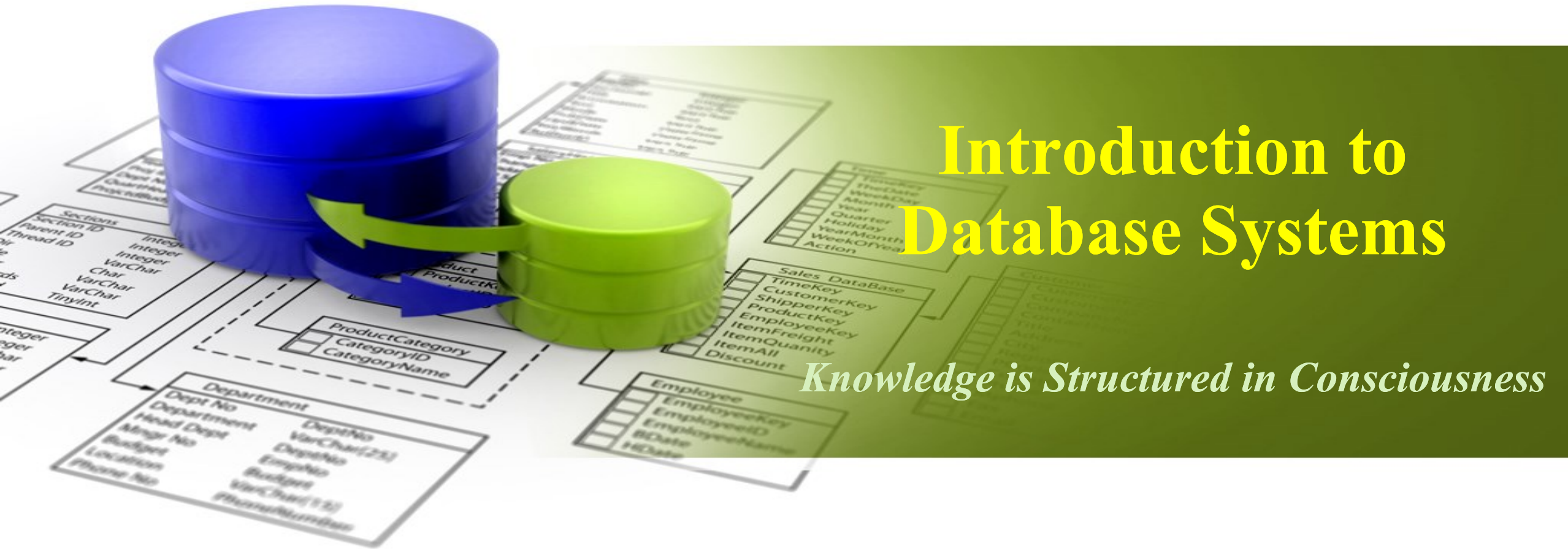


## Lesson 1 - Chapter 1





# WHOLENESS OF THE LESSON

File-based systems, the precursor to the database systems, had a lot of limitations and problems. With the advent of DBMS, it fundamentally changed the way organizations used to operate. The simplicity and advantages offered by the database approach quickly made it the de-facto standard for running businesses. **Science & Technology of Consciousness:** TM is a simple, effortless mental technique that can be used by anyone to promote spontaneous fulfillment of their desires, by bringing the desires of the individual into accord with Natural Law, without the individual having to know the underlying mechanism.



# Introduction

- While barely 60 years old, database research has had a profound impact on the economy and society, creating an industry sector valued at between US\$35-US\$50 billion annually.
- Database systems, a crucial development in software engineering, serve as the foundation of information systems, fundamentally altering organizational operations.
- In this course, we'll explore a range of issues associated with the implementation and applications of database systems. We'll also focus on how to design a database and present a methodology that should help you design both simple and complex databases.



# Basic Terminologies

## ➤ Data

- For end users, the word “data” constitutes all the different values connected with the various objects/entities that are of concern to them.

## ➤ Database

- *Structured* set of data held in a computer or server.
- A *shared* collection of *logically related* data (and a description of this data), designed to meet the information needs of an organization.
  - Logically related data comprises entities, attributes, and relationships of an organization’s information.



# Basic Terminologies

## ➤ Database Management System (DBMS)

- A software system that enables users to define, create, and maintain the database and provides controlled access to this database.

## ➤ Database Application

- A computer program that interacts with the database at some point in its execution by issuing an appropriate request (typically a SQL statement) to the DBMS.



# Examples of Database Applications

- Purchases from the supermarket
- Purchases using your credit card
- Booking a holiday with travel agent
- Using the local library
- Taking out insurance
- Renting a video
- Using the Internet
- Studying at University



# Manual Filing System

- Many files stored in cabinet
- Lock for security
- Use of indexing system
  - Use folders to organize
  - Labeled folders
  - Search using the labels





# Manual Filing System contd..

- Works well if
  - Number of items to be stored is small
  - We only have to store and retrieve them
- Does not work well if
  - we have to cross-reference or process the information in the files.







# Manual Filing System contd..

- For example, a typical real estate agent's office might have a separate file for each property for sale or rent, each potential buyer and renter, and each member of staff.
- Consider the effort that would be required to answer the following questions:
  - What 3-bedroom properties do you have for sale with an acre of land and a garage?
  - What apartments do you have for rent within three miles of downtown?
  - What is the average rent for a two-bedroom apartment?
  - How does last month's net income compare with the projected figure for this month?
  - What is the expected monthly net income for the next financial year?



# File-based System

Flat\_File - Notepad

File Edit Format Help

This is a sample Data File.

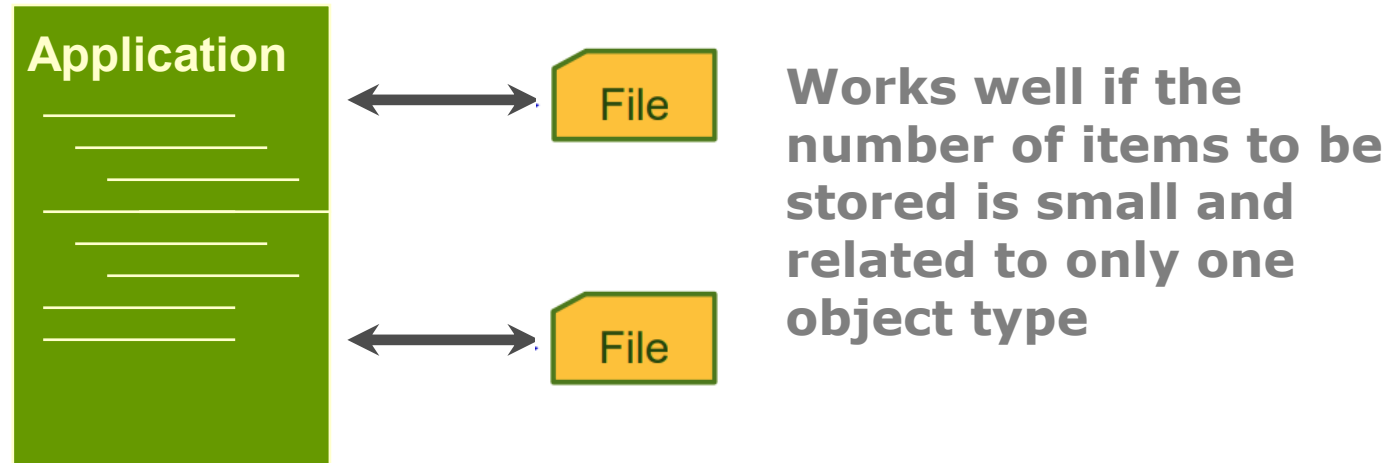
CustomerID	CompanyName	ContactName	ContactTitle
ALFKI	Alfreds Futterkiste	Maria Anders	Sales Representative
ANATR	Ana Trujillo Emparedados y helados	Ana Trujillo	Owner
ANTON	Antonio Moreno Taqueria	Antonio Moreno	Owner
AROUT	Around the Horn	Thomas Hardy	Sales Representative
BERGS	Berglunds snabbköp	Christina Berglund	Order Administrator
BLAUS	Blauer See Delikatessen	Hanna Moos	Sales Representative
BLONP	Blondesddsl père et fils	Frédérique Citeaux	Marketing Manager
BOLID	Bólido Comidas preparadas	Martin Sommer	Owner
BONAP	Bon app'	Laurence Lebihan	Owner
BOTTM	Bottom-Dollar Markets	Elizabeth Lincoln	Accounting Manager
BSBEV	B's Beverages	Victoria Ashworth	Sales Representative
CACTU	Cactus Comidas para llevar	Patricio Simpson	Sales Agent
CENTC	Centro comercial Moctezuma	Francisco Chang	Marketing Manager
CHOPS	Chop-suey Chinese	Yang wang	Owner
COMMI	Comércio Mineiro	Pedro Afonso	Sales Associate
CONSH	Consolidated Holdings	Elizabeth Brown	Sales Representative
DRACD	Drachenblut Delikatessen	Sven Ottlieb	Order Administrator
DUMON	Du monde entier	Janine Labrune	Owner
EASTC	Eastern Connection	Ann Devon	Sales Agent
ERNSH	Ernst Handel	Roland Mendel	Sales Manager
FAMIA	Familia Arguinaldo	Aria Cruz	Marketing Assistant
FISSA	FISSA Fabrica Inter. Salchichas S.A.	Diego Roel	Accounting Manager

- The file-based system was developed in response to the needs of industry for more efficient data access.
- A file is simply a collection of records (set of fields) which contains logically related data.



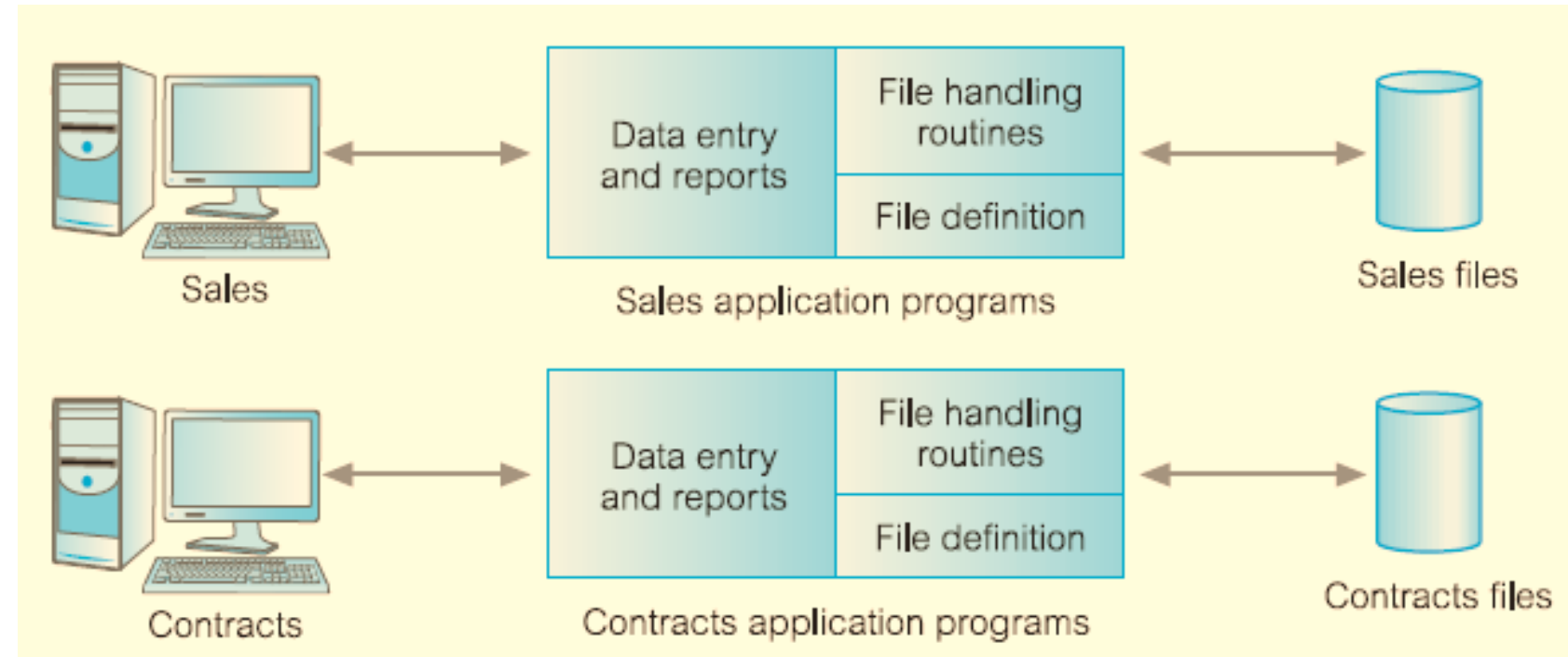
## File-based System contd..

- A collection of application programs that perform services for the end-users such as the production of reports.
- Each program defines and manages its own data.





# File-based Processing



## Sales Files

**PropertyForRent** (propertyNo, street, city, postcode, type, rooms, rent, ownerNo)

**PrivateOwner** (ownerNo, fName, lName, address, telNo)

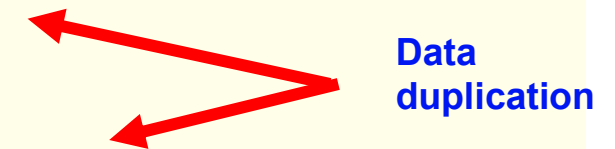
**Client** (clientNo, fName, lName, address, telNo, prefType, maxRent)

## Contracts Files

**Lease** (leaseNo, propertyNo, clientNo, rent, paymentMethod, deposit, paid, rentStart, rentFinish, duration)

**PropertyForRent** (propertyNo, street, city, postcode, rent)

**Client** (clientNo, fName, lName, address, telNo)





# Limitations of File-based System

## 1. Separation and Isolation of data

- Each program maintains its own set of data.
- Users of one program may be unaware of potentially useful data held by other programs.
- If we need information which is based on data from 2 separate files then it's difficult to synchronize the processing.

## 2. Duplication of data

- Same data is held by different programs.
- Wasted space and potentially different values and/or different formats for the same item.
- Possibility of data inconsistency



# Limitations of File-based System contd..

## 3. Data dependence (program-data dependence)

- File structure is defined in the program code and so it's difficult to make changes to the existing structure.

## 4. Incompatible file formats

- Programs are written in different languages, and so cannot easily access each other's files.
  - The structure of a file generated by a COBOL program will be different from the structure of a file generated by a C program.

## 5. Fixed Queries/Proliferation of application programs

- Programs are written to satisfy particular functions. Any new requirement needs a new program.



## **Limitations of File-based System** contd..

- 6. No provision for security or integrity**
- 7. Recovery, in the event of a h/w or s/w failure was limited or non-existent.**
- 8. Access to the files was restricted to one user at a time - there was no provision for shared access by staff in the same department.**





# Database Approach

- **The limitations of file-based systems are attributed to two factors:**
  - The definition of data is embedded in the application programs, rather than being stored or defined separately and independently.
  - No control over access and manipulation of data beyond that imposed by application programs.
- **New approach emerged**
  - Database and Database Management System (DBMS)
  - Database approach separates the structure of the data from the application programs and stores it in the database.





# Database Definition



- The definition of a **database** :
  - A shared collection of logically related data and its description designed to meet the information needs of an organization.
- The database is a single, possibly large repository of data that can be used simultaneously by many departments and users.
- Instead of disconnected files with redundant data, all data items are integrated with a minimum amount of duplication.



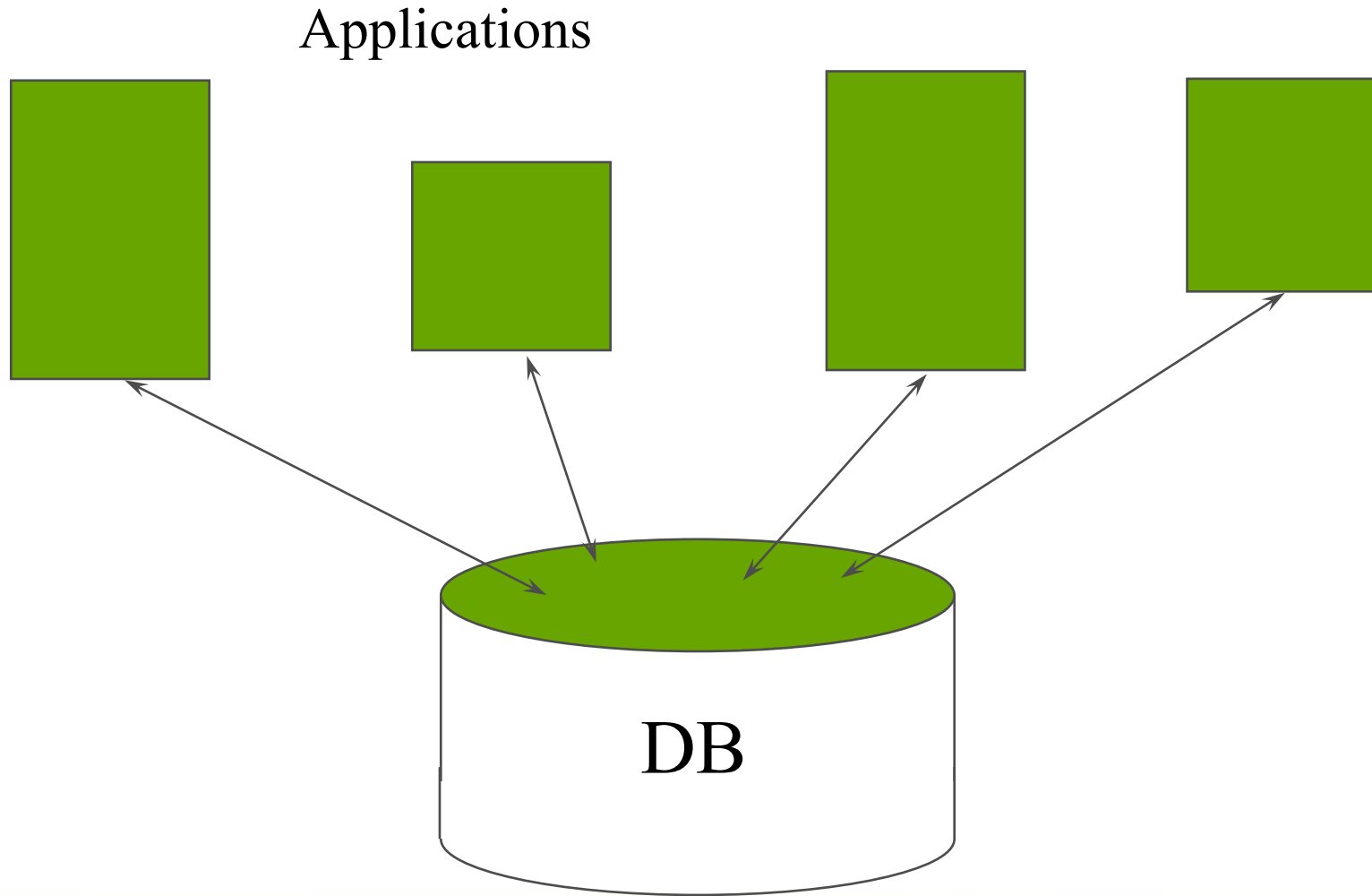
## Database Definition contd..

*A shared collection of logically related data and it's description designed to meet the information needs of an organization.*

- **Shared collection** means that the database:
  - should not be seen as owned by one person or one department
  - holds not only the organization's operational data but also a description of this data (system catalog/data dictionary/metadata) and this self-describing nature of a database provides program-data independence.
- **Logically related** means that :
  - not only the entities and their attributes but also the logical relationships between entities are represented in the database.



# Database Approach



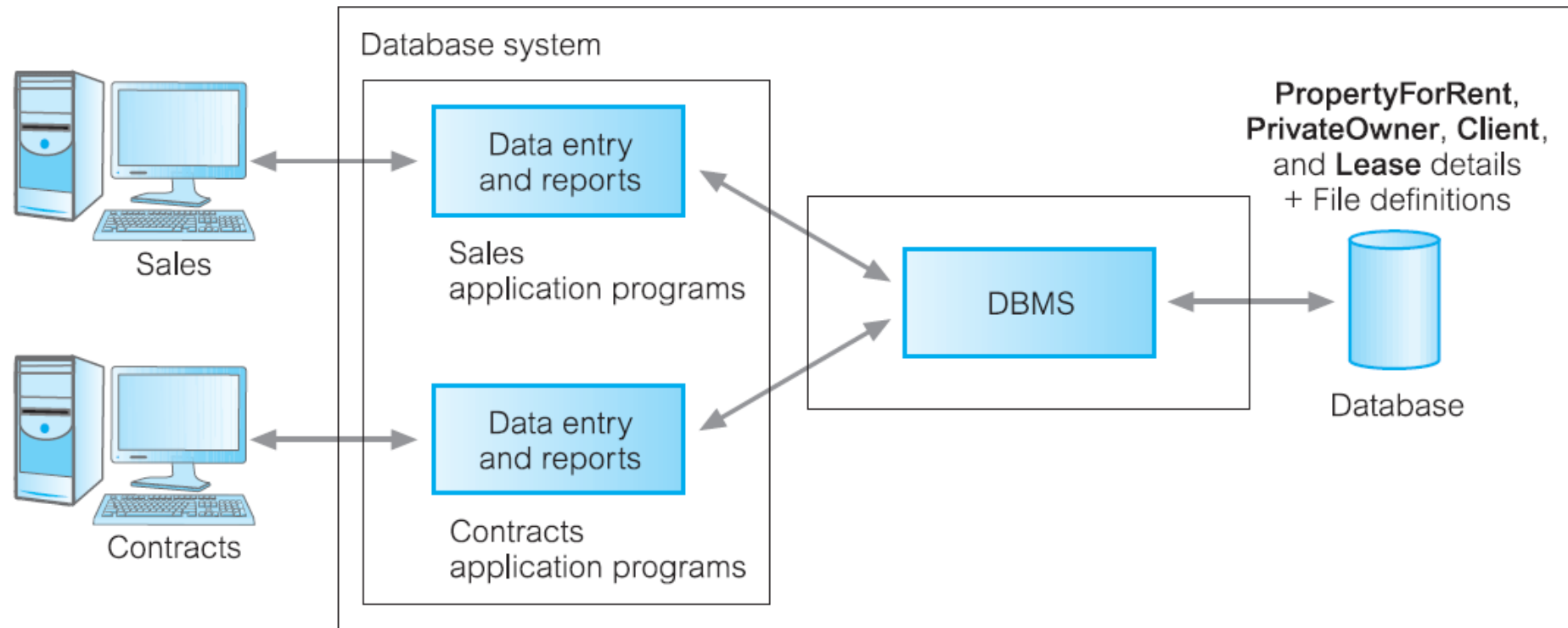


# DBMS and DS

- **DBMS** (DataBase Management System) is a ***Software System*** that enables users to define, create, maintain and control access to the database.
- DBMS is a software that interacts with the users' application programs and the database.
- **Database system** is a collection of application programs that interact with the database along with the DBMS and the database itself!



# DBMS and DS



**PropertyForRent** (propertyNo, street, city, postcode, type, rooms, rent, ownerNo)

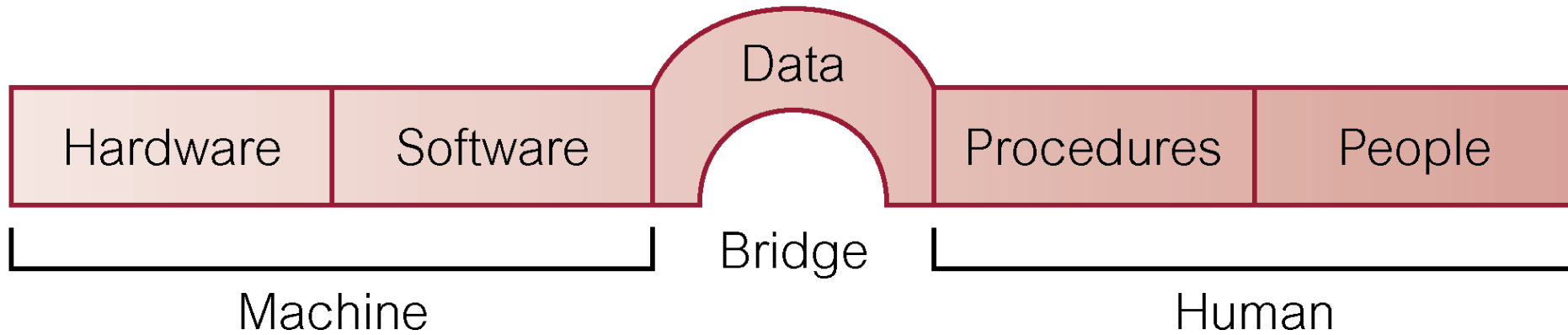
**PrivateOwner** (ownerNo, fName, lName, address, telNo)

**Client** (clientNo, fName, lName, address, telNo, prefType, maxRent)

**Lease** (leaseNo, propertyNo, clientNo, paymentMethod, deposit, paid, rentStart, rentFinish)



# Components of DBMS Environment





# Components of DBMS Environment (contd..)

## ➤ **Hardware**

The computer system(s) that the DBMS and the application programs run on. This can range from a single PC, to a single mainframe, to a network of computers.

## ➤ **Software**

The DBMS software and the application programs, together with the OS, including network software if the DBMS is being used over a network.

## ➤ **Data**

The data acts as a bridge between the machine components and the human components. The database contains both the operational data and the meta-data (the 'data about data').



# Components of DBMS Environment (contd..)

## ➤ Procedures

The instructions and rules that govern the design and use of the database. This may include instructions on how to log on to the DBMS, make backup copies of the database, and how to handle h/w or s/w failures.

## ➤ People

This includes the database designers, database administrators (DBAs), application programmers and the end-users.





# Roles in the Database Environment

- Data Administrator
- Database Administrator
- Database Designers
- Application Developers
- End Users



# Roles in the Database Environment contd..

## Data Administrator (DA)

- Also called Data Analyst
- Owns the data
- Management of the data resource
  - Analyzes data flow throughout the organization
  - Converts the relevant information into a data model
  - Sets policies and standards
- Advisor of senior management concerning information plan and ensuring that the direction of database development will ultimately support corporate objectives.



# Roles in the Database Environment contd..

## Database Administrator (DBA)

- Owns the database
  - Responsible for the physical realization of the database including physical DB design & implementation, security & integrity control, maintenance & ensuring satisfactory performance of the applications for users.
- More technical
- DBAs are normally proficient with one or more popular DB s/w packages, such as Oracle or MS SQL Server, and are normally familiar with one or more DB query languages, such as SQL, OQL, Xquery etc.



# Roles in the Database Environment contd..

## Database Designers

### ● Logical Database Designers

- concerned with identifying the data (entities, attributes) and relationship between the data
- need a complete understanding of the organization's data, the business rules (constraints on the data) and the company strategic plan

### ● Physical Database Designers

- decides how the logical DB design is to be physically realized.
- mapping logical model into a set of tables and integrity constraints
- select storage structures and access methods
- designing any security measures on the data



# Roles in the Database Environment contd..

## Application Developers

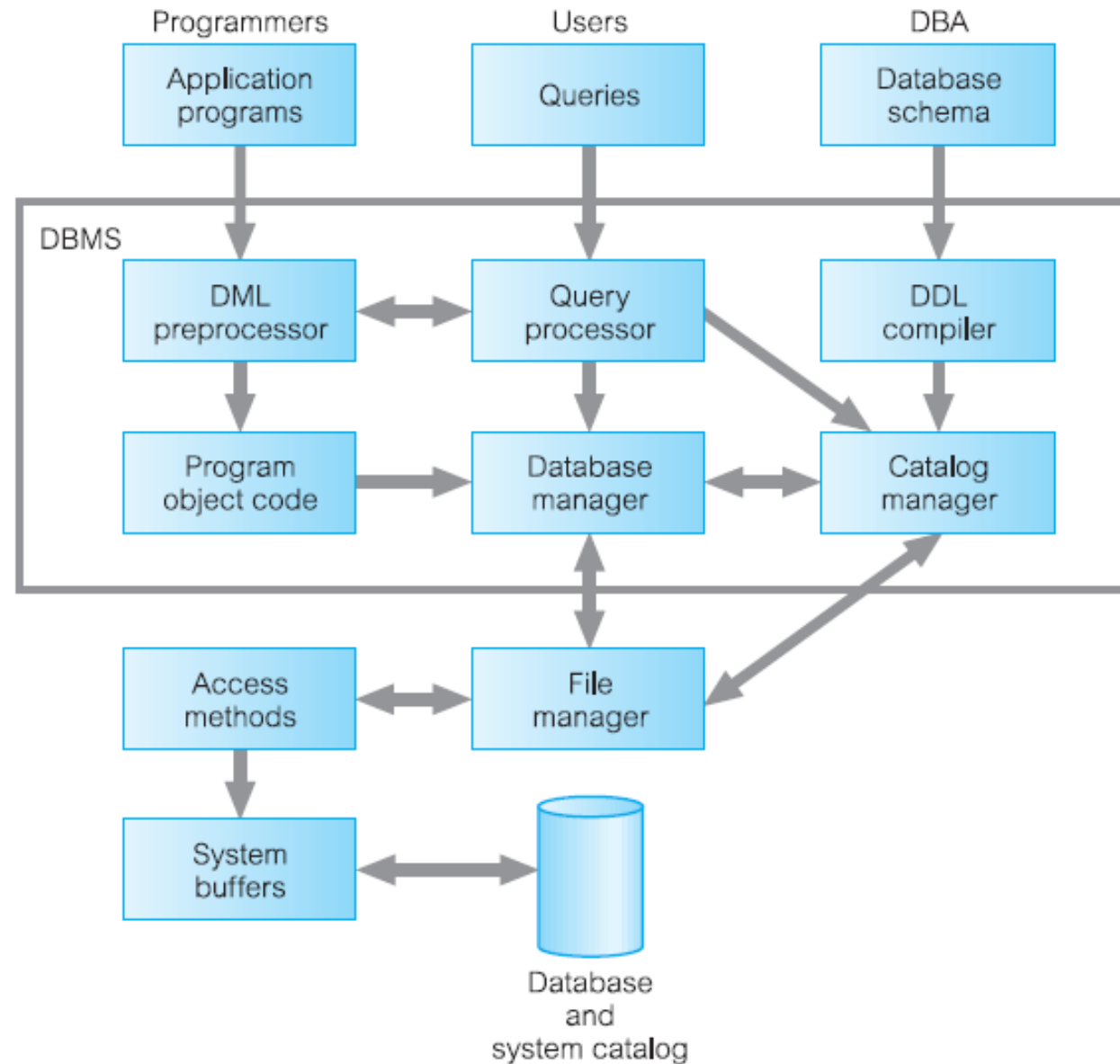
- Write programs which request DBMS to perform some operation on the database (retrieving data, inserting, updating and deleting data)

## End-Users

- Clients of database
- **Naïve users** – e.g. checkout assistant at a supermarket
- **Sophisticated users** – may use SQL to perform some operation. Might even write application programs for their own use.



# Major Components of a DBMS





# Database Schema

- It is important to distinguish between the description of the database and the database itself.
- The overall description of the database is called as database **schema** also called as the **structure of the database**.
- The schema is specified during the database design process and is not expected to change frequently. However, the actual data in the database may change frequently.



# Relation Schema

## STUDENT

Name	Student_number	Class	Major
------	----------------	-------	-------

## COURSE

Course_name	Course_number	Credit_hours	Department
-------------	---------------	--------------	------------

## PREREQUISITE

Course_number	Prerequisite_number
---------------	---------------------

## SECTION

Section_identifier	Course_number	Semester	Year	Instructor
--------------------	---------------	----------	------	------------

## GRADE\_REPORT

Student_number	Section_identifier	Grade
----------------	--------------------	-------





# Example of a Database State (database instance)

## COURSE

Course_name	Course_number	Credit_hours	Department
Intro to Computer Science	CS1310	4	CS
Data Structures	CS3320	4	CS
Discrete Mathematics	MATH2410	3	MATH
Database	CS3380	3	CS

## SECTION

Section_identifier	Course_number	Semester	Year	Instructor
85	MATH2410	Fall	04	King
92	CS1310	Fall	04	Anderson
102	CS3320	Spring	05	Knuth
112	MATH2410	Fall	05	Chang
119	CS1310	Fall	05	Anderson
135	CS3380	Fall	05	Stone

## GRADE\_REPORT

Student_number	Section_identifier	Grade
17	112	B
17	119	C
8	85	A
8	92	A
8	102	B
8	135	A

## PREREQUISITE

Course_number	Prerequisite_number
CS3380	CS3320
CS3380	MATH2410
CS3320	CS1310

The schema is sometimes called the **intension** of the database; and an instance is called an **extension** of the database.



# System Catalog

- **Repository of information (metadata) describing the data in the database.**
- One of the fundamental components of DBMS
- The DBMS normally consults the system catalog before the actual data is accessed in the database
- Typically stores:
  - names, types, and sizes of data items
  - constraints on the data
  - names of authorized users
  - data items accessible by a user and the type of access
  - usage statistics



# Example of a Simplified System Catalog

## RELATIONS

Relation_name	No_of_columns
STUDENT	4
COURSE	4
SECTION	5
GRADE_REPORT	3
PREREQUISITE	2

## COLUMNS

Column_name	Data_type	Belongs_to_relation
Name	Character (30)	STUDENT
Student_number	Character (4)	STUDENT
Class	Integer (1)	STUDENT
Major	Major_type	STUDENT
Course_name	Character (10)	COURSE
Course_number	XXXXNNNN	COURSE
....	....	.....
....	....	.....
....	....	.....
Prerequisite_number	XXXXNNNN	PREREQUISITE



# Benefits of System Catalog

- Information about data can be collected and stored centrally. This helps to maintain control over the data as a resource.
- The meaning of data can be defined, which will help other users understand the purpose of the data.
- Simplifies communication by storing exact meanings; identifies data owners and users.
- Redundancy and inconsistencies can be identified more easily as the data is centralized.
- Records changes to the database.
- The impact of a change can be determined before it is implemented because the system catalog records each data item, all its relationships, and all its users.
- Security can be enforced.
- Integrity can be ensured.
- Audit information can be provided.



# DBMS Facilities

DBMS provides a **Data Definition Language** to specify the database schema (define the DB) and a **Data Manipulation Language** to express database queries and updates.

- **Data Definition Language (DDL)**
  - Permits specification of data types, structures and any data constraints.
  - All specifications are stored in the database.
- **Data Manipulation Language (DML)**
  - General enquiry facility (query language) of the data.
  - *insert, update, delete* and *retrieve* data from the database.
  - Query Language
    - SQL



## DBMS Facilities contd..

- SQL provides controlled access to the database. For example, it may provide:
  - a **security system**, which prevents unauthorized users accessing the DB;
  - an **integrity system**, which maintains the consistency of stored data;
  - a **concurrency control system**, which allows shared access of the DB;
  - a **recovery control system**, which restores the DB to a previous consistent state following a hardware or software failure;
  - a **user-accessible catalog**, which contains descriptions of the data in the DB.



# DBMS Facilities - Views

## A View mechanism:

- Provides users with only the data they want or need to use.
- Allows each user to have his or her own view of the database.
- A View is essentially some subset of the database.



# Benefits of Views

- **Reduced complexity** by letting users see the data in the way they want to see it;
- **Provide a level of security** : Views can be set up to exclude data that some users should not see.
  - For example, we could create a View that allows a branch manager and the Payroll department to see all staff data, including salary details, and we could create a second View that other staff would use that excludes salary details.





## Benefits of Views contd..

- **Provide a mechanism to customize the appearance of the DB.**
  - E.g., the Contracts department may wish to call the monthly rent field (rent) by the more obvious name, Monthly Rent.
- **Present a consistent, unchanging picture of the structure of the DB,** even if the underlying DB is changed.
  - E.g., if fields are added or removed from a file, and these fields are not required by the View, the View is not affected by this change. Thus, a View also helps to provide the program–data independence.



## Main Point

DBMS provides controlled access to the database. It provides security, integrity, concurrency and recovery control and a user-accessible catalog. It also provides a view mechanism to simplify the data that users have to deal with. **Science & Technology of Consciousness: Vedic Science** has discovered that the simplest form of awareness is the basis for all of the creation.



# Functions of a DBMS

- Data Storage, Retrieval, and Update
- A User-Accessible Catalog
- Transaction Support
  - OLTP (Online Transaction Processing) is a major part of database applications. This allows hundreds of concurrent transactions to execute per second.
- Concurrency Control Services
- Recovery Services
- Authorization Services
- Support for Data Communication (How user accesses the DB over a n/w from a remote location)
- Integrity Services (correctness and consistency of stored data)
- Services to Promote Data Independence
- Utility Services such as importing excel data to a table, etc.



# Advantages of Database Systems

- Control of data redundancy
- Data consistency
- More information from same amount of data
- Sharing of data
- Improved data integrity
- Improved security
- Enforcement of standards
- Economy of scale
- Balance of conflicting requirements
- Improved data accessibility and responsiveness
- Increased productivity
- Improved maintenance through data independence
- Increased concurrency
- Improved backup and recovery services



# Disadvantages of Database Systems

- Complexity
- Size
- Cost of DBMS
- Additional hardware costs
- Cost of conversion
- Performance
- Higher impact of a failure



# Main Point

Some advantages of database approach include control of data redundancy, data consistency, sharing of data and improved security and integrity. Some disadvantages include complexity, cost, reduced performance and higher impact of a failure. **Science & Technology of Consciousness:** Scientific research studies show that during the practice of the TM technique, the body gains a unique state of deep rest that dissolves accumulated stress and fatigue. At the same time, brain functioning becomes more orderly. As a result, the body becomes healthier and more integrated, leading to greater success in dynamic activity.



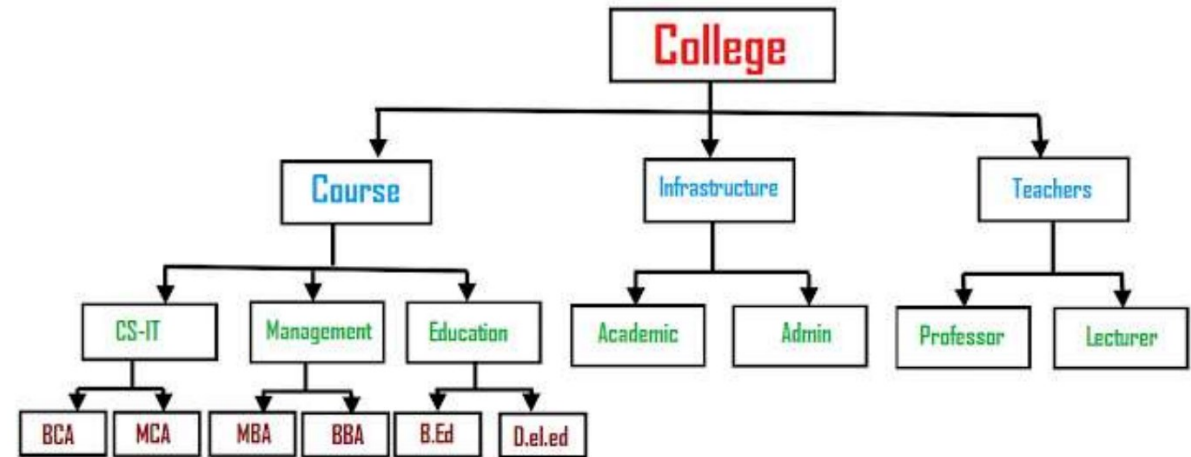
# Database Types

- Hierarchical database
- Network databases
- Relational database
- Object-oriented database
- NoSQL database



# Hierarchical Database

- Data is organized in a tree-like structure
- Records that are connected through links
  - Used in mainframe computers
- Each entity has only one parent but can have several children.
- At the top of hierarchy there's only one entity called as Root.

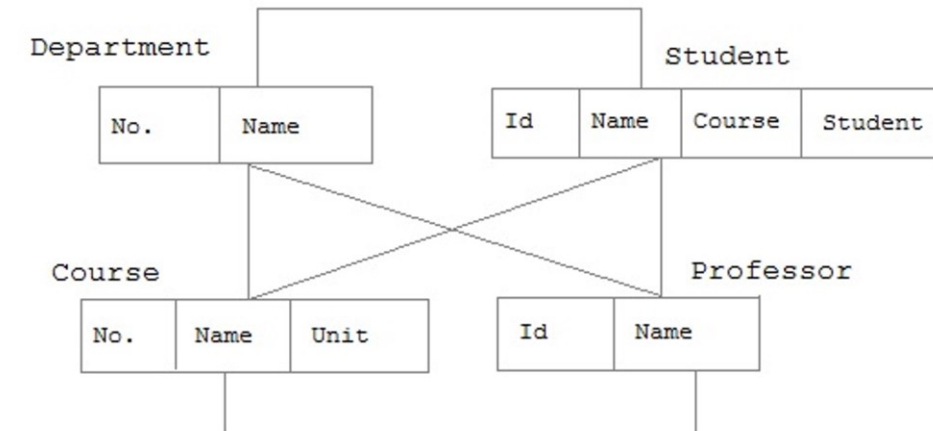






# Network Database

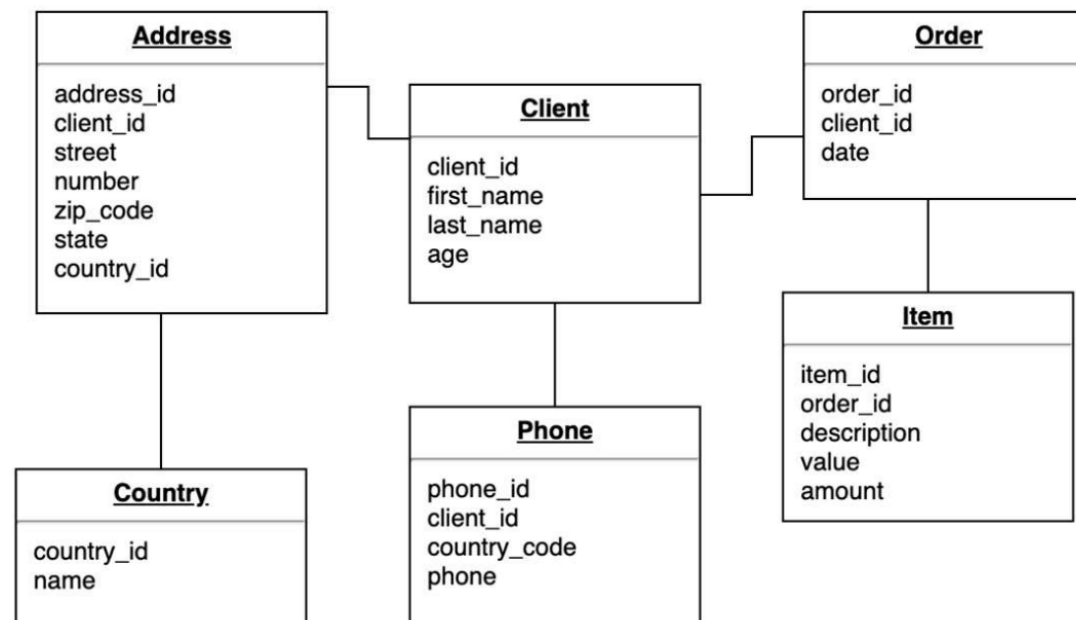
- Like hierarchical but allows each child to have multiple parents.
- Entities are organized in a graph, in which some entities can be accessed through several path.
- Can address the need to model more complex relationships like orders/parts many-to-many relationship.





# Relational Database

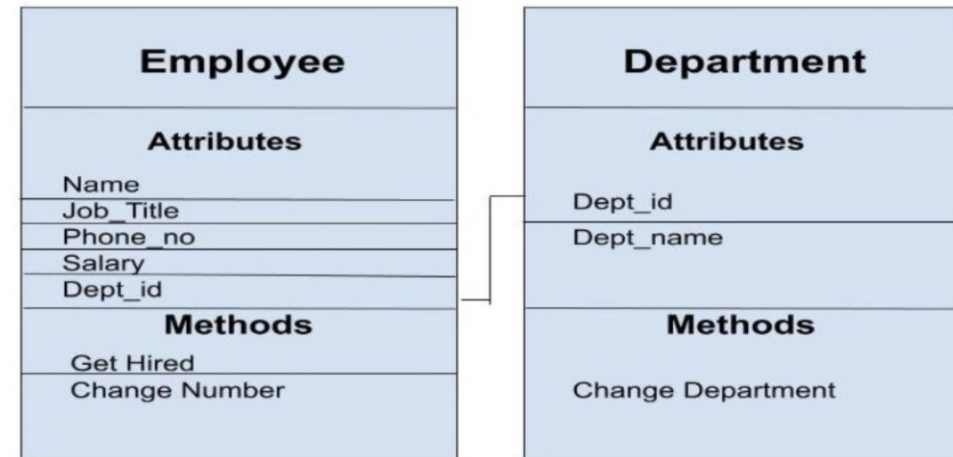
- Organizes data in two-dimensional tables called relations and their attributes.  
The tables or relations are related to each other.
- Fixed schema
- Most used database model





# Object-oriented Database

- Stores application objects into the database - both the data and relationship are present in a single structure known as an object.
- Supports inheritance, composition
- Two or more objects are connected through links.  
We use this link to relate one object to other objects.





# NoSQL Database

- Uses a non-relational model for data storage
- Optimized for
  - Scalability
  - Speed
  - Large amounts of data
- No fixed schema

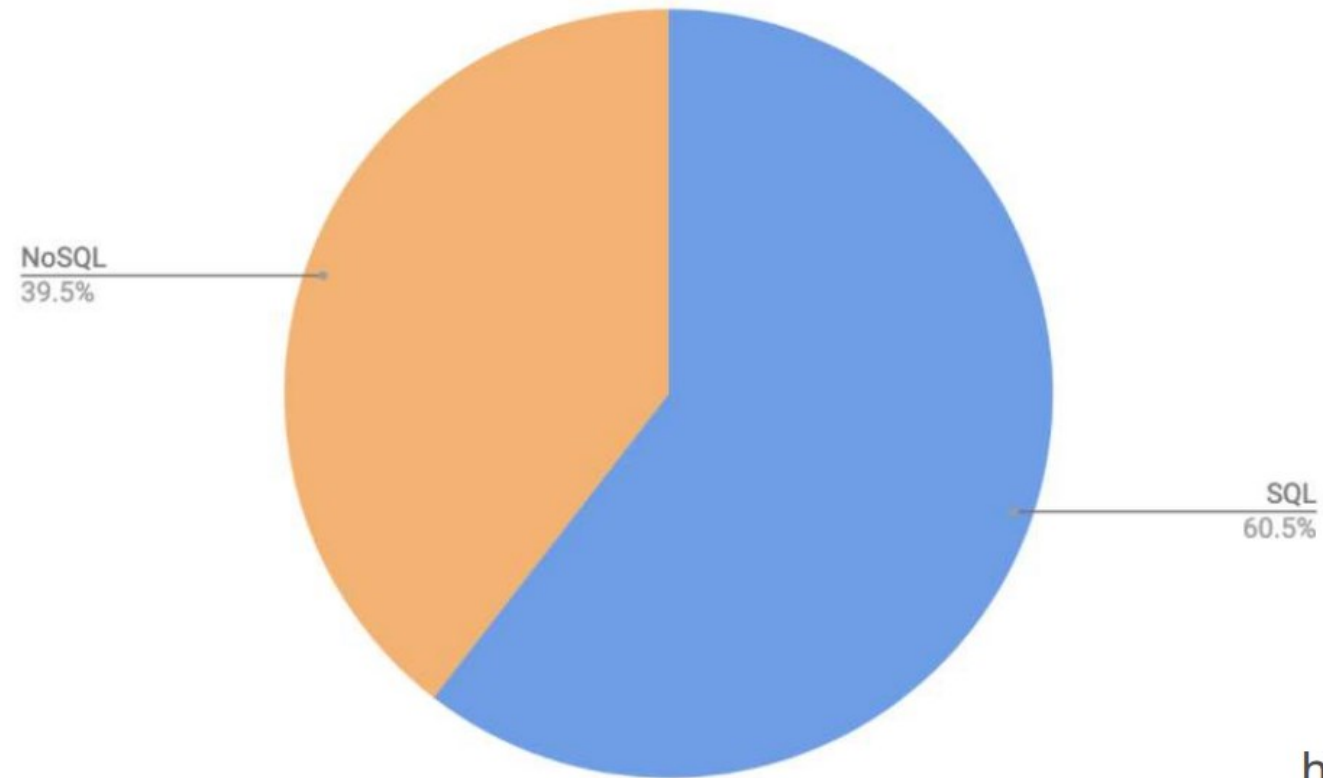




# Relational vs. No-SQL usage

SQL Database Use: 60.48%

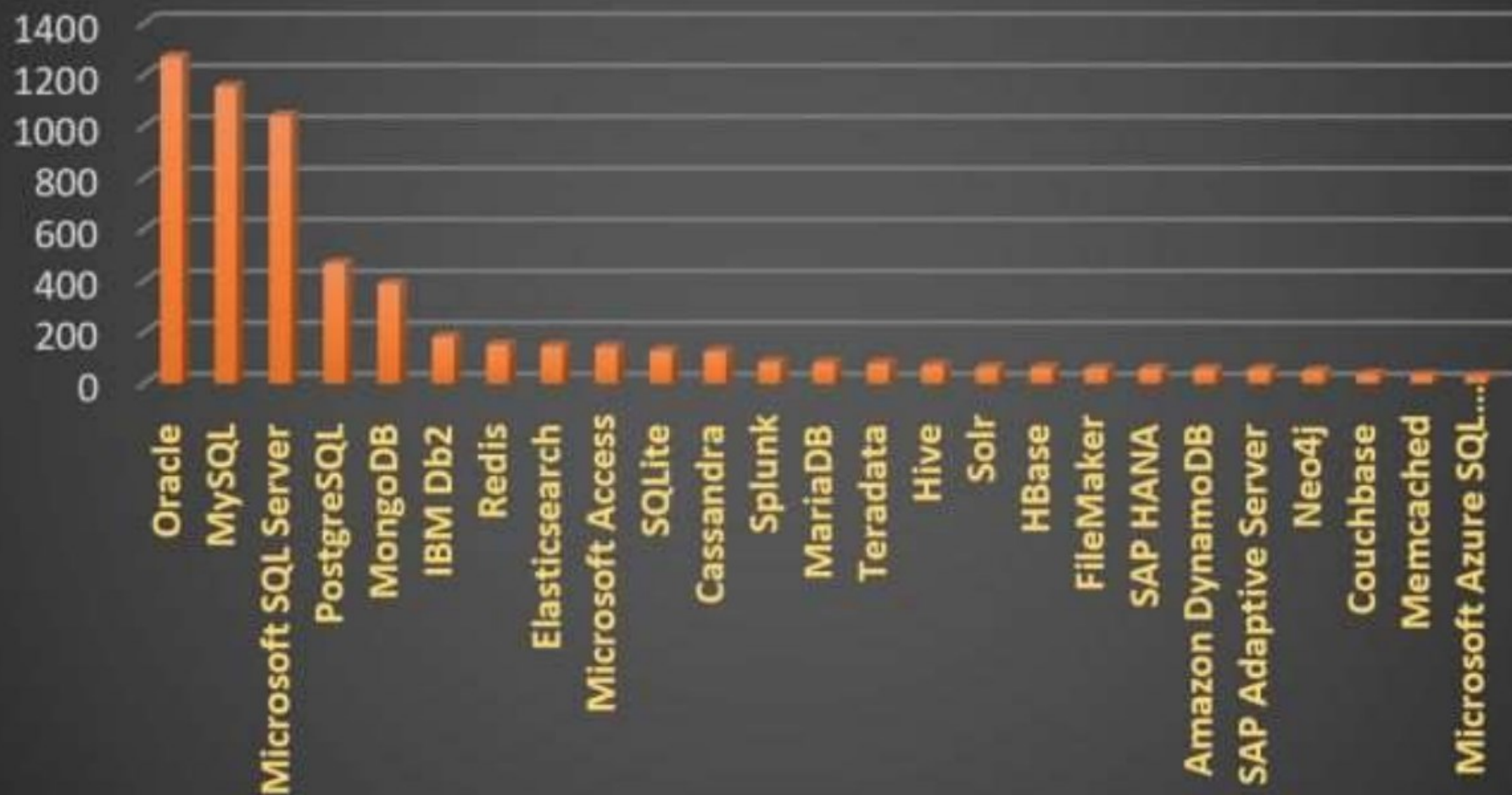
NoSQL Database Use: 39.52%



highscalability.com - 2019



# World's Most Popular Databases

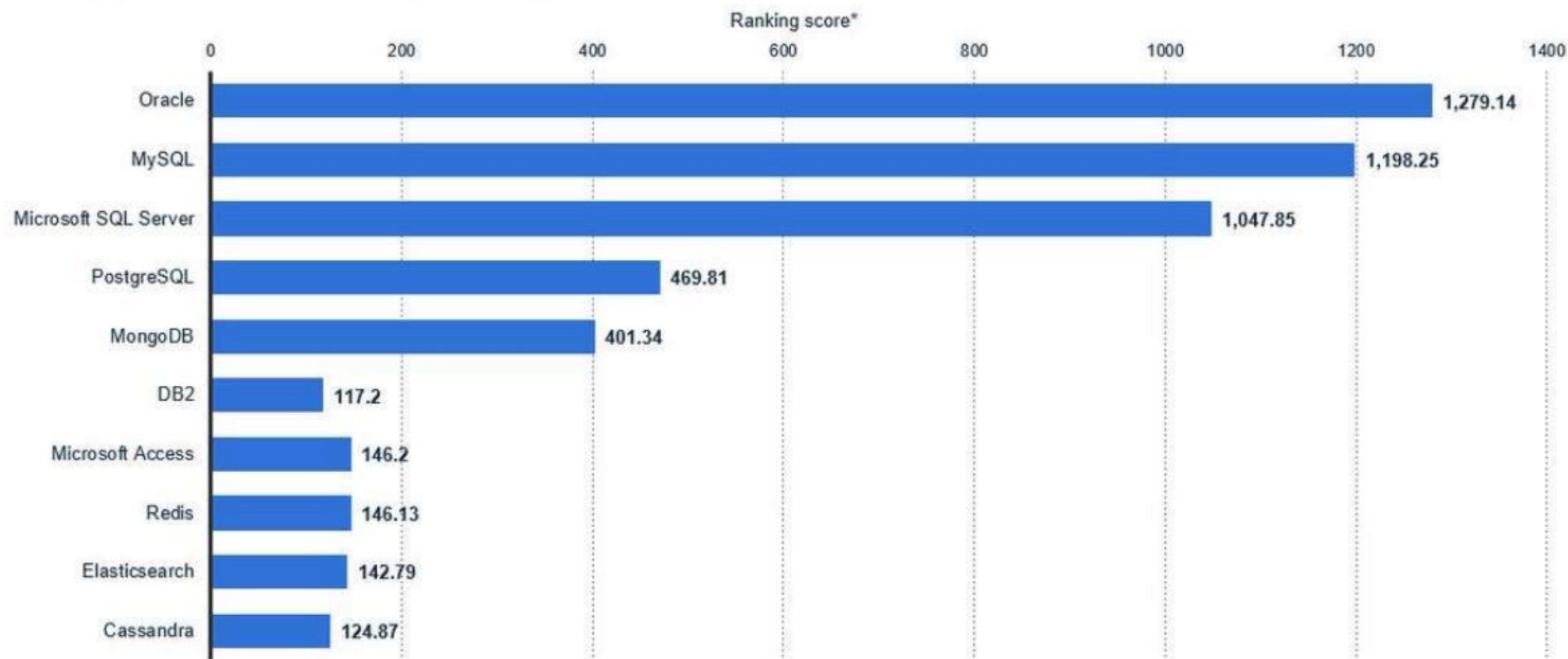






## Ranking of the most popular Database Management Systems Worldwide March 2019

Most popular database management systems worldwide 2019



Note: Worldwide; March 2019.  
Source(s): DB-Engines



# Concluding Remarks

- Database technology has been an exciting area to work in and, since its emergence, it has been the catalyst for many important developments in software engineering.
- Database research is not over and there are still many problems that need to be addressed.
- Moreover, as the applications of database systems become even more complex, we will have to rethink many of the algorithms currently being used, such as the algorithms for file storage, file access, and query optimization.
- These original algorithms have made significant contributions in software engineering, and, without doubt, the development of new algorithms will have similar effects.



## UNITY CHART

### CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE:

#### Database Approach As A Successor To File-Based Systems

1. A database is a computerized record keeping system.
  2. A database contains both data and a description of the structure of the data (metadata).
- 

3. Transcendental consciousness contains the unmanifest structure of all creation.
4. Impulses within the Transcendental Field: These infinitely subtle impulses are responsible for the different states of consciousness that a human being is able to experience.
5. Wholeness moving within itself: In unity consciousness the structure of experience is dominated by Wholeness, which is simply the pure field of consciousness, our own Self.

