University of Toronto
CSC343, 2016 Fall
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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.

Answer:

- Find the patients who have 3 different doctors

OverTwoDoctors(patient) := $\Pi_{p1.patient}(\sigma_{p1.patient = p2.patient \wedge p2.patient = p3.patient \wedge p1.doctor \neq p2.doctor \wedge p1.doctor \neq p3.doctor \wedge p2.doctor \neq p3.doctor}(\rho_{p1}(\text{Prescription}) \times \rho_{p2}(\text{Prescription}) \times \rho_{p3}(\text{Prescription}))$

PP := $\rho_{\text{NewPrescription(RxID, date, patient, DIN, doctor, dosage, note)}}(\text{Prescription}) \bowtie \text{Product}$

- Find patients who have never had narcotics

NeverNarcoFromOneDoc(patient) := $\Pi_{\text{Prescription.patient}}(\sigma_{\text{Product.schedule} \neq \text{"narcotic"}}(\text{PP}) \cap (\text{PP} - \sigma_{\text{Product.schedule} = \text{"narcotic"}}(\text{PP})))$

Answer(patient) := OverTwoDoctors(patient) $\cap$ ($\Pi_{\text{Prescription.patient}}$(Prescription) – NeverNarcoFromOneDoc (patient))

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

Answer:

(Assuming that prescription year can be accessed through Prescription.date.year)

- Find all prescription from 2016

From2016(patient, RxID, date, DIN) = $\Pi_{\text{patient, Rxid, date, drug}}(\sigma_{\text{Prescription.date.year} = 2016}$ (Prescription))

- Find all the prescription that has already been filled that was written in 2016

AlreadyFilled(patient, RxID, date, DIN) = $\Pi_{\text{from2016.patient, from2016. Rxid, from2016.date, from2016.drug}}$ ($\sigma_{\text{From2016.Rxid=Filled.Rxid}}$ (From2016 $\bowtie$ Filled))

- All 2016 prescription minus 2016 prescriptions that have been filled is the 2016 prescriptions that have not yet been filled

Answer(patient, RxID, date, DIN) = From2016(patient, RxID, date, DIN) - AlreadyFilled(patient, RxID, date, DIN)

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

   Answer:

   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 starti and endi 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 endi = start i+1, we do not consider that the periods overlap. Report the patient's OHIP number.

   Answer:

   - find all the narcotics prescriptions

   NarcoticPrescription := $\sigma_{\text{product. schedule = 'narcotics'}}(\sigma_{\text{prescription.drug = product.DIN}} = (\text{Prescription} \bowtie \text{Product}))$

   - Rule out non-start, non-finish prescriptions

   Non-finish(patient, doctor, date) := $\Pi_{\text{p1.patient,p1.doctor,p1.date}}(\sigma_{\text{p1.patient=p2.patient ^ p1.doctor=p2.doctor ^ p1.date<p2.date}}(\rho_{p1}\ (\text{NarcoticPrescription}) \bowtie \rho_{p2}\ (\text{NarcoticPrescription})))$

   Non-start(patient, doctor, date) := $\Pi_{\text{p1.patient,p1.doctor,p1.date}}(\sigma_{\text{p1.patient=p2.patient ^ p1.doctor=p2.doctor ^ p1.date>p2.date}}(\rho_{p1}\ (\text{NarcoticPrescription}) \bowtie \rho_{p2}\ (\text{NarcoticPrescription})))$

   Start(patient, doctor, start) = $\Pi_{\text{narcoticprecription.patient, narcoticprecription.doctor,}}$

$_{narcoticprecription.date}$(NarcoticPrescription) – Non-start(patient, doctor, date)

finish(patient, doctor, finish) = $\Pi_{narcoticprecription.patient,\ narcoticprecription.doctor,\ narcoticprecription.date}$(NarcoticPrescription) – Non-finish(patient, doctor, date)

Procedure(patient, doctor, start, finish) = start $\bowtie$ finish

- now we focus on the interactions between different prescriptions, interaction only contains the part where p3 and p4 time frame intersect

Interactions := $\Pi_{patient}$ ($\sigma_{p3.patient = p4.patient \wedge p3.doctor \neq p4.doctor \wedge p3.start<p4.finish}$($\rho_{p3}$ (Procedure) $\bowtie$ ρ_{p4} (Procedure)))

Answer:= $\Pi_{patient}$ (Prescription) - Interactions

5. Find all pharmacists who have never filled a prescription for a drug product for which codeine is an active ingredient. 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".

   Answer:

   - Filled prescription is the prescription that has been filled

   FilledPrescription(RxID, DIN, patient, pharmacist) := $\Pi_{NewPrescription.RxID,\ NewPrescription.DIN,\ NewPrescription.patient,\ Filled.pharmacist}$($\rho_{NewPrescription(RxID,\ writedate,\ patient,\ DIN,\ doctor,\ dosage,\ note)}$ (Prescription) $\bowtie$ Filled)

   - Find doctors that prescribe drugs with codeine as active ingredient, have OCP and DIN

   DoctorsWithCodeine(OCP, DIN) = $\Pi_{NewFilledPrescription.pharmacist,\ ActiveIngredient.DIN}$ ($\sigma_{ActiveIngredient.name = "codeine"}$($\rho_{NewFilledPrescription\ (RxID,\ DIN,\ patient,\ OCP)}$ (FilledPrescription) $\bowtie$ ActiveIngredient))

   - All the doctors – doctors that provide codeine is the doctors that do no supply codeine

   DoctorsWithoutCodeine (OCP, DIN) := $\Pi_{AllDocs.OCP,\ AllDocs.DIN}$($\rho_{AllDocs(RxID,\ DIN,\ patient,\ OCP)}$ (FilledPrescription)) - DoctorsWithCodeine(OCP, DIN)

   - Attach schedule to the OCP

   Answer(OCP, schedule) = $\Pi_{DoctorsWithourCodeine.OCP,\ Product.schedule}$(DoctorsWithoutCodeine $\bowtie$ Product)

6. Let's 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 trainers. (They may have trained other pharmacists who were not minor trainers.) Report the pharmacist's

OCP number.

Answer:

- Trainers that trained at least 3 different people (not minor trainers)

NotMinorTrainers(P2) := $\Pi_{p1.p2}$ ($\sigma_{p1.P2 = p2.P2 \wedge p2.P2 = p3.P2 \wedge p1.P1 \neq p2.P1 \wedge p1.P1 \neq p3.P1 \wedge p2.P1 \neq p3.P1}$ (ρ_{p1} (TrainedUnder) × ρ_{p2} (TrainedUnder) × ρ_{p3} (TrainedUnder))

- Minor trainers is total trainers minus the ones that are not minor trainers

MinorTrainers(P2) := $\Pi_{TrainedUnder.P2}$ (TrainedUnder) – NotMinorTrainer

- Get the trainers that have trained at least 2 minor trainers

Trainers(P2) := $\Pi_{TrainedUnder.p2}$ ($\sigma_{M1.P2 = M2.P2 \wedge M3.OCP \neq M4.OCP \wedge M1.P1 = M3 \wedge M2.P1 = M4}$ (ρ_{M1}(TrainedUnder) × ρ_{M2}(TrainedUnder) × ρ_{M3}(MinorTrainers) × ρ_{M4}(MinorTrainers)))

- Translate from P2 to OCP

Answer(OCP) = $\rho_{NewTrainer\ (OCP)}$ (Trainers)

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.

   Answer:

   - Find the first by minus the not first filled prescriptions by the same pharmacist

   NotFirst := $\sigma_{p1.pharmacist = p2.pharmacist \wedge p1.date > p2.date}$ (ρ_{p1} (Filled) × ρ_{p2} (Filled))

   PossibleFirst:= Π_{RxID} (Filled – NotFirst)

   - Comparing between different people by paring the possible first with all the filled

   NotThisPerson = $\sigma_{p3.pharmacist \neq p4.pharmacist \wedge p3.date > p4.date}$ (ρ_{p3} (Filled ⋈ PossibleFirst) × ρ_{p4} (Filled ⋈ PossibleFirst))

   ThisPrescription = Π_{RxID}(Filled ⋈ PossibleFirst – NotThisPerson)

   Answer =$\Pi_{Filled.pharmacist,Filled.RxID,Prescription.writedate,Filled.date}$($\sigma_{RxID = ThisPrescription}$ (Filled ⋈ $\rho_{NewPrescription(RxID, writedate, patient, drug, doctor, dosage, note)}$ (Prescription)))

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.

   Answer:

FilledPrescription(RxID, drug, patient) := $\Pi_{\text{NewPrescription.RxID, NewPrescription.drug, NewPrescription.patient}}(\rho_{\text{NewPrescription(RxID, writedate, patient, drug, doctor, dosage, note)}}(\text{Prescription}) \bowtie \text{Filled})$

FilledPrescriptionWithSchedule(RxID, DIN, patient, schedule) := $\Pi_{\text{NewFilledPrescription.RxID, NewFilledPrescription.DIN, NewFilledPrescription.patient,Product.schedule}}(\rho_{\text{NewFilledPrescription(RxID, DIN, patient)}}(\text{FilledPrescription}) \bowtie \text{Product})$

Result(RxID, DIN, patient, schedule) = (FilledPrescriptionWithSchedule - $\sigma_{schedule="prescription"}$(FilledPrescriptionWithSchedule)) $\cap$ (FilledPrescriptionWithSchedule - $\sigma_{schedule="narcotic"}$(FilledPrescriptionWithSchedule)) $\cap$ (FilledPrescriptionWithSchedule - $\sigma_{schedule="OTC"}$(FilledPrescriptionWithSchedule))

Answer(patient) = $\Pi_{\text{Result.schedule}}$ (Result)

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 decreases from one prescription to the next. Report their OHIP number.

   Answer:

   -This finds all the prescription of narcotics that have more than 2 active ingredients

   OverOnePrescNar = $\Pi_{\text{p1.DIN}}(\sigma_{p1.name \neq p2.name \wedge p1.DIN = p2.DIN}(\rho_{\text{p1}}(\text{ActiveIngredient}) \times \rho_{\text{p2}}(\text{ActiveIngredient}))$

   - Finds all the narcotics that have only 1 single active ingredient

   One(DIN) = Π_{DIN} (ActiveIngredient) – OverOnePrescNar

   - Finds all the narcotics that satisfy other criteria

   Narcotics = $\sigma_{ActiveIngredient.unit = 'mg'}$(ActiveIngredient $\bowtie$ One)

   LessThanPrev= $\Pi_{\text{p3.patient}}(\sigma_{p3.RxID \neq p4.RxID \wedge p3.date < p4.date \wedge p3.dosage > p4.dosage \wedge p3.patient = p4.patient}(\rho_{\text{p3}}(\text{Prescription} \bowtie \text{Narcotics}) \times \rho_{\text{p4}}(\text{Prescription} \bowtie \text{Narcotics}))$

   Answer = Π_{patient} (Prescription) - LessThanPrev

10. Let's say a pharmacist X is a descendant of Y if either X trained under Y, or X trained under someone else who is a descendant of Y. Report the OCP number of everyone who is a descendant of the pharmacist with OCP number 55555.

    Answer:

    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”

Answer:

AnyTrainerPharm:= Π_{OCP} ($\rho_{p1(P1, OCP, completed)}$ (TrainedUnder))
NotFirst := $\sigma_{p2.OCP = p3.OCP \wedge p2.\ completed >= p3.\ completed}$ (ρ_{p2} (AnyTrainerPharm) × ρ_{p3} (AnyTrainerPharm))
NotLast := $\sigma_{p2.OCP = p3.OCP \wedge p2.\ completed <= p3.\ completed}$ (ρ_{p2} (AnyTrainerPharm) × ρ_{p3} (AnyTrainerPharm))
First := AnyTrainerPharm – NotFirst
Last := AnyTrainerPharm – NotLast
Answer = AnyTrainerPharm ⋈ First ⋈ 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.

Answer:

FilledPrescription(RxID, filledDate, patient) := $\Pi_{NewPrescription.RxID,\ Filled.date,\ NewPrescription.patient}$($\rho_{NewPrescription(RxID,\ writedate,\ patient,\ doctor,\ doctor,\ dosage,\ note)}$ (Prescription) ⋈ Filled)

2OverOnceAYear(patient) := $\Pi_{FilledPrescription.patient}$ ($\sigma_{N1.patient=N2.patient \wedge N1.fillDate \neq N2.fillDate \wedge N1.fillDate.year = N2.fillDate.year \wedge \sigma N2.patient=N3.patient \wedge \sigma N3.patient=N4.patient \wedge N3.fillDate \neq N4.fillDate \wedge N3.fillDate.year = N4.fillDate.year \wedge N1.fillDate.year \neq N3.fillDate.year}$ (ρ_{N1} (FilledPrescription) × ρ_{N2} (FilledPrescription) × ρ_{N3} (FilledPrescription) × ρ_{N4} (FilledPrescription)))

Havesince2014(patient) := $\Pi_{FilledPrescription.patient}$ ($\sigma_{N1.FilledPrecription.fillDate.year>2014}$ (ρ_{N1} (FilledPrescription))

Answer(patient) = 2OverOnceAYear(patient) ∩ ($\Pi_{FilledPrescription.patient}$(FilledPrescription) - Havesince2014(patient))

Part 2: Additional Integrity Constraints

Express the following integrity constraints with the notation R = Φ, where R is an expression of relational algebra.

1. A pharmacist can only train under someone who registered with the Ontario College of Physicians before they did.

Answer:

AllowedToTrainPhar = $\Pi_{OCP}(\rho_{p1(P1, OCP, completed)}$ (TrainedUnder) $\bowtie$ Pharmacist)
- assuming doctor is the same as Pharmacist and may not have OCP
DoesnotAllow = Π_{doctor}(Prescription) – AllowedToTrainPhar
TrainedUnder $\bowtie$ DoesnotAllow = Φ

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 (product with schedule "OTC")

Answer:

- Find out the narc allowed patient

NarcAllowedPatients := $\Pi_{p1.patient}$ ($\sigma_{p1.patient = p2.patient \wedge p2.patient = p3.patient \wedge p1.doctor = p2.doctor \wedge p2.doctor = p3.doctor \wedge p1.schedule = 'OTC' \wedge p2.schedule = 'OTC' \wedge p3.schedule = 'OTC' \wedge p1.DIN \neq p2.DIN \wedge p1.DIN \neq p3.DIN \wedge p2.DIN \neq p3.DIN \wedge}$
(ρ_{p1} (Prescription $\bowtie$ Product) × ρ_{p2} (Prescription $\bowtie$ Product) × ρ_{p3} (Prescription $\bowtie$ Product))

NarcNotAllowedPatient := $\Pi_{patient}$ (Prescription) – NarcAllowedPatients
$\sigma_{p3.drug = 'narcotics'}$ (ρ_{p3}(NarcNotAllowedPatient $\bowtie$ Prescription)) = Φ