



Committee on Information Technology
The Institute of Chartered Accountants of India
(Set up by an Act of Parliament)

ISA COURSE 2.0
DVD
Ver. 1.0

Data Base Management Systems

Introduction to Information System Components

Chapter 1 Part 3 of 4
CA M S Mehta, FCA



Do you see anything common



Well, they all use Data Base Management Systems



Data Base Management Systems

Learning Objectives

Task Statements

- 1.1 Identify deployment of different components of IT and their functions: ... **Database management system**....

Knowledge Statements

- 1.2 Knowledge of Fundamental concepts of different components of IT and their functions: ...**Database management system**...



Data Base Management Systems

Topics Covered



DBMS Models

Database Languages/SQL

Roles and Duties of DBA

Database Controls

User Creation and Access Rights in DBMS

Auditing DBMS



What is DBMS?



Introduction

Every Organisation should

Know what information it needs

Acquire that information

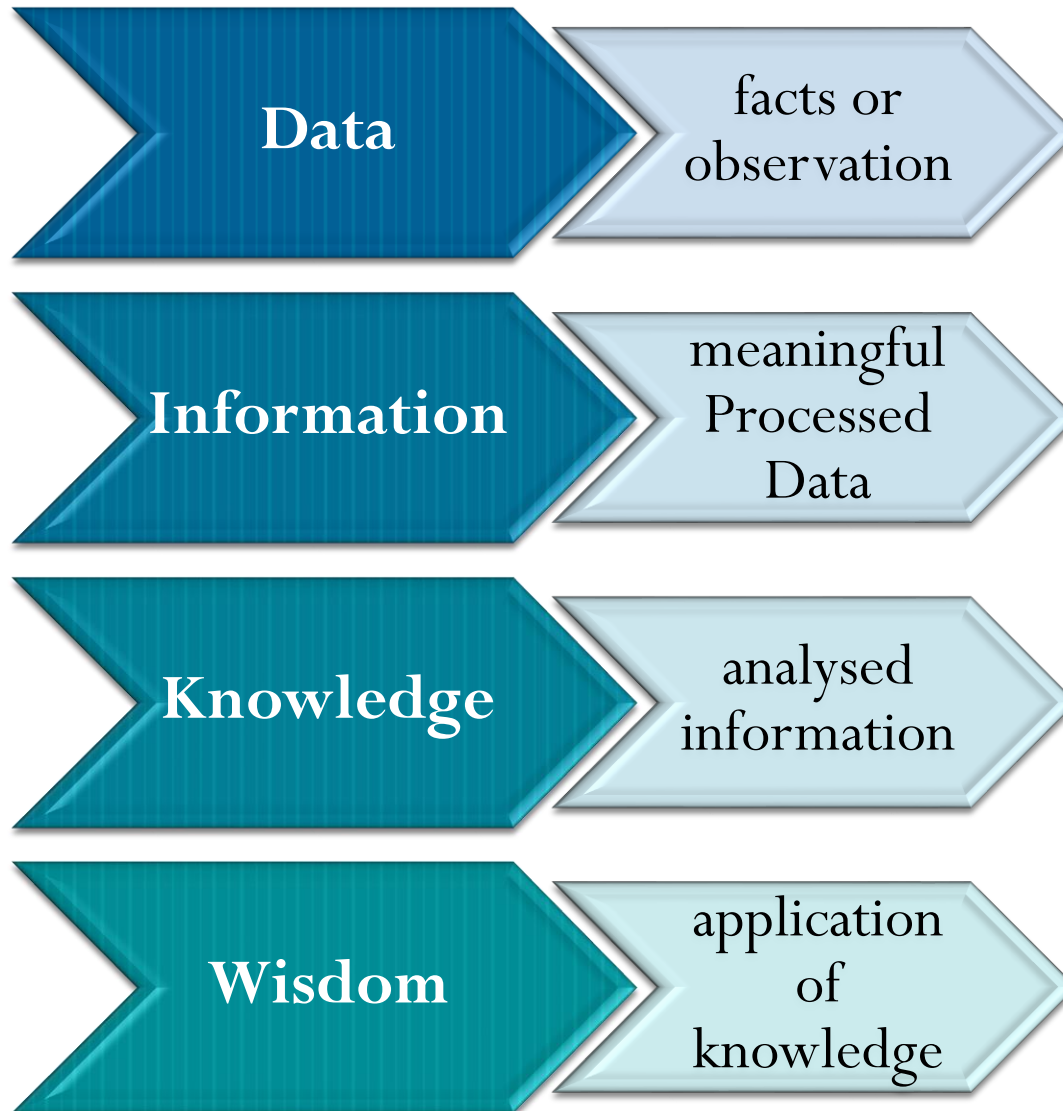
Organise that information in a meaningful way

Assure information quality

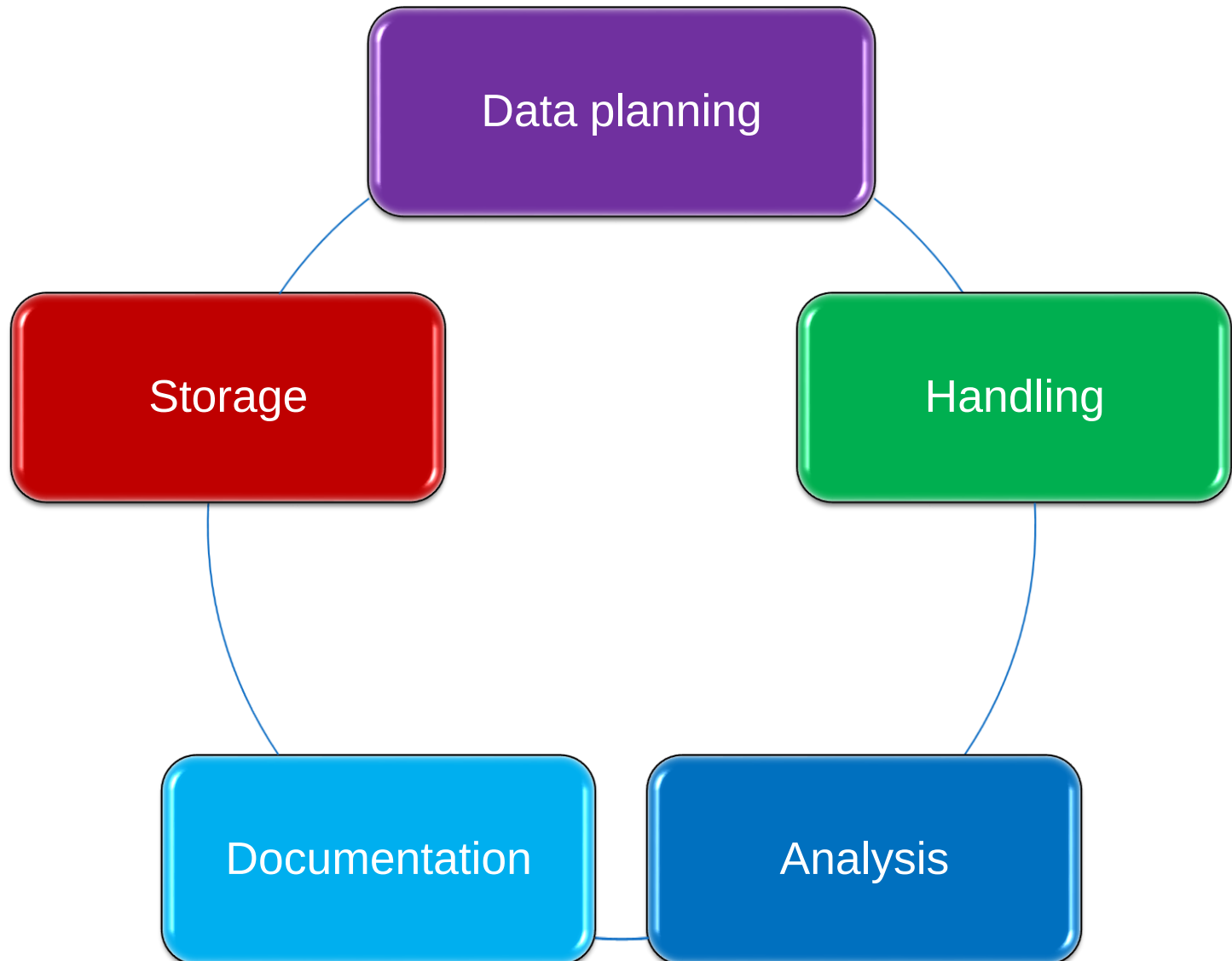
Provide software tools to access information



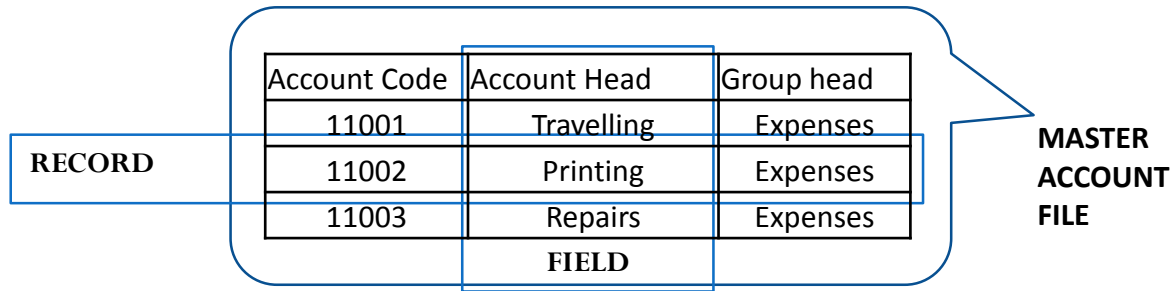
DIKW Continuum



Data Management Includes



Hierarchy of Data



Database: Collection of related Files

File: Collection of related Records

Record: Collection of related fields

Field: Collection of Characters

Character: Collection of Bits



Problems with Conventional File Systems

High Redundancy

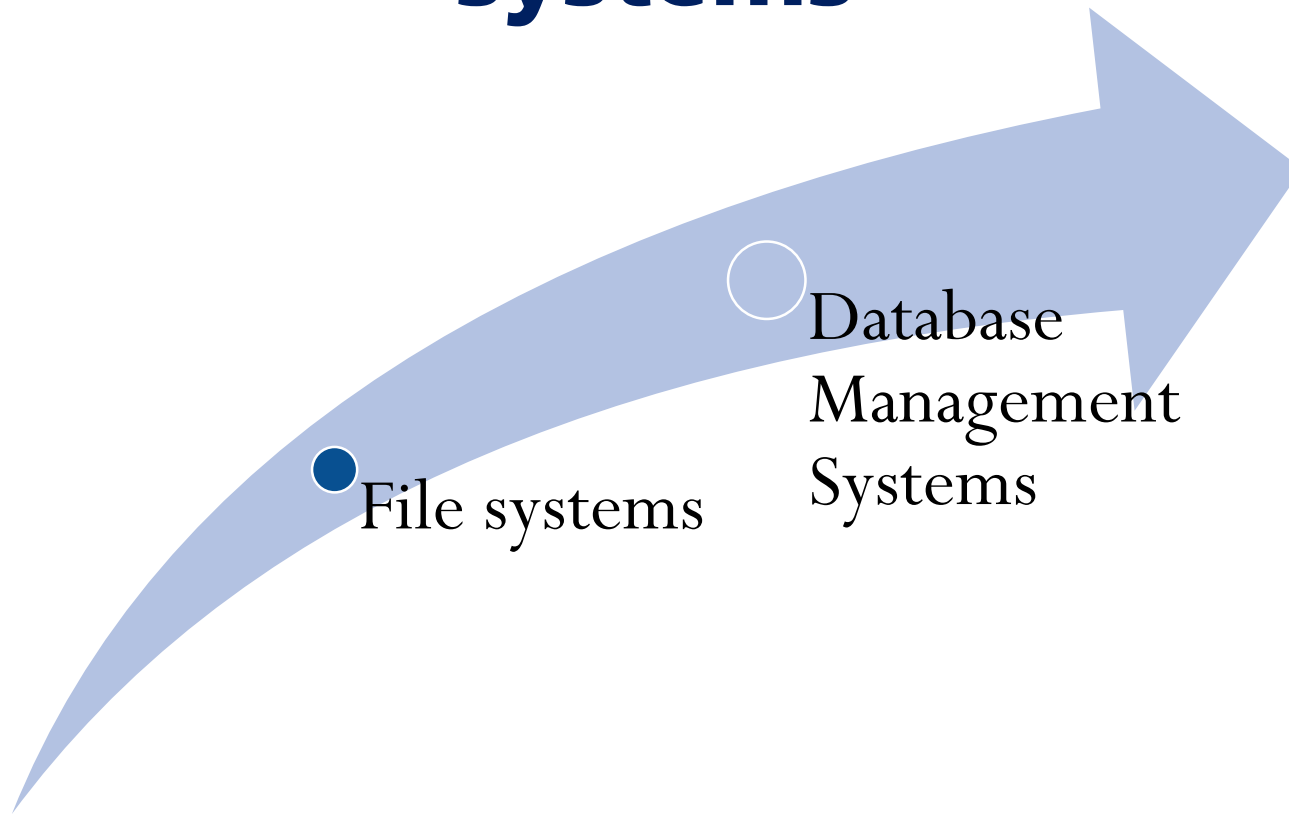
Limited Data Sharing

Low Data Integrity

High Dependence between Data and Application



Move to Database Management systems

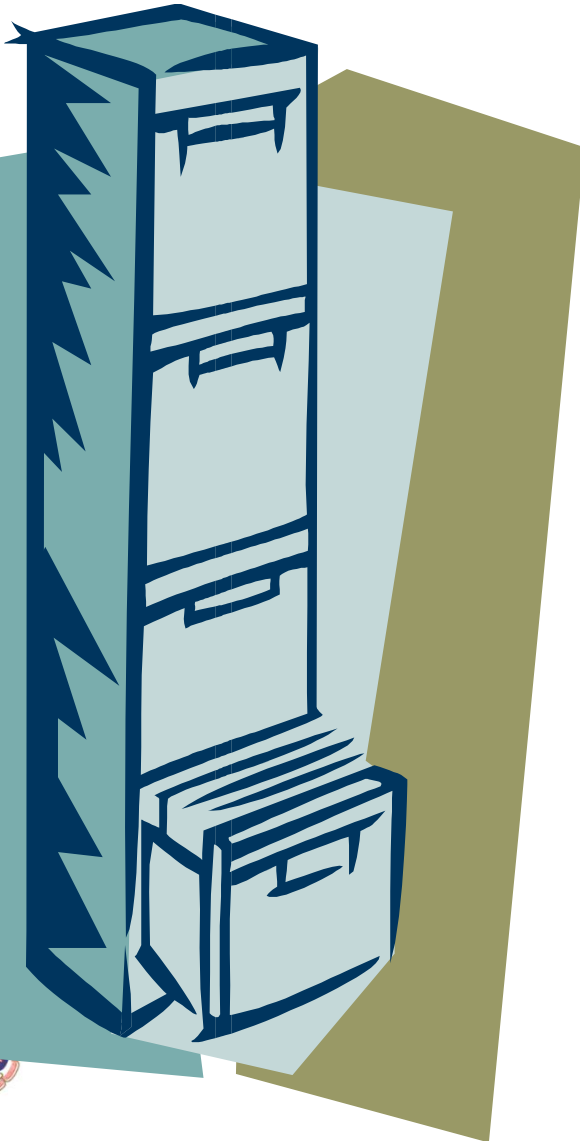


Database-Collection of data describing one or more related functions of an organisation

A Database Management System is a software system for creation & control of a database and manipulation of the data in the database.



Database-Electronic filing cabinet



Adding new files

Deleting existing files

Inserting data in existing files

Modifying data in existing files

Deleting data in existing files

Retrieving data from existing files

Database Management Systems

Software that
aid in
organizing,
controlling and
using
the data
needed by the application programme
e.g.: Oracle, MySQL, SQL Servers etc.



Why is DBMS required?



Advantages

Permitting data sharing

- Data is available to different users

Minimizing Data Redundancy

- Data need not be repeated

Integrity maintained

- Accurate, consistent and up-to-date data.

Program/file consistency

- Standardized File formats and programs

User-friendly

- Easier Data access & manipulation

Improved security

- Security constraints can be defined

Program/data Independence:

- Database Program & Data are independent



Disadvantages

Expensive

- Implementation Expensive and time-consuming
- Cost of conversion from Legacy to DBMS
- Requirement of skilled staff to manage database

Security:

- All or nothing proposition

DBMS failure - single point of failure

- Organisation could be dependent on DBMS



How is DBMS Organized?



Database Model

A **database model** is a type of data model that determines the logical structure of a database

Hierarchical Database Model

Network Database Model

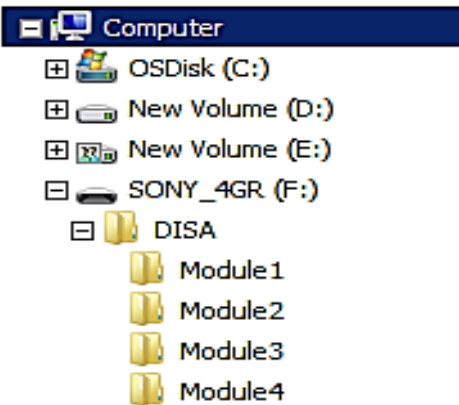
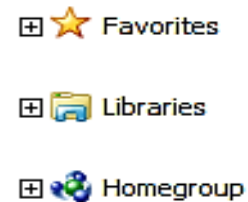
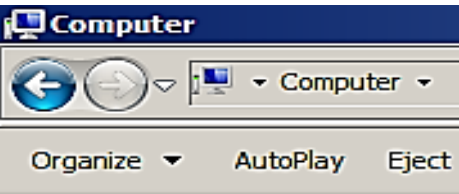
Relational Database Model(RDBMS)



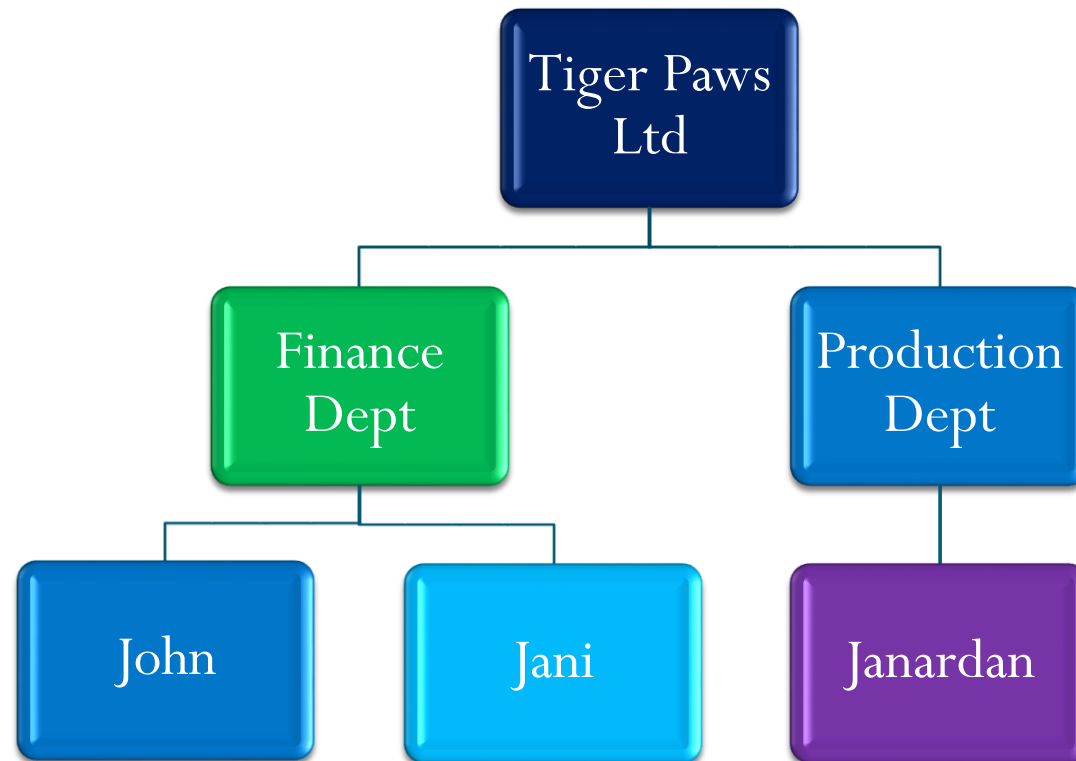
Database Models

Hierarchical Database Model

organises data in a tree structure



Windows File structure is organized in an hierarchical Model



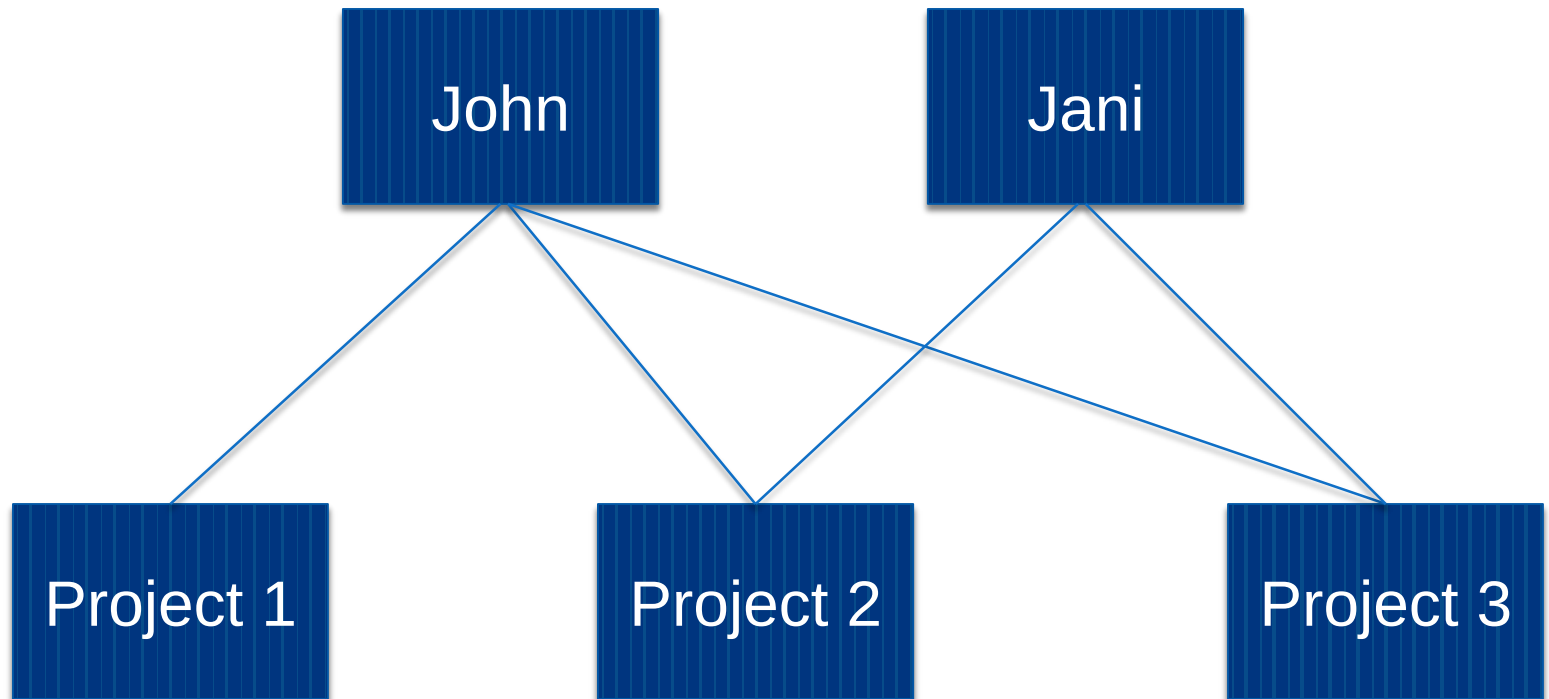
Root

Node



Network Database Model

Many to Many Relationships



Relational Database Model

AccountID	Name	Balance	Dr./Cr.
39820010023	Amar	2369852.38	Cr.
39820010024	Akbar	69857.50	Cr.
39820010025	Anthony	548236.35	Cr.

Key

Field/ Attribute

Row/Tuple

Related
Table

CustomerID	AccountID
54326987	39820010025



Rules of RDBMS

Data is represented in a two-dimensional table

Columns describe the attributes.

Each column has a unique name.

All the entries in any column are of the same domain.

A row in the table is called Tuple.

Ordering of rows and columns is insignificant.

Duplicate rows are not allowed.

Data items are atomic in nature

There is a Key Column whose value is unique and cannot be null.



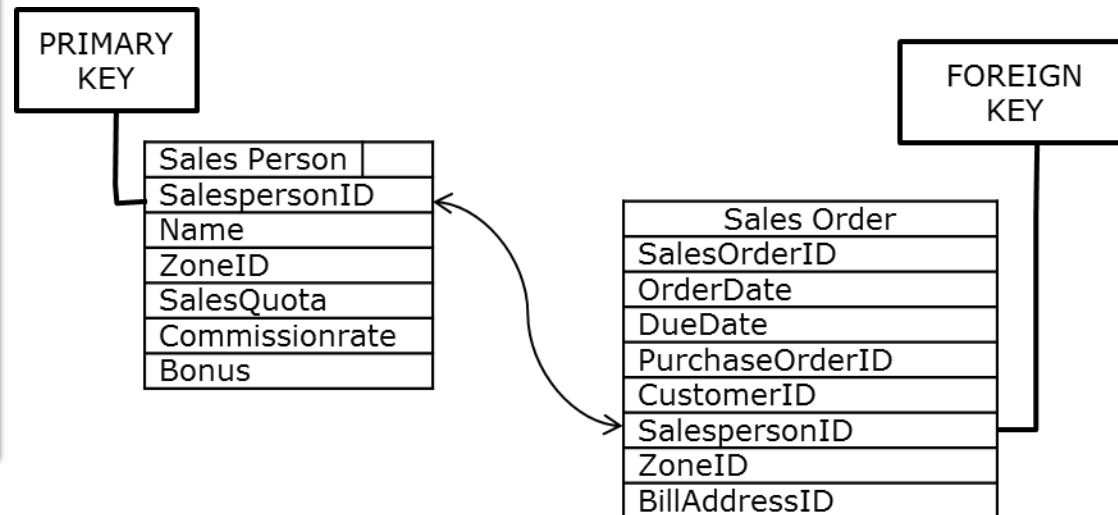
Relational Data integrity

Domain Integrity Constraint

Values in column of table from same domain.

Entity Integrity Constraint

Data values of primary key are all valid & not null.



Referential Integrity Constraint

Foreign key in one table must match primary key of other table or should be null.

Who uses/requires DBMS?



People Associated with DBMS

System Analysts

- Analyse needs of Database Users

Database Designers

- Help in Database design & Structure

Application Developers

- Implement Database Design & application programs

Data & Database Administrators

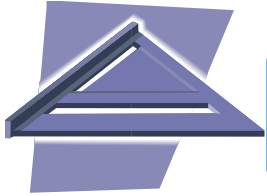
- Manage Database management systems

End Users

- Who query & update databases



Designing Databases .. Normalisation



Conceptual Database Design Technique

- Achieved through

Organizing fields and tables so as to minimize redundancy and dependency.

Tables divided into smaller tables, so that all non-key field items are dependent upon Key field.

- Result ...

Improved

- Storage efficiency
- Data integrity
- Scalability.



Example of Normalisation

Before...

StudentID	StudentName	Address	Subject	SubjectCost	Grade
12345678	Amar Akbar	1 Wall street	Accounts	1500	B
			Economics	2000	A
			Management	1500	B+

After...

StudentID	StudentName	Address
12345678	Amar Akbar	1 Wall street

Subject	SubjectCost
Accounts	1500
Economics	2000
Management	1500

SUBJECTS TABLE (key = Subject)

StudentID	Subject	Grade
12345678	Accounts	B
12345678	Economics	A
12345678	Management	B+

RESULTS TABLE (key = StudentID+Subject)



Advantages of Normalisation

Reduced redundancy.

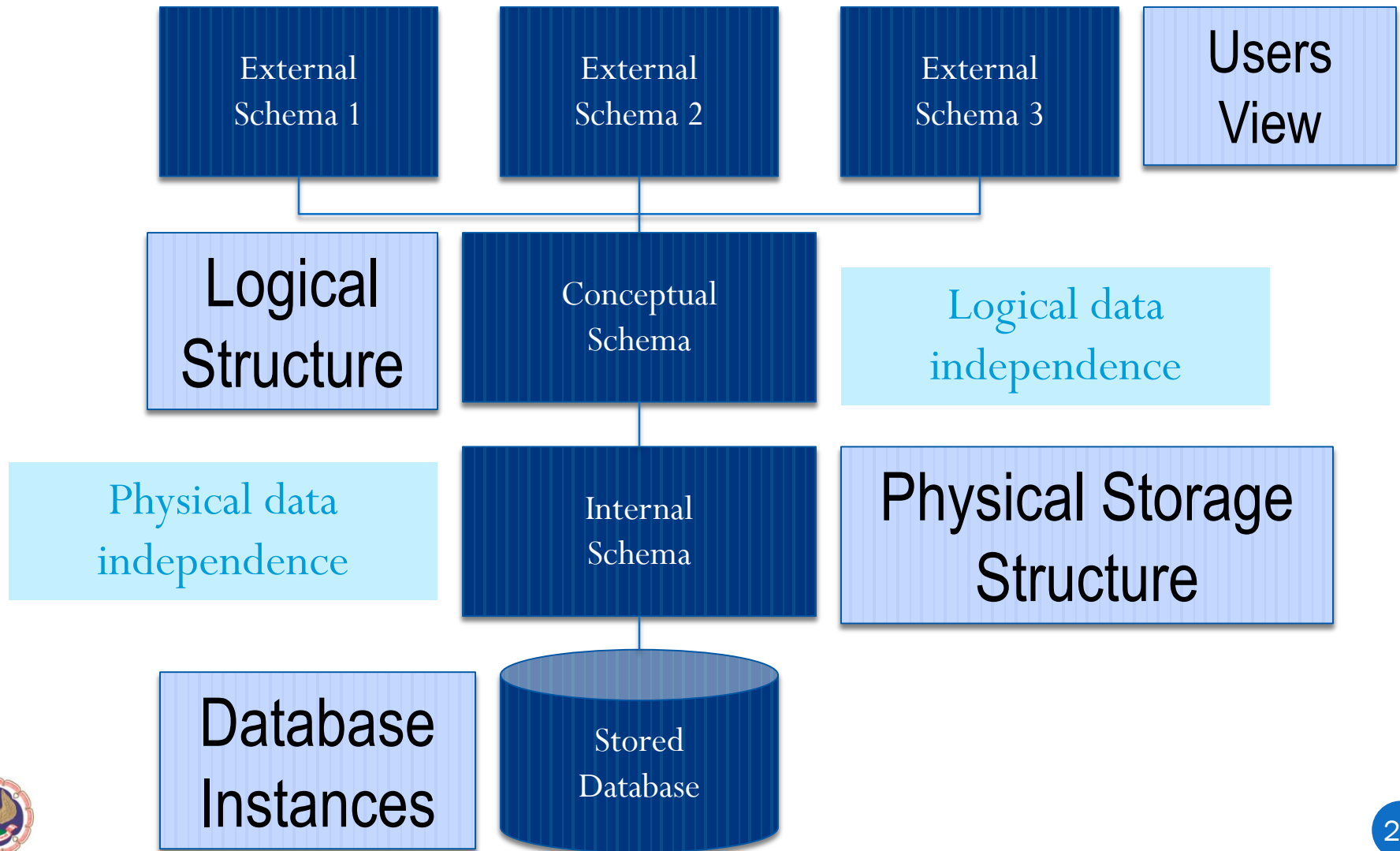
More efficient data structure.

More flexible data structure.

Better understanding of data.



Database Schemas



Database Languages

A Database needs facilities for

Creating, Modifying, Deleting Database objects.

Inserting, Updating and Deleting data.

Querying the Database.

Controlling access to the Database.

Facilities for Data Integrity and Consistency.

All these are provided by Database Languages

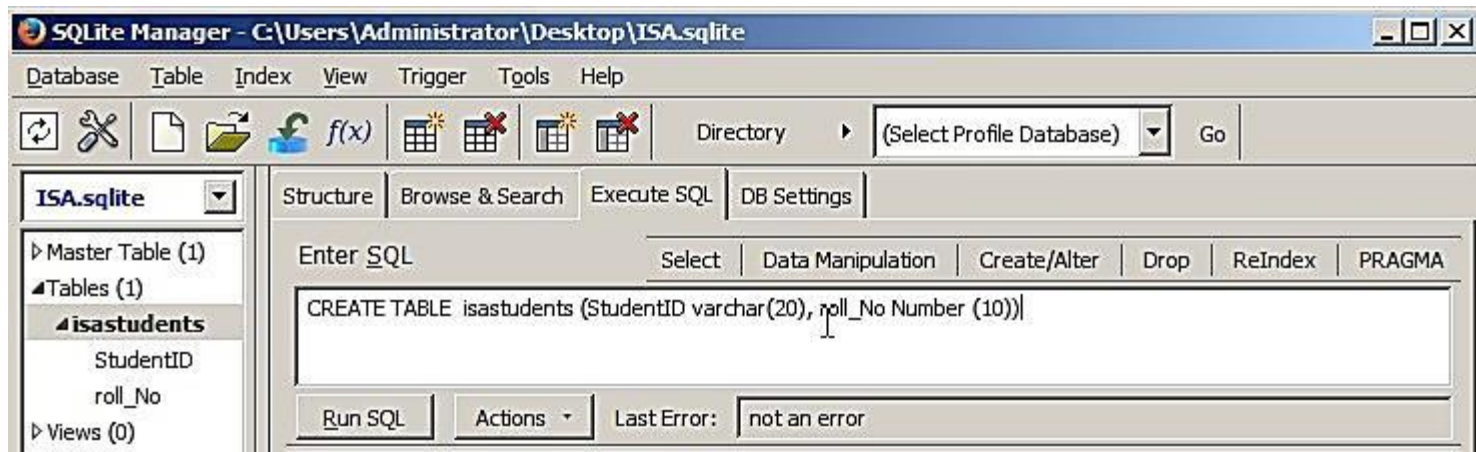
Structured Query Language or SQL is a language of RDBMS



Data Definition Language (DDL)

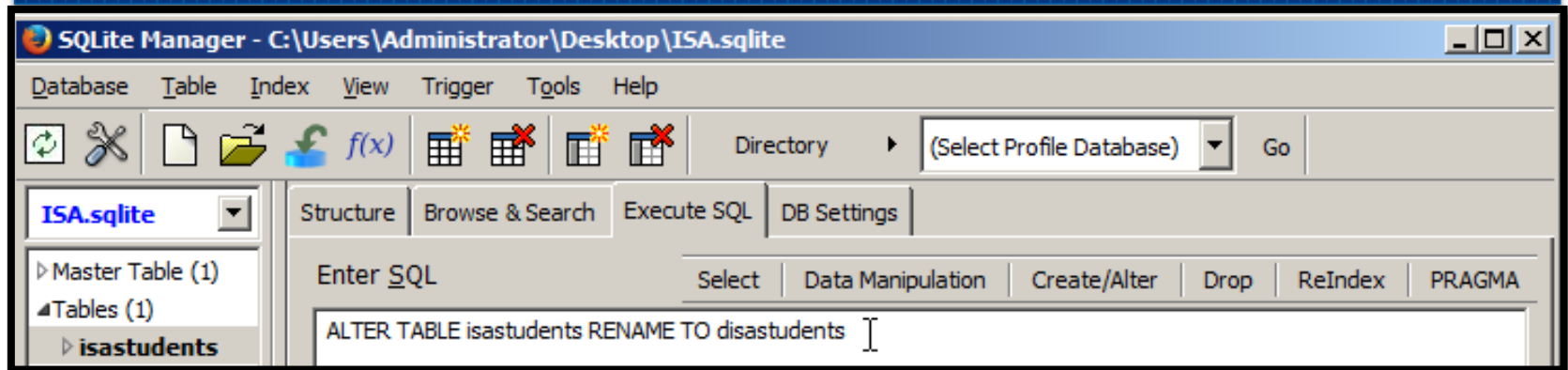
SQL commands used to create, modify and drop database structures

e.g.: to create Schema, the SQL Statement 'Create' is used

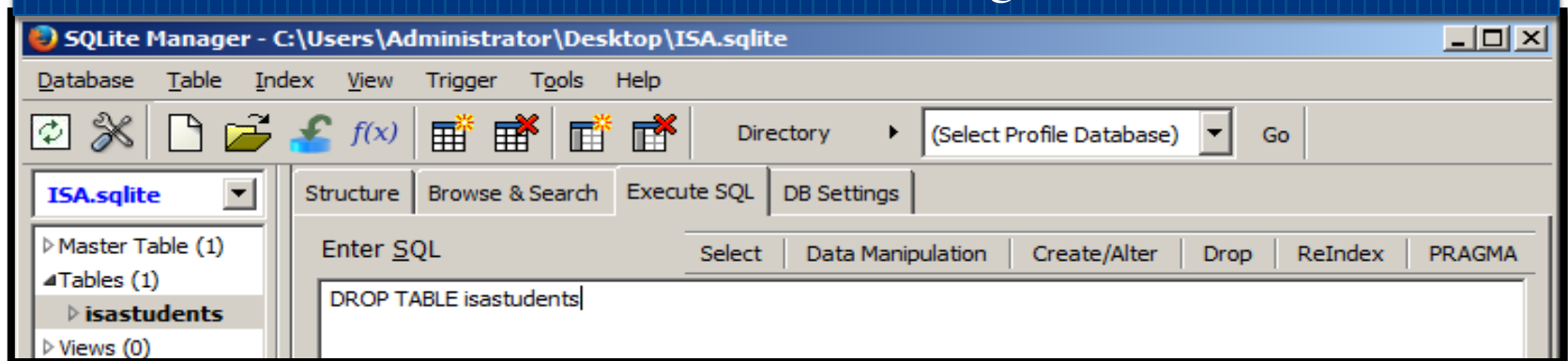


Some more DDL examples

Use of ALTER with RENAME for Renaming Table



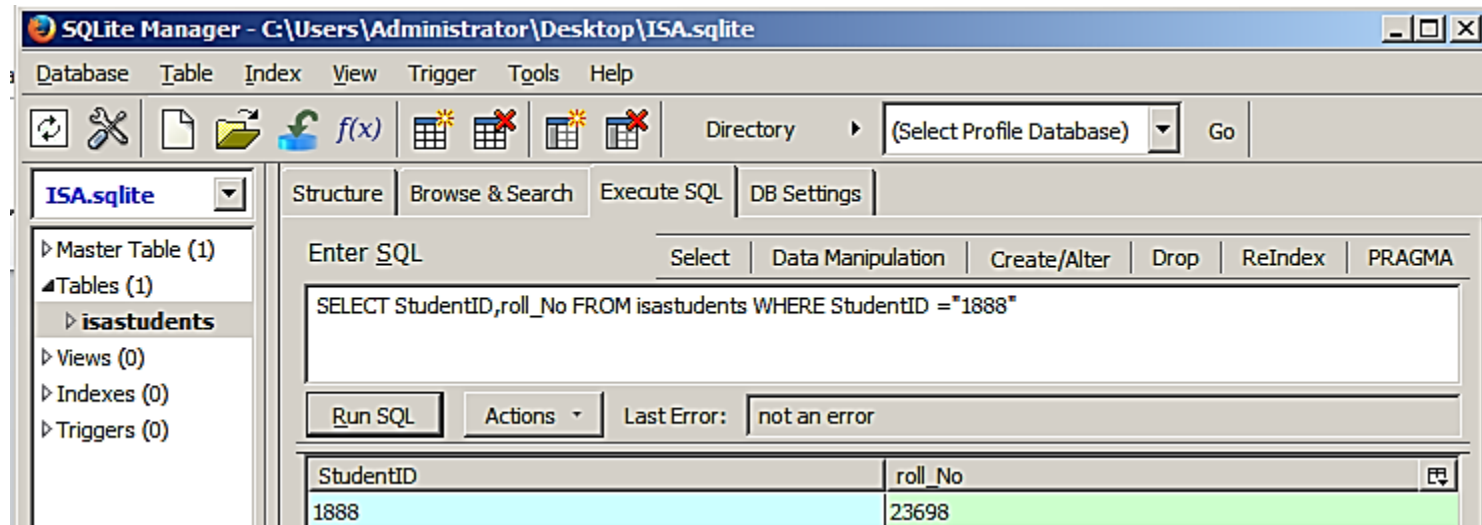
Use of DROP for Deleting Table



Data Manipulation Language (DML)

SQL commands used to manipulate data and query a database. Applications access data through DML

e.g.: to Query for a Student with ID '1888', an SQL Statement `SELECT` with `WHERE` is used



Data Control Language (DCL)

SQL commands used to control access to data and to the database

e.g.: To grant the user Pyare.Lal the ability to retrieve information from the isastudents Table we use GRANT with SELECT

```
SQL>GRANT SELECT ON isastudents TO Pyare.Lal
```



Meta Data

Data about Data

Where data came from

How data were changed

How data are stored

How data are mapped

Who owns data

Who can access data

Data usage history

Data usage statistics



Data Dictionary

Data Dictionary is a tool –enable one to control & Manage information in databases.

NAME: AMT-PAY-BASE
FOCUS NAME: BASEPAY
PC NAME: SALARY

DESCRIPTION: EMPLOYEE'S ANNUAL SALARY

SIZE: 9 BYTES
TYPE: N (NUMERIC)
DATE CHANGED: 01/01/04
OWNERSHIP: COMPENSATION
UPDATE SECURITY: SITE PERSONNEL
ACCESS SECURITY: MANAGER, COMPENSATION PLANNING AND RESEARCH
MANAGER, JOB EVALUATION SYSTEMS
MANAGER, HUMAN RESOURCES PLANNING
MANAGER, SITE EQUAL OPPORTUNITY AFFAIRS
MANAGER, SITE BENEFITS
MANAGER, CLAIMS PAYING SYSTEMS
MANAGER, QUALIFIED PLANS
MANAGER, SITE EMPLOYMENT/EEO

BUSINESS FUNCTIONS USED BY: COMPENSATION
HR PLANNING
EMPLOYMENT
INSURANCE
PENSION
401K

PROGRAMS USING: PI01000
PI02000
PI03000
PI04000
PI05000

REPORTS USING: REPORT 124 (SALARY INCREASE TRACKING REPORT)
REPORT 448 (GROUP INSURANCE AUDIT REPORT)
REPORT 452 (SALARY REVIEW LISTING)
PENSION REFERENCE LISTING

The sample data dictionary report for a human resources database provides helpful information, such as the size of the data element, which programs and reports use it, and which group in the organization is the owner responsible for maintaining it. The report also shows some of the other names that the organization uses for this piece of data.



When the database is up and running it acts as a useful reference

Roles of DA and DBA

Data Administrator

About Data
Administrative &
Policy Functions

Data Base Administrator

About Database
Technical
Functions

Designing

Implementation



Database Administrator(DBA)

Manages a DBMS for an enterprise.

Well versed in the use of Database Management System.

Keeps track of new emerging technologies & methodologies.

Designs schemas, provides security, restores the system after a failure.

Tunes the database to meet changing user needs.



Management Tasks of DBA

Liaising with management, Database Users, data administrator

Liaising with database vendors.

Acquire latest information on database technologies and tools.

Prepare the project status report on the usage of databases.

Prepare staff requirements.

Prepare budgets



Security & Technical Tasks of DBA

Monitoring and maintaining security of databases.

Granting access rights and revoking them to users.

Perform database tuning and optimizing database performance.

Maintaining availability and ensuring integrity of databases.

Managing database backups and restorations.

Guiding application programmers in their work.

Performing the process of capacity planning.

Providing education and training suggestions.



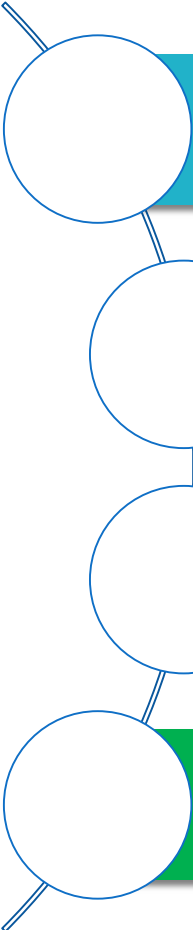
When is DBMS Useful

Databases are extremely useful when there is a need for

- Data storage
- Data analysis
- Data retrieval



Linking Databases to the Web



Databases are the functional muscle of the web.

Web provides interactive interface to back-end databases

"Facebook" is a database built upon the "MySQL" database system

Reason of popularity of internet is the ability to link databases.



Security and control features of DBMS



Database Security & Controls

Database Roles and Permissions

- Segregation of duties

Concurrency Control

- addresses conflicts relating to simultaneous accesses

Views

- Restrict user **views** of the **database**

Stored Procedures

- Reduce the long SQL queries and reduce network traffic

Triggers

- Automatically 'fired' when a specific action/event takes place



Database Security & Controls

Database security

- Right people
- Right access to the right data

User management

Types of database users

- Application programmers
- Sophisticated users
- Specialised users
- Naïve users



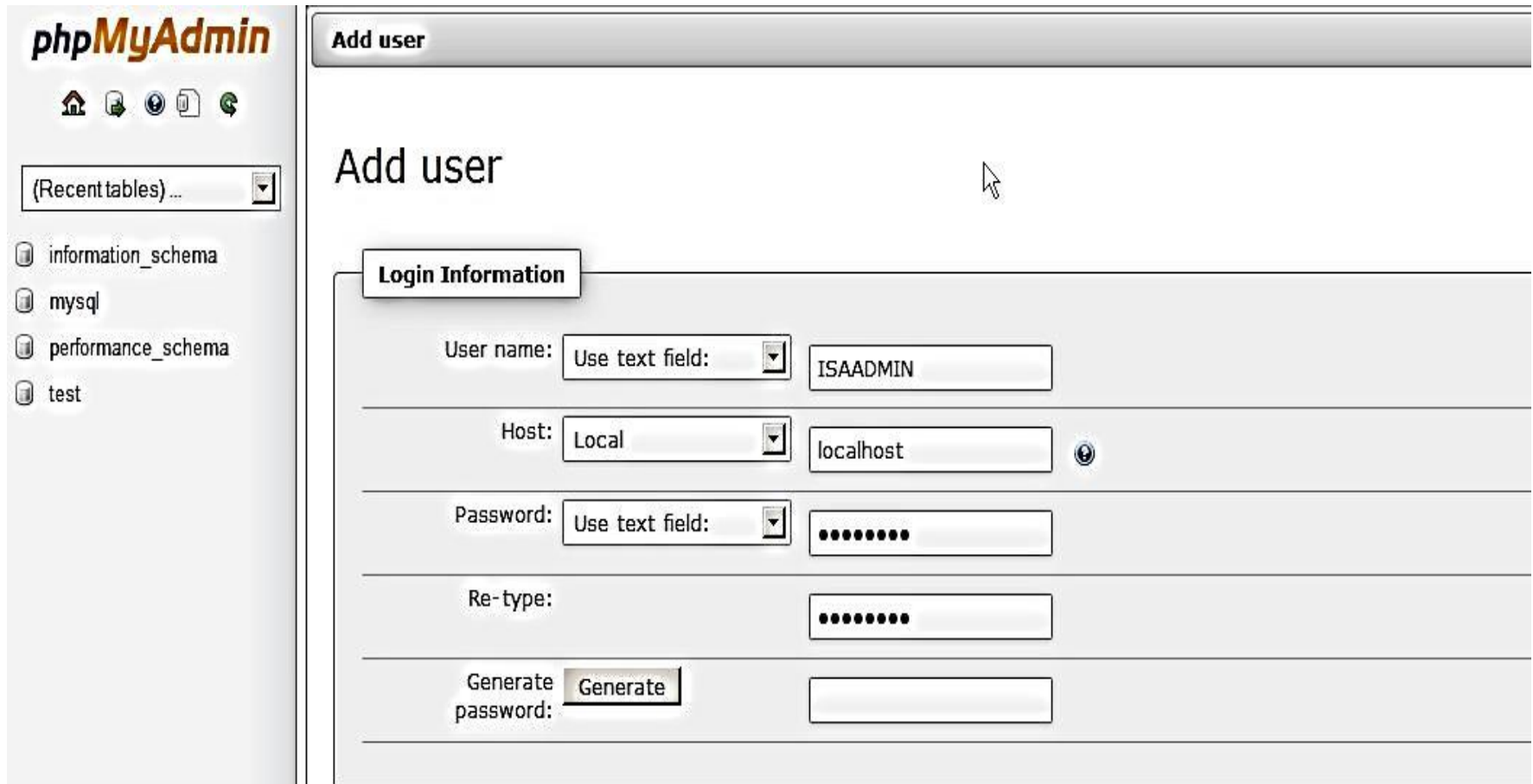
Database Security & Controls

Authorisation and access control

- Basic model for accessing control involves:
 - Subjects
 - Objects
 - Access Rights



Creating a user



The screenshot shows the phpMyAdmin interface with the 'Add user' form. The left sidebar contains the phpMyAdmin logo, navigation icons, and a list of databases: information_schema, mysql, performance_schema, and test. The main content area is titled 'Add user' and contains a 'Login Information' section. This section has five rows of input fields: 'User name' with a dropdown set to 'Use text field' and a text box containing 'ISAADMIN'; 'Host' with a dropdown set to 'Local' and a text box containing 'localhost'; 'Password' with a dropdown set to 'Use text field' and a masked text box; 'Re-type:' with a masked text box; and 'Generate password:' with a 'Generate' button and an empty text box. A mouse cursor is visible over the 'Add user' title.

phpMyAdmin

(Recent tables) ...

- information_schema
- mysql
- performance_schema
- test

Add user

Login Information

User name: Use text field: ISAADMIN

Host: Local localhost

Password: Use text field:

Re-type:

Generate password:



Privilege

Rules defining what users can do within database.

System privileges

- Allow a user to perform a particular database command or operation

Object privileges

- Allow a user to access an object in a particular manner



Granting Access Rights to User

The screenshot shows the phpMyAdmin interface for editing privileges for the user 'ISAADMIN'@'localhost'. The left sidebar contains the phpMyAdmin logo, navigation icons, and a list of databases: information_schema, isaadmin, mysql, performance_schema, and test. The main content area is titled 'Edit Privileges: User 'ISAADMIN'@'localhost'' and features a 'Global privileges (Check All / Uncheck All)' button. A note states: 'Note: MySQL privilege names are expressed in English'. Below this, there are four panels: Data, Structure, Administration, and Resource limits. The Data panel has checkboxes for SELECT, INSERT, UPDATE, DELETE, and FILE, all of which are checked. The Structure panel has checkboxes for CREATE, ALTER, INDEX, DROP, CREATE TEMPORARY TABLES, SHOW VIEW, CREATE ROUTINE, ALTER ROUTINE, EXECUTE, CREATE VIEW, EVENT, and TRIGGER, all of which are checked. The Administration panel has checkboxes for GRANT, PROCESS, RELOAD, SHUTDOWN, SHOW DATABASES, LOCK TABLES, REFERENCES, REPLICATION CLIENT, REPLICATION SLAVE, and CREATE USER, all of which are checked. A tooltip for the GRANT checkbox reads: 'Allows adding users and privileges without reloading the privilege tables.' The Resource limits panel has a note: 'Note: Setting these options to 0 (zero) removes the limit.' and four input fields: MAX QUERIES PER HOUR (0), MAX UPDATES PER HOUR (0), MAX CONNECTIONS PER HOUR (0), and MAX USER_CONNECTIONS (0).

phpMyAdmin

(Recent tables) ...

- information_schema
- isaadmin
- mysql
- performance_schema
- test

Edit Privileges: User 'ISAADMIN'@'localhost'

Global privileges (Check All / Uncheck All)

Note: MySQL privilege names are expressed in English

Data

- ☒ SELECT
- ☒ INSERT
- ☒ UPDATE
- ☒ DELETE
- ☐ FILE

Structure

- ☒ CREATE
- ☒ ALTER
- ☐ INDEX
- ☐ DROP
- ☐ CREATE TEMPORARY TABLES
- ☐ SHOW VIEW
- ☐ CREATE ROUTINE
- ☐ ALTER ROUTINE
- ☐ EXECUTE
- ☐ CREATE VIEW
- ☐ EVENT
- ☐ TRIGGER

Administration

- ☒ GRANT
 - Allows adding users and privileges without reloading the privilege tables.
- ☐ PROCESS
- ☐ RELOAD
- ☐ SHUTDOWN
- ☐ SHOW DATABASES
- ☐ LOCK TABLES
- ☐ REFERENCES
- ☐ REPLICATION CLIENT
- ☐ REPLICATION SLAVE
- ☐ CREATE USER

Resource limits

Note: Setting these options to 0 (zero) removes the limit.

MAX QUERIES PER HOUR

MAX UPDATES PER HOUR

MAX CONNECTIONS PER HOUR

MAX USER_CONNECTIONS



Auditing DBMS



Why Audit

Cost of Breach

- Identity theft, Privacy

Regulatory Compliance

- Database monitoring is key requirement

Database Leak Prevention

- Sensitive data needs protection

Open Accessibility

- Web applications have melted traditional perimeter controls



Auditing DBMS

Databases may be

- Front End
- Back end
- It is important to audit

Application Controls

Perimeter Controls

Database Controls



Auditor to Check

Auditing DBMS

Definition standards

Separate Test Database & Live database

Access controls, Database user rights should be need based

Controls to handle concurrent access problems.

Monitoring database performance



Auditor to Check..Contd.

Auditing DBMS

All database logs should be periodically verified

Documentation regarding database incidents

Checkpoints to minimize data loss

Data backup and recovery procedures

Whether Backups Tested



Step by Step approach

Understand application system / network infrastructure

Identify Database Administrators

Identify Database environments and versions

Arrange database access

Look at Logs



Look at Logs

System Access

- Logins – Success / Fail
- Account / Role / Permissions Changes
- Password Changes

Data Access

- SELECT – Success / Fail

Data Change

- INSERT, UPDATE, DELETE

Schema / Object Changes

- CREATE, ALTER, DROP

Privileged User Activity

- All



Database Auditing

The process of monitoring access to and modification of selected database objects and resources within operational databases and retaining a detailed record of the access where said record can be used to proactively trigger actions and can be retrieved and analyzed as needed. This can be accomplished using a database auditing Tools



Audit Tools

Database Management Systems generally have integrated data base audit tools.

Database Monitoring

Filter: [x] Last hour (1) [x] Last 2 hours (1) [x] Today (11) [x] Yesterdays (13)

Rev	Type	Last Update	Server	Source IP	Username	Description
32	[icon]	07/20/2010 07:33:56	Dallas-SG	1.1.15.1	n/a	Unauthorized Access to Service
31	[icon]	07/20/2010 06:09:54	Dallas-SG	1.1.15.1	n/a	Untraceable Database User
30	[icon]	07/19/2010 19:22:07	Dallas-SG	1.1.15.1	n/a	Untraceable Database User
21	[icon]	07/19/2010 17:58:10	Dallas-SG	1.1.15.1	n/a	Unauthorized Sensitive Query
29	[icon]	07/19/2010 17:20:13	OC-SG	1.1.115.10	Kasey	Unauthorized Sensitive Table
20	[icon]	07/19/2010 17:09:15	OC-SG	1.1.115.1	Yoshi	Unauthorized Query
22	[icon]	07/19/2010 16:13:54	OC-SG	1.1.115.10	Kasey	Unauthorized Host
28	[icon]	07/19/2010 13:57:04	Dallas-SG	1.1.15.24	n/a	Attempt to Execute Privileged Operation
27	[icon]	07/19/2010 12:43:36	Dallas-SG	1.1.15.24	n/a	Illegal HTTP Version
26	[icon]	07/19/2010 10:36:52	OC-SG	1.1.115.1	Yoshi	Unauthorized Source IP Address
25	[icon]	07/19/2010 10:36:51	OC-SG	1.1.115.1	Yoshi	Unauthorized Database Schema
24	[icon]	07/19/2010 10:23:30	OC-SG	1.1.115.1	Yoshi	Excessive Attempts of Database Login
23	[icon]	07/19/2010 10:20:27	Dallas-SG	1.1.15.20	n/a	Unauthorized Access to Service
18	[icon]	07/19/2010 07:16:40	OC-SG	1.1.115.10	n/a	Time of Day Violation
19	[icon]	07/19/2010 07:01:43	Dallas-SG	1.1.15.1	n/a	Attempt to Execute Privileged Operation
14	[icon]	07/19/2010 06:09:12	OC-SG	1.1.115.1	n/a	Time of Day Violation
15	[icon]	07/19/2010 05:59:42	OC-SG	24.5.11.14	Steve	Unauthorized OS User
17	[icon]	07/19/2010 05:58:39	OC-SG	24.5.11.14	Steve	Unauthorized Source IP Address
16	[icon]	07/18/2010 19:24:04	OC-SG	24.5.11.14	Steve	Missing cookie signature
12	[icon]	07/18/2010 19:13:05	OC-SG	24.5.11.14	Steve	Access to a black-listed table
13	[icon]	07/18/2010 19:05:37	OC-SG	24.5.11.14	Steve	Access to a black-listed table
9	[icon]	07/18/2010 16:24:41	OC-SG	24.5.11.14	Steve	Access to a black-listed table
8	[icon]	07/18/2010 16:24:38	OC-SG	24.5.11.14	Steve	Access to a black-listed table
7	[icon]	07/18/2010 16:24:33	OC-SG	24.5.11.14	Steve	Access to a black-listed table
6	[icon]	07/18/2010 16:23:11	OC-SG	24.5.11.14	Steve	Access to a black-listed table
3	[icon]	07/18/2010 08:02:41	OC-SG	24.5.11.14	Steve	Access to a black-listed table

OS Client Details

Source IP: 1.1.115.1 (stream: 1.1.115.1:4637 - 1.1.115.10:1433)
OS User: n/a
Host: secspserver

Source Application details

Application Name: sql query analyzer - object browser
Application User: n/a

Server-side details

User: Yoshi
Raw User: sa
Query Group: (sysobjects,select)

Parsed Query

```
select name, cnumber, date, from  
creditcardtable where id = '25'
```

Raw Data: select name, cnumber, date, from
creditcardtable where id = '25'

Table Groups:
DB - Schema
msdb - n/a
msdb - dbo

Response Size: 76 records
Response Time: 10 msec

Violations

- Unauthorized Database Schema
- Unauthorized Database Schema

Audit Tools

Reporting

Report Filters

- By Group
 - Idan
 - Terry
 - Joe
- By Keywords
 - EBS
 - PCI
 - SAP
 - SOX
- By Data Source Type
 - Audit
 - Audit Raw Data
 - Alerts
 - Assessment
 - Assessment Result
 - Compilation
 - System Events
 - Predefined
- By ADC Defined
 - ADC
 - Custom
- By Run Date

Reports

Name	User	Scheduled	Followed Action
SOX - Application data changes by administrator (Alerts)			
SOX - Changes to data structures (Audit Raw Data)			
SOX - Changes to data structures (User) (Audit Raw Data)			
SOX - Changes to database code objects (Audit Raw Data)			
SOX - Changes to tables (Audit Raw Data)			
SOX - Daily change log (Audit Raw Data)			
SOX - Database configuration changes (Audit Raw Data)			
SOX - Financial data changes - Summary (Audit)			
SOX - List new objects (Audit)			
SOX - List new users (summary) (Audit)			
SOX - Manual data changes (Alerts)			
SOX - New database objects (Audit Raw Data)			
SOX - New users (detailed) (Audit Raw Data)			
SOX - Object privilege changes over financial data (Audit Raw Data)			
SOX - Object privilege delegation over financial data (Audit Raw Data)			
SOX - Unauthorized data changes (Alerts)			
SOX - Unauthorized direct changes to data dictionary (Alerts)			
SOX - User and privilege management (Audit Raw Data)			
SOX - Weekly change log (Audit Raw Data)			
SOX - Weekly change log - user view (Audit Raw Data)			

Data Scope

Tabular

Data Analysis Views

☐ Data Analysis View 1

Title:

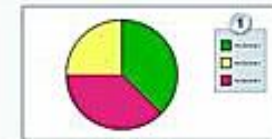
Chart Type:

Pie

1 X-Axis:

App User

2 Grouping:



Maximal number of values displayed in X-Axis:

10

Maximal number of values displayed in grouping:

5

☒ Present Chart

☐ Present Tabular View

☐ Data Analysis View 2

☐ Data Analysis View 3



Data Base Management Systems

To conclude, we can, very well say that Databases and Database Management Systems form the foundation of Information Economy. DBMS is crucial for any organisation and needs to be controlled, monitored and Assessed.



References

Websites/links/publications

- C J Date, An Introduction to Database Systems (8th Edition), Addison-Wesley.
- Raghu Ramakrishnan, Database Management Systems, 3rd Edition, McGraw-Hill
- <http://asktom.oracle.com>
- <http://www.java2s.com/Code/SQLServer/CatalogSQLServer.htm>



Summary: DBMS

We have learnt about

DBMS models

Database Languages/SQL

Roles and Duties of DBA

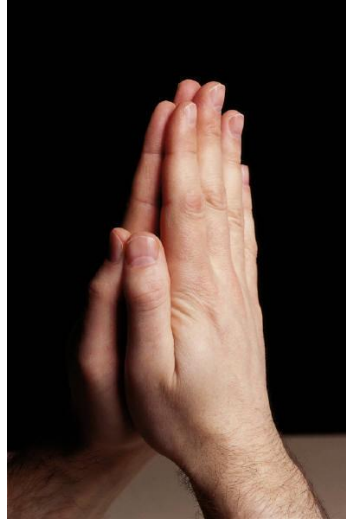
Database Controls

User Creation and Access Rights in DBMS

Auditing DBMS



Data Base Management Systems



Thank You

