

## 2. Exercise

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### 1 Exercise 2.1

2.1.1 **Definition 1 (relational completeness)** *A query language is relationally complete if it is at least as expressive as relational algebra.*

Methods with Example table  $A(\underline{x_1}, y_1)$  and  $B(\underline{y_1})$

method	RA (Example)	keyword	SQL(Example)
selection	$\sigma_{x_1 > 0}(A)$	WHERE	SELECT * FROM A WHERE A. $x_1 > 0$
projection	$\pi_{x_1}(A)$	SELECT	SELECT $x_1$ FROM A
cartesian product	$A \times B$	FROM, CROSS	SELECT * FROM A, B
union	$\sigma_{x_1 > 0}(A) \cup \sigma_{x_1 < 0}(A)$	UNION	SELECT * FROM A WHERE $x_1 > 0$ UNION SELECT * FROM A WHERE $x_1 < 0$
difference	$A - A$	EXCEPT, NOT IN	SELECT * FROM B WHERE $y_1$ NOT IN A

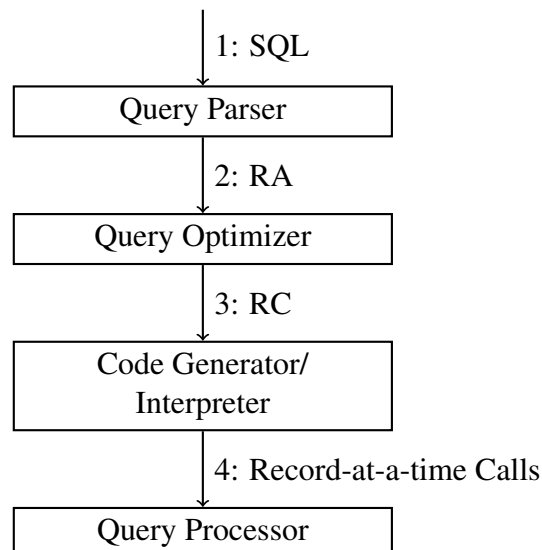
#### 2.1.2 1. Beispiel

SELECT SUM(salary) FROM works;

#### 2. Beispiel

SELECT COUNT(city) FROM located;

#### 2.1.3 Solution Graph:



### 2.1.4 Overview:

operator	operation type
selection	unary operator
projection	unary operator
cartesian product	set & binary operator
union	set & binary operator
difference	set & binary operator

## 2 Exercise 2.2

### 2.2.1 relational algebra:

$$\pi_{pname}(\rho_p(works) \bowtie_{p.cname=b.cname \wedge p.salary > b.salary} \rho_b(works \bowtie_{works.pname=boss.mname} \rho_{pname1 \leftarrow pname}(boss)))$$

**tuple relational calculus:**

$$\{ \langle w.pname \rangle \mid w \in works \wedge \exists m \in boss (w.pname = m.pname \wedge \exists w' \in works (w'.pname = m.pname \wedge w.cname = w'.cname \wedge w.salary > w'.salary)) \}$$

**domain relational calculus:**

$$\{ pname \mid \exists cname, salary1, salary2, mname \wedge works(pname, cname, salary1) \wedge works(mname, cname, salary2) \wedge boss(pname, cname) \wedge salary1 > salary2 \}$$

### 2.2.2 relational algebra:

$$\pi_{pname}(\rho_{c_1}(works) \bowtie_{c_1.pname=c_2.pname \wedge c_1.cname \neq c_2.cname} \rho_{p_2}(works))$$

**tuple relational calculus:**

$$\{ \langle w_1.pname \rangle \mid w_1 \in works \wedge \exists w_2 \in works (w_1.pname = w_2.pname \wedge w_1.cname \neq w_2.cname) \}$$

**domain relational calculus:**

$$\{ pname \mid \exists cname_1, cname_2, salary_1, salary_2 \wedge works(pname, cname_1, salary_1) \wedge works(pname, cname_2, salary_2) \wedge cname_1 \neq cname_2 \}$$

### 2.2.3 relational algebra:

$$\pi_{pname}(works) - \pi_{pname}(\rho_{p_1}(works) \bowtie_{p_1.salary < p_2.salary} \rho_{p_2}(works))$$

**tuple relational calculus:**

$$\{ \langle w_1.pname \rangle \mid w_1 \in works \wedge \neg (\exists w_2 \in works (w_1.cname = w_2.cname \wedge w_2.salary > w_1.salary)) \}$$

**domain relational calculus:**

$$\{ pname \mid \exists cname, salary_1 \wedge works(pname, cname, salary_1) \wedge \neg (\exists pname_2, salary_2 \wedge works(pname_2, cname, salary_2) \wedge salary_2 > salary_1) \}$$

### 2.2.4 relational algebra:

$$\pi_{c_1.cname}(\rho_{c_1}(located) \bowtie_{c_1.city \neq c_2.city} \rho_{c_2}(\sigma_{cname='IBM'}(located)))$$

**tuple relational calculus:**

$$\{ \langle c_1.cname \rangle \mid c_1 \in located \wedge \forall c_2 \in located (c_2.cname \neq 'IBM' \vee c_1.city \neq c_2.city) \}$$

**domain relational calculus:**

$$\{ cname \mid \exists city \wedge located(cname, city) \wedge \neg located('IBM', city) \}$$

### 3 Exercise 2.3

2.3.1 with  $N = 15000$  and  $B = 8$ :  $\lceil \frac{N}{B} \rceil \Rightarrow \lceil \frac{15000}{8} \rceil = 1875$

2.3.2 Number of passes given by:  $1 + \lceil \log_{B-1} \lceil \frac{N}{B} \rceil \rceil$   
with  $N = 15000$  and  $B = 8 \Rightarrow 1 + \lceil \log_{8-1} \lceil \frac{15000}{8} \rceil \rceil = 1 + \lceil \log_7 1875 \rceil = 5$

2.3.3  $2 = 1 + \lceil \log_{B-1} \lceil \frac{15000}{B} \rceil \rceil \Leftrightarrow 1 = \lceil \log_{B-1} \lceil \frac{15000}{B} \rceil \rceil \Leftrightarrow \frac{1}{2}(1 + \sqrt{600001}) \leq B \Rightarrow 123 \leq B$   
So we need at-least 123 Buffer to be able to sort the file in two passes.

2.3.4 TODO