Relational Calculus

CSE 132a Winter 2016

Existential and Universal Quantifiers

$\exists b \in \text{Books}[...]$
There exists a book b where this condition holds.

$\exists b \in \text{Books}[\forall c \in \text{Customers}[\exists p \in \text{Purchases}[...]]]$
There exists a book, where for each customer, there exists a purchase where this condition holds.

Analagous to ”FROM Books b WHERE ...” in SQL.

Tuples

Tuples are like rows in a database

$\exists b \in \text{Books}[b(\text{title})...]$

$\exists b \in \text{Books}[\forall c \in \text{Customers}[\exists p \in \text{Purchases}[$
$c(\text{customerid})...p(\text{customerid})...p(\text{bookid})...b(\text{bookid})]]]$

Similar to b.title and p.price

Additional Operators

Operators: $\wedge, \vee, =, \neq, \rightarrow, <, >, \leq, \geq$

$\exists b \in \text{Books}[b(\text{title}) = \text{'Twilight'}]$

$\exists b \in \text{Books}[\forall c \in \text{Customers}[\exists p \in \text{Purchases}[$
$c(\text{customerid}) = p(\text{customerid}) \wedge p(\text{bookid}) = b(\text{bookid})]]]$

SELECT Analogy

$\{r : \text{bookid} \mid \exists b \in \text{Books}[b(\text{title}) = \text{'Twilight'} \wedge r(\text{bookid}) = b(\text{bookid})]\}$

$\{r : \text{title} \mid \exists b \in \text{Books}[\forall c \in \text{Customers}[\exists p \in \text{Purchases}[c(\text{customerid}) = p(\text{customerid}) \wedge p(\text{bookid}) = b(\text{bookid})]] \wedge b(\text{title}) = r(\text{title})]\}$

Example 1
SQL to Relational Calculus

```
SELECT title
FROM Books
WHERE author = 'EDMUND MORGAN'
AND year >= 1990;
```

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SELECT title
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$\{r : \text{title} \mid \exists b \in \text{Books}[...]\}$

Example 1
SQL to Relational Calculus

SELECT title
FROM Books
WHERE author = 'EDMUND MORGAN'
AND year $>=$ 1990;

$\{r$: title $\mid \exists b \in$
Books$[b(\text{author}) = \text{'EDMUND MORGAN'} \wedge b(\text{year}) \geq 1990]\}$
DONE?

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SQL to Relational Calculus

```
SELECT title
FROM Books
WHERE author = 'EDMUND MORGAN'
AND year >= 1990;
```

$$\{r : \text{title} \mid \exists b \in \text{Books}[b(\text{author}) = \text{'EDMUND MORGAN'} \wedge b(\text{year}) \geq 1990 \wedge r(\text{title}) = b(\text{title})]\}$$

Example 2
Relational Calculus to SQL

What are the titles of the newest books?

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$\{r : \text{title} \mid \exists b \in \text{Books}[\forall o \in \text{Books}[b(\text{year}) \geq o(\text{year})]]\}$
DONE?

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Relational Calculus to SQL

What are the titles of the newest books?

$$\{r : \text{title} \mid \exists b \in \text{Books}[\forall o \in \text{Books}[b(\text{year}) \geq o(\text{year})] \wedge b(\text{title}) = r(\text{title})]\}$$

Example 2
Relational Calculus to SQL

What are the titles of the newest books?

$$\{r : \text{title} \mid \exists b \in \text{Books}[\neg\exists o \in \text{Books}[b(\text{year}) < o(\text{year})] \wedge b(\text{title}) = r(\text{title})]\}$$

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Relational Calculus to SQL

What are the titles of the newest books?

$\{r : \text{title} \mid \exists b \in \text{Books}[\neg\exists o \in \text{Books}[b(\text{year}) < o(\text{year})] \wedge b(\text{title}) = r(\text{title})]\}$

```
SELECT b.title
FROM Books b
WHERE ...
```

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```
SELECT b.title
FROM Books b
WHERE NOT EXISTS( SELECT ...
FROM Books o
WHERE b.year < o.year);
```

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Relational Calculus to SQL

What are the titles of the newest books?

$\{r : \text{title} \mid \exists b \in \text{Books}[\neg\exists o \in \text{Books}[b(\text{year}) < o(\text{year})] \wedge b(\text{title}) = r(\text{title})]\}$

```
SELECT b.title
FROM Books b
WHERE NOT EXISTS( SELECT *
FROM Books o
WHERE b.year < o.year);
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