A1: Relational Algebra

Andrew Choi

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1 Barnes and Noble Office Equipment Database

1. Find the name of the company and the model name for all personal computers (non-laptops) that are more than $800 and less than $1200.

   $CompanyWithComputer := Company \bowtie (ProduceComputer \bowtie Computer)$
   Answer: $\Pi_{cname,model}\sigma_{laptop=False \wedge price>800 \wedge price<1200} CompanyWithComputer$

2. What company only sells computer with a "Windows" operating system?

   Answer: $\Pi_{companyID} CompanyWithComputer - \Pi_{companyID}\sigma_{os \neq "Windows"} CompanyWithComputer$

3. What company makes the laptop with the largest ram and what city are they located in?

   $CompanyWithLaptop := \sigma_{laptop=True} CompanyWithComputer$
   NotMaxRam(companyID, city) :=
   $\Pi_{c1.companyID,c1.city}\sigma_{c1.ram<c2.ram}(\rho_{c1} CompanyWithLaptop \times \rho_{c2} CompanyWithLaptop$
   Answer: $CompanyWithLaptop - NotMaxRam$

4. Which company makes at least 3 different color printers but does not make a laptop with a 15-inch screen?

   CompanyWithComputerColorPrinter :=
   $Company \bowtie [(Computer \bowtie ProduceComputer) \times \sigma_{color=True}(Printer \bowtie ProducePrinter)]$
   ComputerCombo :=
   $\rho_{c1} CompanyWithComputerColorPrinter \times \rho_{c2} CompanyWithComputerColorPrinter \times$

$\rho_{c3} CompanyWithComputerColorPrinter$

3DiffColorPrinters := $\sigma_{(c1.companyID=c2.companyID \wedge c1.printerID \neq c2.printerID) \wedge (c1.companyID=c3.companyID \wedge c1.printerID \neq c3.printerID) \wedge (c2.companyID=c3.companyID \wedge c2.printerID \neq c3.printerID)} ComputerCombo$

Answer: $\Pi_{companyID}$3DiffColorPrinters$-\Pi_{companyID}\sigma_{laptop=True \wedge screen=15}$3DiffColorPrinters

2 Olympic Games

5. Find all the sporting disciplines that Colombian athletes have competed in so far.

   Answer: $\Pi_{sport}\sigma_{cname=''Colombia''}(Country \bowtie Athlete)$

6. Find the last names of the athlete(s) of the country(ies) that did not win any medals yet (either because they did not compete, or because their athletes did not rank in the top 3 in any event so far).

   CountriesNoMedal:=

   $\Pi_{CID} Country - \Pi_{CID}\sigma_{medal=''gold'' \vee medal=''silver'' \vee medal=''bronze''}(Result \bowtie (Athlete \bowtie Country))$

   Answer: $\Pi_{lname}\sigma_{Athlete.CID=Countries.CID}(Athlete \times CountriesNoMedal)$

7. Find the first and last name of the athletes whose sporting discipline is "swimming" and have won the highest number of gold medals among all athletes who compete in the same sport (i.e., swimming).

   SwimmingAthlete := $\sigma_{sport=''swimming''} Athlete$

   NotHighGold(AID, fname, lname) :=

   $\Pi_{a1.AID,a1.fname,a1.lname}\sigma_{a1.gold<a2.gold}(\rho_{a1} SwimmingAthlete \times \rho_{a2} SwimmingAthlete)$

   Answer: $\Pi_{fname,lname}(\Pi_{AID,fname,lname} SwimmingAthlete - NotHighGold)$

8. Find the name of every country that has won at least one of every type of medal (gold, silver, and bronze).

   CountryWithResult := $Result \bowtie (Athlete \bowtie Country)$

   CountryGold := $\sigma_{medal=''gold''} CountryWithResult$

   CountrySilver := $\sigma_{medal=''silver''} CountryWithResult$

   CountryBronze := $\sigma_{medal=''bronze''} CountryWithResult$

   CountryOneOfEach := $\sigma_{CountryGold.CID=CountrySilver.CID \wedge CountryGold.CID=CountryBronze.CID \wedge CountrySilver.CID=CountryBronze.CID}(CountryGold \times CountrySilver \times CountryBronze)$

   Answer: $\Pi_{cname} CountryOneOfEach$

9. Find the sports disciplines of the events for which at least two tickets were bought on the date of the event.

EventTicket := $\rho_{e1}(Event \bowtie Ticket) \times \rho_{e2}(Event \bowtie Ticket)$
EventsWithTwoOrMoreTickets := $\sigma_{e1.dateIssued=e2.date \wedge e1.TID \neq e2.TID} EventTicket$
Answer: $\Pi_{sport} EventsWithTwoOrMoreTickets$

10. Find the discipline (sport) of the event for which the highest number of tickets was purchased.

    Answer: This query is not possible given the current database schema given, as there is no aggregate function available in RA to find the total number of tickets for one event.

11. Find the athlete with the highest overall number of gold medals won so far, and report that athlete's first and last name, country name, and number of gold medals won.

    NotHighGoldAthlete(AID, fname, lname, CID, gold) :=
    $\Pi_{a1.AID,a1.fname,a1.lname,a1.CID,a1.gold} \sigma_{a1.gold<a2.gold}(\rho_{a1} Athlete \times \rho_{a2} Athlete)$
    HighestAthlete := $\Pi_{AID,fname,lname,CID,gold} Athlete - NotHighGoldAthlete$
    Answer: $\Pi_{fname,lname,cname,gold}(Country \bowtie HighestAthlete)$

12. Find the first and last name for all athletes who have won a gold medal in an event for which no tickets were sold.

    EventsWithNoTickets := $\Pi_{EID}(\Pi_{EID,TID} Ticket - \Pi_{EID,TID}(Event \bowtie Ticket))$
    ResultAtEvent := $\sigma_{Results.EID=EventsWithNoTickets.EID}(Result \times EventsWithNoTickets)$
    AthleteResultAtEvent := $\sigma_{ResultAtEvent.AID=Athlete.AID}(ResultAtEvent \times Athlete)$
    Answer: $\Pi_{fname,lname} \sigma_{medal=''gold''} AthleteResultAtEvent$

13. Find the gold medalist country of the event for which the very first ticket out of all the tickets in the database was purchased.

    NotEarlyDateTicket(TID, dateIssued, timeIssued, EID) :=
    $\Pi_{t1.TID,t1.dateIssued,t1.timeIssued,t1.EID} \sigma_{t1.dateIssued>t2.dateIssued}(\rho_{t1} Ticket \times \rho_{t2} Ticket)$
    EarliestDateTicket := $Ticket - NotEarlyDateTicket$
    NotEarlyTimeTicket(TID, EID) :=
    $\Pi_{t1.TID,t1.EID} \sigma_{t1.timeIssued>t2.timeIssued}(\rho_{t1} EarliestDateTicket) \times \rho_{t2} EarliestDateTicket)$
    EventWithEarlyDateTime := $\Pi_{EID}(\Pi_{TID,EID} EarliestDateTicket - NotEarlyTimeTicket)$
    GoldAthleteOnEarlyEvent :=
    $\Pi_{AID} \sigma_{medal=''gold''}(EventWithEarliestTime \bowtie_{EventWithEarliestTime.EID=Result.EID} Result)$
    GoldAthleteInfo := $GoldAthleteOnEarlyEvent \bowtie_{GoldAthleteOnEarlyEvent.AID=Athlete.AID} Athlete$

    Answer: $\Pi_{cname}(Country \bowtie_{Country.CID=GoldAthleteInfo.CID} \text{GoldAthleteInfo})$

3 Olympic Games: Integrity Constants

1. All tickets for an event have to be purchased before the time of the event.

   TicketAfterEvent := $\sigma_{dateIssued \geq date \wedge timeIssued \geq time}(Ticket \bowtie Event)$
   Answer: $TicketAfterEvent = \emptyset$

2. An athlete could not have competed in an event for a sporting discipline that they are not qualified to participate in.

   AthleteWrongEvent := $\sigma_{Athlete.sport \neq Event.sport}(Athlete \bowtie Event)$
   Answer: $AthleteWrongEvent = \emptyset$

3. The number of tickets purchased for an event should not exceed the capacity of the stadium where the event takes place.

   Answer: This integrity constant is not possible given the constraints given in this database schema. There is no way to calculate the total number of tickets purchased for one event, as RA functions do not have an aggregate function.