
COMPUTER SCIENCE 631
DATABASE MANAGEMENT SYSTEM DESIGN
MIDTERM EXAMINATION Fall 2020

- Exam Duration: 120 min (+15 min additional if needed)
- You are allowed to bring to the exam one sheet of paper HAND-WRITTEN on both sides (if needed). On this sheet of paper you can write down what you think you will need for the exam.
- There is no question during the exam. If you are unsure, write down your assumptions
- The total points is 100

Database Querying

There are six tables describing a company's database, describing employees, departments, buildings, which department(s) an employee works in (and a percentage of the time for each), department managers (possibly more than one per department), and in which building an employee works (an employee may have more than one office). The primary key of each table is the attribute(s) in capitals. Other attributes are not necessarily unique.

EMPLOYEE(EID, EName, Salary, Start_Date, End_Date)

DEPARTMENT(DID, DName, Annual_Budget)

BUILDING(BID, BName, Address)

IN_DEPARTMENT(EID, DID, Percent_Time)

IN_BUILDING(EID, BID, ROOM)

MANAGES_DEPARTMENT(EID, DID)

I. Express the following queries in Algebra and SQL

1. Which employees (EID, EName) share their office with John?

$\pi_{EID, EName} ((\sigma_{EName="John"} (EMPLOYEE)) \bowtie_{EID=EID} IN_BUILDING) \bowtie_{EID \neq EID \wedge BID=BID \wedge ROOM=ROOM} (EMPLOYEE \bowtie_{EID=EID} IN_BUILDING)$

```
SELECT E2.EID, E2.EName
FROM EMPLOYEE E1, IN_BUILDING IB1, EMPLOYEE E2,
     IN_BUILDING IB2
WHERE E1.EName = "John"
     AND E1.EID = I1.EID
     AND E2.EID = I2.EID
     AND E1.EID <> E2.EID
     AND IB1.BID = IB2.BID
     AND IB1.ROOM = IB2.ROOM
```

2. Who are the managers (EID, EName, DID) of the department of John?

$\pi_{EID, EName} ((\sigma_{EName="John"} (EMPLOYEE)) \bowtie_{EID=EID} (IN_DEPARTMENT) \bowtie_{DID=DID} (EMPLOYEE \bowtie_{EID=DID} MANAGES_DEPARTMENT))$

```
SELECT E2.EID, E2.EName
FROM EMPLOYEE E1, IN_DEPARTMENT ID,
     MANAGES_DEPARTMENT MD, EMPLOYEE E2
WHERE E1.EName = "John"
     AND E.EID = ID.EID
     AND MD.DID = ID.DID
     AND E2.EID = MD.EID
```

3. Which buildings (BID, BName) host at least one employee working for the Computing department?

$\pi_{BID, BName} (IN_BUILDING \bowtie_{BID=BID} BUILDING) \bowtie_{EID=EID} (IN_DEPARTMENT \bowtie_{DID=DID} (\sigma_{DName="Computing"} (DEPARTMENT))))$

```
SELECT B.BID, B.BName
FROM BUILDING B, IN_BUILDING IB, IN_DEPARTMENT ID,
     DEPARTMENT D
WHERE D.DName = "Computing"
     AND IB.EID = ID.EID
     AND D.DID = ID.DID
     AND IB.BID = B.BID
```

4. Which employees work for both the Computing and the Finance departments

$$\pi_{EID} (IN_DEPARTMENT \bowtie_{DID=DID} (\sigma_{DName="Computing"} (DEPARTMENT))) \cap \\ \pi_{EID} (IN_DEPARTMENT \bowtie_{DID=DID} (\sigma_{DName="Finance"} (DEPARTMENT)))$$

Or

$$\pi_{EID} ((IN_DEPARTMENT \bowtie_{DID=DID} (\sigma_{DName="Computing"} (DEPARTMENT))) \\ \bowtie_{EID=EID} (IN_DEPARTMENT \bowtie_{DID=DID} (\sigma_{DName="Finance"} (DEPARTMENT))))$$

```
(SELECT E.EID, E.ENAME
FROM EMPLOYEE E, IN_DEPARTMENT ID, DEPARTMENT D
WHERE D.DNAME = "Computing"
      AND E.EID=ID.EID
      AND D.DID=ID.DID)
```

INTERSECT

```
(SELECT E.EID, E.ENAME
FROM EMPLOYEE E, IN_DEPARTMENT ID, DEPARTMENT D
WHERE D.DNAME = "Finance"
      AND E.EID = ID.EID
      AND D.DID = ID.DID)
```

OR

```
(SELECT E.EID, E.ENAME
FROM EMPLOYEE E, IN_DEPARTMENT ID, DEPARTMENT D
WHERE D.DNAME = "Computing"
      AND E.EID = ID.EID
      AND D.DID = ID.DID)
AND E.EID IN
      (SELECT E.EID
       FROM EMPLOYEE E, IN_DEPARTMENT ID, DEPARTMENT D
       WHERE D.DNAME = "Finance"
             AND E.EID = ID.EID
             AND D.DID = ID.DID)
```

OR

```
SELECT E.EID, E.ENAME
FROM EMPLOYEE E1, IN_DEPARTMENT ID1, DEPARTMENT D1,
EMPLOYEE E2, IN_DEPARTMENT ID2, DEPARTMENT D
WHERE D1.DNAME = "Computing"
      AND E1.EID = ID1.EID
      AND D1.DID = ID1.DID
      AND D2.DNAME = "Finance"
      AND E2.EID = ID2.EID
      AND D2.DID = ID2.DID
      AND E2.EID = E1.EID
```

5. Which employees do not work for the Computing department?

$\pi_{EID} (EMPLOYEE) - \pi_{EID} (IN_DEPARTMENT \bowtie_{DID=DID}$
 $(\sigma_{DName="Computing"} (DEPARTMENT)))$

```
SELECT EID, EName
FROM EMPLOYEE
WHERE EID NOT IN
    (SELECT E.EID, E.EName
     FROM EMPLOYEE E, IN_DEPARTMENT ID, DEPARTMENT D
     WHERE D.DName = "Computing"
           AND E.EID = ID.EID
           AND D.DID = ID.DID)
```

6. Which employees work only for the Computing department?

$\pi_{EID} ((IN_DEPARTMENT \bowtie_{DID=DID} (\sigma_{DName='Computing'} (DEPARTMENT)))) -$
 $\pi_{EID} (IN_DEPARTMENT \bowtie_{DID=DID} (\sigma_{DName \neq 'Computing'} (DEPARTMENT))))$

```
SELECT E.EID, E.ENAME
FROM EMPLOYEE E IN_DEPARTMENT ID, DEPARTMENT D
WHERE D.DNAME = "Computing"
      AND E.EID = ID.EID
      AND D.DID = ID.DID
      AND E.EID NOT IN
        (SELECT E.EID,
         FROM EMPLOYEE E, IN_DEPARTMENT ID,
          DEPARTMENT D
         WHERE D.DNAME <> "Computing"
              AND E.EID = ID.EID
              AND D.DID = ID.DID)
```

OR

```
SELECT E.EID, E.ENAME
FROM EMPLOYEE E1 IN_DEPARTMENT ID, DEPARTMENT D
WHERE D.DNAME = "Computing"
      AND E1.EID=ID.EID
      AND D.DID=ID.DID
      AND NOT EXISTS
        (SELECT *
         FROM EMPLOYEE E2, IN_DEPARTMENT ID,
          DEPARTMENT D
         WHERE D.DNAME <> "Computing"
              AND E2.EID = ID.EID
              AND D.DID = ID.DID
              AND E2.EID=E1.EID)
```

7. Which employees do not work for any department?

$\pi_{EID} (EMPLOYEE) - \pi_{EID} (IN_DEPARTMENT)$

```
SELECT EID, ENAME
FROM EMPLOYEE
WHERE EID NOT IN
  (SELECT E.EID,
   FROM IN_DEPARTMENT ID)
```

8. Which employees work in all the departments?

$\pi_{EID, DID} (IN_DEPARTMENT) \div \pi_{DID} (DEPARTMENT)$

```
SELECT E.EID, E.ENAME
FROM EMPLOYEE E
WHERE EID NOT IN
  (SELECT E2.EID,
   FROM EMPLOYEE E2, DEPARTMENT D
   WHERE E2.EID NOT IN
     (SELECT ID.EID
      FROM IN_DEPARTMENT ID
      WHERE ID.DID=D.DID))
```

OR

```
SELECT E.EID, E.ENAME
FROM EMPLOYEE E
WHERE NOT EXISTS
  (SELECT *
   FROM DEPARTMENT D
   WHERE NOT EXISTS
     (SELECT *
      FROM IN_DEPARTMENT ID
      WHERE D.DID=ID.DID
      AND E.EID=ID.EID))
```

II. Express the following queries in SQL only

9. List the number of employees working for each department

```
SELECT DID, COUNT(*)  
FROM IN_DEPARTMENT  
GROUP BY DID
```

10. Which department has the maximum number of employees working 100% for that department?

```
SELECT DID  
FROM IN_DEPARTMENT  
WHERE Percent_Time = 100  
GROUP BY DID  
HAVING COUNT(*) =  
    (SELECT MAX(COUNT(*))  
     FROM IN_DEPARTMENT  
     WHERE Percent_Time = 100  
     GROUP BY DID)
```

OR

```
SELECT DID  
FROM IN_DEPARTMENT  
WHERE Percent_Time = 100  
GROUP BY DID  
HAVING COUNT(*) >= ALL (SELECT COUNT(*)  
                        FROM IN_DEPARTMENT  
                        WHERE Percent_Time = 100  
                        GROUP BY DID)
```