

Assignment 1

Solution 1:

a)

- **Relational Algebra Form:**

$$\pi_{\text{dname}}((\sigma_{\text{age} < 40}(\text{Emp}) \bowtie_{(\text{Emp.eid}=\text{Works.eid})}(\text{Works})) \bowtie_{(\text{Works.did}=\text{Dept.did})}(\text{Dept}))$$

- **Datalog Form:**

$$Q(y) \text{:- Dept}(x, y, z, w), \text{Works}(e, x, p), \text{Emp}(e, a, b, c), b < 40$$

b)

```
SELECT DISTINCT dept.dname
FROM dept, works
WHERE works.eid
IN (SELECT eid FROM emp WHERE age < 40)
AND dept.did = works.did
```

c)

```
SELECT DISTINCT emp.ename
FROM emp, dept, works
WHERE emp.salary > dept.budget
AND works.eid = emp.eid
AND dept.did = works.did
```

d)

```
SELECT dept.dname, COUNT(works.eid) AS numofemp
FROM dept, works, emp
WHERE works.eid = emp.eid
AND dept.did = works.did
GROUP BY dept.dname
HAVING AVG(emp.salary) < 64000
ORDER BY dept.dname DESC
```

Solution 2:

Functional Dependencies:

A → B

BC → E

ED → A

a) All keys for R:

- ACD
- BCD
- CDE

b) R is not in BCNF.

For each functional dependency $X \rightarrow Y$, X should have been a super key of R to be in the BCNF. Also, every attribute depends only on super keys in BCNF.

Here, $A \rightarrow B$

- A is not a super Key
- R is not in BCNF

Decomposition into a collection of BCNF relations:

$R = \{A, B, C, D, E\}$

Decomposing R into the following (Considering functional dependency $ED \rightarrow A$):

- $R_1 = \{E, D, A\}$
- $R_2 = \{B, C, D, E\}$

Now, R_1 is in BCNF.

Further decomposing R_2 (considering functional dependency $BC \rightarrow E$):

- $R_{21} = \{B, C, E\}$
- $R_{22} = \{B, C, D\}$

Hence, $R_1 \{A, D, E\}$, $R_{21} \{B, C, E\}$, $R_{22} \{B, C, D\}$ are the desired collection of BCNF relations.

c) R is in 3NF.

A relation R is in 3NF if for each FD $X \rightarrow Y$ in R, X is a super key 'or' Y is part of a key. Here,

- $A \rightarrow B$
B is part of a candidate key BCD.
- $BC \rightarrow E$
E is part of a candidate key CDE.
- $ED \rightarrow A$
A is part of a candidate key ACD.