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- I. Return names of every employee who works in the "Hardware", "Software", and "Research" departments.

Datalog:

Case1:

If we consider that employee is working in all the department mentioned In the question

Q1 (y) :-

Emp(x,y,z,w), Works(x,t,l), Dept(t,g,b,m),(g='hardware' ;g='software' ;
g='research')

Or

Q1 (y) :-

Emp(x1,y,z,w), Works(x1,t1,l), Dept(t1,'hardware',b,m), Emp(x2,y,z,w),
Works(x2,t2,l), Dept(t2,'software',b,m), Emp(x3,y,z,w), Works(x3,t3,l),
Dept(t3,'research',b,m)

Case 2:

If we consider that employee either working for research or hardware or software.

Q1 (x) :-

Emp(t,x,y,z), Works(t,l,m), Dept(l,'Hardware',j,k)

Q1 (x) :-

Emp(t,x,y,z), Works(t,l,m), Dept(l,'Software',j,k)

Q1 (x):-

Emp(t,x,y,z), Works(t,l,m), Dept(l,'Research',j,k)

Relational Algebra:

$\pi_{ename} (\sigma_{dname='Hardware' \vee dname='Software' \vee dname='Research'} (Emp \bowtie_{Emp.eid=Works.eid} Works \bowtie_{Works.did=Dept.did} Dept))$

Relational Calculus:

$Q(a,b,c,d) = \exists x. \exists p. \exists q. \exists r. \exists s. \exists t. \exists u. \exists l. \exists m. \exists n (Emp(a,b,c,d) \wedge Works(a,p,x) \wedge (Dept(p,"Hardware",q,r) \vee Dept(l,"Software",m,n) \vee Dept(s,"Research",t,u)))$

- II. Return the names of every department without any employee.

Datalog:

Q1(y) :-

Dept(x,y,b,m),works(t,x,p),emp(t,e,a,s)

Q2(y) :-

Dept(x,y,b,m), not Q1(y)

Or

Q3(y) :-

Dept(x,y,z,t), not Works(m,x,w)

Relational Algebra:

$\pi \text{ dname } (\text{Dept} - (\text{Dept} \bowtie_{\text{Dept.did}=\text{Works.did}} \text{Works}))$

Relational Calculus:

$Q(y) = \text{Dept}(x,y,z,t) \wedge \text{not } \exists p. \exists q (\text{Works}(p,x,q))$

- III. Print the managerid of managers who manage only departments with budgets greater than \$1.5 million.

Datalog:

Q3 (z) :-

Dept(w,x,y,z), $y > 1.5 * 1000000$, not Dept(p,q,r,s), $r \leq 1.5e6$

Or

Q3 (y) :-

Dept(x,d,b,y), $b \leq 1.5 * 1000000$

Q4(y) :-

Dept(x,d,b,y) Not Q3(y)

Relational Algebra:

$\pi_{\text{managerid}} ((\sigma_{\text{budget} > 1.5e6})\text{Dept} - (\sigma_{\text{budget} \leq 1.5e6})\text{Dept})$

or

$\pi_{\text{managerid}} (\text{Dept} - (\sigma_{\text{budget} \leq 1.5e6})\text{Dept})$

Relational Calculus:

$Q(z) = \text{Dept}(x,y,t,z) \wedge \text{not } \exists p \exists q \exists r \exists s (\text{Dept}(p,q,r,s) \wedge (r \leq 1.5e6) \wedge (s = z))$

- IV. Print the name of employees whose salary is less than or equal to the salary of every employee.

Datalog:

Q4 (x) :-

Emp(w,x,y,s1), Emp(p,q,r,s2), $w \neq p$, $s1 \leq s2$

Relational Algebra

$\rho \text{ Emp2 (Emp)}$

$\pi \text{ ename (Emp - (}\sigma_{\text{Emp.salary} > \text{Emp2.salary}} (\text{Emp} \bowtie_{\text{Emp.eid} \neq \text{Emp2.eid}} \text{Emp2})))$

Relational Calculus

$Q(b) = \text{Emp}(a,b,c,d) \wedge \text{not } \exists p \exists q \exists r \exists s (\text{Emp}(p,q,r,s) \wedge (d > s))$