Tutorial 5
Relational Algebra

Classroom Exercise

Consider a database with three tables as follows:

Shopper(**shopperName**, street, ageGroup)
Mall(**mallName**, street)
ShopAt(**shopperName, mallName, date, time**, dayOfWeek)

The three tables record information about shoppers, shopping malls, as well as "which shoppers shop at which malls". Primary Keys are in **bold**.

Write the following queries in relational algebra. When answering relational algebra queries, breakdown your answers into intermediate steps. When answering relational algebra queries, each answer should be in the form of one single table containing only relevant output attributes. If you think a question's solution cannot be expressed in relational algebra, explain why.

1. Find those shopper(s) who shopped at all the malls on "Nanyang Ave" every Thursday between 10am to 5pm, and find the streets that these shoppers live in.
2. Find the age groups of those shoppers(s) who only shop at malls that are located on the street where he/she lives.
3. Consider Jurong Point Mall, the shopping mall that is 3.5km south of NTU. Find those shoppers who have shopped there more times than anyone else does. Also find out these shoppers' age groups.
4. Consider Jurong Point Mall, the shopping mall that is 3.5km south of NTU. Find those shoppers in the 20s-30s age group who have never shopped at Jurong Point Mall on Friday evenings between 7pm to 10pm. Also find out which streets these shoppers live in.
5. Find shopping malls that have never been visited by shoppers in the 40s-50s age group on Wednesday mornings between 9am to 11am. Also find out which streets these malls are located.
6. For each shopper, find how many other shoppers shopped at the same malls as him/her on the same date.
7. Find the mall(s) that is/are shopped by the largest number of repeat shoppers in the 20s-30s age group. Repeat shoppers of a mall are shoppers who have shopped at least once in the mall.

Additional Exercises (Optional)

1. A library database schema contains the following tables:

   LIB-MEMBER(ID, name, age)
   BOOK(serial#, title, author, year-of-publication)
   LOAN(ID, serial#, date-due)

   State what each of the following relational algebra queries is looking for:

   (a) $\pi_{name}((\sigma_{year\text{-}of\text{-}publication<1960}\ BOOK \bowtie LOAN) \bowtie LIB\text{-}MEMBER)$

   (b) $\pi_{ID}(\sigma_{age<21}\ LIB\text{-}MEMBER) - \pi_{ID}(\sigma_{author=\text{“J.K.Rowling”}}\ BOOK \bowtie LOAN)$

   (c) $\pi_{name}((\pi_{ID,serial\#}\ LOAN \div \pi_{serial\#}(\sigma_{title\ like\ \text{‘C Progamming’}}\ BOOK)) \bowtie LIB\text{-}MEMBER)$

2. The schema of a database containing university-type data is given below. Primary key is underlined for each relation.

   STUDENT(Sid, Sname, Sex, Age, Year, GPA)
   DEPT(Dname, NumPhds)
   PROF(Pname, Dname)
   MAJOR(Dname, Sid)
   COURSE(Dname, C#, Cname)
   SECTION(Dname, C#, Sect#, Pname)
   ENROLL(Sid, Dname, C#, Sect#, Grade)

   Write the following queries in relational algebra.

   (a) Find the names of professors who work in departments that have fewer than 50 PhD students.

   (b) Find the name(s) of student(s) with the lowest GPA.

   (c) Find the names and majors of students who have taken the ‘Database System’ course.

   (d) Find the ids, names, and GPAs of the students who have taken all courses from the ‘Civil Engineering’ department.

3. Consider the following relational schema (primary keys are underlined). eventtype can take values: SWI (swimming), ATH (athletics), GYM (gymnastics), etc. medal can take values: gold, silver, bronze. You may assume player names are unique.

   PLAYERS(player-id, name, countryname, age)
   EVENTS(event-id, name, eventtype)
   RESULTS(player-id, event-id, medal)

   Write relational algebra expression for the following queries.

   (a) Find the names of the players who won at least one gold and one silver.

(b) Find the players who did not win a medal.