ASSIGNMENT 5

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Question 1

Below, s is sid ,c is the course and d is the dept

E(s)={c|(s,c,g) is a tuple in Enroll relation}

C(d)={c|(c,n,d) is a tuple in the Course relation}

S has all SIDs in Student

SET SEMIJOIN

SOME:

$$\text{SOME} \Leftrightarrow \{(\text{s}) \mid \exists\, c : c \in C^{sd}\}$$

$$\text{SOME} \Leftrightarrow \{(\text{s}) \mid \exists\, c : c \in E(s) \cap c \in C(d)\}$$

$$\text{SOME} \Leftrightarrow \{(\text{s}) \mid \exists\, c : c \in E(s) \bigwedge c \in C(d)\}$$

We need to find

$$\text{SOME} \Leftrightarrow \{(\text{s}, \text{c}) \mid E(s,c) \bigwedge C(c)\}$$

But, $E(s,c) \wedge C(d)$ = E ⋉ C

Hence,

$$\boldsymbol{SOME = \pi_{sid}(E \ltimes C)}$$

NOT ONLY:

$$\text{NOT ONLY} \Leftrightarrow \{\text{s} \mid \exists\, c : c \in C^{s\ \bar{d}}\}$$

$$\text{NOT ONLY} \Leftrightarrow \{\text{s} \mid \exists\, c : c \in E(s) \cap \neg(c \in C(d))\}$$

$$\text{NOT ONLY} \Leftrightarrow \{\text{s} \mid \exists\, c: c \epsilon E(s) \bigwedge \neg(c \epsilon\ C(d))\}$$

$$\text{NOT ONLY} \Leftrightarrow \{\text{s}\,,\text{c}\mid \exists\, c : E(s,c) \bigwedge \neg\, C(c)\}$$

We need to find

$$\text{NOT ONLY} \Leftrightarrow \{(\text{s,c})\mid E(s,c) \bigwedge \neg\, (\big(E(s,c) \bigwedge C(c)\big))\}$$

But $E(s,c)\ \wedge \neg\big((E(s,c)\ \wedge C(c))\big)= E - E\ \ltimes C = \text{E}\ \ \bar{\ltimes}\, C$

Hence,

$$\boldsymbol{NOT\ ONLY} = \boldsymbol{\pi_{sid}}(\boldsymbol{E}\ \ \bar{\ltimes}\, \boldsymbol{C}))$$

NOT ALL:

$$\text{NOT ONLY} \Leftrightarrow \{\text{s} \mid \exists\, c : c \,\epsilon C^{\ \bar{s}\,d}$$

$$\text{NOT ALL} \Leftrightarrow \{\text{s} \mid \exists\, c : c \,\epsilon\, C(d) \cap \neg(c \,\epsilon\, E(s))\}$$

$$\text{NOT ALL} \Leftrightarrow \{\text{s} \mid \exists\, c : c \,\epsilon\, C(d) \bigwedge \neg(c \,\epsilon\, E(s))\}$$

We need to find,

$$\{(s,c)\mid C(c,d) \bigwedge \neg(E(s,c)\ )\}$$

Adding S (list of Sids)

$$\{(s,c)\mid (s \,\epsilon S \bigwedge C(c)) \bigwedge \neg(E(s,c) \bigwedge C(c))\}$$

This gives,

$$\{(s,c)\mid (s,c)\,\epsilon\,(C(c)\ \times\ \text{S}) \bigwedge \neg((s,c)\,\epsilon(E(s,c) \ltimes C(c)))\}$$

This is equivalent to $(S\ \times\ \ \text{C}) - (\text{E}\ \ltimes\ \text{C})$

Hence,

$$\boldsymbol{NOT\ ALL} = \boldsymbol{\pi_{sid}}((\boldsymbol{S}\ \times\ \ \boldsymbol{C}) - (\boldsymbol{E}\ \ltimes\ \boldsymbol{C}))$$

NO:

We get the sids that are not in “some” result set . This will give us result for NO.

SOME is $\pi_{sid}(E \ltimes C)$

Hence,

$$\mathrm{NO} = \pi_{\mathrm{sid}}(\mathrm{S}) - \mathrm{SOME}$$

$$\boldsymbol{NO = \pi_{sid}(S) - \pi_{sid}(E \ltimes C)}$$

ONLY:

We get the sids that are not in “not only” result set . This will give us result for ONLY.

Not ONLY is $\pi_{\mathrm{sid}}(\mathrm{E}\ \overline{\ltimes}\ \mathrm{C}))$

Hence,

$$\mathrm{ONLY} = \pi_{\mathrm{sid}}(\mathrm{S}) - \mathrm{NOT\ ONLY}$$

$$\boldsymbol{ONLY = \pi_{sid}(S) - \pi_{sid}(E\ \overline{\ltimes}\ C)}$$

ALL:

We get the sids that are not in “not all” result set . This will give us result for ALL.

Not ALL is $\pi_{\mathrm{sid}}((\mathrm{S} \times \mathrm{C}) - (\mathrm{E} \ltimes \mathrm{C}))$

Hence,

$$\mathrm{ALL} = \pi_{\mathrm{sid}}(\mathrm{S}) - \mathrm{NOT\ ALL}$$

$$\boldsymbol{ALL = \pi_{sid}(S) - \pi_{sid}((S \times C) - (E \ltimes C))}$$

Question 2)

$CS = \pi_{cno}(\sigma_{dept='CS'}(Course))$

$$\begin{aligned}\pi_{sid}\Big(&\pi_{sid,cno}(CS \times Student) - \pi_{sid,cno}(Enroll \bowtie CS)\Big)\\ &- \pi_{sid}(\pi_{sid,c1.cno,c2.cno}\big(Student \times (CS \bowtie_{c1.cno<>c2.cno} CS)\big)\\ &- (\pi_{e.sid,e.cno,c.cno}(Enroll \times CS) \cup \pi_{e.sid,c.cno,e.cno}(Enroll \times CS)))\end{aligned}$$

The time and space complexity is quadratic $O(n^2)$ in best case due to the cross product. In the worst case due to the normal join and the cross product the complexity is cubic i.e. O(|S||CS1||CS2|)-O(n^3)

Question 3)

select S.sid from student S where (select count(1) from(select cno from course where dept='CS' except select cno from enroll where sid=S.sid) q)=1;

Here , the time and space complexity is quadratic $O(n^2)$, because the subquery runs for every sid in student.-O(|S||E|).

This tells that although the set semi joins are efficient with Some,ONLY, No and Not ONLY, but when it comes to ALL but one count proves to be more efficient than set semi join.

Question 4)

a)

E=$\rho_{E(nullcount)}(\pi_{is\ null(countF)}(\rho_{F(countF)}(\pi_1(F))))$

$$\pi_{A,B}\left(\sigma_{E.nullcount='f'}(E1 \times E)\right) \bigcup \pi_{A,B}\left(\sigma_{E.nullcount='t'}(E2 \times E)\right)$$

E is a relation with attribute nullcount which will have one tuple with true value('t') if the expression F is null and false('f') if F is not null. We then do a cross product of the expression E1 with the relation E and fetch the result only if null count is false and fetch E2 when nullcount is true.

b)

The time and space complexity is quadratic $O(n^2)$.due to the cross join-O(|E||F|).

Question 5)

a)

$$\pi_{A,B}\left(\sigma_{F1.nullcount='f'}\left(E1 \times \left(\rho_{F1(nullcount)}\left(\pi_{is\ null(countF1)}\left(\rho_{F(countF1)}(\pi_1(F1))\right)\right)\right)\right)\right)$$

$$\bigcup \pi_{A,B}\Big(\sigma_{F2.nullcount='f' \wedge F1.nullcount='t'}\big(E2 \times (\rho_{F2(nullcount)}(\pi_{is\ null(countF2)}(\rho_{F(countF2)}(\pi_1(F2))))) \times (\rho_{F1(nullcount)}(\pi_{is\ null(countF1)}(\rho_{F(countF1)}(\pi_1(F1)))))\big)\Big)$$

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$$\bigcup \pi_{A,B}\left(\sigma_{F(k-1).nullcount='f' \wedge F(k-2).nullcount='t' \ldots\ldots \wedge F1.nullcount='t'}\left(E(k-1)\right.\right.$$

$$\times\left(\rho_{F(k-1)(nullcount)}\left(\pi_{is\ null(countF(k-1))}\left(\rho_{F(countF(k-1))}\left(\pi_1\big(F(k-1)\big)\right)\right)\right)\right)\ldots.$$

$$\left.\left.\times\,(\rho_{F1(nullcount)}(\pi_{is\ null(countF1)}(\rho_{F(countF1)}(\pi_1(F1)))))\right)\right)$$

$$\bigcup \pi_{A,B}\left(\sigma_{F(k-1).nullcount='t' \wedge F(k-2).nullcount='t' \ldots\ldots \wedge F1.nullcount='t'}\left(E(k)\right.\right.$$

$$\times\left(\rho_{F(k-1)(nullcount)}\left(\pi_{is\ null(countF(k-1))}\left(\rho_{F(countF(k-1))}\left(\pi_1\big(F(k-1)\big)\right)\right)\right)\right)\ldots.$$

$$\left.\left.\times\,(\rho_{F1(nullcount)}(\pi_{is\ null(countF1)}(\rho_{F(countF1)}(\pi_1(F1)))))\right)\right)$$

The concept here is – for each case condition d we cross product E with all F expression from F1 to F(d).and check if the previous F expressions are empty while the F(d) is not empty.

b)

Here the time and space complexity in best case is quadratic $O(n^2)$ where F1 is not null O(|E1||F1|).

But if F1 is empty then we cross product with F2 and check F2 is empty, this way if all F starting from 1 to k-2 is empty then E(k-1) is evaluated- -this requires doing a cross product with all the previous F expressions also i.e. cross product with F1 to F(k-1) hence the worst case time complexity is exponential with k (+1 for cross product with E)- $O(n^{(k)})$.

Question 6a)

$\pi_{bookno,title}(Book \ltimes (Buys \ltimes ((Student \ltimes \sigma_{major='Math'}Major) \ltimes \sigma_{major='CS}Major)))$

Question 6b)

$E = Cites \ltimes \sigma_{price<50}Book$

$\rho_{sid,bookno \to s,b}(\pi_{sid,bookno}(Buys \ltimes (\rho_{citedbookno \to bookno}\ (\pi_{citedbookno}($

$E \bowtie_{citedbookno=citedbookno1 \wedge bookno<>bookno1}\ (\rho_{citedbookno,bookno \to citedbookno1,bookno1}E))))))$

Question 6c)

$$\pi_{sid,bookno,citedbookno}((Buys \bowtie Cites) \bowtie \pi_{T1.sid,C1.bookno,C1.citedbookno}(T1 \bowtie_{T1.bookno=C1.citedbookno}\ C1))$$

Question 6d)

$\pi_{(sid,sname)}Student \ltimes (Buys \ltimes (\pi_{bookno}(Book) - \pi_{citedbookno}(Cites)))$

Question 6e)

$E = Book \ltimes \left(\pi_{bookno}\left(Buys \ltimes \sigma_{major='CS'}Major\right)\right)$

$\pi_{bookno,title}(E \ltimes (\pi_{price}(E) - \pi_{e1.price}(E \bowtie_{e1.price<e2.price}\ E)))$

Question 6f)

$$\pi_{bookno,title}(Book \ltimes \rho_{citedbookno \to bookno}(\pi_{citedbookno}(cites) - \pi_{citedbookno}(\pi_{citedbookno,bookno}(cites)\ \ \overline{\ltimes}\ \pi_{bookno}(\sigma_{price>50}Book))))$$

Question 6g)

$E = \pi_{bookno}(\sigma_{price>50}(Book))$

$\pi_{bookno,title}(Book \ltimes_{bookno=citedbookno}\ (\pi_{citedbookno}\left(\pi_{bookno,citedbookno}\left((\rho_{bookno \to citedbookno}(\pi_{bookno}\ (Book))\right)\right.$
$\left.\times E\right) - \pi_{bookno,citedbookno}(Cites \ltimes E))))$

Question 6h)

$$\rho_{sid\to s,citedbookno\to b}\left(\pi_{sid,citedbookno}Buys\right.$$
$$\bowtie\left(\pi_{bookno,citedbookno}\left(\pi_{bookno}(Book)\times\rho_{bookno\to citedbookno}\left(\pi_{bookno}(Book)\right)\right)\right.$$
$$\left.\left.-\,\pi_{bookno,citedbookno}(Cites)\right)\right)$$

Question 6i)

$$E=\pi_{s1,s2}(\rho_{s1}(\pi_{sid}(Student))\times\rho_{s2}(\pi_{sid}(Student)))$$

$$\sigma_{s1<>s2}(\pi_{s1,s2}(E)-\pi_{sid,sid2}(\rho_{sid\to sid2}\left(\pi_{bookno,sid}(Buys)\right)\bowtie Buys))$$

Question 6j)

$$T3=\rho_{Book(bookno,sid)}(\pi_{bookno,-1}(\pi_{bookno}(Book)\ \ \overline{\ltimes}\ \pi_{bookno}(Buys)))$$

$$T1=\pi_{bookno,sid}\left(Buys\ltimes\sigma_{major='CS'}(Major)\right)\bigcup\pi_{bookno,sid}(T3)$$

$$E1=\pi_{bookno,bookno2,sid2}(T1\times\rho_{bookno,sid\to bookno2,sid2}(\pi_{bookno,sid}(T1)))$$

$$E2=\pi_{bookno,bookno2,sid}\ (T1\bowtie\rho_{bookno\to bookno2}(\pi_{bookno,sid}(T1)))$$

--note here E3 is same as E1 but the bookno and bookno2 order is swapped.

$$E3=\pi_{bookno2,bookno,sid2}(T1\times\rho_{bookno,sid\to bookno2,sid2}(\pi_{bookno,sid}(T1)))$$

$$\rho_{bookno,bookno2\to b1,b2}\left(\pi_{bookno,bookno2}(E1-E2)\right)\bigcup\pi_{bookno,bookno2}(E3-E2)$$