

ADC Assignment 6

Ans 1.0.1(a)

$$\Pi_{L(R_1, \dots, R_K)}(\sigma_{C_1}(R_1)) \times$$

$$(R_2 \bowtie_{C_2}(S, R_2) \wedge S_1 \cdot B_1 = R_1 \cdot A_1 \cdot S)$$

$$[V | n | -] \quad \text{---}$$

$$R_3 \bowtie_{C_3}(T, R_3) \wedge T_1 \cdot C_1 = R_1 \cdot A_1 \cdot T)$$

'NOT IN'

$$\Pi_{L(R_1, \dots, R_K)}(\Pi_{R_1,*}(\sigma_{C_1}(R_1))) -$$

$$(\Pi_{R_1,*}(\sigma_{C_1}(R_1)) \times 2)$$

$$(R_2 \bowtie_{C_2}(S, R_2) \wedge S_1 \cdot B_1 = R_1 \cdot A_1 \cdot S)$$

$$[V | n | -]$$

$$R_3 \bowtie_{C_3}(T, R_3) \wedge T_1 \cdot C_1 = R_1 \cdot A_1 \cdot T)))$$

Ans 1(a) (b) 'IN'

$$\Pi_L(R_1) \left(\sigma_{C_1}(R_1) \bowtie (\Pi_{S_1, B_1} \left(\sigma_{C_2(S_1)} \wedge S_1.B_1 = R_1.A_1(S) \right)) [v|n|-] \right)$$

$$S(\Pi_{T_1.C_1}(\sigma_{C_3(T)} \wedge T_1.C_1 = R_1.A_1(T))) - \textcircled{1}$$

'NOT IN'

$$\Pi_L(R_1) \left(\cancel{\sigma_{C_1}(R_1)} \Pi_{R_1.*}(\sigma_{C_1}(R_1)) \right) - \textcircled{1}$$

Ans 2

$$\Pi_a(R \bowtie_{R.a = S.b \wedge R.b = S.a} S) = \text{(a) 8/1A}$$

$$\Pi_a(\Pi_{a,b}(R) \wedge \Pi_{b,a}(S))$$

In Predicate Logic, LHS =

$$= \{ a \mid \exists b \exists c \exists d (R(a, b, c) \wedge R.a = S.b \wedge R.b = S.a \wedge S(a, b, d)) \}$$

$$= \{ a \mid \exists b \exists c (R(a, b, c) \wedge R.a = S.b \wedge R.b = S.a \wedge (\exists d S(a, b, d))) \}$$

$$= \{ a \mid \exists b ((\exists c R(a, b, c)) \wedge R.a = S.b \wedge R.b = S.a \wedge \\ (\exists d S(a, b, d))) \} \quad (8) \text{ IT}$$

$$= \{ a \mid \exists a \exists b ((a, b) \in \Pi_{a,b}(R) \wedge R.a = S.b \wedge S.b = R.a \wedge \\ ((a, b) \in \Pi_{a,b}(S)) \} \quad (1)$$

$$= \{ a \mid \exists a \exists b ((a, b) \in \Pi_{a,b}(R) \wedge R.a = S.b \wedge S.b = R.a \wedge \Pi_{b,a}(S)) \}$$

$$= \Pi_a (\Pi_{a,b}(R) \cap \Pi_{b,a}(S))$$

Ans 3.

[SQL Translation] Let S = Student, M = Major,
C = Cities, B = book, T = buys

Let X = $\prod_{S.i.d, S.name, bookno} T$ ($S \bowtie T$)
 $S.i.d = T.i.d$
 $T.i.d = S.i.d$)

books = $\prod_{bookno, price} T$ (B)

Y = $\prod_{C.bookno} T$ (C \bowtie T)
 $C.bookno = B_1.bookno$
 B_1
 \bowtie
 $C.citedbookno = B_2.bookno$
 $B_1.price < B_2.price$
 B_2)

Z = $\prod_{S.i.d, S.name} (X \bowtie Y)$
 $X.bookno = Y.bookno$

[Optimized Query]

Let,

CS = $\prod_{S.i.d} (\sigma_{major = CS(M)} T)$

books = $\prod_{bookno, price} T$ (B)

X = $\prod_{S.i.d, S.name, bookno} (S \bowtie CS \bowtie T)$

Y = $\prod_{C.bookno} (\sigma_{B_1.price < B_2.price} (C \bowtie \sigma_{C.bookno = B_1.bookno} T) \bowtie \sigma_{C.citedbookno = B_2.bookno} T)$

$$Z = \Pi_{sid, sname} (X \bowtie Y)$$

Ans. 4 SQL Translation:

$$V = \Pi_{sid, sname} (S) - \Pi_{sid, sname} (S \bowtie M)$$

$S.sid = M.sid$
 $M.major = 'CSE'$

$$W = \Pi_{sid, sname} (S \bowtie T)$$

$S.sid = T.sid$
 $T.bookno = B.bookno$
 $B.price < 30$

$$X = \Pi_{sid, sname} (V) - \Pi_{sid, sname} (W)$$

$$Y = \Pi_{x.sid, x.sname, m.major} (X \bowtie M)$$

$x.sid = M.sid$

$$\bowtie x.sid = T.sid$$

$$\bowtie T.bookno = B.bookno$$

$B.price < 60$

Query Optimization:

Let,

$$Books = \Pi_{bookno, price} (B)$$

$$CS = \Pi_{sid} (S \bowtie M)$$

$S.major = 'CS'$

$$V = \Pi_{S.sid, S.sname} (S) - \Pi_{S.sid, S.sname} (S) \bowtie CS$$

$$W = \Pi_{S.sid, S.sname} (S) \bowtie T \bowtie (\Pi_{bookno} (\sigma_{price < 30} (B)))$$

$$X = \Pi_{*} (V) - \Pi_{*} (W)$$

$$Y = \Pi_{x.sid, x.sname, M.major} (X \bowtie M \bowtie T \bowtie (\Pi_{bookno} (\sigma_{price < 60} (B))))$$

Ans 5. SQL Translation:

$$X = \Pi_{S.sid, S.sname, B.bookno} (S \bowtie_{S.sid = T.sid} T \bowtie_{T.bookno = B.bookno} B)$$

$$Y = \Pi_{S.sid, S.sname, B.bookno} ((S \bowtie_{S.sid = T.sid} T \bowtie_{T.bookno = B.bookno} B) \bowtie_{T.sid = T.sid \wedge B.price < B1.price}$$

$$(T \bowtie_{T1.bookno = B1.bookno} B1)$$

$$Z = \Pi_{*} (X) - \Pi_{*} (Y)$$

$$F = \Pi_{sid, sname, bookno} (Z)$$

Query Optimization :

$$\text{Let } Books = \Pi_{bookno, price}(B)$$

$$X = \Pi_{s.sid, s.sname, b.bookno} (S \bowtie T \bowtie B)$$

$$Y = \Pi_{s.sid, s.sname, B_1.bookno} ((S \bowtie T \bowtie B_1) \bowtie (T_1 \bowtie B_2))$$

$T_1.sid = T.sid \wedge$
 $B_1.price < B_2.price$

$$Z = \Pi_{sid, sname, bookno} (\Pi_{\cdot \#}(X) - \Pi_{\cdot \#}(Y))$$

Ans 06 SQL Translation :

Let,

$$V = \Pi_{s.sid, B.bookno} (S \times B)$$

$$W = \Pi_{M.sid} (m.major = 'CS' \vee m.major = 'Math')$$

$$X = \Pi_{V.sid, V.bookno} (V \bowtie W)$$

$$Y = \Pi_{sid, bookno} (\Pi_{\cdot \#}(X) - \Pi_{\cdot \#}(T))$$

$$Z = \Pi_{B.\text{bookno}, B.\text{title}} (B \bowtie Y) \quad B.\text{bookno} = Y.\text{bookno}$$

Query Optimization:

$$\text{Let, Books} = \Pi_{\text{bookno}, \text{title}} (B)$$

$$V = \Pi_{S.\text{sid}, B.\text{bookno}} (S \times B)$$

$$W = \Pi_{M.\text{sid}} (\sigma_{M.\text{major} = 'CS' \vee M.\text{major} = 'Math'} (M))$$

$$X = \Pi_{\text{sid}, \text{bookno}} (V \bowtie W)$$

$$Y = \Pi_{\text{sid}, \text{bookno}} (\Pi_{\cdot, *} (X) - \Pi_{\cdot, *} (T))$$

$$Z = \Pi_{\text{bookno}, \text{title}} (B \bowtie Y)$$

Ans. 7(a) Select distinct $r_1.a$
from $R \bowtie r$ natural join
(select distinct $r_2.a$ as b from $R \bowtie r_2$
natural join (select distinct $r_3.a$ as b
from $R \bowtie r_3$) r_3) r_2

(b)	Size of R	Q_3 (in ms)	Q_4 (in ms)
	(1000, 1000, 100)	10.581	0.709
	(1000, 1000, 1000)	10.370	7.419
	(1000, 1000, 10000)	1207.477	43.032

(c) From these results, we see that optimization clearly works. This is because Q_3 has triple nested loop with $O(R^3)$ complexity whereas Q_4 has $O(R)$ complexity.

Ans. 8
Select $r_a.a$
from $R_a \bowtie r_a$
except
Select distinct $q.a$
from (select * from r except
Select $r.*$ from r natural joins) q

(b)	Size of R & Resp $(1000, 1000, 100) \circ (1000, 100)$	Q_5 (in ms) 1.602	Q_6 (in ms) 4.038
	$(1000, 1000, 1000) \circ (1000, 1000)$	4.0384	11.050
	$(1000, 1000, 10000) \circ (1000, 10000)$	11.0398	46.0420

(c) Here, even after optimization of the query (i) , Q_5 performs better than Q_6 . This could be because of multiple set differences present in the query.

Ans. 9(a) Select

from (Select ra.a
from Ra ra, Natural join Rr
Except

Select ya.a

from (Select ra.a from Ra ra, Ss
Except

Select ra.a

from Ra ra Natural join Rr
Natural join Ss) y) x

(b) Size of R	Size of S	Q_7 (in ms)	Q_8 (in ms)
(1000, 1000, 1000)	(1000, 100)	418.225 230.752	230.752 138.126
"	(1000, 1000)	249.016	1182.067
"	(1000, 10000)	233.511	1251.544

(c) We see that again Q_8 which is the optimised query doesn't fair that well as compared to Q_7 as we increase the value of S for same value of R. This could be again due to multiple except i.e set differences.

(d) If we compare problem 8 to problem 9, Problem 9 takes more time. This is due to multiple sub-queries

Ans 10.

Execution Time (Q_9) (in ms) for same size of R & S in problem 8

(i) 5.840 ms

(ii) 30.092 ms

(iii) 131.388 ms

(b) Here again the execution time is higher due to nested for-loops

Ans. 11

Θ_{10} (Run-time) for same size of R & S in problem 9.

= (i) 50.307 ms

(ii) 70.874 ms

(iii) 100.075 ms.

Θ_{10} is leaps & bounds quicker than Θ_8