

4. Exercise

Timo Bergerbusch 344408

Thomas N  veke 311392

Shu Xing 381176

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Exercise 4.1

1.

T_1 and T_2

$T_1 \subseteq T_2?$

Find mapping $h : T_2 \rightarrow T_1, x \mapsto \begin{cases} b_3 & x = b_1 \\ 5 & x = b_2 \\ b_4 & x = b_3 \\ b_3 & x = b_4 \\ a_1 & x = a_1 \\ a_2 & x = a_2 \end{cases} \Rightarrow T_1 \subseteq T_2$

$T_2 \subseteq T_1?$

Impossible since we would have to map the constant 5 to another constant and T_2 does not contain a constant. So $T_2 \not\subseteq T_1$

Overall

$\Rightarrow T_1 \subset T_2$, but $T_2 \not\subseteq T_1$ and therefore $T_1 \neq T_2$

T_2 and T_3

$T_2 \subseteq T_3?$

When we map T_3 to T_2 :

$a1 \rightarrow a1$

$a2 \rightarrow a2$

$b3 \rightarrow b4$

$b2 \rightarrow b3$

$b1 \rightarrow a1$, but then for $(b4, b1)$ in T_3 we cannot find a matched instance in T_1

So there cannot exist a function $h : T_3 \rightarrow T_2. \Rightarrow T_2 \not\subseteq T_3$

$T_3 \subseteq T_2?$

When we map T_2 to T_3 :

$a1 \rightarrow a1$

$a2 \rightarrow a2$

$b4 \rightarrow b3$

$b1 \rightarrow b4$

$b3 \rightarrow b2$

$b2 \rightarrow b2$ (or $b1$)

but then for $(b3, b2)$ in T_2 we cannot find a matched instance in T_3

So there cannot exist a function $h : T_2 \rightarrow T_3. \Rightarrow T_3 \not\subseteq T_2$

Overall

$\Rightarrow T_2 \not\subseteq T_3, T_3 \not\subseteq T_2$ and therefore especially $T_2 \neq T_3$

T_1 and T_3

$T_1 \subseteq T_3?$

When we map T_3 to T_1 :

$a1 \rightarrow a1$

$a2 \rightarrow a2$

$b3 \rightarrow b3$

$b2 \rightarrow b4$

$b1 \rightarrow a1$

$b2 \rightarrow 5$, because of $(b2, b3)$ in T_3 and $b3 \rightarrow b3$, so conflict with $b2 \rightarrow b4$

So there cannot exist a function $h : T_3 \rightarrow T_1. \Rightarrow T_1 \not\subseteq T_3$

$T_3 \subseteq T_3?$

Analogously to $T_2 \subseteq T_1$ we would have to map the constant 5 to an other constant and T_3 does not contain a constant. So $T_3 \not\subseteq T_1$

Overall

$\Rightarrow T_1 \not\subseteq T_3, T_3 \not\subseteq T_1$ and therefore especially $T_1 \neq T_3$

2.

T_1 :

T_1 is minimal, because if we delete any row and so create T' we can not have a function $h : T \rightarrow T'$ such that $T' \subseteq T$

T_2 :

1. delete row (b_4, a_2) , since we have a function h_1 , with $h_1(x) = \begin{cases} b_1 & \text{if } x = b_4 \\ x & \text{if } x \neq b_4 \end{cases}$

New Tableau T'_2 :

a_1	a_2	
b_1	a_2	(R)
a_1	b_3	(R)
b_2	b_1	(R)
b_3	b_2	(R)

2. we can't minimize T''_2 any further, so T''_2 is the minimal tableau

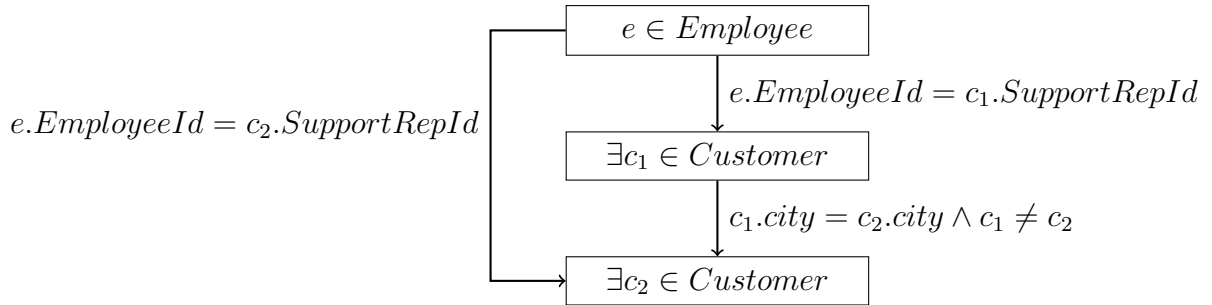
T_3 :

T_3 is minimal, because if we delete any row and so create T' we can not have a function $h : T \rightarrow T'$ such that $T' \subseteq T$

Exercise 4.2

1.a)

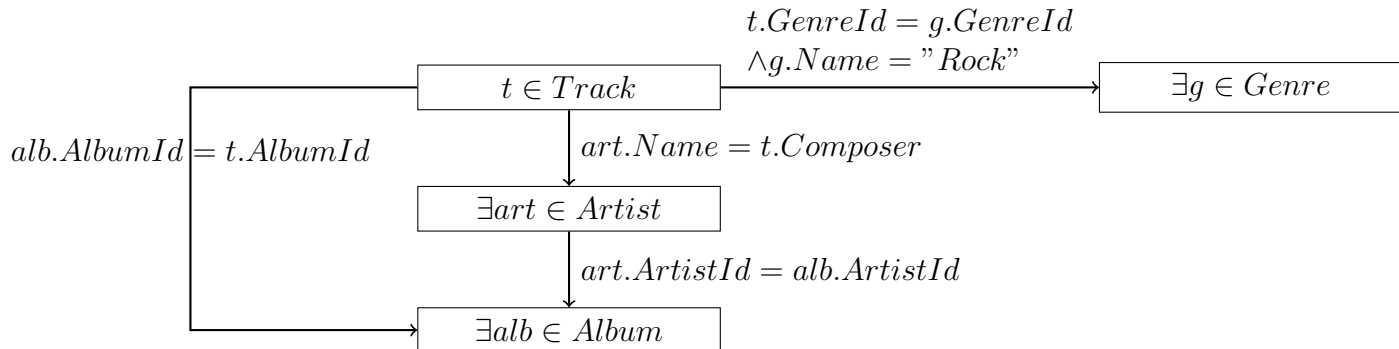
$\{ \langle e.EmployeeId, e.LastName \rangle \mid e \in Employee \wedge \exists c_1 \in Customer \wedge c_1.SupportedRepId = e.EmployeeId \wedge \exists c_2 \in Customer \wedge c_2.SupportRepId = e.EmployeeId \wedge c_1.City = c_2.City \wedge c_1 \neq c_2 \}$



This Graph has a cycle. This means the query is not optimizable using semi-joins.

1.b)

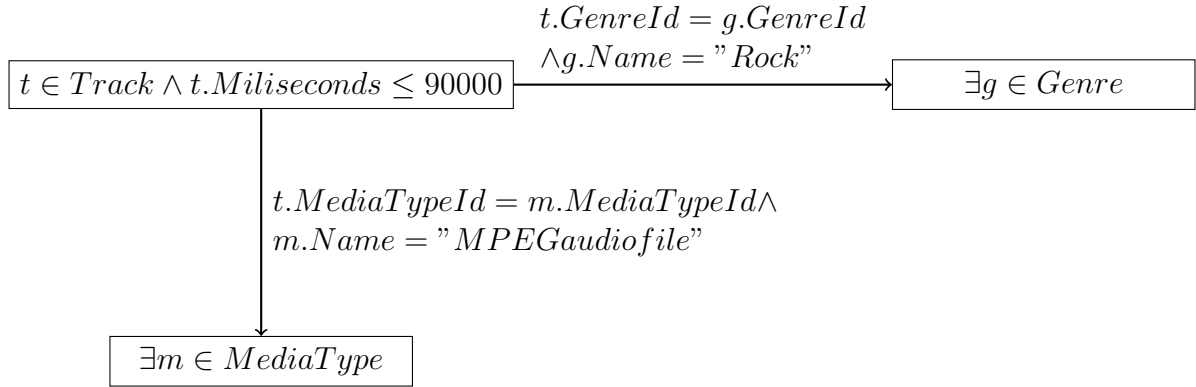
$\{ \langle t.name, t.composer \rangle \mid t \in Track \wedge \exists g \in Genre \wedge g.GenreId = t.GenreId \wedge g.Name = "Rock" \wedge \exists art \in Artist \wedge \exists alb \in Album \wedge alb.ArtistId = art.ArtistId \wedge t.AlbumId = alb.AlbumId \wedge t.Composer = art.Name \}$



This Graph has a cycle. This means the query is not optimizable using semi-joins.

2.

$\{ \langle t.Name \rangle \mid t \in Track \wedge t.Milliseconds \leq 90000 \wedge \exists g \in Genre \wedge t.GenreId = g.GenreId \wedge g.Name = "Rock" \wedge \exists m \in MediaType \wedge t.MediaTypeId = m.MediaTypeId \wedge m.Name = "MP3Audiofile" \}$



The graph is cycle free, which means it can be optimized using semi-joins.

Exercise 4.3

1.

$B = \#$ buffer pages in memory = 4

$N = \#$ pages in the input file = $\lceil \frac{7500 \cdot 36}{1024 - 64} \rceil = 282$

After the initial pass:

$\#$ runs (subfiles) = $\lceil \frac{N}{B} \rceil = \lceil \frac{282}{4} \rceil = 71$, each subfiles: 4-pages runs

2.

$\#$ passes = $1 + \lceil \log_{B-1} \lceil \frac{N}{B} \rceil \rceil = 1 + \lceil \log_{4-1} 71 \rceil = 1 + 4 = 5$

3.

Total costs = $2N \cdot (\#passes) = 2 \cdot 282 \cdot 5 = 2820$ I/Os

4.

If $B = 4$:

$1 + \lceil \log_3 \lceil \frac{N}{B} \rceil \rceil = 2 \Rightarrow (\log_3 \lceil \frac{N}{4} \rceil)_{max} = 1 \Rightarrow (\lceil \frac{N}{4} \rceil)_{max} = 3 \Rightarrow N_{max} = 12$

$\#$ records in the file = $\frac{12 \cdot (1024 - 64)}{36} = 320$ records

If $B = 42$:

$$1 + \lceil \log_{41} \lceil \frac{N}{B} \rceil \rceil = 2 \Rightarrow (\log_4 1 \lceil \frac{N}{42} \rceil)_{max} = 1 \Rightarrow (\lceil \frac{N}{42} \rceil)_{max} = 41 \Rightarrow N_{max} = 41 \cdot 42 = 1722$$

$$\# \text{ records in the file} = \frac{1722 \cdot (1024 - 64)}{36} = 45920 \text{ records}$$