DBS TUTORIAL

For the first three problems, we use the schema below.

- `Dept(dept#, manager, budget)` (that is, department name, employee ID of its manager, and the budget)
- `Empl(emplId, dept, salary)` (that is, emploee ID, department name, and emplloee's salary)
- Assume that `dept#` is the primary key for `Dept`, and `emplId` is the primary key for `Empl`
- Assume furthermore the following inclusion dependencies:
  `Dept[manager]` $\subseteq$ `Empl[emplId]`
  `Empl[dept]` $\subseteq$ `Dept[dept#]`

Problem 1. Write the following query in relational calculus: Find names of departments with at least one employee having higher salary than his/her manager.

Answer:

$$\begin{array}{lll} \{d \mid \exists m, b, s_1, s_2, e & (& \mathit{Dept}(d, m, b) \\ & \wedge & \mathit{Empl}(m, d, s_1) \\ & \wedge & \mathit{Empl}(e, d, s_2) \\ & \wedge & s_2 > s_1 \;)\; \} \end{array}$$

Problem 2. Write the query from Problem 1 in SQL.

```
SELECT D.dept#
FROM Dept D
WHERE EXISTS (SELECT *
              FROM Empl E1, Empl E2
              WHERE E1.emplId = D.manager AND
                    E2.dept = D.dept# AND
                    E2.salary > E1.salary)
```

Problem 3. Write the following in SQL: Find managers of departments that spend more than half of their budget on salaries.

```
SELECT D.manager
FROM Dept D
WHERE 05 * D.budget < (SELECT SUM(E.Salary)
                       FROM Empl E
                       WHERE E.dept# = D.dept#
                       GROUP BY E.dept#)
```

Problem 4. Given two relations R and S, each with attributes A and B. Express the following relational calculus query in relational algebra:

$$\{x \mid (\exists z\ (R(z,x) \vee S(z,x)))\ \wedge\ (\forall y\ (S(x,y) \vee \neg R(x,y)))\}$$

Answer: $\pi_B(S \cup R) - \rho_{B \leftarrow A}(\pi_A(R - S))$

Because: $R(z,x) \vee S(z,x)$ is $R \cup S$, so $\exists z R(z,x) \vee S(z,x)$ is $\pi_B(S \cup R)$.

$\forall y\ (S(x,y) \vee \neg R(x,y))$ is $\neg \exists y\ \neg(S(x,y) \vee \neg R(x,y))$ which is the same as $\neg \exists y\ (\neg S(x,y) \wedge R(x,y))$.

We know that $(\neg S(x,y) \wedge R(x,y))$ is $R - S$, so $\exists y\ (\neg S(x,y) \wedge R(x,y))$ is $\pi_A(R - S)$. Combining the two subexpressions, we get the answer. We have to rename to be able to apply the difference.