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# FROM CHAOS TO INSIGHT

Introduction to DBMS Architecture & Analytics with SQL

A guide to structuring, storing, and querying data for analytical value.

# The Evolution of Storage: Why We Need DBMS

## File Systems



- **Data Redundancy:** Duplicate files stored in multiple locations, leading to wasted space and inconsistencies.
- **Data Isolation:** Data trapped in incompatible formats and separate applications, making integration difficult.
- **Integrity Problems:** No rules to enforce validity (e.g., negative balances, missing required fields), resulting in unreliable data.

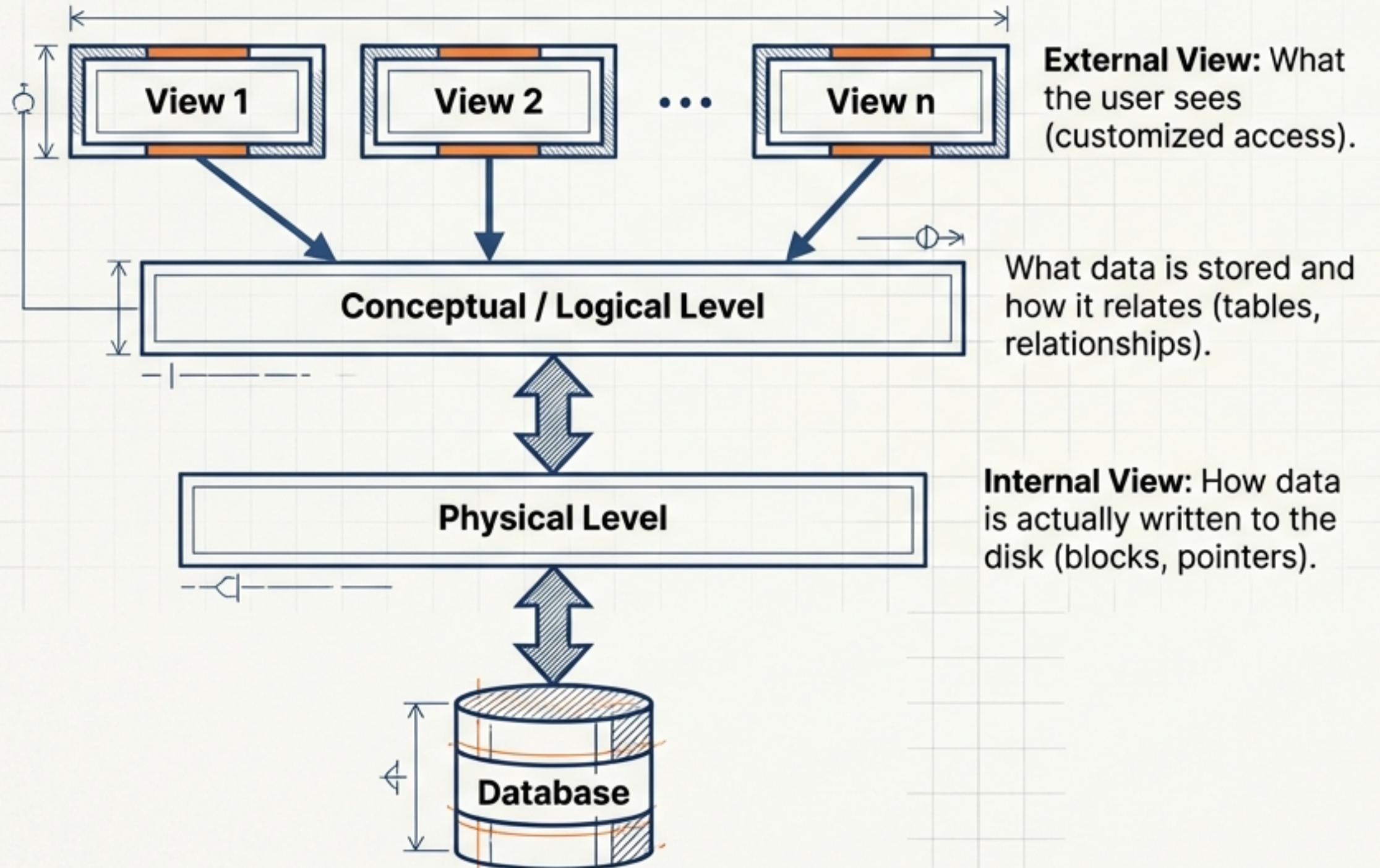
## Database Management Systems (DBMS)



- **Centralized Control:** Single source of truth where changes propagate instantly, ensuring efficient management.
- **Data Consistency:** All users see the exact same, up-to-date data, eliminating conflicts and errors.
- **Security:** Granular access control managed by administrators with user roles, permissions, and encryption.

# The Architecture of Abstraction

## Three-Level Architecture



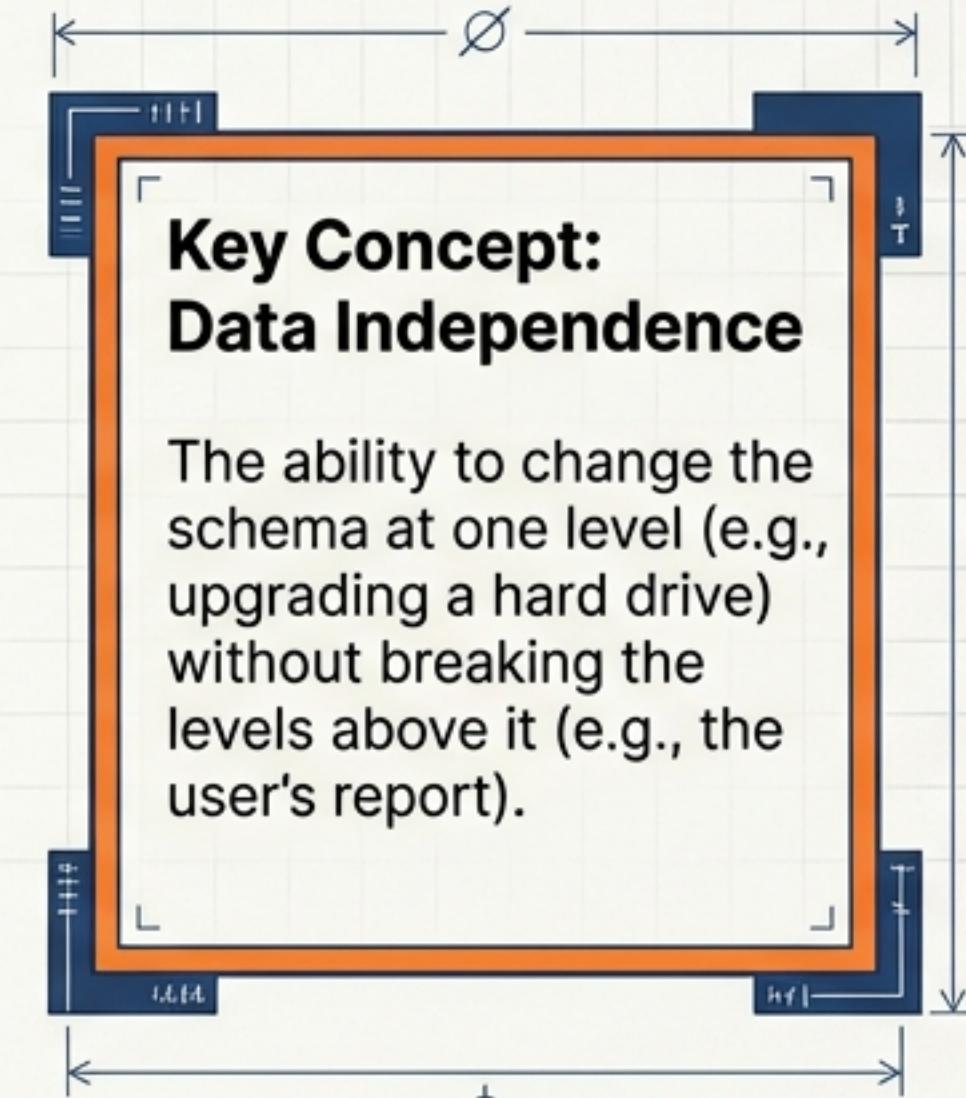
**External View:** What the user sees (customized access).

What data is stored and how it relates (tables, relationships).

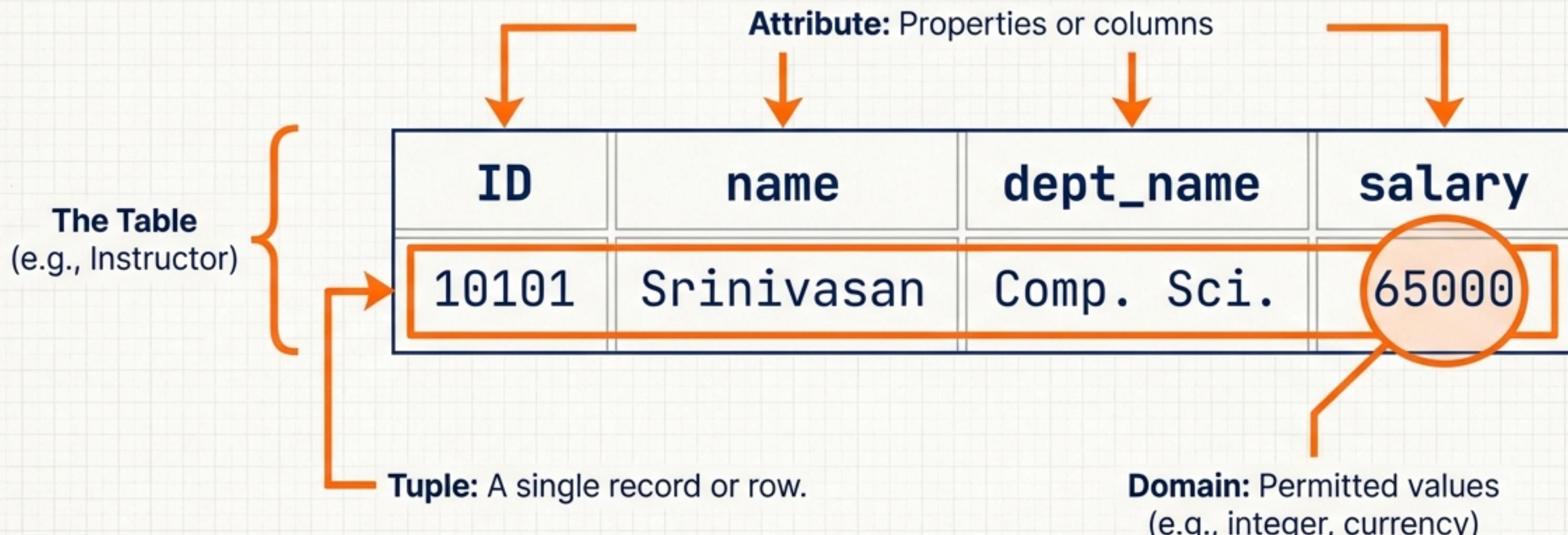
**Internal View:** How data is actually written to the disk (blocks, pointers).

## Key Concept: Data Independence

The ability to change the schema at one level (e.g., upgrading a hard drive) without breaking the levels above it (e.g., the user's report).



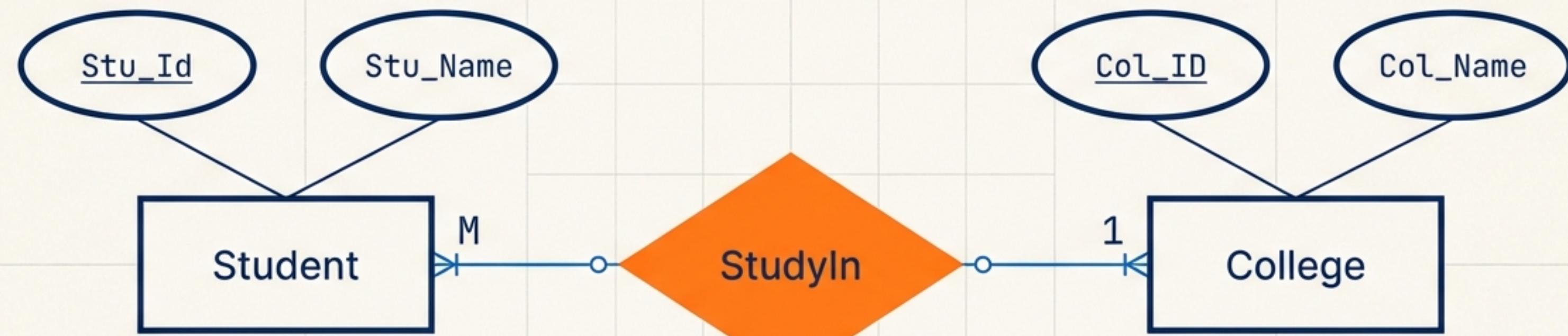
# Structuring Reality: The Relational Model



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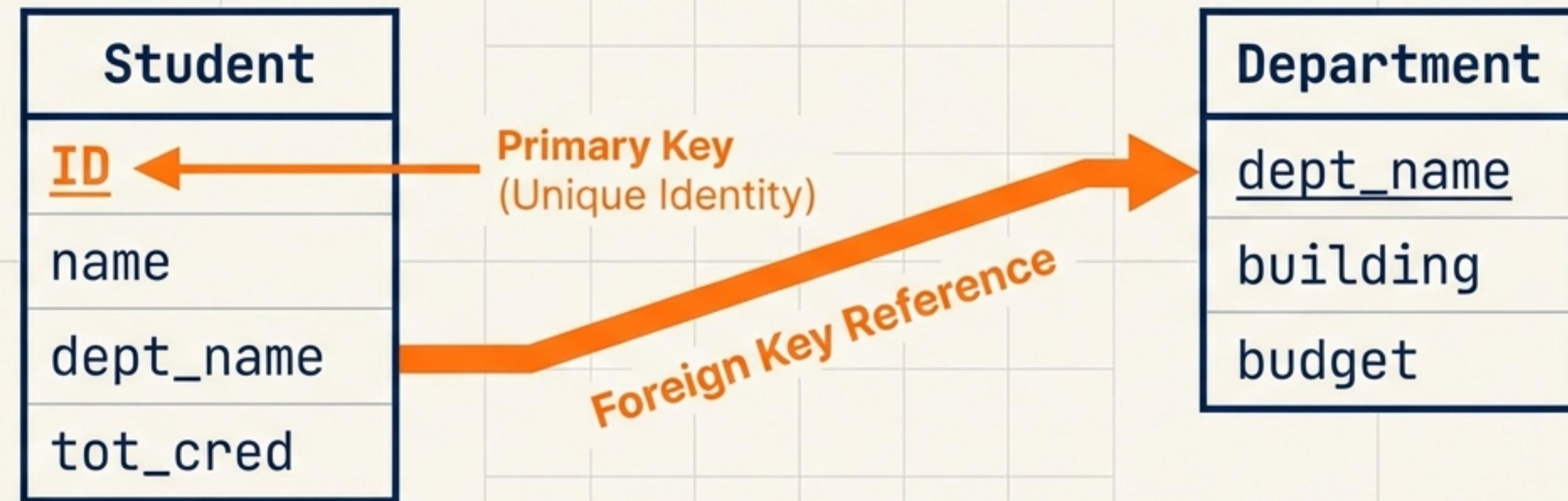
1 1 2 3 4 5 6 7 8

# The Blueprint: Entity-Relationship (ER) Modeling



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# Connecting the Dots: Keys & Relationships



Relationships are formed when a Foreign Key in one table points to a Primary Key in another, creating a web of connected data.

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# SQL: The Language of Data

## DDL (Data Definition)

Defining Structure

CREATE  
DROP  
ALTER

## DML (Data Manipulation)

Managing Content

INSERT  
UPDATE  
DELETE

## DQL (Data Query)

Asking Questions

SELECT

## DCL (Data Control)

Managing Permissions

GRANT  
REVOKE

SQL is declarative: You specify *what* you want, not *how* the system should find it.

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# Building the Structure (DDL)

## Code Panel

```
CREATE TABLE Students (
    StudentID int,
    Name varchar(255),
    GPA decimal(3,2)
);
```

## Visual Result

StudentID	Name	GPA

**CREATE TABLE:**  
Initializes a new object.

**ALTER TABLE:**  
Adds or modifies columns.

**DROP TABLE:**  
Deletes the table entirely.

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# Populating and Maintaining Data (DML)

## Code Panel

```
INSERT INTO Students  
VALUES (1, 'John', 3.5);
```



## Visual Result

StudentID	Name	GPA
1	John	3.5

```
UPDATE Students  
SET GPA = 3.8  
WHERE Name = 'John';
```



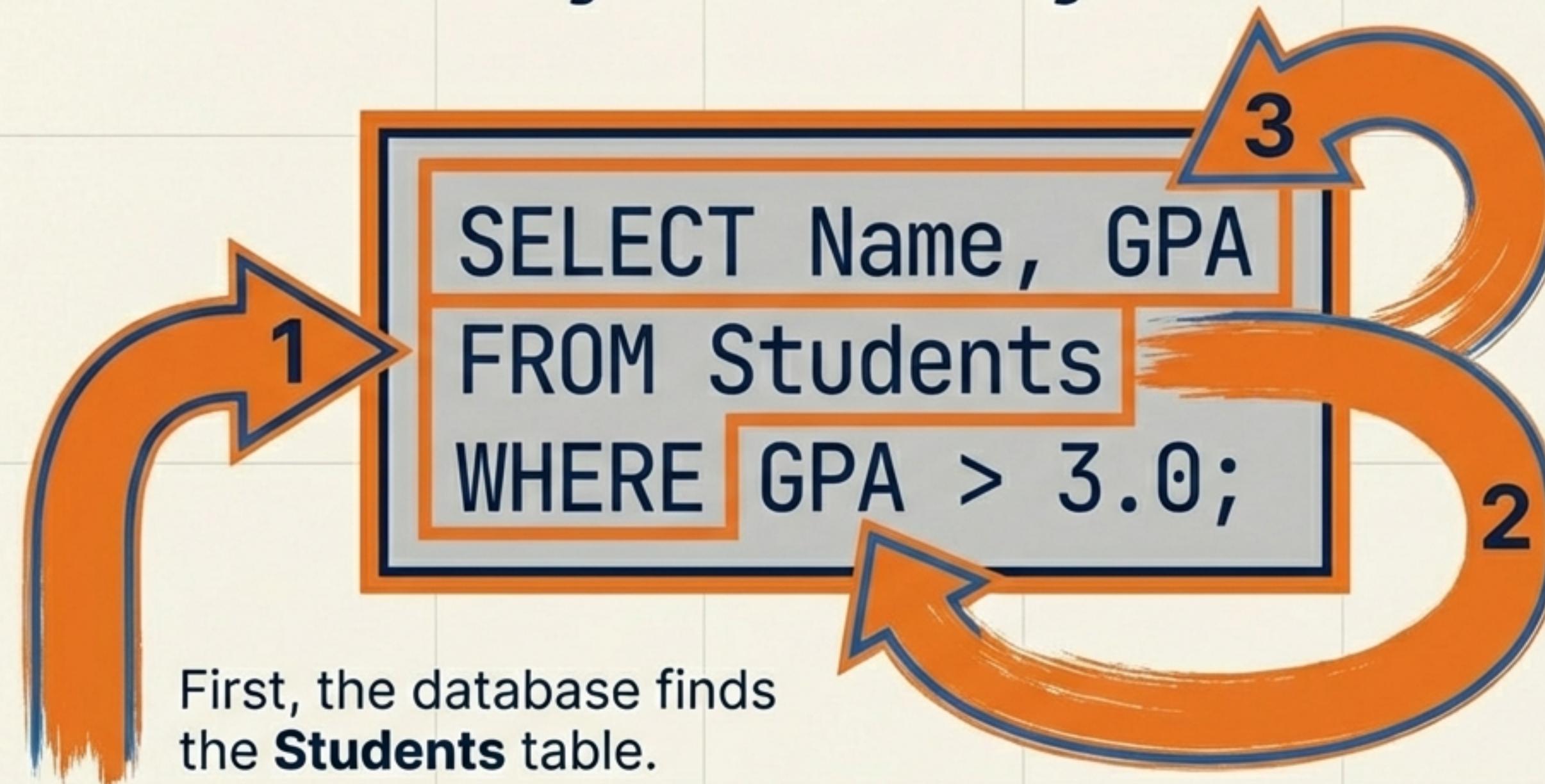
StudentID	Name	GPA
1	John	<del>3.5</del> 3.8

```
DELETE FROM Students  
WHERE GPA < 2.0;
```



StudentID	Name	GPA
2	Mark	1.8
2	Mark	1.8

# The Anatomy of a Query



**The logical order of execution differs from the written order.**

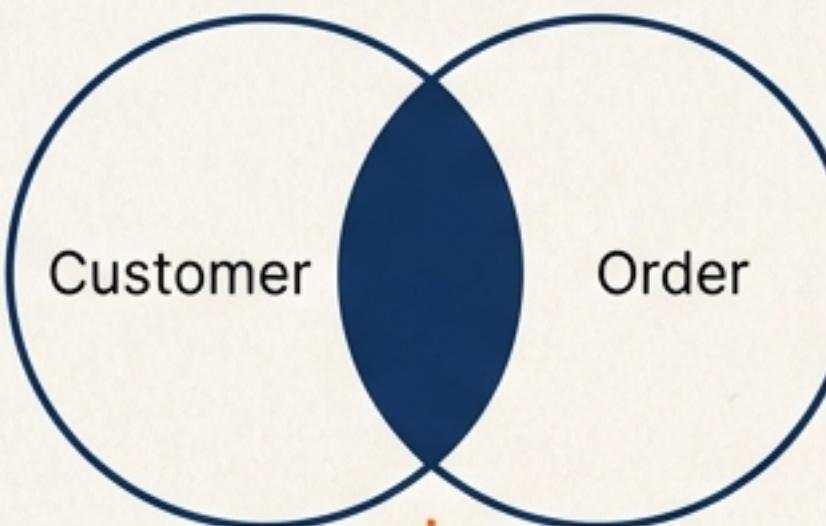
Finally, it returns only the **Name** and **GPA** columns.

Second, it filters rows where **GPA > 3.0**.

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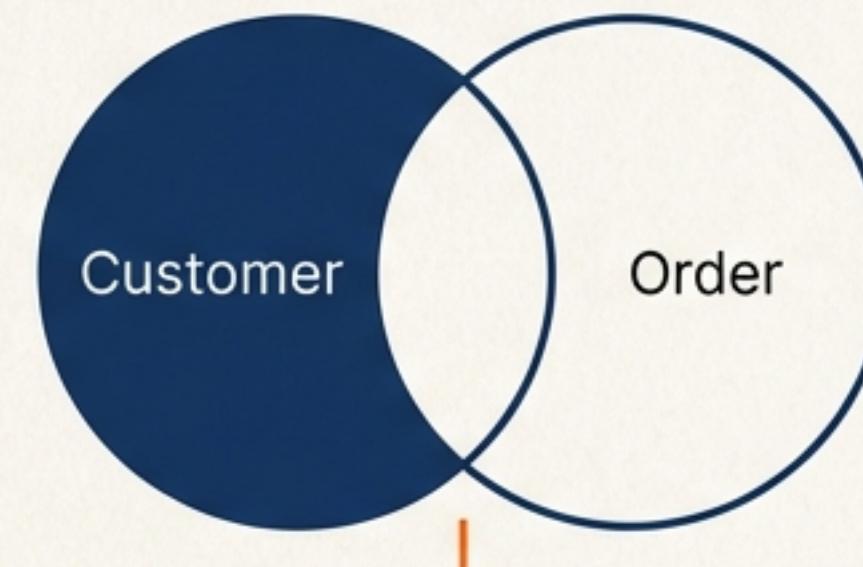
# Combining Perspectives: SQL JOINS

## 1. INNER JOIN



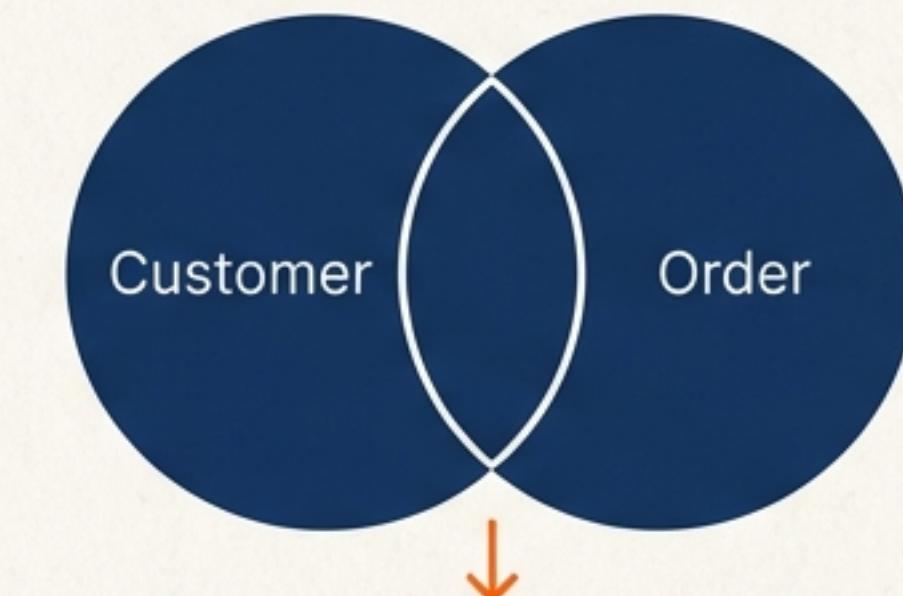
Returns rows with matches in BOTH tables.

## 2. LEFT JOIN



Returns ALL rows from Left, plus matches from Right.

## 3. FULL OUTER JOIN



Returns ALL rows when a match exists in EITHER table.

### Code Snippet

```
SELECT * FROM Customer  
JOIN Order ON Customer.ID = Order.CustomerID;
```

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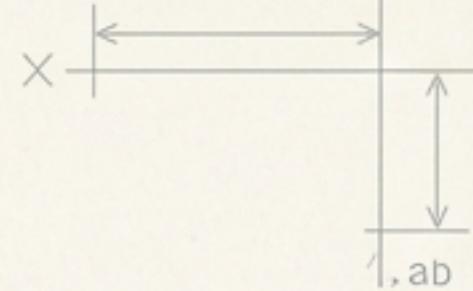
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# From Data to Insight: Aggregation

Order Records																
OrderID	Date	Region	Product	Sales	Units	Quantity	Predictions	OrderID	Date	Region	Product	Product	SubCategory	Quantity	Croats	NetWdg
00001	2023-01-01	North	Scouts	\$150,000	5	100	0.95	00001	2023-01-01	North	Scouts	Product 101	Decks	1000	5	500
00002	2023-01-01	North	Scouts	\$175,000	5	100	0.95	00002	2023-01-01	North	Scouts	Product 102	Decks	1000	5	500
00003	2023-01-01	North	Scouts	\$180,000	5	100	0.95	00003	2023-01-01	North	Scouts	Product 103	Decks	1000	5	500
00004	2023-01-01	North	Scouts	\$110,000	5	100	0.95	00004	2023-01-01	North	Scouts	Product 104	Decks	1000	5	500
00005	2023-01-01	North	Scouts	\$170,000	5	100	0.95	00005	2023-01-01	North	Scouts	Product 105	Decks	1000	5	500
00006	2023-01-01	North	Scouts	\$155,000	5	100	0.95	00006	2023-01-01	North	Scouts	Product 106	Decks	1000	5	500
00007	2023-01-01	North	Scouts	\$120,000	5	100	0.95	00007	2023-01-01	North	Scouts	Product 107	Decks	1000	5	500
00008	2023-01-01	North	Scouts	\$150,000	5	100	0.95	00008	2023-01-01	North	Scouts	Product 108	Decks	1000	5	500
00009	2023-01-01	North	Scouts	\$115,000	5	100	0.95	00009	2023-01-01	North	Scouts	Product 109	Decks	1000	5	500
00010	2023-01-01	North	Scouts	\$175,000	5	100	0.95	00010	2023-01-01	North	Scouts	Product 110	Decks	1000	5	500
00011	2023-01-01	North	Scouts	\$160,000	5	100	0.95	00011	2023-01-01	North	Scouts	Product 111	Decks	1000	5	500
00012	2023-01-01	North	Scouts	\$150,000	5	100	0.95	00012	2023-01-01	North	Scouts	Product 112	Decks	1000	5	500
00013	2023-01-01	North	Scouts	\$170,000	5	100	0.95	00013	2023-01-01	North	Scouts	Product 113	Decks	1000	5	500
00014	2023-01-01	North	Scouts	\$155,000	5	100	0.95	00014	2023-01-01	North	Scouts	Product 114	Decks	1000	5	500
00015	2023-01-01	North	Scouts	\$120,000	5	100	0.95	00015	2023-01-01	North	Scouts	Product 115	Decks	1000	5	500
00016	2023-01-01	North	Scouts	\$150,000	5	100	0.95	00016	2023-01-01	North	Scouts	Product 116	Decks	1000	5	500
00017	2023-01-01	North	Scouts	\$110,000	5	100	0.95	00017	2023-01-01	North	Scouts	Product 117	Decks	1000	5	500
00018	2023-01-01	North	Scouts	\$175,000	5	100	0.95	00018	2023-01-01	North	Scouts	Product 118	Decks	1000	5	500
00019	2023-01-01	North	Scouts	\$160,000	5	100	0.95	00019	2023-01-01	North	Scouts	Product 119	Decks	1000	5	500
00020	2023-01-01	North	Scouts	\$150,000	5	100	0.95	00020	2023-01-01	North	Scouts	Product 120	Decks	1000	5	500
00021	2023-01-01	North	Scouts	\$170,000	5	100	0.95	00021	2023-01-01	North	Scouts	Product 121	Decks	1000	5	500
00022	2023-01-01	North	Scouts	\$155,000	5	100	0.95	00022	2023-01-01	North	Scouts	Product 122	Decks	1000	5	500
00023	2023-01-01	North	Scouts	\$120,000	5	100	0.95	00023	2023-01-01	North	Scouts	Product 123	Decks	1000	5	500
00024	2023-01-01	North	Scouts	\$150,000	5	100	0.95	00024	2023-01-01	North	Scouts	Product 124	Decks	1000	5	500
00025	2023-01-01	North	Scouts	\$115,000	5	100	0.95	00025	2023-01-01	North	Scouts	Product 125	Decks	1000	5	500
00026	2023-01-01	North	Scouts	\$170,000	5	100	0.95	00026	2023-01-01	North	Scouts	Product 126	Decks	1000	5	500
00027	2023-01-01	North	Scouts	\$155,000	5	100	0.95	00027	2023-01-01	North	Scouts	Product 127	Decks	1000	5	500
00028	2023-01-01	North	Scouts	\$120,000	5	100	0.95	00028	2023-01-01	North	Scouts	Product 128	Decks	1000	5	500
00029	2023-01-01	North	Scouts	\$150,000	5	100	0.95	00029	2023-01-01	North	Scouts	Product 129	Decks	1000	5	500
00030	2023-01-01	North	Scouts	\$110,000	5	100	0.95	00030	2023-01-01	North	Scouts	Product 130	Decks	1000	5	500
00031	2023-01-01	North	Scouts	\$175,000	5	100	0.95	00031	2023-01-01	North	Scouts	Product 131	Decks	1000	5	500
00032	2023-01-01	North	Scouts	\$160,000	5	100	0.95	00032	2023-01-01	North	Scouts	Product 132	Decks	1000	5	500
00033	2023-01-01	North	Scouts	\$150,000	5	100	0.95	00033	2023-01-01	North	Scouts	Product 133	Decks	1000	5	500
00034	2023-01-01	North	Scouts	\$170,000	5	100	0.95	00034	2023-01-01	North	Scouts	Product 134	Decks	1000	5	500
00035	2023-01-01	North	Scouts	\$155,000	5	100	0.95	00035	2023-01-01	North	Scouts	Product 135	Decks	1000	5	500
00036	2023-01-01	North	Scouts	\$120,000	5	100	0.95	00036	2023-01-01	North	Scouts	Product 136	Decks	1000	5	500
00037	2023-01-01	North	Scouts	\$150,000	5	100	0.95	00037	2023-01-01	North	Scouts	Product 137	Decks	1000	5	500
00038	2023-01-01	North	Scouts	\$115,000	5	100	0.95	00038	2023-01-01	North	Scouts	Product 138	Decks	1000	5	500
00039	2023-01-01	North	Scouts	\$170,000	5	100	0.95	00039	2023-01-01	North	Scouts	Product 139	Decks	1000	5	500
00040	2023-01-01	North	Scouts	\$155,000	5	100	0.95	00040	2023-01-01	North	Scouts	Product 140	Decks	1000	5	500
00041	2023-01-01	North	Scouts	\$120,000	5	100	0.95	00041	2023-01-01	North	Scouts	Product 141	Decks	1000	5	500
00042	2023-01-01	North	Scouts	\$150,000	5	100	0.95	00042	2023-01-01	North	Scouts	Product 142	Decks	1000	5	500
00043	2023-01-01	North	Scouts	\$110,000	5	100	0.95	00043	2023-01-01	North	Scouts	Product 143	Decks	1000	5	500
00044	2023-01-01	North	Scouts	\$175,000	5	100	0.95	00044	2023-01-01	North	Scouts	Product 144	Decks	1000	5	500
00045	2023-01-01	North	Scouts	\$160,000	5	100										

# Operational vs. Analytical Workloads



## OLTP (Online Transaction Processing)



## OLAP (Online Analytical Processing)

**METAPHOR:** Running the Hospital.

**METAPHOR:** Understanding the Hospital.

### CHARACTERISTICS:

- Many users, fast updates, single-row focus.

**EXAMPLE:** Booking an appointment.

### CHARACTERISTICS:

- Fewer users, heavy queries, historical focus.

**EXAMPLE:** Quarterly admission trends.

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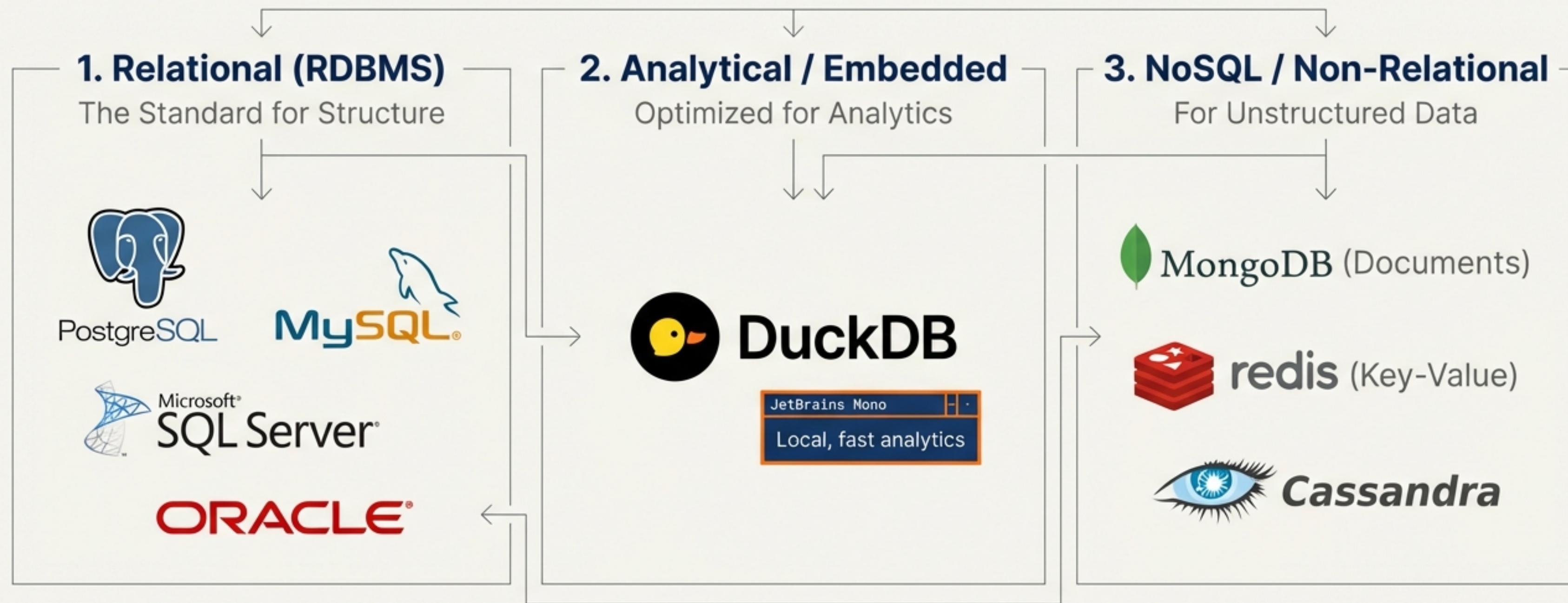


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# The Modern DBMS Landscape

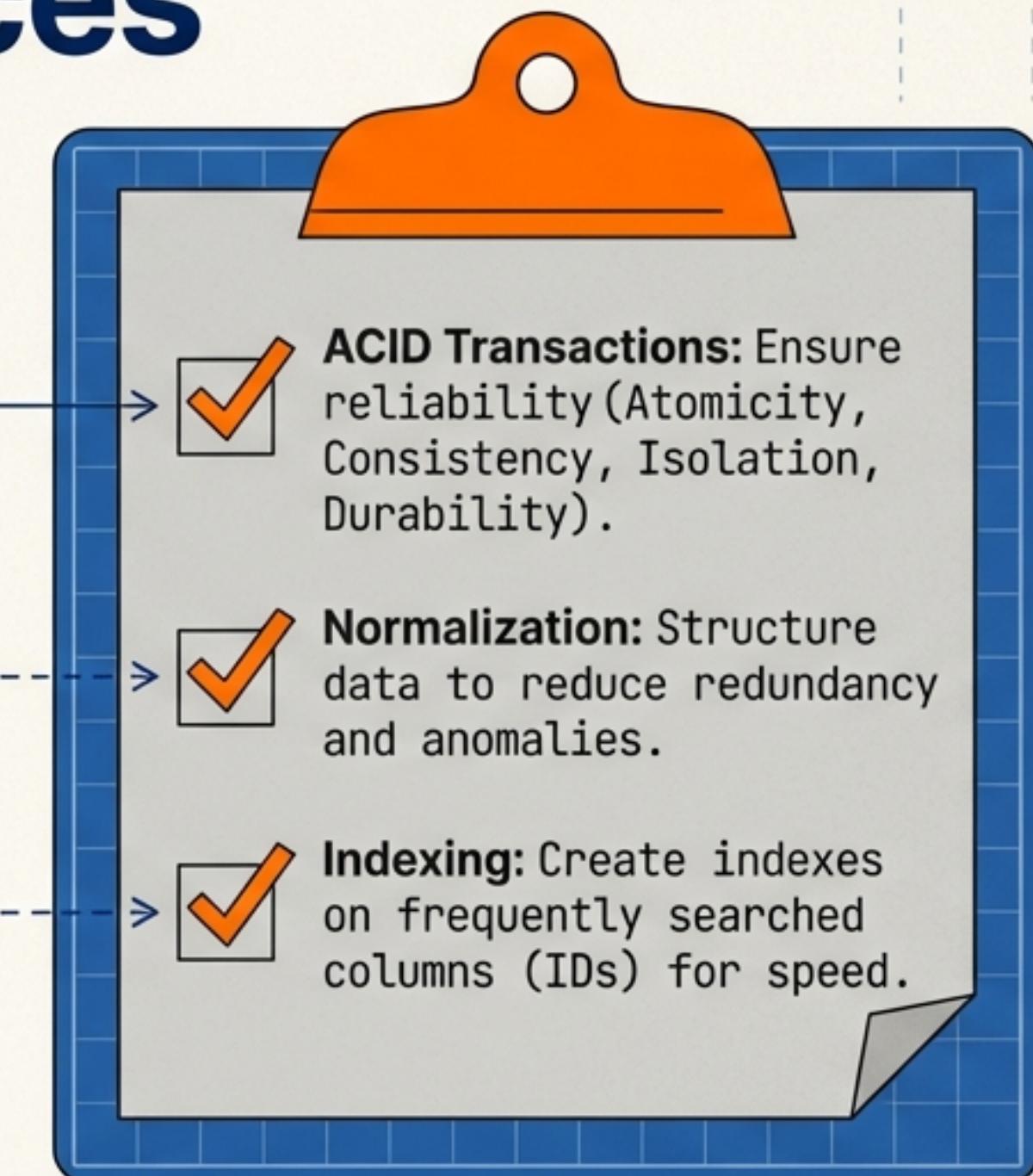


The industry trend is toward Multi-Model databases that support both SQL and JSON.

PROJECT:	DBMS OVERVIEW	
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DATES:	2024-05-22	SHEET:
	3 OF 3	Company

# Summary & Best Practices

**Golden Rule:**  
**Structure your data**  
**to mirror reality, but**  
**query your data to**  
**answer specific**  
**questions.**



PROJECT: DBMS OVERVIEW	DATE: 2024-05-22	SHEET: 4 OF 4
APPROVED BY: <i>Signature</i>	 Company	NotebookLM