Part1

1.

Doctor drug pairs, for further use

Doc-Drug(RxID, DIN, DocID) := ΠRxID, drug, doctor (Prescription)

Doctor who has issued at least 2 drugs

Doc2(DocID) := $\Pi_{DD1.DocID}\ \sigma_{DD1.DocID = DD2.DocID \wedge DD1.RxID < DD2.RxID \wedge DD1.DIN != DD2.DIN}$

(ρ_{DD1}(Doc-Drug)×ρ_{DD1}(Doc-Drug))

Doctor who has issued at least 2 drugs and drug pairs Doctor drug pairs, for further use

Doc2-Drug(DocID, DIN) := $\Pi_{DocID,\ drug}\ \sigma_{DcoID = doctor}$ (Doc2×Prescription)

Doctor who chose brand drug rather than generic drug

Brand-Doc(DocID) := $\Pi_{DocID}\ \sigma_{Doc2-Drug.DIN = Generic.brand}$ (Doc2-Drug×Generic)

Doctor more than 2 drugs and durg price

Doc2-Generic-Price(DocID, DIN, brand, price) :=

$\Pi_{DocID,\ Generic.DIN,\ brand,\ price}\ \sigma_{Doc2-Drug.DIN = Generic.DIN = Price.DIN}$(Doc2-Drug×Generic×Price)

All-Generic-Price(DIN, brand, price) :=

$\Pi_{Generic.DIN,\ brand,\ price}\ \sigma_{Generic.DIN = Price.DIN}$ (Generic×Price)

Doctor who gives expensive generic price

Exp-Doc(DocID) := $\Pi_{\text{DocID}}\ \sigma_{\text{D.brand=A.brand} \wedge \text{D.DIN != A.DIN} \wedge \text{D.price > A.price}}$

(ρD(Doc2-Generic-Price) × ρA(All-Generic-Price))

Frugal-Doc(DocID) := Doc2 − (Brand-Doc ∪ Exp-Doc)

2.

$(\Pi_{\text{pharmacist}}\ \text{Filled}) - (\Pi_{\text{pharmacist}}\ \sigma_{\text{Filled.RxID = Prescription.RxID} \wedge \text{drug = DIN}}\ (\text{Filled} \times \text{Prescription} \times \text{Generic}))$

3.

Patient who received 2 different drug

PatientDrugs(OHIP, D1, D2):=

$\Pi_{\text{P1.patient, P1.drug, P2.drug}}\ \sigma_{\text{P1.RxID > P2.RxID} \wedge \text{P1.patient = P2.patient} \wedge \text{P1.doctor != P2.doctor}}$

$(\rho_{P1}(\text{Prescrition}) \times \rho_{P2}(\text{Prescriton}))$

2 same drug

P1(OHIP):= $\Pi_{\text{OHIP}}\ \sigma_{\text{D1 = D2}}$ (PatientDrugs)

Brand drug and equal generic drug

$P2(OHIP) := \Pi_{OHIP}\ \sigma_{(D1=DIN \wedge D2=brand) \vee (D2=DIN \wedge D1=brand)}\ (\rho_P(PatientDrugs) \times \rho_G(Generic))$

Generic drug with same brand drug

$P3(OHIP) := \Pi_{OHIP}\ \sigma_{D1 = G1.DIN \wedge D2 = G2.DIN \wedge G1.DIN != G2.DIN \wedge G1.brand = G2.brand}\ (\rho_P(PatientDrugs) \times \rho_{G1}(Generic) \times \rho_{G2}(Generic))$

$P(OHIP, name, phone) := \Pi_{OHIP, name, phone}\ ((P1 \cup P2 \cup P3) \bowtie Patient)$

4.

Impossible

5.

All unfilled prescrition

Unfilled(RxID, patient, DIN):=

$\Pi_{RxID, patient, drug}\ (Prescrition \bowtie (\Pi_{RxID}(Prescrition) - \Pi_{RxID}(Filled))$

Cross 3 times, find at least 3 times and 2 different patients

TripleUnfilled(DIN):=

$\Pi_{U1.DIN}$

$\sigma_{U1.RxID != U2.RxID \wedge U1.RxID != U3.RxID \wedge U2.RxID != U3.RxID \wedge (U1.patient != U2.patient \vee U1.patient != U3.patient \vee U2.patient != U3.patient) \wedge U1.DIN = U2.DIN = U3.DIN}$

$(\rho_{U1}(Unfilled) \times \rho_{U2}(Unfilled) \times \rho_{U3}(Unfilled))$

Report(DIN, manufacture):= $((\Pi_{DIN, manufature} Product) \bowtie (\Pi_{DIN, manufature} Generic)) \bowtie$ TripleUnfilled

6.

If all drugs have exact same ingredient

ShouldBe(DIN1, ingredient1, ingredient2, DIN2):=

$\Pi_{C1.DIN, C1.ingredient, C1.ingredient, C2.DIN} \sigma_{C1.DIN != C2.DIN}$

$(\rho_{C1}(Contains) \times \rho_{C2}(Contains))$

What 2 drugs have comman ingredient

Real(DIN1, ingredient1, ingredient2, DIN2):=

$\Pi_{\text{C1.DIN, C1.ingredient, C2.ingredient, C2.DIN}}\ \sigma_{\text{C1.DIN != C2.DIN} \wedge \text{C1.ingredient = C2.ingredient}}$

$(\rho_{C1}\ (\text{Contains})\ \times\ \rho_{C2}\ (\text{Contains}))$

What Real not achieved in ShouldBe

Diff(DIN1, DIN2):= $\Pi_{\text{DIN1, DIN2}}$ (ShouldBe – Real)

Diff-Verse(DIN1, DIN2):= $\Pi_{\text{DIN2, DIN1}}$ (Diff)

Diff-Dup(DIN1, DIN2):= Diff $\cup$ Diif-Verse

Drugs with exact same ingredients

Match-Pairs(DIN1, DIN2):= $\sigma_{\text{DIN1 < DIN2}}$ ($\Pi_{\text{DIN1,DIN2}}$ (ShouldBe) – Diff-Dup)

Report(DIN1, name1, DIN2, name2):=

$\Pi_{\text{D1, P1.name, D2, P2.name}}\ \sigma_{\text{DIN1 = P1.DIN} \wedge \text{DIN2 = P2.DIN}}$

$(\text{Match-Pairs}\ \times\ \rho_{P1}\ (\text{Product})\ \times\ \rho_{P2}\ (\text{Product}))$

7.

Generic Narcotic drug

Generic-Narcotic(DIN, name):=

$\Pi_{\text{Generic.DIN, Generic.name}} \sigma_{\text{brand = Product.DIN} \wedge \text{schedule = 'narcotic'}}$ (Generic × Product)

All-Narcotic(DIN, name):=

Generic-Narcotic $\cup$ ($\Pi_{\text{DIN, name}} \sigma_{\text{schedule='narcotic'}}$ (Product))

Who has filled narcotic prescription

Narcotic-Filled(OCP, drug, date):=

$\Pi_{\text{Pharmacist, All-Narcotic.name, Filled.date}} \sigma_{\text{Prescription.RxID = Filled.RxID} \wedge \text{drug = DIN}}$

(All-Narcotic × Prescription × Filled)

Find earlier filled time

M(OCP1, drug1, date1, OCP2, drug2, date2):=

$\Pi_{\text{N1.OCP, N1.date, N2.OCP, N2.date}}$

$\sigma_{\text{N1.OCP = N2.OCP} \wedge \text{N1.date > N2.date}}$

(ρ_{N1}(Narcotic-Filled) × ρ_{N2}(Narcotic-Filled))

Pharmacist who only filled 1 narcotic perscription

Once(OCP, drug, date):=

Narcotic-Filled – (Narcotic-Filled $\bowtie_{\text{OCP=OCP1}} \Pi_{\text{OCP1}}$M)

Pharmacist who have filled muilti narcotic prescription, earliest time

Multi (OCP, drug, date):= $\Pi_{OCP1, drug1, date1}$ (M) − $\Pi_{OCP2, drug2, date2}$ (M)

Report(OCP, drug, date, name)(ONCE ∪ Multi) ⋈ $\Pi_{OCP, name}$ (Pharmacist)

8.

Generic drugs and their ingredient

GenericContain(DIN, ingredient)s:=

$\Pi_{Contains.DIN, ingredient}$ $\sigma_{brand = Contains.DIN}$ (Generic×Contains)

All drugs and their ingredients

Drug-Ingredient(DIN, ingredient):=

($\Pi_{DIN, ingredient}$(Product ⋈ Contains)) ∪ GenericContain

All prescription and their ingredients

PI(RxID, doctor, patient, ingredient, date):=

$\Pi_{RxID, doctor, patient, ingredient, date}$ $\sigma_{Prescrition.drug = Drug-Ingredient.DIN}$

(Prescription × Drug-Ingredient)

Report(doctor, date):=

Π PI1.doctor, PI1.date

σ PI1.RxID > PI2.RxID ∧ PI1.doctor = PI2.doctor ∧ PI1.patient = PI2.patient ∧ PI1.date = PI2.date ∧ ((PI1.ingredient = Int.ingredient1 ∧ PI2.ingredient = Int.ingredient2)∨(PI1.ingredient = Int.ingredient2 ∧ PI2.ingredient = Int.ingredient1))

(ρ_{PI1} (PI) × ρ_{PI2} (PI) × ρ_{Int} (Interatction))

9.

Impossible

10.

Parmacist cross Pharmacist, to find earliest and nearest register time

PhPh(OCP1, registered1, OCP2, registered2):=

Π P1.OCP, P1.registered, P2.OCP, P2.registered σ P1.OCP != P2.OCP ∧ P1.registered > P2.registered

(ρ_{P1} (Pharmacist) × ρ_{P2} (Pharmacist))

Most Junior and Most Senior pharmacist

Junior(OCP):= Π_{OCP1} (PhPh) − Π_{OCP2} (PhPh)

Senior(OCP):= Π_{OCP2} (PhPh) − Π_{OCP1} (PhPh)

All filled prescription and cores patient

F(RxID, date, OCP, OHIP, name):=

Π Filled.RxID, Filled.date, Filled.pharmacist, Patient.OHIP, Patient.name

σ Filled.RxID = Prescription.RxID $\wedge$ Prescription.patient = Patient.OHIP

(Filled $\times$ Prescrition $\times$ Patient)

Patient who was filled by most junior pharmacist

J-date(OHIP, name, date):= $\Pi_{OHIP, name, date}$ (Junior $\bowtie$ F)

Self cross, for time compare use

J-Twice(OHIP1, name1, date1, OHIP2, name2, date2):=

Π J1.OHIP, J1.name, J1.date, J2.OHIP, J2.name, J2.date σ J1.OHIP=J2.OHIP $\wedge$ J1.name=J2.name $\wedge$ J1.date<J2.date

(ρ_{J1} (J-date) $\times$ ρ_{J2} (J-date))

Earliest date for whose script filled muilitple times by junior pharmacist

J-Muilt(OHIP, name, date):=

$\Pi_{OHIP1, name1, date1}$ J-Twice $-$ $\Pi_{OHIP2, name2, date2}$ J-Twice

date for whose script filled only one times by junior pharmacist

J-Once(OHIP, name, date)=: J-date $\bowtie$ (Π_{OHIP} J-date $-$ Π_{OHIP1} J-Twice)

J(OHIP, name, date)=: J-Once $\cup$ J-Muilt

Patient who was filled by most senior pharmacist

S-date(OHIP, name, date):= $\Pi_{\text{OHIP, name, date}}$Senior $\bowtie$ F

Self cross, for time compare use

S-Twice(OHIP1, name1, date1, OHIP2, name2, date2):=

Π S1.OHIP, S1.name, S1.date, S2.OHIP, S2.name, S2.date σ S1.OHIP=S2.OHIP $\wedge$ S1.name=S2.name $\wedge$ S1.date<S2.date

(ρ_{S1} (S-date) $\times$ ρ_{S2} (S-date))

Earliest date for whose script filled muilitple times by senior pharmacist

S-Muilt(OHIP, name, date):=

$\Pi_{\text{OHIP1, name1, date1}}$ S-Twice $-$ $\Pi_{\text{OHIP2, name2, date2}}$ S-Twice

date for whose script filled only one times by senior pharmacist

S-Once(OHIP, name, date)=: S-date $\bowtie$ (Π_{OHIP} S-date $-$ Π_{OHIP1} S-Twice)

S(OHIP, name, date)=: S-Once $\cup$ S-Muilt

Report(OHIP, name, earliest-J, earliest-S):=

Π J.OHIP, J.name, J.date, S.date σ J.OHIP = S.OHIP

(J $\times$ S)

11.

DIN for who does not satiesfy (1) and (2)

Not-12(DIN) :=

$\Pi_{P.DIN}\ \sigma_{P.DIN = G.brand \wedge P.manufacture = G.manufature}$

$(\rho_P(Product) \times \rho_G(Generic))$

Product satisfies (1) and (2)

B := Product – (Product $\bowtie$ Not-12)

M12 := $\Pi_{manufacture}$ (Product) - $\Pi_{manufacture}$ (B)

DIN for who does not satiesfy (1) and (2)

Not-3(DIN) :=

$\Pi_{P.DIN}\ \sigma_{P.DIN = G.brand \wedge P.manufacture != G.manufature}$

$(\rho_P(Product) \times \rho_G(Generic))$

Product satisfies (3)

D := Product – (Product $\bowtie$ Not-3(DIN))

M3:= $\Pi_{manufacture}$ (Product) – $\Pi_{manufacture}$ (D)

M123 := M12 $\cap$ M3

Part2

1.

$(\Pi_{ingredient1}$ (Interaction) - $\Pi_{ingredient2}$ (Interaction) = $\emptyset)$

$\wedge$

$(\Pi_{ingredient2}$ (Interaction) - $\Pi_{ingredient1}$ (Interaction) = $\emptyset)$

2.

Impossible

3. *Set of generic prescriptions which doc never issued brand before is empty*

PG(RxID, DIN, brand, doctor, date) := $\Pi_{RxID,\ DIN,\ brand,\ doctor,\ date}$ $\sigma_{drug\ =\ DIN}$ (Prescription × Generic)

PB(RxID, DIN, doctor, date) := $\Pi_{RxID,\ DIN,\ doctor,\ date}$ $\sigma_{drug\ =\ DIN}$ (Prescription × Product)

GoodG(RxID, DIN, brand, doctor, date) := $\Pi_{PG.RxID,\ PG.DIN,\ PG.brand,\ PG.doctor,\ PG.date}$ $\sigma_{PG.brand\ =\ PB.DIN\ \wedge\ PG.date\ >\ PB.date\ \wedge\ PG.doctor\ =\ PB.doctor}$ (PG × PB)

PG – GoodG = $\emptyset$

4.

$\sigma_{Pre1.doctor = Pre2.doctor \wedge Pre1.patient = Pre2.\ patient \wedge Pre1.date = Pre2.date \wedge Pre1.RxID != Pre2.\ RxID \wedge Pre1.drug = Pre2.\ Drug = Pro.DIN \wedge Pro.schedule = 'narcotic'} (\rho_{Pre1}(Prescription) \times \rho_{Pre2}(Prescription) \times \rho_{Pro}(Product)) = \emptyset$