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CSCI 362
Homework # 3
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Problem 1: Consider the LIBRARY relational schema shown below, which is used to keep track of books, borrowers, and book loans. Referential integrity constraints are shown as directed arcs. Write down relational algebra expressions for the following queries on the LIBRARY database:

1. How many copies of the book titled “The Lost Tribe” are owned by the library branch whose name is "Sharpstown"?

$A \leftarrow \sigma_{Title = 'The\ Lost\ Tribe'}$ *(BOOK)*
$B \leftarrow \sigma_{Branch\_name = 'Sharpstown'}$ *(LIBRARY_BRANCH)*
$\Pi_{No\_of\_copies}$ *((A x B) * (BOOK_COPIES))*

2. How many copies of the book titled “The Lost Tribe” are owned by each library branch?

$A \leftarrow \sigma_{Title = 'The\ Lost\ Tribe'}$ *(BOOK)*
$\Pi_{Title, Branch\_Name, No\_of\_copies}$ *((A x LIBRARY_BRANCH) * (BOOK_COPIES))*

3. Retrieve the names of all borrowers who do not have any books checked out.

$A \leftarrow \sigma_{Date\_out = 'null'}$ *(BOOK_LOANS)*
Π_{Name} *(A x BORROWER)*

4. For each book that is loaned out from the "Sharpstown" branch and whose DueDate is today, retrieve the book title, the borrower's name, and the borrower's address.

$A \leftarrow \sigma_{Branch\_name = 'Sharpstown'}$ *(LIBRARY_BRANCH)*
$B \leftarrow \sigma_{Due\_date = TODAY}$ *(BOOK_LOANS)*
$\Pi_{Title, Name, Address}$ *(((A x BOOK)*B)*BORROWER)*

5. For each library branch, retrieve the branch name and the total number of books loaned out from that branch.

A(bran,tot) $\leftarrow Branch\_id\ \xi\ Count\ (Book\_id)$ *(BOOK_LOANS)*
$\Pi_{Branch\_name, tot}$ *(A * LIBRARY_BRANCH)*

6. Retrieve the names, addresses, and number of books checked out for all borrowers who have more than five books checked out.

$A(card,tot) \leftarrow Card\_no\ \xi\ Count\ (Book\_id)$ *(BOOK_LOANS)*
$II_{Name, Address, Tot}$ *(BORROWER x* $\sigma_{tot>5}$ *(A))*

7. For each book authored (or co-authored) by "Stephen King", retrieve the title and the number of copies owned by the library branch whose name is "Central".

$A \leftarrow \sigma_{Branch\_Name = 'Central'}$ *(LIBRARY_BRANCH)*
$B \leftarrow \sigma_{Author\_name = 'Stephen\ King'}$ *(BOOK_AUTHORS)*
II_{Title, No_of_Copies} *((BOOK_COPIES * A) * (B*BOOK))*

Problem 2: Consider the two tables T1 and T2 shown below. Show the results of the following operations:

The Theta Join operation

P	**Q**	**R**	**A**	**B**	**C**
10	a	5	10	b	6
10	a	5	10	b	5
25	a	6	25	c	3

Using T.1 Q = T2.B

P	**Q**	**R**	**A**	**B**	**C**
15	b	8	10	b	6
15	b	8	10	b	5

Next, we are to use the operation Left Outer Join. Within this, we are going from the left relation of T1. This will then combine the condition T1.P = T2.A. However, if we see that no tuple are matching, we must take the values of T2. These values will now be labeled as NULL.

P	Q	R	A	B	C
10	a	5	10	b	6
10	a	5	10	b	5
15	a	8	NULL	NULL	NULL
25	a	8	25	c	3

We now must use the right outer join operation. We use this to create the tuples located upon the right relation of T2. This is with the condition of T1.Q = T2.B. However, if we come to find that no tuple are matching in T1, the values located there will be NULL.

P	Q	R	A	B	C
15	b	8	10	b	6
NULL	NULL	NULL	25	c	3
15	b	8	10	b	5

Now we must use the union formula. With this, the tuples located within T1 and T2 are created within a relation. This is possible, if and only if the union of T1 and T2 are compatible.

P	Q	R
10	a	5
15	b	8
25	a	6
10	b	6
25	c	3
10	b	5

Finally, we end off with another Theta join operation. This is used in order to satisfy the condition of T1.P = T.A AND T1.R = T2.C

P	Q	R	A	B	C
10	a	5	10	b	5

Problem 3: Specify queries a, b, and d of Problem 1 in tuple relational calculus.

A,

$A \leftarrow \sigma_{Title = 'The\ Lost\ Tribe'}$ *(BOOK)*

$B \leftarrow \sigma_{Branch\_name = 'Sharpstown'}$ *(LIBRARY_BRANCH)*

$\Pi_{No\_of\_copies}$ *((A x B) * (BOOK_COPIES))*

Tuple Relational Calculus

Book considered as the *b*

b.Book id, 1. Book Branch Name
BOOK (b) **AND** BOOK_BRANCH **AND** ($\exists d$) (b.Book id = 1. Book_id)

B.

$A \leftarrow \sigma_{Title = 'The\ Lost\ Tribe'}$ *(BOOK)*

$\Pi_{Title, Branch\_Name,\ No\_of\_copies}$ *((A x LIBRARY_BRANCH) * (BOOK_COPIES))*

Tuple Relational Calculus

b. Book id, *b.* Title | BOOK(*b)* AND BOOK_BRANCH(*br)* AND 1.library_branch = ‘iah’ AND Branch_Name = ‘lax’ ($\exists d$) (b.Book id = 1. Book_id)

D.

$A \leftarrow \sigma_{Branch\_name = 'Sharpstown'}$ *(LIBRARY_BRANCH)*

$B \leftarrow \sigma_{Due\_date = TODAY}$ *(BOOK_LOANS)*

$\Pi_{Title, Name, Address}$ *(((A x BOOK)*B)*BORROWER)*

Tuple Relational Calculus

R. Book_id, *r.* Branch_id, *r.* Card_no*, r.* Date_out, *r.* Due_date | BOOK_LOANS(r) AND BOOK(*b)* AND *r.* Book_id = ‘col197’ (∃ *d*) (b.Book id = 1. Book_id)