

Introduction to Database Systems

Introduction to Database Systems

Key concepts, components, and fundamentals for anyone starting out in data management.

1. What Is a Database?

Aspect	Description
Definition	An organized collection of related data stored electronically for efficient retrieval, update, and management.
Purpose	Preserve data integrity, eliminate redundancy, enable concurrent access, and support decision-making.
Typical Uses	Business transactions, inventory control, customer relationship management (CRM), scientific research, web applications, etc.

2. Core Terminology

Term	Meaning
DBMS (Database Management System)	Software that creates, maintains, and controls access to databases (e.g., MySQL, PostgreSQL, Oracle, MongoDB).
Schema	The logical structure describing tables, fields, relationships, constraints, and indexes.
Instance	The actual data stored in the database at a particular moment (a snapshot of the database).
Tuple/Row	A single record in a table.
Attribute/Column	A field within a table that holds a specific type of data.
Primary Key	A unique identifier for each row in a table.
Foreign Key	A column that references a primary key in another table, establishing a relationship.
Normalization	Process of organizing data to reduce redundancy and improve integrity.
Transaction	A logical unit of work that must be atomic , consistent , isolated , and durable (ACID).

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3. Types of Database Models

Model	Characteristics	Typical Use Cases
Relational (RDBMS)	Data stored in tables; uses SQL; strong ACID guarantees.	Financial systems, ERP, CRM.
NoSQL	Flexible schemas; various subtypes (document, key-value, column-family, graph).	Big data, real-time analytics, content management.
Object-Oriented	Stores objects directly; aligns with object-oriented programming.	CAD/CAM, multimedia databases.
Hierarchical	Tree-like structure; parent-child relationships.	Legacy mainframe systems (e.g., IBM IMS).
Network	Graph-like structure; many-to-many relationships.	Complex routing or bill-of-materials data.

4. Relational Database Fundamentals

4.1. Tables (Relations)

- Consist of rows (records) and columns (attributes).
- Must have a **primary key**.

4.2. Relationships

Cardinality	Description	Example
One-to-One (1:1)	Each row in Table A matches at most one row in Table B.	Person ? Passport.
One-to-Many (1:N)	One row in Table A relates to many rows in Table B.	Customer ? Orders.
Many-to-Many (M:N)	Rows in Table A can relate to multiple rows in Table B and vice versa. Implemented via a junction (link) table.	Students ? Courses.

4.3. SQL – Structured Query Language

Category	Common Commands
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Data Definition Language (DDL) CREATE, ALTER, DROP, TRUNCATE

Data Manipulation Language (DML) SELECT, INSERT,