

# 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';
```

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

Title	Author
-----	-----
The History of Databases	D. Base
...	...

## For-Each Semantics

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

I'm looking for **single** travel insurance for

Google  
DISPLAY NETWORK

facebook  
Ads

Google Ads

#tiq

by Etiqa Insurance



FWD  
insurance

START OVER

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

compare.

*Q: Which are our profitable travel insurance products?*

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

# Joins

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## 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: *alias*

```
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
...	...	...

- Borrow Table

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`

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- Borrow Table

BookID	MemberID	BorrowDate	ReturnDate
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# Nested-Loop Semantics

## Understanding Through Examples:

- Books Table:

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- SQL Query:

```
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FROM Books b
INNER JOIN Borrow br ON b.BookID = br.BookID;
```

- Output Table:

Title	ReturnDate
Journey Through SQL	2022-01-30
Adventures in Coding	2022-02-14

- Borrow Table:

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

# Nested-Loop Semantics

## Exploring How SQL Executes Joins:

- Books Table:

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101	Journey Through SQL	A. Coder
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- SQL Query:

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SELECT b.Title, br.ReturnDate
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Title	ReturnDate
-----	-----

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- Nested-Loop Semantics:

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

# Nested-Loop Semantics

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Title	ReturnDate
Journey Through SQL	2022-01-30

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- Nested-Loop Semantics:

```
for each row1 in Books:
    for each row2 in Borrow:
        if (row1.BookID = row2.BookID):
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```



# Inner Joins: Implicit vs Explicit

## Understanding Through Examples:

### ■ Books Table:

BookID	Title	Author
101	Journey Through SQL	A. Coder
102	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.

Title	ReturnDate
Journey Through SQL	2022-01-30
Adventures in Coding	2022-02-14

### ■ 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	Journey Through SQL	A. Coder
102	The History of Databases	D. Base
103	Adventures in Coding	P. Programmer
...	...	...

- SQL Query:

```
SELECT b.Title, br.ReturnDate
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:

Title	ReturnDate
Journey Through SQL	2022-01-30
The History of Databases	NULL
Adventures in Coding	2022-02-14

- Borrow Table:

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

- 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
...	...	...

- 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
WHERE br.BookID IS NULL;
```

- Purpose: Identifying Unborrowed Books.

- Output Table:

Title
The History of Databases

- 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 Education and Technology genres.

- Source Table: 'Books'

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

- SQL Query:

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

- For-Each Semantics:

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

- Output Table:

Author
-----

# Self Joins

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

- Source Table: 'Books'

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

- SQL Query:

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

- Output Table:

Author
A. Coder
D. Base
D. Base

- For-Each Semantics:

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

# Self Joins

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

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

- For-Each Semantics:

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

- Output Table:

Author
D. Base

- 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.