University of Toronto
CSC343, Fall 2016

# Assignment 1: Bin Liu 1002700133 Maosong Yue 1002613200

Unary operators on relations:

- $\Pi_{x,y,z}(R)$
- $\sigma_{condition}(R)$
- $\rho_{New}(R)$
- $\rho_{New(a,b,c)}(R)$

Binary operators on relations:

- $R \times S$
- $R \bowtie S$
- $R \bowtie_{condition} S$
- $R \cup S$
- $R \cap S$
- $R - S$

Logical operators:

- $\vee$
- $\wedge$
- $\neg$

Assignment:

- $New(a, b, c) := R$

Stacked subscripts:

- $\sigma_{this.something > that.something \wedge \\ this.otherthing \leq that.otherthing}$

Below is the text of the assignment questions; we suggest you include it in your solution. We have also included a nonsense example of how a query might look in LaTeX. We used `\var` in a couple of places to show what that looks like. If you leave it out, most of the time the algebra looks okay, but certain words, *e.g.*, "Offer" look horrific without it.

The characters "\\" create a line break and "[5pt]" puts in five points of extra vertical space. The algebra is easier to read with extra vertical space. We chose "–" to indicate comments, and added less vertical space between comments and the algebra they pertain to than between steps in the algebra. This helps the comments visually stick to the algebra.

# Part 1: Queries

1. Find all patients who (a) have had more than 2 different doctors write them a prescription, and (b) have had a narcotic prescribed to them by every doctor who has written them a prescription. A narcotic is a drug whose schedule is "narcotics". Report the patient's OHIP number.

   – patient satisfied a.

   $HaveMT(patient) := \Pi_{T1.patient}\sigma_{T1.patient=T2.patient \wedge T2.patient=T3.patient \wedge T1.patient=T3.patient \wedge T1.doctor \neq T2.doctor \wedge T2.doctor \neq T3.doctor \wedge T1.doctor \neq T3.doctor}[(\rho_{T1}Prescription) \times (\rho_{T2}Prescription) \times (\rho_{T3}Prescription)]$

   – patient satisfied b.

   $PreWithDrug(patient, doctor, schedule) := \Pi_{patient,doctor,schedule}\sigma_{Product.DIN=Prescription.drug}(Product \times Prescription)$

   $PreSatB(patient) := \Pi_{T1.patient}\sigma_{T1.RxID \neq T2.RxID \wedge T1.patient=T2.patient \wedge T1.doctor=T2.doctor \wedge (T1.schedule="narcotic" \vee T2.schedule="narcotic")}[(\rho_{T1}PreWithDrug) \times (\rho_{T2}PreWithDrug)]$

   – Result.

   $Result(OHIP) := \Pi_{patient}[HaveMT \cap PreSatB]$

2. Find every prescription from 2016 that has never been filled. Report the patient's OHIP number, the prescription ID, prescription date, and drug.

   – Prescription from 2016.

   $PreFrom2016(RxID, pdate, patient, drug) := \Pi_{RxID,date,patient,drug}\sigma_{date \geq 2016}(Prescription)$

   – PreFrom2016 and have been filled.

   $PreFilled(RxID, pdate, patient, drug) := \Pi_{RxID,pdate,patient,drug}\sigma_{PreFrom2016.RxID=Filled.RxID}(PreFrom2016 \times Filled)$

   – Result.

   $Result(patient, RxID, pdate, drug) := \Pi_{patient,RxID,pdate,drug}(PreFrom2016 - PreFilled)$

3. Find the pharmacist who has trained the most people. Report the pharmacist's OCP number and name.

   – Cannot be expressed.

4. The "narcotics prescription period" of a doctor for a patient is the time from the first prescription for narcotics from that doctor for that patient to the most recent one. (It would be zero if that doctor

wrote only one prescription for narcotics for that patient.) Find all patients who have had narcotics prescribed by two or more doctors, and for whom the narcotics prescription periods never overlap. In other words, if they had narcotics prescribed by $n$ different doctors,

$$[start_1..end_1] < [start_2..end_2] < ... < [start_n..end_n]$$

where $start_i$ and $end_i$ are the start and end of the narcotics prescription period of doctor $i$ for that patient. Notice that we have written strictly less than. This means that if $end_i = start_{i+1}$ we do not consider that the periods overlap. Report the patient's OHIP number.

– Prescription with schedule .

$PreWithS(RxID, date, patient, drug, doctor, schedule) := \Pi_{RxID,date,patient,drug,doctor,schedule}\sigma_{drug=DI}$
$Product)$

– DoctorPatient with narcotics period.

$DoctorWithN(RxID, sdate, edate, patient, doctor) :=$
$\Pi_{T1.RxID,T1.date,T2.date,T1.patient,T1.doctor}\sigma_{\substack{T1.doctor=T2.doctor \wedge T1.patient=T2.patient \wedge \\ T1.RxID \neq T2.RxID \wedge T1.date<T2.date \wedge \\ T1.schedule='narcotic' \wedge T2.schedule='narcotic'}} [\rho_{T1}(PreWithS) \times$
$\rho_{T2}(PreWithS)]$

– DoctorPatient with longest narcotics period.

$Doctor1(RxID, sdate, edate, patient, doctor) :=$
$\Pi_{T1.RxID,T1.sdate,T1.edate,T1.patient}\sigma_{\substack{T1.doctor=T2.doctor \wedge T1.patient=T2.patient \wedge \\ T1.RxID \neq T2.RxID \wedge T1.date<T2.date \wedge \\ T1.sdate>T2.sdate \wedge T1.edate<T2.edate}} [\rho_{T1}(DoctorWithN) \times$
$\rho_{T2}(DoctorWithN)]$

$DoctorWithLongest(RxID, sdate, edate, patient, doctor) :=$
$(DoctorWithW - Doctor1)$

– Patient who have narcotics prescribed by two or more doctors.

$DoctorWithN(patient) :=$
$\Pi_{T1.patient}\sigma_{\substack{T1.doctor \neq T2.doctor \wedge T1.patient=T2.patient \wedge \\ T1.RxID \neq T2.RxID \wedge T1.schedule='narcotic' \wedge \\ T2.schedule='narcotic'}} [\rho_{T1}(Prescription) \times \rho_{T2}(Prescription)]$

5. Find all pharmacists who have never filled a prescription for a drug product whose active ingredient is "codeine". Report their OCP number and every schedule for which they *have* filled a prescription. Put the information into a relation with attributes "OCP" and "schedule".

– Rename prescription attribute date for natural join

$Prescription(RxID, pdate, patient, drug, doctor, dosage, note) :=$
$\Pi_{RxID,date,patient,drug,doctor,dosage,note}(Prescription)$

– Drug DIN for which codeine is an active ingredient

$DrugWC(drug) := \Pi_{DIN}\sigma_{name="codeine"}(Product \bowtie ActiveIngredient)$

– All pharmacists who have filled a prescription for a drug product for which codeine

is an active ingredient.

$PharFilled(OCP) := \Pi_{OCP}(Prescription \bowtie DrugWC \bowtie Filled)$

– All pharmacists who never do above.

$PharNot(pharmacist) := [(\Pi_{OCP} Pharmacist) - PharFilled]$

– Result.

$Result(OCP, schedule) := \Pi_{pharmacist,schedule}[PharNot \bowtie Filled \bowtie Prescription \bowtie (\rho_{Product(drug,manufacturer,name,form,schedule)}(Product))]$

6. Lets say a minor trainer is a pharmacist who has trained no more than two people. (They may have trained none.) Find all pharmacists who have trained 2 or more minor trainors. (They may have trained other pharmacists who were not minor trainors.) Report the pharmacist's OCP number.

– Those are not minor trainer(trained more than 2).

$NotMT(OCP) := \Pi_{T1.P2}\sigma_{T1.P1 \neq T2.P1 \wedge T1.P1 \neq T3.P1 \wedge T2.P1 \neq T3.P1 \wedge T1.P2=T2.P2 \wedge T1.P2=T3.P2 \wedge T2.P2=T3.P2}[(\rho_{T1}(TrainedUnder)) \times (\rho_{T2}(TrainedUnder)) \times (\rho_{T3}(TrainedUnder))]$

– Those are minor trainer.

$MT(OCP) := [(\Pi_{OCP} Pharmacist) - NotMT]$

– People have trained minor trainer.

$PeopleTrained(P1, P2) := [TrainedUnder \bowtie (\rho_{MT(P1)}(MT))]$

– Result.

$Result(OCP) := \Pi_{T1.P2}\sigma_{T1.P1 \neq T2.P1 \wedge T1.P2=T2.P2}[(\rho_{T1}(PeopleTrained)) \times (\rho_{T2}(PeopleTrained))]$

7. Find the most junior pharmacist: the pharmacist whose first time filling a prescription has the latest date. Report the pharmacist's OCP number, the prescription ID for the first prescription they filled, the date on which it was written, and the date on which it was filled.

– Rename the Prescription attribute date for natural join

$Prescription(RxID, pdate, patient, drug, doctor, dosage, note) := \Pi_{RxID,date,patient,drug,doctor,dosage,note}(Prescription)$

–We find the first time filling a prescription of every doctor.

$NotFirstTimeForAll(OCP, RxID, writtenDate, filledDate) := \Pi_{N1.phramacist,N1.RxID,N1.pdate,N1.date}$
$\sigma_{N1.phramasist=N2.phramacist \wedge N1.date<N2.date}$
$(\rho_{N1}(Filled \bowtie Prescription)) \times (\rho_{N2}(Filled \bowtie Prescription))$

$FirstTimeForAll(OCP, RxID, writtenDate, filledDate) := (\Pi_{phramacist,RxID,pdate,date}(Filled \bowtie Prescription)) - NotFirstTimeForALL$

–then we find the most junior phramacist among all the phramacists.

$NotJunior(OCP, RxID, writtenDate, filledDate) :=$
$\sigma_{F1.date<F2.date}[(\rho_{F1}(FirstTimeForAll)) \times (\rho_{F2}(FirstTimeForall))]$

$Answer(OCP, RxID, writtenDate, filledDate) := FirstTimeForALL - NorJunior$

8. Find every patient who has had a prescription for a homeopathic drug product filled, that is, a product whose schedule is "homeopathic", but has never had a prescription filled for a drug product with any other schedule.

   – Rename the Prescription attribute date for natural join

   $Prescription(RxID, pdate, patient, drug, doctor, dosage, note) :=$
   $\Pi_{RxID,date,patient,drug,doctor,dosage,note}(Prescription)$

   $FilledPrescription(RxID, patient, schedule) := \Pi_{RxID,patient,schedule}$
   $(Prescription \bowtie Filled)$

   –First we choose every patient who had prescription for homeopathic

   $homeopathic(patient) := \Pi_{patient}\sigma schedule = "homeopathic"(FilledPrescription)$

   –Then we find every patient who had all other prescription except homeopathic

   $other(patient) := \Pi_{patient}$
   $Answer(patient) := homeopathic - other$

9. Find all patients who have had at least two prescriptions for narcotics that have a single active ingredient, whose units are mg, and for whom the dosage of the ingredient in these prescriptions never decreased from one prescription to the next. Report their OHIP number.

   –First, we make production to get all useful parameters

   $newPrescription(DIN, name, unit, RxID, patient, dosage) := \Pi_{DIN,name,unit,RxID,patient,dosage}$

   $\sigma_{P.drug=A.DIN}((\rho_P Prescription) \times (\rho_A ActiveIngredient))$

   $usefulPrescription(DIN, name, unit, RxID, paitent, dosage, schedule) :=$

   $\Pi_{DIN,name,unit,RxID,paitent,dosage,schedule}(newPrescription \bowtie Product)$

   –Then we find the answer

$answer(patient) := \Pi_{patient}$

$\sigma_{n1.patient=n2.patient \wedge n1.schedule=n2.schedule=\text{"}narcotic\text{"}}$

$\wedge n1.name = n2.name \wedge n1.unit = n2.unit = \text{"}mg\text{"} \wedge n1.date < n2.date \wedge n1.dosage < n2.dosage$

$((\rho_{n1} usefulPrescription) \times (\rho_{n2} usefulPrescription))$

10. Report the OCP number of the pharmacist who has had the greatest number of other pharmacists train under him or her.

    – Cannot be expressed.

11. For each pharmacist who has trained anyone, report their OCP number, the OCP number of the first person to complete training under them, and the OCP number of the last person to complete training under them. Your resulting relation should have three attributes: "OCP", "first" and "last".

    –First we find the last person

    $NotLast(P1, P2, date) := \Pi_{T1.P1,T1.P2,T1.date} \sigma_{T1.p2=T2.p2 \wedge T1.date<T2.date}((\rho_{T1} TrainedUnder) \times (\rho_{T2} TrainedUnder))$

    $Last(P1, P2) := \Pi_{P1,P2}(TrainedUnder - NotLast)$

    –Then we find the first person

    $NotFirst(P1, P2, date) := \Pi_{T1.P1,T1.P2,T1.date} \sigma_{T1.p2=T2.p2 \wedge T1.date>T2.date}((\rho_{T1} TrainedUnder) \times (\rho_{T2} TrainedUnder))$

    $First(P1, P2) := \Pi_{P1,P2}(TrainedUnder - NotFirst)$

    –We combine them together

    $Answer(OCP, first, last) := \Pi_{First.P1,First.P2,Last.P2} \sigma_{First.P1=Last.P1} First \times Last$

12. Find all people who have, at least twice, had more than one prescription filled in a year, but haven't had one filled since 2014. Report the person's OHIP number and the last date on which they had a prescription filled.

    – Rename the Prescription attribute date for natural join

    $Prescription(RxID, pdate, patient, drug, doctor, dosage, note) := \Pi_{RxID,date,patient,drug,doctor,dosage,note}(Prescription)$

    –First we find all the patients have at least twice, more than one prescription – filled in a year

    $sameYear(patient, date) := \Pi_{patient,date}$

$\sigma_{N1.patient=N2.patient \wedge N1.RxID!=N2.RxID \wedge N1.date!=N2.date \wedge N1.date.year=N2.date.year}[(\rho_{N1}(Filled \bowtie Prescription)) \times (\rho_{N2}(Filled \bowtie Prescription))]$

$since2014(patient, date) := \Pi_{patient,date}\sigma_{N1.date.year>=2014}(\rho_{N1}(Filled \bowtie Prescription))$

–Then we deduct people had prescription filled since 2014

$NotSince2014(patient, date) := sameYear - since2014$

–Last, we find the last day of them

$notLastDate(patient, date) := \Pi_{N1.patient,N1.date}\sigma_{N1.date<N2.date}$

$(\rho_{N1}NotSince2014 \times \rho_{N1}NotSince2014)$

$last(patient, date) := NotSince2014 - notLastDate$

## Part 2: Additional Integrity Constraints

1. A pharmacist can only train under someone who registered with the Ontario College of Physicians before they did.
   – Make two copy of Pharmacist and rename them .

   $PharmacistOne(P1, P1registered) := \Pi_{OCP,registered}(Pharmacist)$

   $PharmacistTwo(P2, P2registered) := \Pi_{OCP,registered}(Pharmacist)$

   – No pharmacist can be trained under someone registered before them .

   $\Pi_{P1}\sigma_{P1registered<P2registered}(TrainedUnder \bowtie PharmacistOne \bowtie PharmacistTwo) = \phi$

2. A doctor can't prescribe a controlled substance (a product with schedule "narcotics") until after they have prescribed three different over-the-counter drug products (products with schedule "OTC").

   – Doctor with schedule information.

   $DoctorWithS(RxID, date, doctor, schedule) := \Pi_{RxID,date,doctor,schedule}\sigma_{drug=DIN}(Product \times Prescription)$
   – Doctor that can prescribe a controlled substance after date.

   $DoctorCan(doctor, date) := \Pi_{T1.doctor,T3.date}\sigma_{\substack{T1.doctor=T2.doctor \wedge T2.doctor=T3.doctor \wedge \\ T1.doctor=T3.doctor \wedge T1.RxID!=T2.RxID \wedge \\ T2.RxID!=T3.RxID \wedge T1.RxID!=T3.RxID \wedge \\ T1.date \leq T2.date \wedge T2.date \leq T3.date \wedge \\ T1.schedule='OCT' \wedge T2.schedule='OCT' \wedge \\ T3.schedule='OCT'}}[(\rho_{T1}(DoctorWithS)) \times (\rho_{T2}(DoctorWithS)) \times (\rho_{T3}(DoctorWithS))]$

   – The reasult above may contain duplicate doctor.We want the one with earliest date.

   $NotEarliest(doctor, date) := \Pi_{T1.doctor,T2.date}\sigma_{T1.date<T2.date \wedge T1.doctor=T2.doctor}[(\rho_{T1}(DoctorCan)) \times (\rho_{T2}(DoctorCan))]$

   $DocWithE(doctor, edate) := (DoctorCan - NotEarliest)$

– All doctor that have not prescribed three different over-the-counter.

$DoctorCanNot(doctor) := \Pi_{doctor}(Prescription) - \Pi_{doctor}(DoctorCan)$
$\sigma schedule =' narcotics'(DoctorWithS \bowtie DoctorCanNot) = \phi$

– All doctor that can prescribe a controlled substance after their edate.

$\sigma schedule =' narcotics' \wedge date < edate(DocotorWithS \bowtie DocWithE) = \phi$