Bilkent University
Department of Computer Engineering

CS - 353 Database Systems

Homework 2
Relational Algebra

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Section: 3

Question 1)

Product(<u>maker, model</u>, type)
PC(<u>model</u>, speed, ram, hd, price)
Laptop(<u>model</u>, speed, ram, hd, screen, price)
Printer(<u>model</u>, color, type, price)

a) $t1 \leftarrow (\sigma_{color="true"}(Printer))$
$\Pi_{model,price}(t1)$

b) $\Pi_{maker} (\sigma_{type = "PC" \lor type="Laptop"}(Product)) - \Pi_{maker} (\sigma_{type = "Printer"}(Product))$

c) $t1 \leftarrow (\sigma_{type="Laptop"}(Product))$
$t2 \leftarrow (t1 \bowtie Laptop)$
$t3 \leftarrow (\sigma_{hd >120 \land ram\geq1024 \land screen\geq17.0}(t2))$
$\Pi_{maker,model,price}(t3)$

d) $t1 \leftarrow (\sigma_{type="PC"}(Product))$
$t2 \leftarrow (t1 \bowtie PC)$
$t3 \leftarrow \Pi_{model,maker}(\sigma_{speed \geq 2.5}(t2))$
$t4 \leftarrow (\sigma_{first.model = second.model \land first.maker < second.maker} (\rho_{first}(t3) \times \rho_{second}(t3)))$
$\Pi_{first.maker, second.maker}(t4)$

e) i) $t1 \leftarrow \Pi_{maker, model} (\sigma_{type = "Laptop"} (Product))$
$t2 \leftarrow (\sigma_{first.model = second.model \land first.maker < second.maker} (\rho_{first}(t1) \times \rho_{second}(t1) \times \rho_{third}(t1)))$
$t3 \leftarrow (\sigma_{first.model = third.model \land first.maker < third.maker \land second.maker < third.maker} (t2))$
$t4 \leftarrow (\Pi_{first.model}(t3))$

ii) $t1 \leftarrow (\sigma_{type="Laptop"}(Product))$
$t2 \leftarrow (t1 \bowtie Laptop)$
$t3 \leftarrow (_{model} \mathcal{G}_{count (maker) as model\_count}(t2))$
$\Pi_{model} (\sigma_{model\_count \geq 3}(t3)$

f) $t1 \leftarrow (\text{Product} \bowtie \text{PC})$
$t2 \leftarrow (t1 \bowtie \text{Laptop})$
$t3 \leftarrow (\sigma_{\text{speed} \geq 2.50}(t2))$
$\Pi_{\text{maker}}(t3)$

g) i) $t1 \leftarrow (\sigma_{\text{type="PC"}}(\text{Product}))$
$t2 \leftarrow (\sigma_{\text{first.model < second.model} \wedge \text{first.maker = second.maker}}(\rho_{\text{first}}(t1) \times \rho_{\text{second}}(t1))$
$t3 \leftarrow \Pi_{\text{maker}}(t1) - \Pi_{\text{first.maker as maker}}(t2)$
$t4 \leftarrow (\sigma_{\text{type="Laptop"}}(\text{Product}))$
$t5 \leftarrow (\sigma_{\text{first.model < second.model} \wedge \text{first.maker = second.maker}}(\rho_{\text{first}}(t4) \times \rho_{\text{second}}(t4))$
$t6 \leftarrow \Pi_{\text{maker}}(t4) - \Pi_{\text{first.maker as maker}}(t5)$
$t7 \leftarrow (\sigma_{\text{type="Printer"}}(\text{Product}))$
$t8 \leftarrow (\sigma_{\text{first.model < second.model} \wedge \text{first.maker = second.maker}}(\rho_{\text{first}}(t7) \times \rho_{\text{second}}(t7))$
$t9 \leftarrow \Pi_{\text{maker}}(t7) - \Pi_{\text{first.maker as maker}}(t8)$
$t3 \cap t6 \cap t9$

  ii) $t1 \leftarrow (\sigma_{\text{type="PC"}}(\text{Product}))$
$t2 \leftarrow (_{\text{maker}}\mathcal{G}_{\text{count(model) as no\_of\_producer}}(t1))$
$t3 \leftarrow (\Pi_{\text{maker}}(\sigma_{\text{no\_of\_producer = 1}}(t2)))$
$t4 \leftarrow (\sigma_{\text{type="Laptop"}}(\text{Product}))$
$t5 \leftarrow (_{\text{maker}}\mathcal{G}_{\text{count(model) as no\_of\_producer}}(t4))$
$t6 \leftarrow (\Pi_{\text{maker}}(\sigma_{\text{no\_of\_producer = 1}}(t5)))$
$t7 \leftarrow (\sigma_{\text{type="Printer"}}(\text{Product}))$
$t8 \leftarrow (_{\text{maker}}\mathcal{G}_{\text{count(model) as no\_of\_producer}}(t7))$
$t9 \leftarrow (\Pi_{\text{maker}}(\sigma_{\text{no\_of\_producer = 1}}(t8)))$
$t3 \cap t6 \cap t9$

h) i) $t1 \leftarrow \Pi_{\text{first.model}}(\sigma_{\text{first.speed < second.speed}}(\rho_{\text{first}}(\text{Laptop}) \times \rho_{\text{second}}(\text{Laptop})))$
$t2 \leftarrow (\Pi_{\text{model}}(\text{Laptop}) - t1)$
$\Pi_{\text{maker}}(t1 \bowtie \text{Product})$

  ii) $t1 \leftarrow (\sigma_{\text{type="Laptop"}}(\text{Product}))$
$t2 \leftarrow (t1 \bowtie \text{Laptop})$
$t3 \leftarrow (\mathcal{G}_{\text{max(speed) as speed}}(t2))$
$t4 \leftarrow (t2 \bowtie t3)$
$\Pi_{\text{maker}}(t4)$

i) $t1 \leftarrow (\sigma_{\text{first.speed = second.speed} \wedge \text{first.ram = second.ram} \wedge \text{first.screen = second.screen} \wedge \text{first.maker<second.maker}} (\rho_{\text{first}}(\text{Laptop}) \times \rho_{\text{second}}(\text{Laptop})))$

$\Pi_{\text{first.model, second.model}}(t1)$

Question 2)

a) min: $\max(m,n)$ **max:** $m + n$

b) min: 0   **max:** $m * n$

c) min: 0   **max:** $m * n$

d) min: 0   **max**: n

Question 3)

a) $t1 \leftarrow \Pi_{A1, A2, \ldots An}(R)$
     $t2 \leftarrow \Pi_{A1, A2, \ldots An} ((t1 \times S) - R)$
     $t1 - t2$

b)

A / B1

sno
s1

A / B2

sno
s1
s4

A / B3

sno
s1
s2