

## Homework Assignment 2 for CS 550

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1. RA:

$\rho(T1, \text{Instruments} \bowtie_{\text{Instruments.instrID}=\text{Plays.instrID}} \text{Plays} \bowtie_{\text{Plays.ssn}=\text{Musicians.ssn}} \text{Musicians})$

$\pi_{\text{instrID}}(\sigma_{\text{Musicians.name}='John'}(T1))$

TRC :

$\{I.\text{instrID} \mid I \in \text{Instruments} \wedge (\exists P \in \text{Plays}, (\exists M \in \text{Musicians}, M.\text{name} = 'John' \wedge I.\text{instrID} = P.\text{instrID} \wedge P.\text{ssn} = M.\text{ssn}))\}$

2. RA:

$A = \pi_{\text{ssn}, \text{InstrID}} \text{Plays}$

$B = \pi_{\text{ssn}} \sigma_{\text{Musicians.name}='John'} \text{Musicians}$

Result = A/B

TRC:

$\{I.\text{InstrID} \mid \text{Instruments}(I) \wedge \exists Y \in \text{Plays}(Y.\text{InstrID} = I.\text{InstrID}) \Rightarrow (\forall M \in \text{Musicians}(M.\text{name} = 'John' \wedge Y.\text{ssn} = M.\text{ssn}))\}$

3. RA:

Result =  $\pi_{\text{InstrID}}((\pi_{\text{ssn}, \text{InstrID}} \text{Musicians} \bowtie \text{Plays}) - (\pi_{\text{ssn}, \text{InstrID}} \sigma_{\neg \text{Musicians.name}='John'} \text{Musicians} \bowtie \text{Plays}))$

TRC:

Result =  $\{P.\text{InstrID} \mid \text{Plays}(P) \text{ AND NOT } (\forall \text{ NOT } M \in \text{Musicians}(M.\text{name} = \text{John}))\}$

4. RA:

$\rho(T, \text{Musicians} \bowtie_{\text{Musicians.ssn}=\text{Plays.ssn}} \text{Plays} \bowtie_{\text{Plays.instrID}=\text{Instruments.instrID}} \text{Instruments})$

$\rho(X, \pi_{\text{Musicians.ssn}}(\sigma_{\text{iname}='Guitar' \vee \text{iname}='Piano'}(T)))$

$\pi_{\text{title}}(\text{AlbumProducer} \bowtie X)$

TRC:

$\{A.title \mid A \in AlbumProducer \wedge (\exists M \in Musicians, (\exists I \in Instruments, (\exists P \in Plays, A.ssn = M.ssn \wedge (I.iname = 'Guitar' \vee I.iname = 'Piano') \wedge A.ssn = P.ssn \wedge P.instrID = I.instrID))))\}$

5. RA:

$\rho(P1, Perform)$

$\rho(P2, Perform)$

$\pi_{ssn}(\sigma_{P1.songID='song1' \wedge P2.songID='song2'} (P1 \times P2))$

TRC:

$\{P1.ssn \mid P1 \in Perform \wedge (\exists P2 \in Perform, P1.ssn = P2.ssn \wedge P1.songID = 'song1' \wedge P2.songID = 'song2')\}$

6. RA:

$\rho(M1, Musicians)$

$\rho(M2, Musicians)$

$\pi_{ssn,name}(Musicians) - \pi_{M1.ssn,M1.name}(M1 \bowtie_{M2.annualIncome > M1.annualIncome} M2)$

TRC:

$\{M.ssn, M.name \mid M \in Musicians \wedge (\forall M1 \in Musicians, M.annualIncome > M1.annualIncome)\}$

7. RA:

$X = \pi_{ssn,name,annualIncome}(Musicians)[ssn1,name1,annualIncome1]$

$Y = \pi_{ssn,name,annualIncome}(Musicians)[ssn2,name2,annualIncome2]$

$\pi_{ssn1}(Musicians) - \pi_{ssn2}(\sigma_{name1 \neq name2 \text{ AND } annualIncome1 \geq annualIncome2} (X \times Y))$

TRC :

$\{(M1.name, M2.name) \mid M1 \in Musicians \wedge M2 \in Musicians \text{ AND NOT } (M1.annualIncome \geq M2.annualIncome \text{ AND } M1.name \neq M2.name)\}$

8. RA:

$\rho(T1, Lives \bowtie_{Musicians.ssn=Lives.ssn} Musicians)$

$\rho(T2, Lives \bowtie_{Musicians.ssn=Lives.ssn} Musicians)$

$\pi_{T1.name, T2.name} (T2 \bowtie_{T1.address=T2.address} T1)$

TRC:

$\{(M1.name, M2.name) \mid M1 \in Musicians \wedge M2 \in Musicians \wedge (\exists ML1 \in Lives, (\exists ML2 \in Lives, ML1.ssn = M1.ssn \wedge ML2.ssn = M2.ssn \wedge ML1.ssn \neq ML2.ssn \wedge ML1.address = ML2.address))\}$

9. RA :

Result =  $\pi_{songID} (\pi_{songID} \sigma_{songID} \text{SongsAppear} - \pi_{songID} \sigma_{songs} \text{Perform} )$

TRC:

$\{S.songID \mid \text{SongsAppear}(S) \text{ AND NOT } (\exists P \in \text{Perform} (S.songID = P.songID ))\}$

10. RA:

$\rho(\text{Songs}, \pi_{songID} (\sigma_{name='John'} (\text{SongsAppear} \bowtie_{\text{SongsAppear.authorSSN}=\text{Musicians.ssn}} \text{Musicians})))$

$\rho(\text{Performers}, \pi_{ssn, songID} (\text{Performs}) / \text{Songs})$

$\pi_{name} (\text{Musicians} \bowtie \text{Performers})$

TRC:

$\{M.name \mid M \in \text{Musicians} \wedge (\forall T \in \text{SongsAppears}, (\exists M \in \text{Musicians}, T.authorSSN = M.ssn \wedge M.name = 'John') \Rightarrow (\exists P \in \text{Performs}, P.ssn = M.ssn \wedge P.songID = T.songID))\}$

11. RA:

$\text{SongsPerformed} = \pi_{ssn, songID, name} (\text{Perform} \bowtie_{\text{Perform.ssn} = \text{Musicians.ssn}} \text{Musicians})$   
 $[\text{Perform.ssn}, \text{Musicians.name}]$

$\text{SongsAuthored} = \pi_{\text{SongsAppears.authorSSN}, \text{SongsAppears.songID}, \text{Musicians.name}} (\text{SongsAppears} \bowtie_{\text{SongsAppears.authorSSN}=\text{Musicians.ssn}} \text{Musicians})$   
 $[\text{SongsAppear.songID}, \text{SongsAppear.authorSSN}, \text{Musicians.name}]$

$\text{PerformedSongAuthored} = \pi_{name} (\pi_{\text{Musicians.ssn}, \text{SongsAppears.songID}, \text{Musicians.name}} (\text{SongsPerformed} \bowtie_{\text{Perform.ssn}=\text{SongsAppears.authorSSN}} \text{SongsAuthored}))$

TRC:

$\{M.name \mid \text{Musicians} (P) \text{ AND } \forall T \in \text{SongsAppears}, (\exists P \in \text{Perform}, P.ssn=T.authorSSN \wedge P.ssn =M.ssn \wedge T.authorSSN=M.ssn ) \}$

12. RA:

$SongsPerformed = \pi_{songID, name, ssn} ((Perform \bowtie_{Perform.ssn = Musicians.ssn} Musicians)$

$\bowtie_{SongsAppears.authorSSN=Musicians.ssn} SongsAppears) [Perform.ssn, Musicians.name]$

$SongsAuthored = \pi_{SongsAppears.songID} (SongsAppears \bowtie_{SongsAppears.authorSSN=Musicians.ssn} Musicians) [SongsAppear.songID, SongsAppear.authorSSN, Musicians.name]$

$PerformedSongAuthored = \pi_{name, ssn} (\pi_{name, ssn} (SongsPerformed / SongsAuthored))$

TRC:

$\{M.name \mid Musicians (P) \text{ AND } (\forall P \in Perform, P.ssn = M.ssn) \Rightarrow (\exists T \in SongsAppears, P.ssn = T.authorSSN) \}$

13. RA:

$SongsPerformed = \pi_{songID} (Perform \bowtie_{Perform.ssn = Musicians.ssn} Musicians) [Perform.ssn, Musicians.name]$

$SongsAuthored = \pi_{SongsAppears.songID, name, ssn} (SongsAppears \bowtie_{SongsAppears.authorSSN=Musicians.ssn} Musicians) [SongsAppear.songID, SongsAppear.authorSSN, Musicians.name]$

$PerformedSongAuthored = \pi_{name, ssn} (\pi_{name, ssn} (SongsAuthored / SongsPerformed))$

TRC:

$\{M.name \mid Musicians (P) \text{ AND } (\forall T \in SongsAppears, P.ssn = T.authorSSN) \Rightarrow (\exists P \in Perform, P.ssn = M.ssn) \}$

14. RA:

$\pi_{name} ((\pi_{ssn} (Musicians) - (\pi_{ssn} (\pi_{ssn, songID} (Perform) - \pi_{ssn, songID} (SongsAppears)[songID, ssn]))) \bowtie Musicians))$

TRC:

$\{M.name \mid Musicians(M) \wedge S \in SongsAppears (\neg P \in Performs (M.ssn \neq S.authorSSN \text{ AND } M.ssn = P.ssn))\}$

