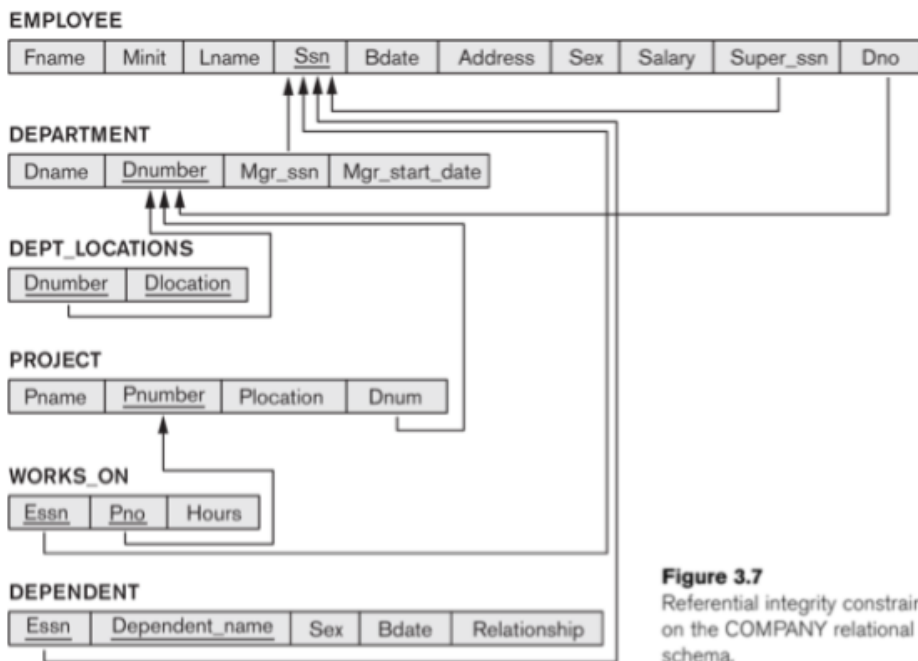


1. Average salary of employees
2. Avg sal. of emp. in research dept.



**Figure 3.7**  
Referential integrity constraints displayed on the COMPANY relational database schema.

salaries ← } avg(salary)(EMPLOYEE)  
result ← → { salaries

$\sigma_{DNAME='Research'}(EMPLOYEE \bowtie_{DNO=DNUM} DEPARTMENT)$

---

$\sigma_{DNAME='Research'}(\{DNO\}_{arg(sal)}(EMP \bowtie_{DNO=DNUM} DEPT))$

Theta Join  $A \bowtie_{\theta} B$

$$\begin{aligned} & EMP \bowtie_{DNO > DNUM} DEPT \\ \equiv & \sigma_{DNO > DNUM}(EMP \times DEPT) \end{aligned}$$

$R(\underline{a}, \underline{b}, c, d, e)$

$ab \rightarrow cde$      $\left\{ \begin{array}{l} ab \rightarrow c \\ ab \rightarrow d \\ ab \rightarrow e \end{array} \right.$   
 $c \rightarrow e$      $x$   
 $a \rightarrow d$      $x$

$R_1(\underline{\epsilon}, e)$

$c \rightarrow e$

$R_2(c, \underline{a}, \underline{b}, d)$

$ab \rightarrow d$   
 $ab \rightarrow \epsilon$   
 $a \rightarrow d$      $x$

$R_3(\underline{a}, d)$

$a \rightarrow d$

$R_4(\underline{a}, \underline{b}, c)$

$ab \rightarrow c$

$R(a, b, c, d, e, f, g)$

$\times ab \rightarrow c$

$c d \rightarrow e$

$e \rightarrow fg$

$de \rightarrow b$

$abd \rightarrow cefg$

$ade \rightarrow bcfg$

$R1(\underline{a}, \underline{b}, \underline{c})$

$ab \rightarrow c$

$R2(a, b, d, \underline{e}, \underline{f}, \underline{g})$

$e \rightarrow fg \quad \times$

$de \rightarrow b \quad \times$

$abd \rightarrow e$

$R3(\underline{e}, \underline{f}, \underline{g})$

$e \rightarrow fg$

$R4(\underline{e}, \underline{a}, \underline{b}, \underline{d})$

$de \rightarrow b \quad \times$

$abd \rightarrow e$

$R5(\underline{d}, \underline{e}, \underline{b})$

$de \rightarrow b$

$R6(\underline{d}, \underline{e}, \underline{a})$

$R(a, b, c, d)$

$ab \rightarrow c$

$b \rightarrow d$  x not in 2NF

---

$R(a, b, c, d)$

$ab \rightarrow c$   
 $c \rightarrow d$  x

3NF

$X \rightarrow A$

x is sk.  
or

A is prime

$R(a, b, c, d)$

$ab \rightarrow cd$

$d \rightarrow a$  x not in BCNF

---

$R(\underline{a}, b, \underline{c})$

$a \rightarrow b$  x not in 2NF

$R(a, b, c, d)$   
 $ab \rightarrow cd$   
 $b \twoheadrightarrow d$  X

is $ab \twoheadrightarrow cd$ true?	<u>yes</u>
is $b \twoheadrightarrow d$ true?	no

in BCNF    not in 4NF

$R_1(b, d)$   
 $b \twoheadrightarrow d$

$R_2(b, a, c)$   
 $ab \rightarrow c$