

CERT/DEGREE IN COMPUTING, YEAR 2

# DATABASE FUNDAMENTALS

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*Unit 1: Introduction to Databases*

# What is a database?

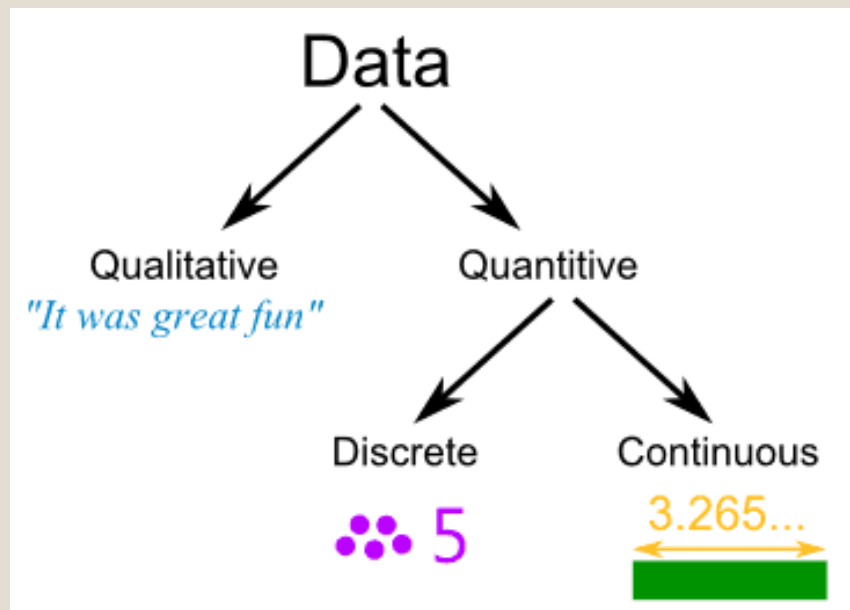
- ▶ At its simplest, a tool to store data permanently, i.e. a persistent data store

# What is data?

- ▶ Data is a collection of facts, such as values or measurements
- ▶ It can be numbers, words, measurements, observations or even just descriptions of things.

# What is data . . . .

- Data can be qualitative or quantitative.
  - **Qualitative data is descriptive information (it describes something)**
  - **Quantitative data**, is numerical information (numbers)



# Collecting data

- Data is collected in many ways:
  - Observation: e.g. science experiment such as “What temperature does oil boil at”?
  - Doing a survey, e.g. the census



- By computer programs . . .

# More on data . . .

## Fahrenheit to Celsius Converter

---

**Enter a number in either field, then click outside the text box.**

F:

C:

- What is the data used by the software program above?
- Where is it stored?
- Does it need to be recorded for use later?

# More on data . . (from amazon.co.uk).

## Or Create a New Account

Enter your name and e-mail address and choose a password for your account.

**Full Name:**

**E-mail Address:**

**Re-enter E-mail Address:**

**Choose a Password:**

**Re-enter Password:**

Create a new account

- ▶ What is the data used by the software program above?
- ▶ Where is it stored?
- ▶ Does it need to be recorded for use later?

# Databases



The focus of this course is  
**how to store  
data**

**Efficiently,  
Accurately**

**and**

**Securely**

so that it can be  
accessed easily from  
software programs

# The Evolution of Database

- The Evolution
- We will come back to this at the end of the course when we have considered the relational database model and the terms/concepts make sense!



# The big picture . . .

Java  
programs

Web pages (ASP  
/ JSP / PHP)

Programs written in  
other languages

request data

Database Management System (DBMS) –  
manages all data going in and out of the  
database (e.g. MySQL, Oracle, SQL Server, MSAccess)

2. Programs  
access data  
using SQL

3. What does  
the DBMS do?

**Actual data**  
Your account  
data (e-mail  
address,  
password, postal  
address etc.)

**Actual data**  
Data about the  
books for sale on  
Amazon: title,  
price, reviews etc.

1. How to organise  
data so that the  
DBMS can process  
queries efficiently?

# Learning outcomes . . . .

**(Knowledge)** Having successfully completing this module the student will be able to:

- ▶ describe the **architecture** of a relational database
- ▶ define the **terminology** and concepts associated with relational databases
- ▶ explain various aspects of **transaction processing**
- ▶ define and describe **SQL**

**(Skills)** Having successfully completed this module, the student will be able to:

- ▶ Model database requirements using an ERD
- ▶ produce a **normalised** set of tables
- ▶ query and manipulate database objects (using **SQL**)

# Databases: Learning Outcomes

(diagram of text on last slide)

## Skills – what you will be able to do

1. Produce a relational model for a database
2. Produce a set of normalised tables
3. query and manipulate data using SQL

## Knowledge – the theory to back up the practical skills above

1. Architecture of Relational Databases
2. Databases Terminology & Concepts
3. Define and Describe SQL
4. Understand transaction processing

# Topics

Topic 1: Features of a Relational Database

Topic 2: SQL

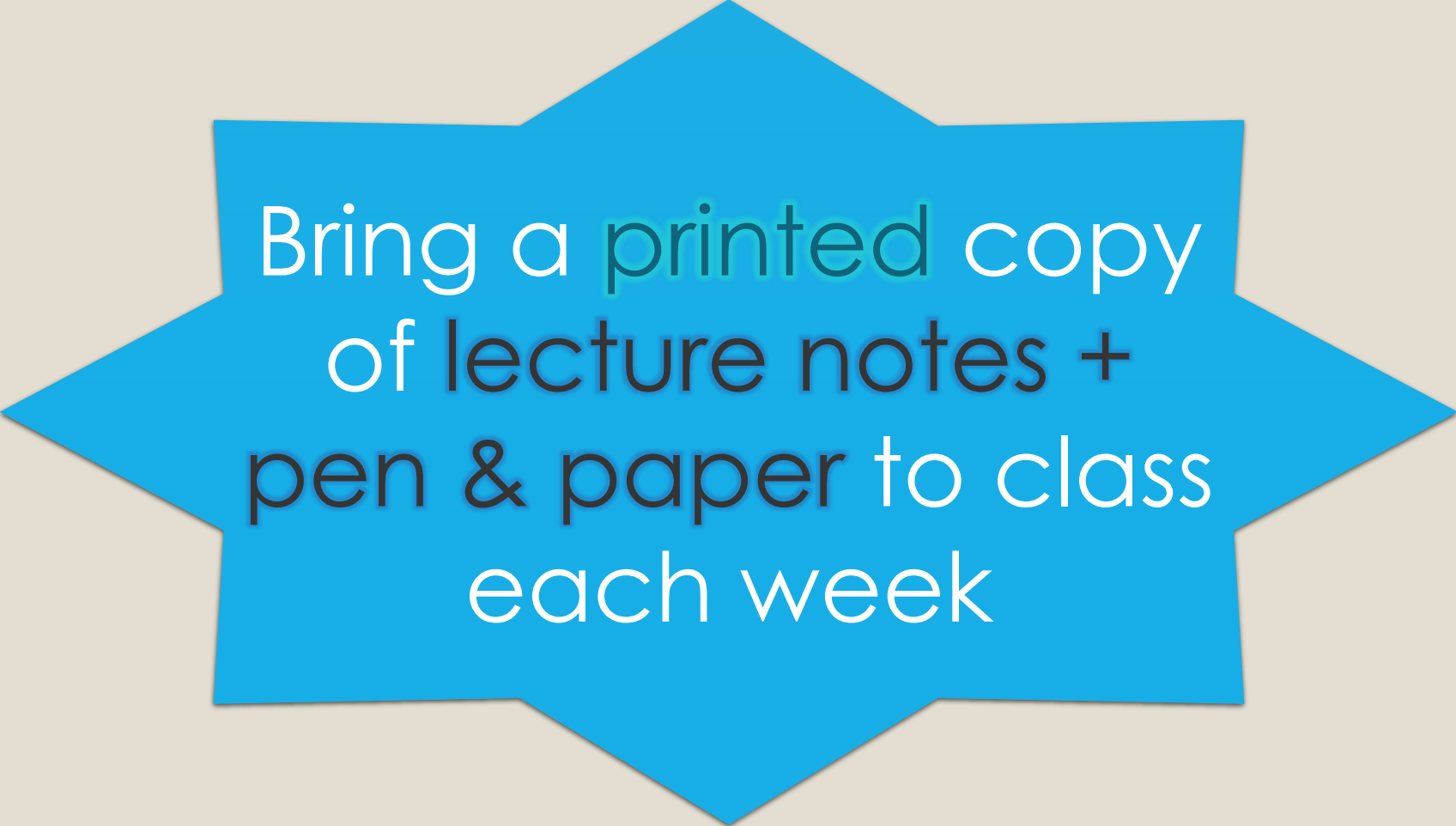
Topic 3: Database Design

(ERDs and Normalisation)

Topic 4: Transaction Processing, Security

Software: MySQL

# House Keeping



Bring a printed copy  
of lecture notes +  
pen & paper to class  
each week

# Schedule

- Continuous Assessment: 50%
- Exam: 50%
- Credits: 5

# Moodle

- The enrolment key for Moodle is as follows:
- **DBF2016**

# Continuous Assessment

- Total Value: 50%
  - 1. Lab worksheets - 10%
    - To be completed throughout the semester - a portfolio of lab worksheets expected and should be uploaded to Moodle weekly (**No late submissions accepted**)
  - 2. SQL in-class test- 15%
    - Will be held around week 6
  - 3. Database Design Assignment - 25%
    - Either as a class test / assignment (report)
    - Will be held/due in week 12



# Why study databases?

## CORE IT Skill

– irishjobs.ie SQL/Databases skills

http://www.irishjobs.ie/ShowResults.aspx?Keywords=database&Loc: Machine Learning is Fu... ITB Moodle: Log in to t... SQL Basics - Lesson2 - ... Relational Database Fu... Course: COMP1111 - Y... database Jobs in Irel... X

>> show more ▾

RELATIVE ROLES/SKILLS ▾

Software Developer (19)	x
Database Developer (14)	x
Java Developer (13)	x
Recruitment Consultant (11)	x
.Net Developer (10)	x

>> show more ▾

LOCATIONS ▾

Leinster (496)	x
Dublin (464)	x
Dublin City Centre (113)	x
Munster (87)	x
Dublin South (65)	x

>> show more ▾

EMPLOYMENT TYPE ▾

Permanent full-time (485)	x
Contract (90)	x
Fixed term contract (23)	x

Contract SQL Database Developer NOT FOR ME  
Irish Recruitment Consultants  
See description Updated 07/09/2016 Wexford / Kilkenny / Waterford  
areas such as Software & Data systems migration, Business Intelligence, data transformation, database ... currently within our Technology Division. Other Key Terms: Contract SQL Database Developer, SQL ...  
★ SAVE THIS JOB SHOW MORE ▸

Database Administrator (DBA) NOT FOR ME  
Clever Techies  
Negotiable Updated 05/09/2016 Dublin  
Database Administrator (MS-SQL & MySQL) Our client is a leading provider of IT systems management ... , widespread engineering team where you'll be working with large distributed database systems to ensure ...  
★ SAVE THIS JOB SHOW MORE ▸

SQL Developer Database Engineer NOT FOR ME  
Reperio Human Capital Ltd  
€ 30000 - 40000 Updated 02/09/2016 Dublin  
in relevant degree PostgreSQL on Linux exposure Scalable database solutions experience Knowledge ... in Database engineering Your new role at this global company will involve writing SQL database ...  
★ SAVE THIS JOB SHOW MORE ▸

Database Administrator (MYSQL) NOT FOR ME  
Eolas - Specialists in IT  
€ 50000 - 60000 Updated 06/09/2016 Dublin

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ACCEPT & CLOSE

# Exercise time

- Suppose you had to write an application for the following.
- Identify what information needs to be persistent (stored permanently) to a database . .
  - ▶ A competitor to face book
  - ▶ A recruitment web site like [www.irishjobs.ie](http://www.irishjobs.ie)
  - ▶ A college system to handle student registrations and exam results.

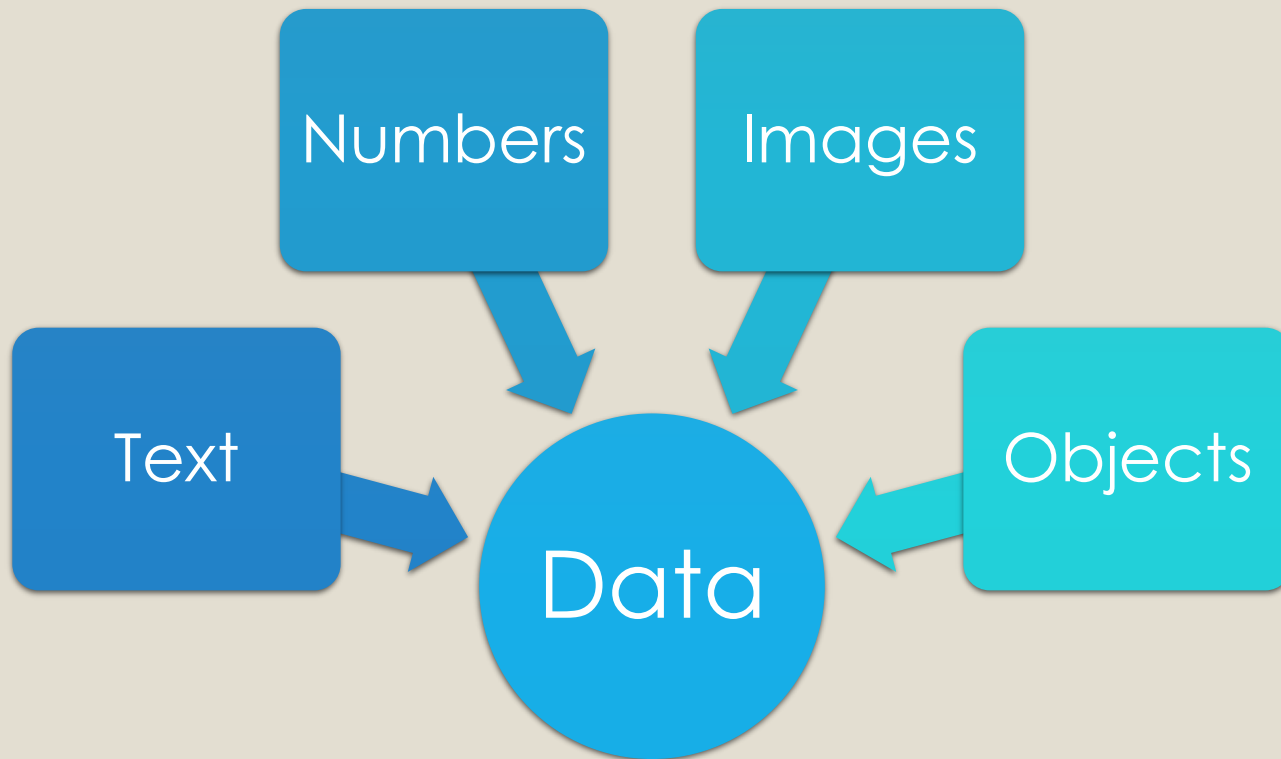




# SOME BACKGROUND AND TERMINOLOGY

# Some Terminology - data

1. Data: known facts that can be recorded



# Some Terminology - database

1. A collection of related data which represents some aspect of the real world

2. Is a logical coherent collection of data- has some structure

A database  
is . . . .

3. Was designed and built for a specific purpose

4. Can be any size or complexity

# 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
-----------	------------	-------



# 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 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)

CRUD application – Acrostic for an application using a database. The letters stand for Create, Read, Update and Delete

# The big picture . . .

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programs

Web pages (ASP  
/ JSP / PHP)

Programs written in  
other languages

request data

Database Management System (DBMS) –  
manages all data going in and out of the  
database (e.g. MySQL, Oracle, SQL Server, MSAccess)

2. Programs  
access data  
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3. What does  
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**Actual data**  
Your account  
data (e-mail  
address,  
password, postal  
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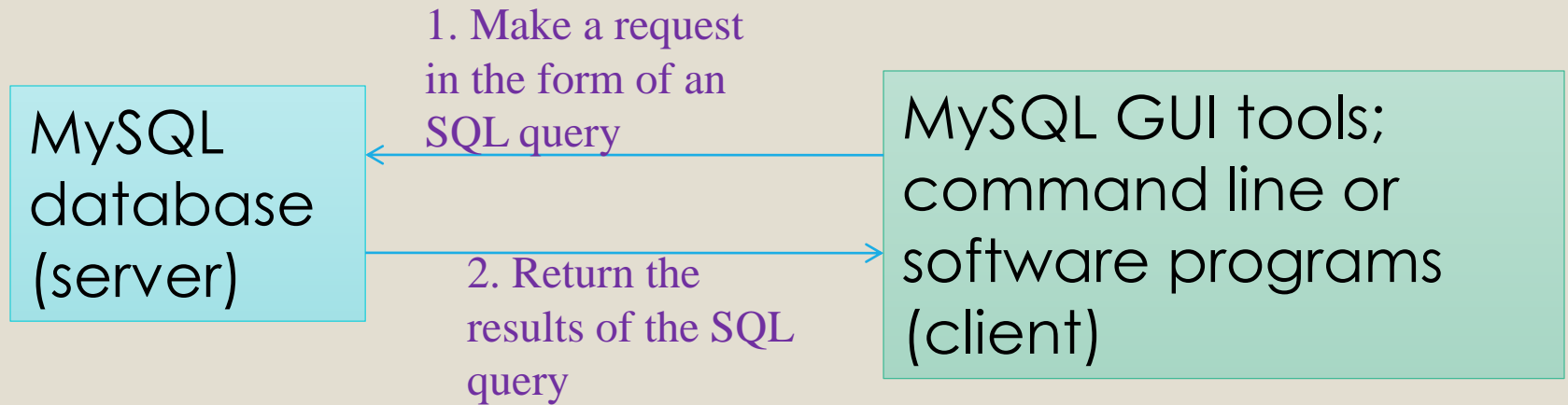
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Data about the  
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1. How to organise  
data so that the  
DBMS can process  
queries efficiently?

# 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

- Download from: <http://dev.mysql.com/downloads/>
- 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 5.7 ->mysql command line client**.

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

Alternatively, you can run the following from a terminal window:

```
c:\program files\mysql\mysql server  
5.0\bin\mysqld --console
```



## Workbench Central



## Welcome to MySQL Workbench

## ➔ What's New in This Release?

Read about all changes in this MySQL Workbench release.

MySQL Doc  
LibraryMySQL Bug  
ReporterWorkbench  
Team Blog

Planet MySQL

Workbench  
Forums

## Workspace



## SQL Development

Connect to existing databases and run SQL Queries, SQL scripts, edit data and manage database objects.



## Data Modeling

Create and manage models, forward &amp; reverse engineer, compare and synchronize schemas, report.



## Server Administration

Configure your database server, setup user accounts, browse status variables and server logs.



## Open Connection to Start Querying

Or click a DB connection to open the SQL Editor.



## Open Existing EER Model

Or select a model to open or click here to browse.



## Server Administration

Or click to manage a database server instance.



## Local instance MySQL

User: root Host: localhost:3306



## B00068221lab7leegerety

Last modified Wed Jan 14 16:04:53 20...



## b00070522\_lab7

Last modified Wed Jan 14 15:51:45 20...



## B00066938\_Group3\_Lab7

Last modified Wed Jan 14 15:50:05 20...



## Lab8

Last modified Wed Jan 14 15:47:54 20...



## lab7

Last modified Wed Jan 14 14:12:54 20...



## Local MySQL

Local Type: Windows



## New Connection

Add a new database connection for querying.



## Edit Table Data

Select a connection and schema table to edit.



## Edit SQL Script

Open an existing SQL Script file for editing.



## Manage Connections

Modify connection settings or add connections.



## Create New EER Model

Create a new EER Model from scratch.



## Create EER Model From Existing Database

Create by connecting and reverse engineering.



## Create EER Model From SQL Script

Import an existing SQL file.



## New Server Instance

Register a new server instance to manage.



## Manage Import / Export

Create a dump file or restore data from a file.



## Manage Security

Manage user accounts and assign privileges.



## Manage Server Instances

Add, delete and update server instance settings.





# 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

and other tables . . . .

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

Employee **table** holding details of all employees

Tax\_bands **table** holding details of current tax bands and rates

and other tables . . . .

# 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 modelling tool



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# MySQL Query Browser

- SQL queries can be run from MySQL Query Browser.

The screenshot displays the MySQL Query Browser interface. At the top, there is a query input field containing the SQL query `select * from client`. To the left of the input field are 'Back' and 'Next' buttons. To the right are 'Execute' (a green lightning bolt icon) and 'Stop' (a red octagon icon) buttons. Below the query input is a table showing the results of the query. The table has five columns: `client_name`, `client_department_number`, `billing_address`, `contact_email`, and `contact_phone`. The results show two rows of data for 'Big Data'. To the right of the results table is a 'Schemas' panel showing a tree view of the database structure. The tree shows a 'def' folder containing 'information\_schema', 'BookDB', 'Customer', and 'consult'. The 'consult' folder is expanded, showing 'address', 'billable', and 'client' tables. A mouse cursor is pointing at the 'client' table.

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

Tables in the database

Available databases

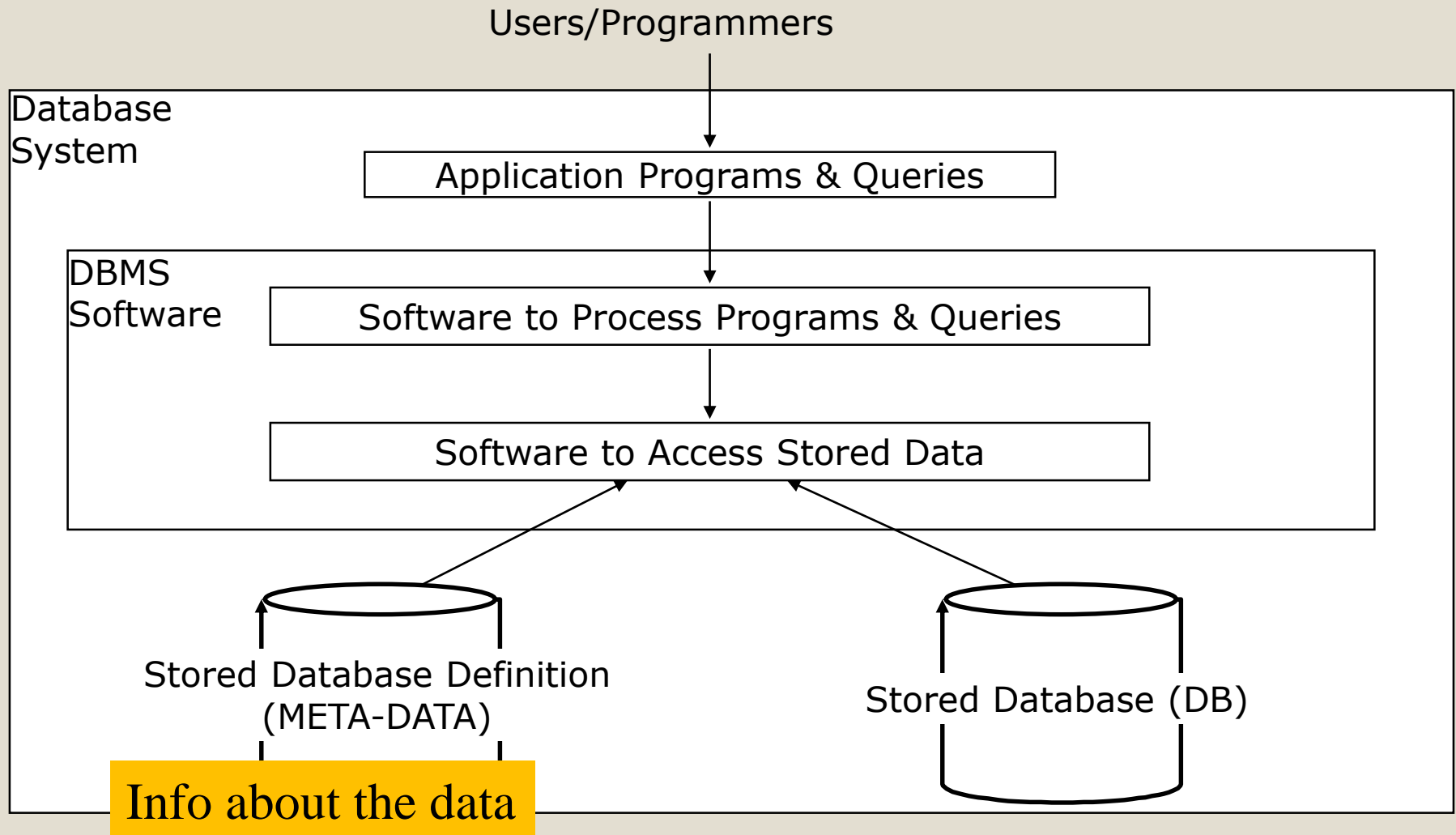
# Some initial SQL queries

- *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

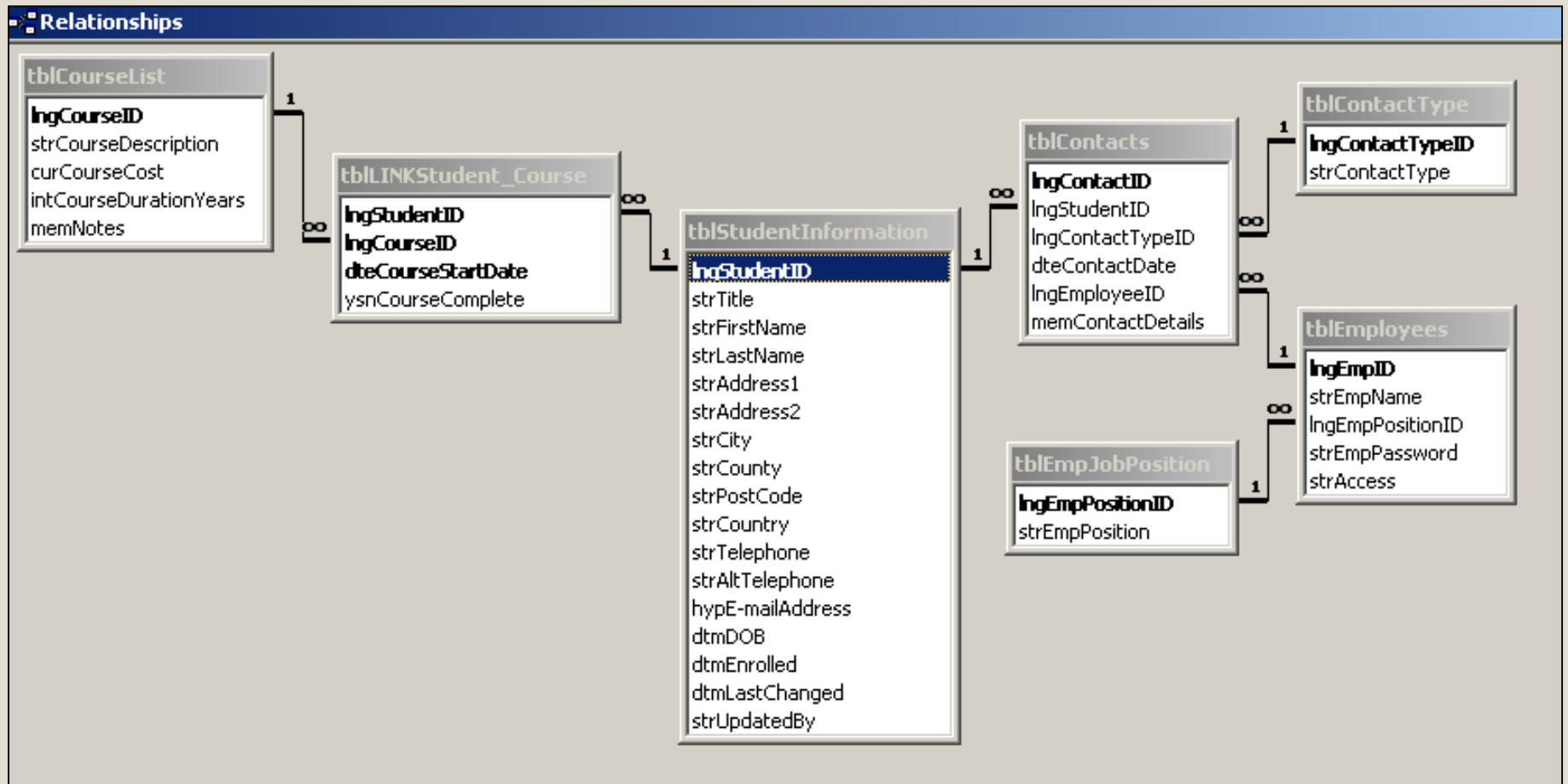




# Advantages of using a database

- The programmer does not need to know **how** to **store** the data.
- The programmer does not need to know **where** to **store** the data.
- The programmer does not need to know how to **manage** the data.

# Exercise – Interpret the following:



# Summary

- Definitions:
  - Data & sources of data
  - DBMS
  - Database Systems
- MySQL
  - Open source RDBMS
  - Tables organised into schema
  - GUI tools: administrator, query browser, EER
- Job market

# Books

- Essential Reading:
- Colin Ritchie - **Relational Database Principles**, Letts Educational
- Recommended Reading:
- R.L. Warrender – **Databases**, Crucial
- McFadden et al, **Modern Database Management**, Addison Wesley
- 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 three 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	

# 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.

# Short Video

- Video:



Intro to Databases and SQL

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