# Relational Databases

Joining Tables

8 February 2024

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# Quick Recap: Basic SQL Query

#### **Key Concepts:**

- Entity and Referential Integrity ensure data consistency in business through Primary Keys for uniqueness within tables and Foreign Keys for accurate cross-table references.
- For-Each Semantics offers a conceptual perspective of SQL queries, envisioning them as row-by-row evaluations, aiding in query formulation and understanding their logical processing within the database.

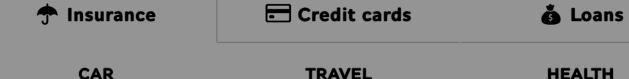
### **SQL** Query Example

```
SELECT Title, Author
FROM Books
WHERE Genre = 'Education';
```

#### For-Each Semantics

```
for each row in Books:
   if (row.Genre = 'Eduction'):
      output row.Title
```

- Purpose: Retrieves titles from the 'Books' table where the genre is 'Education'.
- Output Table:





MORE THAN 40 MILLION USERS HAVE FOUND WHAT THEY WERE LOOKING FOR.

Q: Which are our profitable travel insurance products?

ompare.
asiest

A: To know this, we will need to create an end-to-end platform data, i.e. digital marketing, conversion (or click) and revenues.



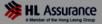


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# Joins

### Key to Linking Data Across Tables

 Primary Role: Joins in SQL are essential for merging data from different tables, enabling a comprehensive analysis of relational data.

### Relationship with Foreign Keys

- Foreign Keys: Serve to define and enforce relationships between tables. While not mandatory for joins, they are commonly used to establish direct links, ensuring data integrity.
- Without Foreign Keys: Joins can still be performed on related columns, allowing flexibility in querying across tables even without strict foreign key constraints.

### **Enhancing Data Insights**

- **Data Combination:** By joining tables, SQL queries can extract and combine relevant information from multiple sources, providing more in-depth insights.
- Example: Linking customer profiles with their transaction records to understand purchasing behaviors.

### **Inner Joins**

#### **Essential Tool in SQL Queries**

Inner Join is a basic SQL operation that merges rows from multiple tables based on a common column.

### Inner Join Syntax

SQL Query:

```
SELECT b.Title, br.ReturnDate
FROM Books b
INNER JOIN Borrow br ON b.BookID = br.BookID;
```

This query joins the Books table (b) and the Borrow table (br) using the BookID as the common column.

#### Books Table

BookID	Title	Author
101	Journey Through SQL	A. Coder
102	The History of Databases	D. Base
103	Adventures in Coding	P. Programmer
<u> </u>	•••	l

BookID   MemberID	BorrowDate   ReturnDate
101   501	2022-01-15   2022-01-30
103   502	2022-02-01   2022-02-14

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- This query joins the Books table (b) and the Borrow table (br) using the BookID as the common column.
- Join Predicate: b.BookID = br.BookID
- Books Table

BookID	Title	Author	
	, , , , , , , , , , , , , , , , , , , ,	A. Coder   D. Base   P. Programmer 	

BookID   MemberID	BorrowDate   ReturnDate
101   501	2022-01-15   2022-01-30
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### **Understanding Through Examples:**

Books Table:

BookID	Title	Author	
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Output Table:

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#### **Understanding Through Examples:**

Books Table:

SQL Query:

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SELECT b.Title, br.ReturnDate
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```

Output Table:

- How does the SQL engine process this JOIN?
- We compare every possible combination and filter the results that match.

#### **Exploring How SQL Executes Joins:**

Books Table:

SQL Query:

```
SELECT b.Title, br.ReturnDate
FROM Books b
INNER JOIN Borrow br ON b.BookID = br.BookID;
```

Output Table:

Borrow Table:

```
for each row1 in Books:
    for each row2 in Borrow:
        if (row1.BookID = row2.BookID):
            output (row1.Title, row2.ReturnDate)
```

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            output (row1.Title, row2.ReturnDate)
```

### Inner Joins: Implicit vs Explicit

#### **Understanding Through Examples:**

Books Table:

BookID	Title	Author
   101	   Journey Through SQL	   A. Coder
1	The History of Databases	D. Base
103 	Adventures in Coding	P. Programmer   

Explicit Join Syntax:

```
SELECT b.Title, br.ReturnDate
FROM Books b
INNER JOIN Borrow br ON b.BookID = br.BookID;
```

- Output Table:
  - Both queries yield the same result.

Borrow Table:

```
| BookID | MemberID | BorrowDate | ReturnDate |
|-----|-----|------|-----|
| 101 | 501 | 2022-01-15 | 2022-01-30 |
| 103 | 502 | 2022-02-01 | 2022-02-14 |
```

Implicit Join Syntax

```
SELECT b.Title, br.ReturnDate
FROM Books b, Borrow br
WHERE b.BookID = br.BookID;
```

### Implicit vs. Explicit

 Both perform inner joins with different syntax: implicit uses a WHERE clause, while explicit uses JOIN ... ON.

# LEFT JOIN

### Inclusive Data Retrieval with Outer Joins

Books Table:

BookID	Title	Author
101   102   103 	Journey Through SQL The History of Databases Adventures in Coding	A. Coder   D. Base   P. Programmer   

Borrow Table:

```
| BookID | MemberID | BorrowDate | ReturnDate |
|-----|-----|------|-----|
| 101 | 501 | 2022-01-15 | 2022-01-30 |
| 103 | 502 | 2022-02-01 | 2022-02-14 |
```

SQL Query:

```
SELECT b.Title
FROM Books b
LEFT JOIN Borrow br ON b.BookID = br.BookID;
```

- Purpose: Retrieves all books, regardless of whether they have been borrowed.
- Output Table:

- LEFT [OUTER] JOIN Concept:
  - For books that have been borrowed, it shows their return date.
  - For books that have not been borrowed, the return date will be NULL.

# ANTI LEFT JOIN

#### Identifying Records with No Match in Another Table

Books Table:

BookID	Title	Author	
101	Journey Through SQL	A. Coder	
102	The History of Databases	D. Base	
103	Adventures in Coding	P. Programmer	
		l	

SQL Query:

```
SELECT b.Title
FROM Books b
LEFT JOIN Borrow br ON b.BookID = br.BookID
WHERE br.BookID IS NULL;
```

- Purpose: Identifying Unborrowed Books.
- Output Table:

```
| Title
|-----|
| The History of Databases |
```

BookID   	MemberID	BorrowDate	ReturnDate   
! !		2022-01-15	

- Critical for Data Analysis:
  - Essential for identifying unlinked records, it offers insights into less popular or demanded items, completing the data picture.

# Self Joins

### Find all authors who published in both Eduction a

for each row1 in Books:
 for each row2 in Borrow:
 if (row1.BookID = row2.BookID):
 if (row1.BookID = row2.BookID):
 output (row1.Title, row2.ReturnDate)

Source Table: 'Books'

```
BookID | Title
                                                                         PublishedYear
                                            Author
                                                            Genre
                                                            Technology
101
         Journey Through SQL
                                            A. Coder
                                                                         2015
102
         The History of Databases
                                                            Education
                                                                         2018
                                            D. Base
         Adventures in Coding
                                                            Fiction
                                                                         2020
103
                                            P. Programmer
104
         Exploring Data Science
                                            A. Coder
                                                            Science
                                                                         2021
105
         Fundamentals of Database Design
                                            D. Base
                                                                         2019
                                                            Technology
```

SQL Query:

```
SELECT Author
FROM Books
WHERE Genre = 'Technology'
AND Genre = 'Education';
```

Output Table:

```
| Author |
| ----- |
```

For-Each Semantics:

```
for each row in Books:
   if (row.Genre='Technology') and (row.Genre=Education') :
      output row.Author
```

### Self Joins

Find all authors who published in both Eduction and Technology genres.

Source Table: 'Books'

```
BookID
        Title
                                            Author
                                                                         PublishedYear
                                                            Genre
101
         Journey Through SQL
                                            A. Coder
                                                            Technology
                                                                         2015
102
         The History of Databases
                                            D. Base
                                                            Education
                                                                         2018
103
         Adventures in Coding
                                                            Fiction
                                                                         2020
                                            P. Programmer
104
         Exploring Data Science
                                                                         2021
                                            A. Coder
                                                            Science
105
         Fundamentals of Database Design
                                            D. Base
                                                            Technology
                                                                         2019
```

SQL Query:

```
SELECT Author
FROM Books
WHERE Genre IN ('Technology', 'Education');
```

For-Each Semantics:

```
for each row in Books:
   if (row.Genre in ['Education', 'Technology']) :
      output row.Author
```

Output Table:

```
| Author |
| ----- |
| A. Coder |
| D. Base |
| D. Base |
```

# Self Joins

- Find all authors who published in both Eduction and Technology genres.
- Source Table: 'Books'

```
BookID
         Title
                                             Author
                                                                           PublishedYear
                                                             Genre
101
         Journey Through SQL
                                             A. Coder
                                                             Technology
                                                                           2015
102
         The History of Databases
                                             D. Base
                                                             Education
                                                                           2018
103
         Adventures in Coding
                                                             Fiction
                                                                           2020
                                             P. Programmer
104
         Exploring Data Science
                                                             Science
                                                                           2021
                                             A. Coder
105
         Fundamentals of Database Design
                                             D. Base
                                                             Technology
                                                                           2019
```

SQL Query:

```
SELECT b1.Author
FROM Books b1
INNER JOIN Books b2
ON b1.Author = b2.Author
WHERE b1.Genre = 'Education'
AND b2.Genre = 'Technology';
```

Output Table:

```
| Author |
| ----- |
| D. Base |
```

For-Each Semantics:

```
for each row1 in Books:
    for each row2 in Books:
        if (row1.BookID = row2.BookID):
            if (row1.BookID = row2.BookID):
                if (row1.Genre = 'Education') and (row2.Genre = 'Technology'):
                output (row1.Title, row2.ReturnDate)
```

- When a relation occurs twice in the FROM clause, we call it a self-join.
- A self-join is used to compare rows within the same table. It's particularly useful for analysing complex relationships within a single table.

# Recap and Key Takeaways

- JOIN operations are crucial for merging and analyzing data across tables, enabling comprehensive insights and informed decision-making in relational databases.
- The JOIN condition can be equality based on a pair of columns from the 2 tables or other more complicated logic based on multiple columns, or even a self-join that compares columns within the same table.

#### Example SQL Recap:

```
SELECT b.Title, br.ReturnDate
FROM Books b
INNER JOIN Borrow br ON b.BookID = br.BookID;
```

• **Purpose:** This query retrieves the titles of borrowed books along with their respective return dates, linking book information with borrowing records.

### Preparing for Aggregates and Grouping:

- Next Lecture Preview:
  - Explore further into SQL Aggregation Functions.
  - Examine Execution Order

Why is maintaining data integrity crucial in a database, and how do primary and foreign keys contribute to this process?

### **Hand-On SQL Demonstration**

- Focus: Understanding and applying SQL joins in a library database scenario.
- Goal: Showcase how SQL joins can combine data from different tables for comprehensive insights.

### **Example Query**

- Find Borrowed Book Titles and Return Dates:
  - SQL Query:

```
SELECT b.Title, br.ReturnDate
FROM Books b INNER JOIN Borrow br
ON b.BookID = br.BookID;
```

Purpose: Demonstrates how INNER JOIN combines book titles with their borrowing details.

#### Try It Yourself

- 1. Find Books Borrowed During a Specific Year:
  - Task: Write a query to list titles of books that were borrowed in the year 2022.
- 2. List Books and Borrowers:
  - Task: Create a query to display the names of members alongside the titles of books they have borrowed.