Midterm Solution

Suppose we have a database consisting of the following three relations

SWIMMER(SSN, SNAME, LEVEL)

BEACH(B#, BNAME, STATE, POLLUTION)

SWIMMING(SSN, B#, DATE, DURATION)

The first relation indicates the swimmers and their level (beginner, intermediate, advanced) the second indicates different beaches across the country. Each beach has a number (B#) a name (BNAME) and a pollution rate of 0 (low pollution), 1 (moderate pollution) or 2 (high pollution). The third records the members swimming.

1. **List the names of beaches that John Smith has visited**

Algebra

$\prod_{B\#,BNAME}$ (SWIMMING $\bowtie_{B\#=B\#}$ ($\sigma_{SNAME='John\ Smith'}$SWIMMER))

SQL

SELECT B.BNAME

FROM BEACH B,SWIMMING SW,SWIMMER S

WHERE SNAME='John Smith'

AND S.SSN=SW.SSN

AND B.B#=SW.B#

Calculus

{t:B#,BNAME | ∃ s ∈ SWIMMER ∃ b ∈ BEACH ∃ sw ∈ SWIMMING s.SNAME='John Smith' ^ s.SSN=b.SSN ^ sw.B#=b.B# ^ t.B#=sw.B# ^ t.BNAME=sw.BNAME}

2. **List the names of swimmers who visited at least one beach to which John Smith has also been.**

Algebra

$\prod_{SNAME}((SWIMMING \bowtie_{SSN=SSN} SWIMMER) \bowtie_{B\#=B\#} (\sigma_{SNAME='John\ Smith'} SWIMMER) \bowtie_{B\#=B\#} SWIMMING))$

SQL

```
SELECT S.SNAME
FROM SWIMMER S, SWIMMING SW
WHERE S.SSN=SW.SSN
AND SW.B# IN
        (SELECT SW.B#
        FROM SWIMMING SW2,SWIMMER S2
        WHERE S2.SNAME='John Smith'
        AND S2.SSN=SW2.SSN)
        OR
SELECT S.SNAME
FROM SWIMMER S, SWIMMING SW SWIMMING SW2, SWIMMER S2
WHERE S.SSN=SW.SSN
AND SW.B# = SW2.B#
AND S2.SNAME='John Smith'
AND S2.SSN=SW2.SSN
```

Calculus

$\{t:SSN,SNAME \mid \exists s1 \in SWIMMER\ \exists sw1 \in SWIMMING\ \exists s2 \in SWIMMER\ \exists sw2 \in SWIMMING\ s1.SNAME='John\ Smith' \wedge s1.SSN=sw1.SSN \wedge sw2.B\#=sw1.B\# \wedge s2.SSN=s1.SSN \wedge t.SSN=s2.SSN \wedge t.SNAME=s2.SNAME\}$

3. **List the names of swimmers who visited only beaches to which John**

Algebra

$\prod_{SNAME}(SWIMMER \bowtie_{SSN=SSN} SWIMMMING)$ -

$\prod_{SNAME}(SWIMMER \bowtie_{SSN=SSN} SWIMMMING \bowtie_{B\#=B\#}(\prod_{B\#}(BEACH) - \prod_{B\#}(\sigma_{SNAME='John\ Smith'} SWIMMER) \bowtie_{SSN=SSN} SWIMMING)))$

SQL

```
SELECT S.SNAME
FROM SWIMMER S,SWIMMING SW
WHERE S.SSN=SW.SSN
AND SW.B# NOT IN
        (SELECT SSN
        FROM SWIMMING SW
        WHERE SW.B# NOT IN
                (SELECT SW.B# FROM SWIMMING SW,SWIMMER S
                 WHERE SNAME='John Smith'
                AND S.SSN=SW.SSN))
```

Calculus

$\{t:SSN,SNAME \mid \exists\ s1 \in SWIMMER\ \forall\ sw1 \in SWIMMING\ (s1.SSN=sw1.SSN\ \wedge\ t.SNAME = s1.SNAME\ \wedge\ t.SSN= s1.SSN) \Longrightarrow \exists\ s2 \in SWIMMER\ \exists\ sw2 \in SWIMMING\ s2.SNAME='John\ Smith'\ \wedge\ sw2.B\#=sw1.B\#\ \}$

4. **List the names of swimmers who visited no beach to which John**

Algebra

$\prod_{SNAME}(SWIMMMING \bowtie_{SSN=SSN} SWIMMER\ ) - \prod_{SNAME}(SWIMMMING \bowtie_{SSN=SSN} SWIMMER \bowtie_{B\#=B\#}(\ \sigma_{SNAME='John\ Smith'} SWIMMER \bowtie_{B\#=B\#} SWIMMING))$

SQL

```
SELECT S.SNAME
FROM SWIMMER S
```

```
WHERE S.SSN NOT IN
        (SELECT SSN
        FROM SWIMMING SW
        WHERE SW.B# IN
                (SELECT SW2.B#
                FROM SWIMMING SW2, SWIMMER S2
                WHERE S2.SNAME='John Smith'
                AND S2.SSN=SW2.SSN))
```

OR

```
SELECT S.SNAME
FROM SWIMMER S
WHERE S.SSN NOT IN
        (SELECT SSN
        FROM SWIMMING SW1, SWIMMING SW2, SWIMMER S2
        WHERE SW1.B# = SW2.B#
                AND S2.SNAME='John Smith'
                AND S2.SSN=SW2.SSN))
```

Calculus

{t : SNAME | ∃ s1 ∈ SWIMMER ∀ sw1 ∈ SWIMMING (s1.SSN=sw1.SSN ^ t.SSN=sw1.SSN t.SNAME=s.SNAME) ⟹(∃ s2 ∈ SWIMMER ∀ sw2 ∈ SWIMMING (s2.SNAME = 'JOHN SMITH' ^ sw2.SSN=s2.SSN ^ sw1.B#<> sw2.B#) }

5. **List the names of the swimmers who visited all the beaches to which John Smith has been.**

Algebra

$\prod_{SNAME,B\#}((SWIMMMING \underset{SSN=SSN}{} SWIMMER) \div \prod_{B\#}(\sigma_{SNAME='John\ Smith'}SWIMMER) \underset{SSN=SSN}{} SWIMMING)$

SQL

```
SELECT SNAME
FROM SWIMMER S1
WHERE S.1SSN NOT IN
        (SELECT S3.SSN
        FROM SWIMMER S2 , SWIMMER S3, SWIMMING SW
        WHERE S2.SNAME ='John Smith'
        AND S2.SSN=SW.SSN
        AND S3.SSN NOT IN
                (SELECT SSN
                FROM SWIMMING SW2
                WHERE SW.B#=SW2.B#))
                OR
SELECT SNAME
FROM SWIMMER S1
WHERE NOT EXISTS
        (SELECT *
        FROM SWIMMER S2 , SWIMMING SW
        WHERE S2.SNAME ='John Smith'
        AND S2.SSN=SW.SSN
        AND NOT EXISTS
                (SELECT *
                FROM SWIMMING SW2
                WHERE SW.B#=SW2.B#
                AND SW2.SSN=S1.SSN))
```

Calculus

{t:SSN,SNAME | ∃ s1 ∈ SWIMMER ∃ s2 ∈ SWIMMER ∀ sw1∈ SWIMMING (s2.SNAME='John Smith ^s2.SSN=sw1.SSN ^t.SNAME = s1.SNAME ^ t.SSN= s1.SSN ⟹ ∃ sw2 ∈ SWIMMING (sw2.SSN=s1.SSN^sw1.B#=sw2.B# }