

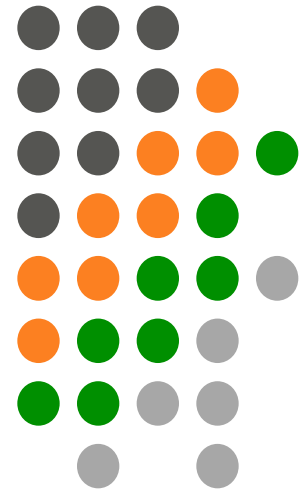
Database Fundamentals

Lecture 1 (Introduction)

Lecturer : Dr Irene Murtagh

Room :A15

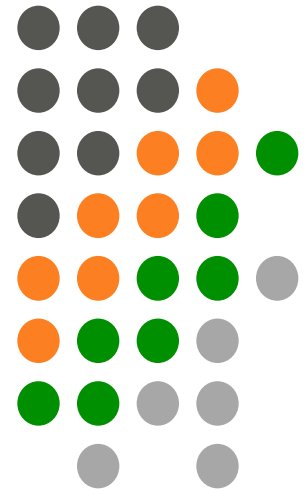
Email: irene.murtagh@tudublin.ie



Course Aims:

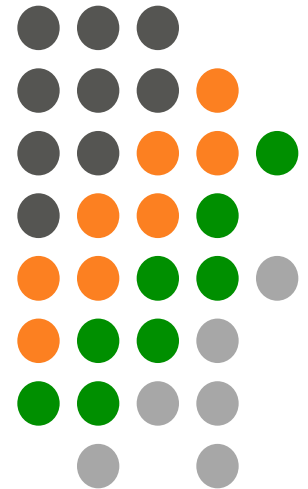
This course has **two** aims:

- To provide the student with an understanding of how to model a system using UML.
- To provide the student with an understanding of how to design a relational database for a system.



Having successfully completed the module you will be able to:

- Explain and describe concepts associated with **database management systems** and the **relational database model**
- Implement a **relational database design**, **data modelling** and a **normalised set of tables**
- Develop solutions to database queries using SQL **Data Manipulation Language** commands
- Implement a database design using **SQL Data Definition Language**
- Explain various aspects of **transaction processing**



Topics

Topic 1: Relational Database features and introduction

Topic 2: SQL

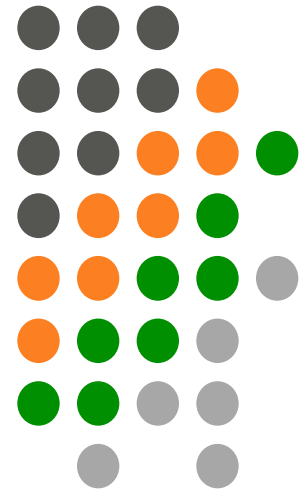
Topic 3: Database Design(ERDs and Normalisation)

Topic 4: Transaction Processing

Software:

MySQL 8.x <https://dev.mysql.com/downloads/>

MySQL workbench <https://dev.mysql.com/downloads/>



Weekly Hours



2 Hour Lecture

2 Hour Practical Work

Some Ground Rules



- Everything on the course is examinable
- All assignment work must be word-processed and printed
- Hand written work will not be accepted for your assignments
- Ask questions and give feedback on course
- All mobile phones must be turned off in class
- No food or laptops in class unless agreed
- It may be helpful to bring a printed copy of lecture notes to class each week

Assessment



Exam 50%

Continuous Assessment

Lab session work

50%

50%

Why Study Database Modelling and Design?

- Core IT skill20/64 jobs are looking for SQL/database skills

The screenshot shows the IrishJobs.ie website with search results for 'Database Administrator' jobs. The sidebar on the left contains filters for Recruiter Type, Relative Roles/Skills, Locations, Employment Type, and Salary. The main table lists several job openings with details on salary, location, and employer. The footer includes a banner for the new CV Database and navigation links for jobseekers and employers.

Recruiter Type	Job Title	Location	Salary	Action
Agency	Junior Database Administrator	Dublin	€25000 - 35000	(+)
Company	Database Administrator	Dublin City Centre	€40000 - 50000	(+)
Database Administrator (37)	Database Administrator	Dublin City Centre	Negotiable	(+)
Database Developer (9)	Oracle Database Administrator	Dublin City Centre	Negotiable	(+)
DbA (8)	Database Administrator	Dublin Cavan Fermanagh	Negotiable	(+)
Data Warehouse Specialist (8)	Database Administrator	Dublin City Centre	See description	(+)
Oracle DbA (7)	DATABASE ADMINISTRATOR	Dublin North Dublin City Centre	€55000 - 65000	(+)
>> more	SQL Database Administrator	Dublin Dublin West	€40000 - 50000	(+)
Locations	Senior Oracle Database Administrator	Dublin Dublin North	€60000 - 70000	(+)
Employment Type				
Salary				

Refine by Keyword >>

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Find The Best IT Jobs
www.real.ie/ Want The Best IT Jobs. RealTime Are The IT Recruitment Specialists.

IT professional?
www.vantage.ie/ The IT sector is booming. Take advantage with Vantage.
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Database Administrator Jobs
www.irishjobs.ie/DatabaseAdminJobs Browse Our Huge Range of Positions. Find Your Ideal Job Online Today!
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Introduction to Databases



Most **computer applications** require a means of storing persistent data i.e.. data that preserves its value between successive invocations of the software that produces it, and also between successive “**switch-ons**” of the computer itself.

Persistent data exists from session to session and traditionally the storage of persistent data has been met by use of magnetic disk or tape. The storage space on disks is generally controlled by **file management software**.

Introduction to Databases



The **file system** provides the user with means to **store** programs and associated data, and is an indispensable part of the computer.

It provides basic tools for *file abstraction, naming, categorisation, reading, writing and positioning*.

However, as technology moved forward, with regard to **storage** and **retrieval** of data, there were many problems and limitations of file-based systems, namely; *integration, file format, duplication, generalised maintenance and querying difficulties*.

Using the Database Approach



The database concept arose in an attempt to solve these problems. The fundamental approach to the problem of **data storage and retrieval** changed.

The major factor for consideration when designing the system was **not** the application programs but the data.

Data can be described as **factual information** or information that has been translated into a form that is more convenient to move or process.

A system that can be described as a database must have two essential properties:

1. It holds data as an **integrated system** of records
2. It contains **self describing** information

Using the Database Approach



Using an **integrated system** implies that data is held under the control of one **software management system**.

An integrated system allows us to exploit inter-relationships between the data.

For example: An order processing system might have a set of **customer records** and a set of **order records**. **Integration** allows the order records belonging to each customer to be readily determined.

Using the Database Approach



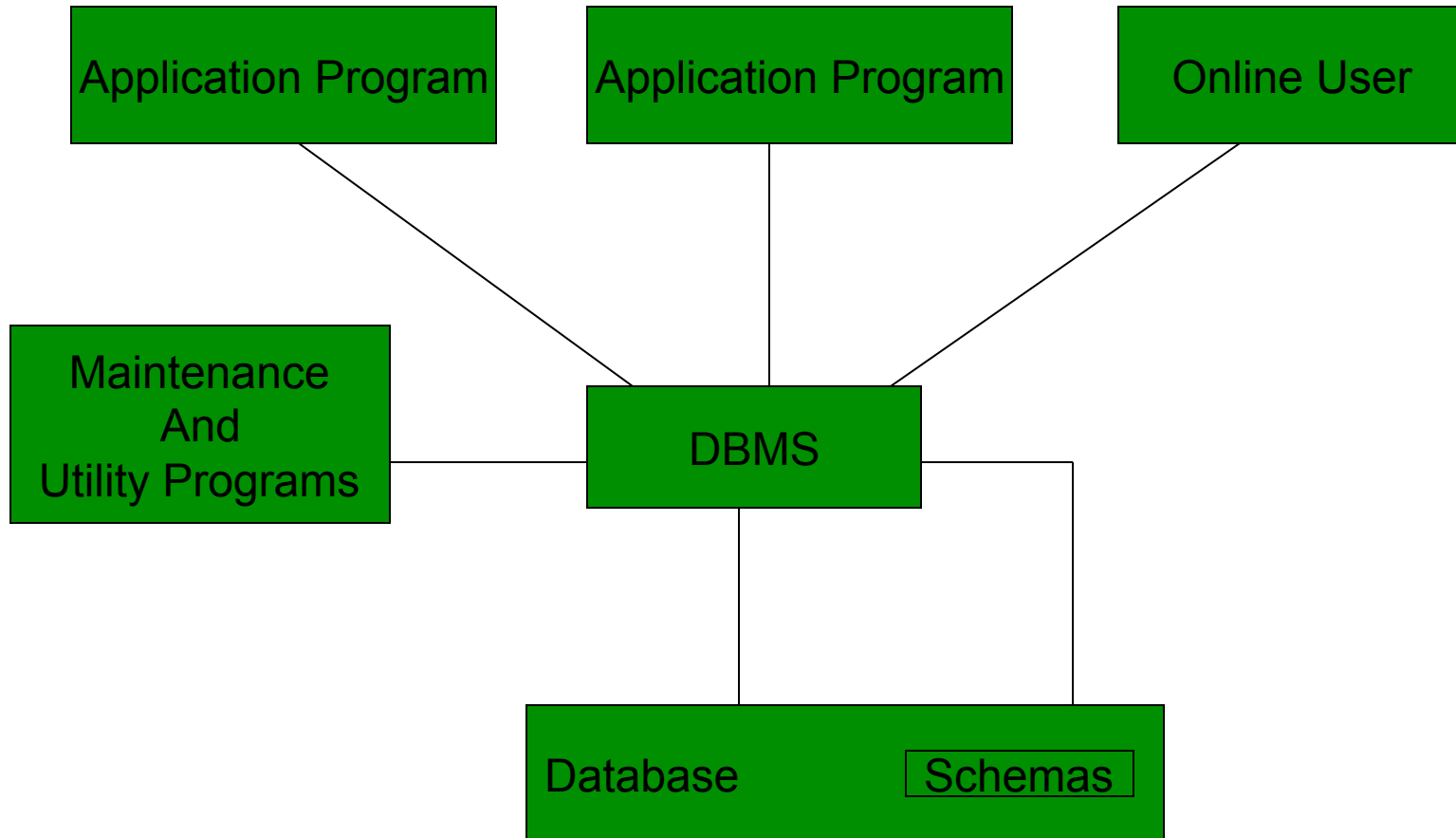
Self Describing Data refers to a database containing **metadata**.

Meta data is a description of the data held in a database. This takes the form of **schemas** which define the structure of records held in a database.

It defines the position, field and type of each component field of each database record type.

A **schema** enables a database to exist independently of any program.

Conceptual view of Database System



DBMS (Database Management System)



Access to the database application data and to the schemas or meta data is vested entirely in DBMS. This means that direct access to the stored data, even in read-only mode is not possible.

The **schemas** are stored in the database itself, so the database contains its own description.

The DBMS facilitates different modes of access e.g interactive facilities provided by UI. Programs can be written to access the DBMS and generate reports.

A DBMS allows organisations to place control of database development in the hands of Database Administrators (DBAs) and other specialists.



Cells, Rows, Tables and Databases

- **Database** -- a collection of related tables describing various facets of a group of objects or events.

Database

Student Table

StudentID	StudentName	CourseCode
B00001234	Joe Bloggs	BN002
B00051413	Ann Ryan	BN001
B00012136	John Smith	BN005

Course Table

Course Code	Course Name
BN001	Certificate in Computer Engineering
BN002	Certificate in Computing
BN005	Certificate in Business Studies

Cells, Rows, Tables and Databases



- **Table** -- a series of rows describing separate objects or events.
 - (tables are also called relations)

StudentID	StudentName	CourseCode
B00001234	Joe Bloggs	BN002
B00051413	Ann Ryan	BN001
B00012136	John Smith	BN005



Cells, Rows, Tables and Databases

- **Row** -- a group of values representing a single instance of an entity – an object or event.
 - (rows are also called tuples)

B00001234	Joe Bloggs	BN002
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Cells, Rows, Tables and Databases



- **Cell** -- a single value, **an item of data**.

B00001234

More on terminology – a database management system (DBMS)



- A collection of programs that enables users to create and maintain a database.
 - Records the structure of the data in the databases (meta data)
 - Handles request from users and programs to:
 - Add data the the database
 - Delete data from the database
 - Update data in the database
 - Query the database (makes requests such as list all books sold by amazon in the last 30 minutes)

Database Models



A **DBMS** allows users and other software to store and retrieve data in a structured way. Instead of having to write computer programs to extract information, user can ask simple questions in a query language Structured Query Language(SQL).

DBMS' s can use a variety of **database models**.

- Hierarchical
- Network
- Relational
- Object Oriented

Relational Model



The **relational database** model was initially seen as processor intensive, however with an increase in computer performance this disadvantage was soon overcome.

The relational model was mainly attributed to Edward Codd. A relational database allows the definition of data structures, storage and retrieval operations and integrity constraints.

The data and relations between them in a relational database are organised in **tables**.

A **table** is a collection of **records** and each record in a table contains the same **fields**.



Evolution of Data Storage

FILE SYSTEMS

Historically, each programmer developed proprietary methods of storing and managing data

1960

1970

DATABASES

Standard approaches to managing were developed and sold as packaged solutions

1980

1990

Market consolidates around a number of products, e.g.
Oracle, Sybase,
SQL Server

2000

Internet-enabled, XML and Object-Relational
Databases

Chronology of DBMS Evolution



- Early days of computers everything stored in flat files
- 1960's Data became structured with the Hierarchical Data Model but it could not model many to many relationships
- 1970 Dr. E.F. Codd introduces the Relational Model
- 1971 The Network Model extended the Hierarchical Model by allowing a child to have zero one or more parents.
- 1974 SQL is Introduced by a colleague of Codd also working at IBM in San Jose
- 1976 Chen introduces the Entity Relationship model
- 1979 Relational Database Technologies release a product called 'Oracle'
- 1986 American National Standards Institute adopts the Relational Model as a standard
- Late 80's OODM emerges
- Late 90's XML (eXtensible Markup Language) emerges as a throwback to the Hierarchical Model
- 2000's Hybrids of Object, XML and Relational emerge.

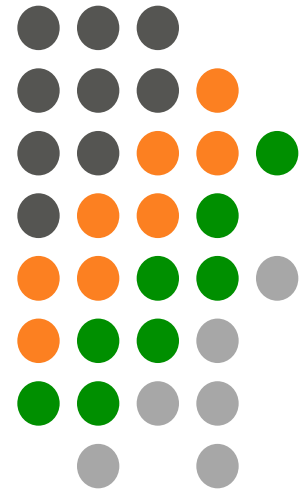
Benefits of using a Database



- Shared Data
- Reduced Redundancy(duplication)
- Reduced Inconsistency
- Support for Transactions(integration)
- Integrity is Maintained (accuracy and consistency between updates, imposed at design stage)
- Security is Enforced
- Reduced data entry storage and retrieval costs

Recap

- What is Data?
-**Raw unprocessed facts**, text, numbers, images.
- What is a Database?
-A **persistent** store for data that holds data in an **integrated system** of records and contains **self describing** information
-A logical coherent collection of data that has some structure.
-A collection of related data which represents some real world aspect
- What is a DBMS?
A **software system** used to record **structure** of database. Manages **updates**, processes **queries**, responsible for **security** and **reliability** of the database.
- Types of Databases?
Hierarchical, Network, **Relational**, Object Oriented, Object Relational



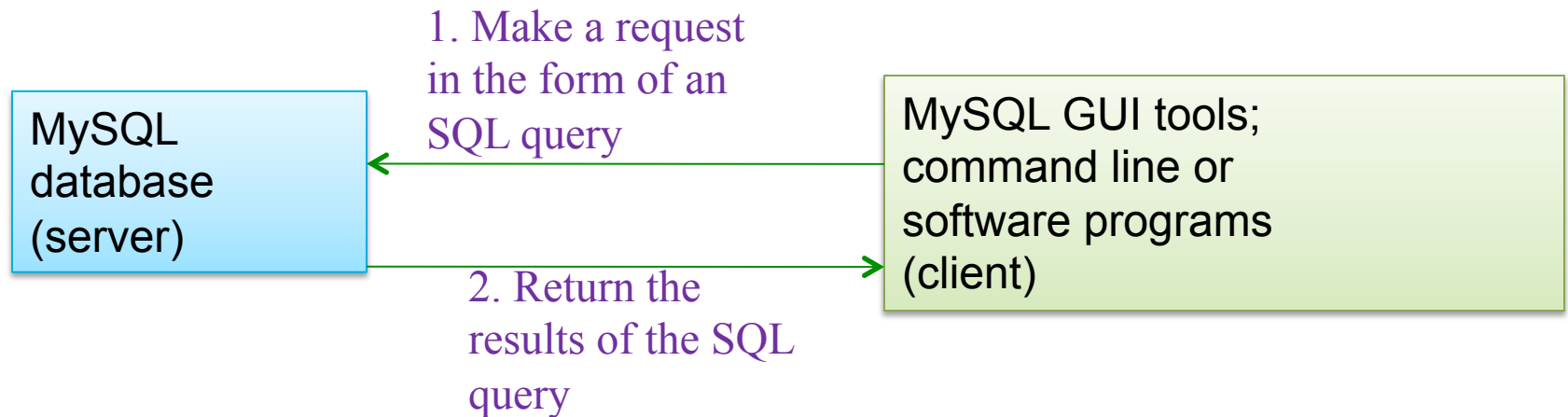
MySQL — the DBMS we will be using in the lab



- MySQL is a **Relational Database Management System** (RDBMS).
- MySQL is the most popular **Open Source** database implementation
- MySQL Database Server is very **fast, reliable,** and **easy to use.**
- The MySQL Database Software is a **client/server** system.



MySQL – Client / Server



- ▶ Client program can be a MySQL command line client, GUI (Graphical User Interface) client, or a program written in any language such as C, Perl, PHP, Java that has an interface to the MySQL server.

MySQL



- MySQL can be installed as a service which starts automatically when your machine starts up.
 - Can add icons on the desktop for starting and stopping the server.
- Alternatively it can be started from a terminal window.
- Default administrator user name and password is:

User name: root

Password:

Starting MySQL



To start the MySQL server, select **start-> program files-> mysql -> mysql server ->mysql command line client.**

Just hit **enter** when asked for a **password** (the password is NULL on installation)

What have you just started?



Answer: A MySQL database **instance**.

- The term **instance** means a complete database environment, including the RDBMS software, table structures and other objects.
- Each **database instance** can store multiple **databases** (also called **schemas**).
- Each **database** will contain multiple **tables**.

Database instance



A MySQL Database **Instance**

RDBMS software

Sales **database** (also called a **schema**)

Customer **table** holding details of all customers

Sales order **table** holding details of all sales

Promotions **table** showing details of all current promotions

Payroll **database** (also called a **schema**)

Employee **table** holding details of all employees

Tax_bands **table** holding details of current tax bands and rates



Working with MySQL

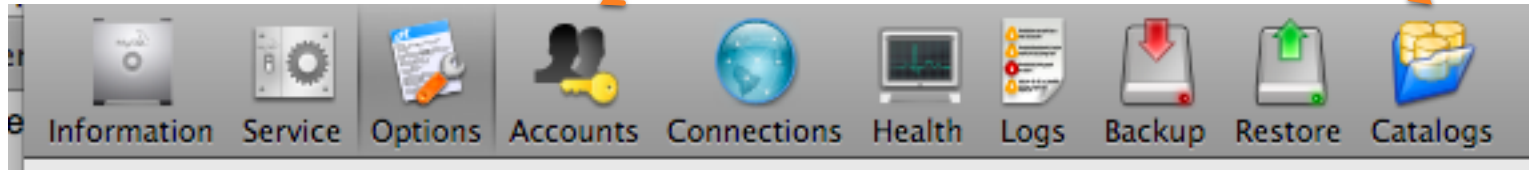
Once the server is started, you can interact with it using GUI clients such as:

- **MySQL Administrator**:- Server Administration to manage the database objects and users.
- **MySql Query Browser**:- for running SQL queries.
- **MySQL workbench**:- incorporates both tools above and an EER (Enhanced Entity Relationship Model) modelling tool

MySQL Administrator



- Used to manage users (accounts) and databases (catalog)



MySQL Query Browser

- SQL queries can be run from MySQL Query Browser.



The screenshot shows the MySQL Query Browser interface. At the top, there is a query input field containing `select * from client`. Below the input field is a table displaying the query results. To the right of the table is a sidebar showing the database schema, including a tree view of databases and tables. The 'client' table is highlighted in the tree view.

client_name	client_department_number	billing_address	contact_email	contact_phone
Big Data	200	2	accounting@bigdatacorp.co	accounting@bigdatacorp.co
Big Data	2000	1	accounting@bigdatacorp.co	accounting@bigdatacorp.co

1. Type in an SQL query

2. Click on Execute

3. Query results are displayed here

Available databases

Tables in the database

Some example SQL queries



- **Show databases**: list all the database the current user has access to
- **Use *databaseName***: tells MySQL which database to run the queries against, e.g. **Use consult**
- **Describe *tablename*** gives the column names and definitions of a table in the database, e.g. **Describe client**
- **Select * from *tablename*** lists all the data in the specified table, e.g. **Select * from client**

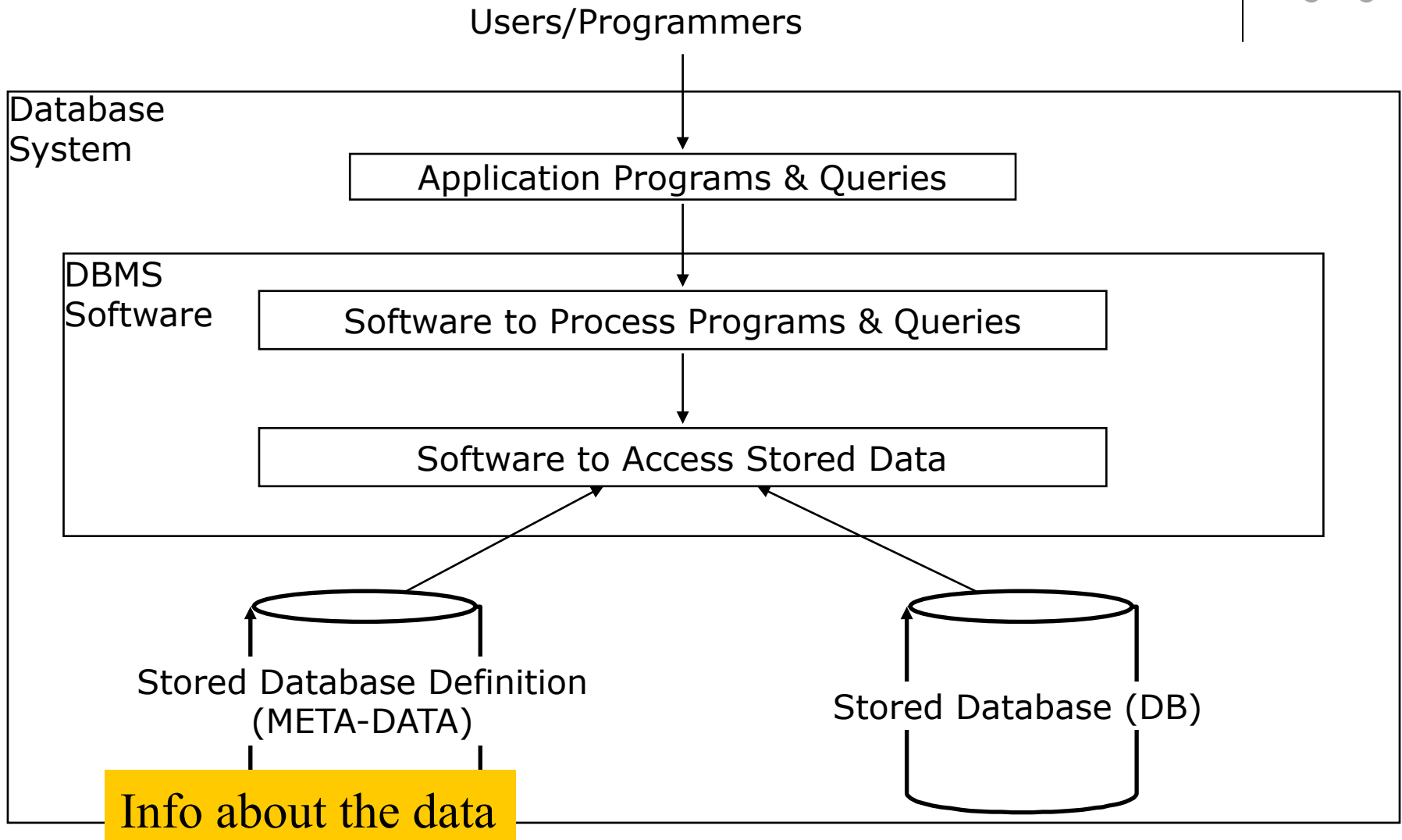
More on terminology – a database system



- The database system is the term given to all of the following together:
 - The DBMS,
 - The data
 - And the programs that access and maintain the data



A database system





Short Video

- Video:

Intro to Databases and SQL

URL: <http://www.youtube.com/watch?v=UeJKioNqe5w>



Books

Essential Reading:

- Colin Ritchie - **Relational Database Principles**, Letts Educational
- McFadden et al, **Modern Database Management**, Addison Wesley
- Fowler, **UML Distilled**, Addison Wesley

Recommended Reading:

- R.L. Warrender – **Databases**, Crucial
- Elmasri/Navaithe, **Fundamentals of Database Systems**, Addison Wesley
- Date, **An Introduction to Database Systems**, Addison Wesley
- Connolly & Beggs, **Database Systems**, Addison Wesley
- McDermid, Donald C, **Software Engineering for Information Systems**, Blackwell

More on books . . .



- There are many book's in the library covering an introduction to database systems, all of which cover most of the material in this course. Here are details of some of them.

Book	Comment
Watson et al, Data Management: Databases and Organisations John Wiley.	I would recommend this book as a starting point for those new to databases. It gives a comprehensive introduction to the topic, but lacks detail in sections.

McFadden et al, Modern Database Management Addison Wesley	These four books give the best coverage of the topics on the course.
Colin Ritchie, Relational Database Principles, Continuum International Publishing Group	
Connolly & Begg, Database Systems, Pearson Education	
Fowler, UML Distilled, Addison Wesley	



More on books

Elmasri/Navaithe,
Fundamental of
Database Systems,
Addison Wesley

For those with previous experience in databases and want to extent their knowledge, this book goes into more detail than the previous three books, and also covers relational algebra, the mathematical theory of relational databases.

Date, An Introduction to
Database Systems,
Addison Wesley

Date is probably the best know database book, and has been for many years. It is suitable if you want to extent your knowledge beyond the scope of this course.