, Q> (R(P, Q, R))`:

   tuple calculus: $\{t.P\ t.B \mid R(t)\ \}$
   domain calculus: $\{ab \mid R(abc)\}$

3. (40 points) Consider the follwing schema of car dealerships:

   DEALERS(***did***: `int`, *dname:* `string`, *dcity:* `string`)
   CARS(***cid***: `int`, *ctype:* `string`, *cmaker:* `string`)
   CATALOG(***did***: `int`, ***cid***: `int`, *cprice*: `float`)

   The key data fields are underlined. Cost of the cars set by the dealers are given in the catelog field.

   A. (10 points) What does the following query compute:

   $\pi_{dname}(\pi_{did}((\sigma_{cmaker='Ford' and\ ctype='sedan'} CARS) \bowtie (\sigma_{cprice<24000} CATALOG)) \bowtie DEALERS)$

   Identify the names of the dealers who sell cars that are made by Ford and of type sedan, and cost less than $24,000.

   B. (10 points) What does the following query compute:

   $\pi_{dname}(\pi_{did}((\sigma_{cmaker='Ford' and\ ctype='sedan'} CARS) \bowtie (\sigma_{cprice<24000} CATALOG) \bowtie DEALERS))$

   This RA does not return anything due to the ordering of the projection operators. Once the *did* is projected, it will be the only field in the resulting set. Thus, projecting *dname* will not return antyhing.

   C. (20 points) Write RA, TRC, and DRC for the query: Find the *cid*s of cars sold by at least two different dealers.

- **RA**:
  $\rho(C1, CATALOG)$
  $\rho(C2, CATALOG)$
  $\pi_{C1.cid}\sigma_{C2.cid \wedge C1.did \neq C2.did}(C1 \times C2)$

- **TRC**:
  $\{R \mid R1 \in CATALOG(\exists R2 \in CATALOG$
  $(R2.cid = R1.cid \wedge R2.did \neq R1.did)$
  $\wedge R.cid = R1.cid)\}$

- **DRC**:
  $\{\langle P \rangle \mid \langle P, Q, R \rangle \in CATALOG \wedge \exists X, Y, Z$
  $(\langle X, Y, Z \rangle \in CATALOG \wedge Y = Q \wedge X \neq P)\}$