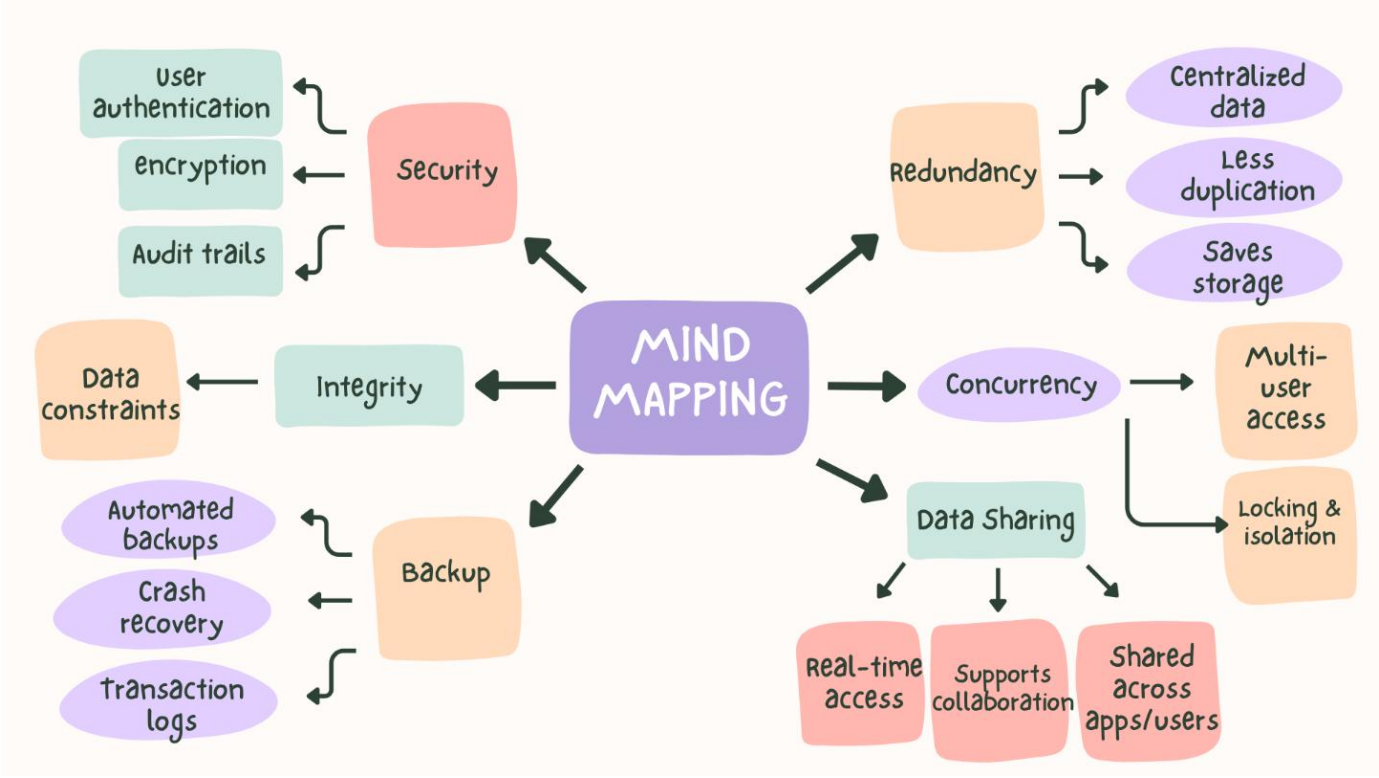
1) **Comparison: Flat File Systems vs. Relational Databases:**

Feature	*Flat File Systems*	*Relational Databases*
Structure	Data stored in a signal table or text file	Data stored in multiple related tables
Data Redundancy	duplicate data appears in multiple files	normalization minimizes redundancy
Relationships	all data kept separately	Supports relationships using primary and foreign keys
Example Usage	Small applications (configuration files)	Business applications (banking systems)
Drawbacks	Hard to update, lacks security and poor scalability	More complex setup, requires database software and management

2) **DBMS Advantages – Mind Map:**



3) Roles in a Database System:

	Role	Key Responsibilities:
System Analyst	Bridge between business needs and technical solutions	• Gathers and analyses business requirements from stakeholders • Identifies data needs and system workflows • Creates functional specifications and use cases
Database Designer	Architect of the database structure	• Designs the logical and physical data model • Applies normalization to reduce redundancy • Defines constraints, data types, and referential integrity rules
Database Developer	Builder of database logic and objects	• Writes and optimizes SQL scripts • Implements the database schema designed
Database Administrator (DBA)	Guardian of the database environment	• Installs, configures, and maintains DBMS software • Manages user accounts, roles, and security permissions • Performs backups, recovery, and disaster planning
Application Developer	Creator of software that uses the database	• Develops front-end or back-end applications • Writes code to query, insert, update, or delete data • Collaborates with Database Developers
BI (Business Intelligence) Developer	Data storyteller and analytics enabler	• Creates dashboards, reports, and visualizations • Transforms raw operational data into actionable business insights • Works with aggregated, historical, and dimensional data models

4) Types of Databases:

1. Relational vs. Non-Relational Databases:

- **Relational Databases:**
  - ✓ **Structure:** Data stored in tables (rows and columns) with predefined schemas.
  - ✓ **Relationships:** Tables linked via keys (primary/foreign keys).
  - ✓ **Query Language:** SQL (Structured Query Language).
  - ✓ **Examples:** MySQL, PostgreSQL, Oracle, Microsoft SQL Server.

- **Non- Relational Databases:**
  - ✓ **Structure:** Flexible schemas; data stored as documents, key-value pairs, columns, or graphs.
  - ✓ **Scalability:** Designed for horizontal scaling (adding more servers).
  - ✓ **Examples:**
    - **MongoDB** → Document-based (stores JSON-like documents)
    - **Apache Cassandra** → Wide-column store (optimized for high write throughput & availability)

	Relational Databases	**Non-Relational Databases**
Data Model	Tables	Document
Schema	Fixed	Dynamic
Relationships	Native support via foreign keys	Not natively supported
Query Language	SQL	Varies by type (e.g., MongoDB Query Language, CQL, etc.)
Performance	Optimized for complex queries & joins	Optimized for high-speed reads/writes on large datasets
Examples	MySQL, PostgreSQL, Oracle, SQL Server	MongoDB (document), Cassandra (column), Redis (key-value), Neo4j (graph)
Best Use Cases	Banking, ERP, payroll, inventory systems	Real-time analytics, IoT, content management, social media, gaming

2. **Centralized vs. Distributed vs. Cloud Databases:**
   - **Centralized Databases:**
     - ✓ **Definition:** Stored and maintained on a single server or location.
     - ✓ **Control:** One point of management and access.
     - ✓ **Pros:** Simpler security, easier backup, consistent state.
     - ✓ **Cons:** Single point of failure; limited scalability.

   - **Distributed Databases:**
     - ✓ **Definition:** Data spread across multiple physical locations (servers, regions, or countries), but logically interconnected.
     - ✓ **Types:** Homogeneous (same DBMS everywhere) or heterogeneous (different systems).
     - ✓ **Pros:** High availability, fault tolerance, local data access.
     - ✓ **Cons:** Complex synchronization, network dependency.

   - **Cloud Databases:**
     - ✓ **Definition:** Hosted on cloud platforms (e.g., AWS, Azure, Google Cloud); can be relational or NoSQL.
     - ✓ **Deployment Models:**
       - **DBaaS (Database as a Service):** Fully managed (e.g., Amazon RDS, Azure Cosmos DB)
       - **Self-managed on cloud VMs**
     - ✓ **Pros:** Elastic scaling, pay-as-you-go pricing, automatic backups, high availability
     - ✓ **Cons:** Ongoing costs, potential vendor lock-in, security considerations

	Centralized Databases	Distributed Databases	Cloud Databases
Definition	Data stored and managed on a single server	Data stored across multiple physical locations	Database hosted, managed, and accessed over the internet via cloud platforms
Architecture	Single-node system	Multi-node, often geographically dispersed	Can be centralized or distributed—but hosted in the cloud
Data Access	All users connect to one central system	Users access local or remote nodes; system appears unified	Accessed via APIs or internet; location abstracted from user
Scalability	Limited	High	Very high
Performance	Fast for local users; slows with high load or remote access	Optimized for local access; latency depends on network	Depends on cloud provider; global CDNs and edge locations reduce latency
Security	Easier to secure (one location)	Harder (data in transit, multiple entry points)	Shared responsibility (provider secures infrastructure; user secures data/access)
Examples	Legacy ERP on a company server, local school database	Google Spanner, Apache Cassandra (multi-region), airline reservation systems	Amazon RDS, Google Cloud Fire store, Azure Cosmos DB, MongoDB Atlas
Best Use Cases	Small businesses, departmental systems, local applications	Global enterprises needing local data access and high availability (e.g., banking, telecom)	Startups, SaaS apps, scalable web services, remote teams

5) Cloud Storage and Databases:

Concept	**Explanation**
What is Cloud Storage	A service that stores data online, accessible via the internet (e.g., Google Drive, Amazon S3).
How it supports databases?	Cloud storage provides the infrastructure for hosting cloud databases, ensuring scalability, availability, and remote access.
Advantages	• **Rapid Deployment:** Launch a production-ready database in minutes—no hardware setup or software installation. • **Elastic Scalability:** Easily scale compute and storage up or down based on demand (e.g., handle Black Friday traffic spikes). • **Automated Management:** patching, backups, monitoring, and updates**.** • **Integrated Security:** Built-in features like encryption at rest/in transit.
Disadvantages	• **Ongoing Costs:** Can become expensive over time—especially with egress fees, premium features, or idle resources. • **Limited Control:** Less access to OS, file system, or low-level tuning (in fully managed services like RDS). • **Network Dependency:** Performance and availability depend on internet connectivity and cloud provider uptime. • **Latency for Global Apps:** Even with replication, cross-region queries may introduce latency unless using globally distributed databases (e.g., Spanner).