

① Information Retrieval: Information Retrieval is a science and technology that is used for searching relevant information within large collections of data especially unstructured text. The goal of IR is to help users find documents, images, videos or other content that matches their queries.

How it works: When we type keywords in a search engine like Google or Bing, the system looks through billions of documents and ranks them by relevance using algorithms. It uses techniques like keyword matching, natural language processing and machine learning to improve results.

Example: Imagine a library with millions of books but no catalog. IR system acts like a digital catalog and search engine. If we search for "climate change impact on agriculture" the IR system finds research papers, news articles, and reports related to that topic.

② Cloud Database: A cloud database is a database service provided and managed through cloud computing platforms. Unlike traditional databases run on remote servers maintained by cloud providers. This setup allows easy scalability, remote access and reduces the need of physical hardware.

Benefits: We do not need to buy expensive servers or worry about maintenance. We can scale storage or computing power up and down depending on needs. Accessible from anywhere with internet access.

Example: Amazon's Amazon RDS or Google's Cloud SQL are cloud databases. A company running an online store may use a cloud database to store customer data and orders. When sales increase during holidays, the database can automatically expand.

to handle more traffic without downtime.

③ Graph Database: A graph database stores data as nodes (entities) and edges (relationships). It is designed to handle highly connected data and complex relationships efficiently. Unlike traditional ^{relational} databases that use tables, graph databases excel at exploring connections.

Use Cases: (i) Social Networks (Facebook, LinkedIn) \Rightarrow Users and their friendships or professional connections.

(ii) Recommendation systems (Netflix, Amazon) \Rightarrow Item related by user preferences or purchases.

(iii) Fraud Detection \Rightarrow Finding suspicious patterns by analyzing connections between transactions or accounts.

Example: In a social media app, a graph database can quickly find "friends of friends" or suggest people you might know based on mutual connections which would be more complex and slower ~~than~~ ^{in a} traditional database.

④ Distributed Database: A Distributed Database is a single logical database that is physically spread across multiple locations or servers, possibly across different cities or countries. These locations work together to provide data access as if it were a single database.

Advantages:

(i) Increased reliability: If one site fails, others can continue working.

(ii) Faster access: Users get data from the nearest server, reducing delay.

(iii) Scalability: We can add more servers as data grows.

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Example: A global e-commerce company like Amazon uses distributed databases to store user data. Customers in US and Europe access their local servers which sync with other services servers worldwide. This avoids delays and prevents data loss if one server fails.

5) Bioinformatics: Bioinformatics is an interdisciplinary field combining biology, computer science and statistics to analyze and interpret biological data. The rapid growth of biological data such as DNA sequences, protein structures and gene expressions requires computational tools to understand them.

Applications:

Genome sequencing: Decoding DNA to study genes and hereditary diseases.

Drug discovery: Identifying molecules that can become medicines.

Evolutionary studies: Comparing genetic information across species.

Example: The Human Genome Project used bioinformatics to sequence the entire human DNA, producing vast amounts of data that needed software tools to analyze genes linked to diseases like cancer or diabetes.