Databases:
Concepts of database design
Databases: Concepts of database design

Your safety and comfort are important

Where is the fire exit?

Please tell us if anything doesn’t work

The toilets are along the corridor outside the teaching rooms

The rest area is where you registered; it has vending machines and a water cooler

Resources for your learning

Activities for you to practice today

- Work at your own pace!
- Be selective

Video playlists with today’s topics in Lynda.com

Follow-up work

- Continue with exercises after the session
- Bookable Clinics later

Road map for “Concepts of database design”

Demo: a finished database

- Joins between tables
- Some more difficult cases
- Break

How to start designing a database with multiple tables

- A workflow for designing a database
- Group work: some scenarios

- More scenarios

Recap and next steps

Demo: A finished database

St. Giles Dental Surgery
Databases: Concepts of database design

**Database Tables**

** Decide on the fields
- Think of all the facts that will be collected
  - plenty of fields
  - consult widely
  - small fields “atomic”
- Set the data type for each field

**Collect the data into tables**

**Assign a data type to each field**

**Join related fields between tables**

**Group work 1**

**Work on the scenarios, in groups of 2 or 3**
- White papers and cards are for you to write on
- Coloured papers we will collect afterwards

**MAX 5 minutes on each scenario**

**Restart at 10:15**
Every table must have a primary key field
A field that never has duplicate values
Used for joining between tables

Usually a field that auto-numbers

Archaeology and swords example

- How many swords are there with wooden handles?
- Give the lengths of all swords found at Hereford
- What is the likely date of the sword that is made of steel & steel?
Databases: Concepts of database design

Project Consultants example

- Which projects are in Scotland?
- Which consultants have worked over 50 hours on a project (give names)?
- Which locations has Mr/Mrs Grey worked in?

And now a tough one:
- Name the consultants who have worked in Bury

Concepts of database design

Take a break

Restart at 11am
If you want to continue with the exercises, you could ...

Copy the Exercise files to a memory stick

Download the files (and more) from the ITLP Portfolio at http://portfolio.it.ox.ac.uk

Download the Step By Steps

Joins between tables

Flat file design?

All data in one table - like a spreadsheet

But does this suit your real situation?

Clues in the data
Redundant data
Inconsistent data
Inflexible data, difficult to analyse

Multiple tables generally mean a better model

Relationship types

One-to-many (the most common)
One record in this table corresponds to several records in that table
Primary key is on the “one” side

One-to-one
Less common

Many-to-many
Modelled using two one-to-many joins, with an intermediate table to link them

Library catalogue scenario

An analysis of a lending library has gathered the following data:

<table>
<thead>
<tr>
<th>catalogID</th>
<th>ISBN</th>
<th>title</th>
<th>author</th>
<th>YearOfPub</th>
<th>PublisherName</th>
<th>address</th>
<th>TelNum</th>
<th>cardID</th>
<th>name</th>
<th>address</th>
<th>TelNum</th>
<th>DateOut</th>
<th>DueDate</th>
<th>ReturnedDate</th>
<th>FeeDue</th>
</tr>
</thead>
</table>

How can this data be organised into tables?
An analysis of a lending library has gathered the following data:

- **tblBooks**
  - catalogID, ISBN, title, author, YearOfPub

- **tblPublishers**
  - PublisherName, address, TelNum, PublisherID

- **tblBorrowers**
  - cardID, name, address, TelNum

- **tblBorrowed-items**
  - DateOut, DueDate, ReturnedDate, FeeDue, BorrowingID

The library catalogue scenario can be represented as a set of tables, each containing specific data fields:

- **tblBooks**
  - catalogID, ISBN, title, author, YearOfPub, PublisherID

- **tblPublishers**
  - PublisherName, address, TelNum, PublisherID

- **tblBorrowers**
  - cardID, name, address, TelNum

- **tblBorrowed-items**
  - DateOut, DueDate, ReturnedDate, FeeDue, BorrowingID, BookID, BorrowerID
Group work 2

Work on the scenarios in your groups

This time, use the Designing workflow

Restart at 12:00

Reflect

Start design for your own project:

Course Clinic
IT teachers will be there to help you

ITLC Portfolio
Downloadable resources & model answers
http://portfolio.it.ox.ac.uk

Further courses

Next steps with databases:
- Databases: Building a database
- Databases: User-friendly database design

Further work:
- Databases: Queries and data analysis
- Databases: MySQL Introduction
- Databases: MySQL Further techniques
- Lynda.com videos about databases and other topics
# 2 - William Gladstone’s Diaries (10 minutes max)

William Gladstone (Prime Minister during the period 1868-94) kept a diary all his life, recording every person he met. He met some people many times, others only once. Most of them associated with one or other political party or group.

The diaries have recently been published and the editor wants to produce a final index volume, giving details about each person mentioned and the date/s when Gladstone met them, as well as their political affiliations. She also wants to be able to find all the people whom he saw on a particular day, for checking.

Discuss in your group the *fields* that may be needed. Using the cards provided, choose which are likely to be needed as fields, discard any irrelevant ones and write more cards for other fields that you think of.

Organise the fields into groups which belong together, and allocate them to *tables* using the printed sheets. For each field in a table, decide on the *data type* (text, number, date, yes/no etc.).

---

# 1 - Archaeological Sites and Swords

An archaeologist is working on the swords found at various burial sites.

She wants to record the details of the swords and compare them with the known age of the site and its location.

In your group, think about the fields you will need to store this information. Draw up a list of the fields (data points) that should be collected. For each field, note the likely data type. Do not try to organise the fields into tables for this exercise.

Note any assumptions or simplifications you agree on.
3 - HR Consultants and Projects

HR Consultants provide consultants to work on clients’ projects. Each consultant works on only one project at a time, but a project may employ more than one consultant.

Look at the table below and produce a data model that can be implemented in a relational database.

<table>
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<tr>
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<th>Hourly rate</th>
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<tbody>
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<td>Glasgow</td>
<td>£ 100.00</td>
</tr>
<tr>
<td>25</td>
<td>Z50</td>
<td>90</td>
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</tr>
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<tr>
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<td>Aberdeen</td>
<td>£ 150.00</td>
</tr>
</tbody>
</table>

4 - Room booking activity

An admin assistant has been asked to look after a set of meeting rooms, and to keep track of room bookings that are made by people from various other departments. He plans to create a computerised database for this.

Discuss in your group the fields that may be needed.

Organise the fields into groups which belong together, and allocate them to tables. For each field in a table, decide on the data type (text, number, date, yes/no etc.).

As with any real-life design, you will have to make assumptions or simplifications. Note these at the bottom of the relevant table.
<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GroupID</td>
<td></td>
</tr>
<tr>
<td>GroupName</td>
<td></td>
</tr>
<tr>
<td>GroupLeader</td>
<td></td>
</tr>
<tr>
<td>GroupPolicyStatement</td>
<td></td>
</tr>
<tr>
<td>PersonID</td>
<td></td>
</tr>
<tr>
<td>FirstName</td>
<td></td>
</tr>
<tr>
<td>LastName</td>
<td></td>
</tr>
<tr>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>GroupJoinedID</td>
<td></td>
</tr>
<tr>
<td>MeetingID</td>
<td></td>
</tr>
<tr>
<td>Table name:</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fields:</th>
<th>Data types:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assumptions &amp; simplifications:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>
Here are some possible ways of answering the group tasks. They are not definitive: the best design is the one that fits well with the practicalities of your situation. The purpose of the activity is to help you practice analysing a scenario and designing a sensible way of managing the data.

You may come up with something quite different!
1. Archaeological Sites and Swords

An archaeologist is working on the swords found at various burial sites.

She wants to record the details of the swords and compare them with the known age of the site and its location.

In your group, think about the fields you will need to store this information. Draw up a list of the fields (data points) that should be collected. For each field, note the likely data type. Do not try to organise the fields into tables for this exercise.

Note any assumptions or simplifications you agree on.

Possible Answer

<table>
<thead>
<tr>
<th>Field</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiteName</td>
<td>text</td>
</tr>
<tr>
<td>GridRef</td>
<td>text</td>
</tr>
<tr>
<td>PostCode</td>
<td>text</td>
</tr>
<tr>
<td>SiteDate</td>
<td>text or number (to discuss)</td>
</tr>
<tr>
<td>SwordLength</td>
<td>number</td>
</tr>
<tr>
<td>SwordHandleLength</td>
<td>number</td>
</tr>
<tr>
<td>SwordBladeLength</td>
<td>number</td>
</tr>
<tr>
<td>BladeMaterial</td>
<td>text</td>
</tr>
<tr>
<td>HandleMaterial</td>
<td>text</td>
</tr>
<tr>
<td>SwordCondition</td>
<td>text</td>
</tr>
<tr>
<td>SwordPhoto</td>
<td>hyperlink or OLE or filename and location as text</td>
</tr>
<tr>
<td>SitePhoto</td>
<td>hyperlink or OLE or filename and location as text</td>
</tr>
<tr>
<td>SoilLayerFoundSwordIn</td>
<td>text</td>
</tr>
</tbody>
</table>
2. William Gladstone’s Diaries

Question
William Gladstone (Prime Minister during the period 1868-94) kept a diary all his life, recording every person he met. He met some people many times, others only once. Most of them associated with one or other political party or group.

The diaries have recently been published and the editor wants to produce a final index volume, giving details about each person mentioned and the date/s when Gladstone met them, as well as their political affiliations. She also wants to be able to find all the people whom he saw on a particular day, for checking.

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Possible Answer

(Notice that it’s not essential for the field name in one table to be the same as the corresponding field name in the joined table.)
3. **HR Consultants**

**Question**

HR Consultants provide consultants to work on clients’ projects. Each consultant works on only one project at a time, but a project may employ more than one consultant.

Take a look at the table below and produce a data model that can be implemented in a relational database.

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</tbody>
</table>

**Possible Answer**

![Data model diagram](image)
4. Room Booking Activity

Question
An admin assistant has been asked to look after a set of meeting rooms, and to keep track of room bookings that are made by people from various other departments. He plans to create a computerised database for this.

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As with any real-life design, you will have to make assumptions or simplifications. Note these at the bottom of the relevant table.

Possible Answer
1 - Highland Holidays

Highland Holidays rent out holiday chalets. They need a system that will produce invoices for their customers, showing which chalet has been booked and for how long, and thus the amount of money owed.

Design a database that includes this and perhaps some other relevant data, organised into tables.

Sketch out the tables needed, and the fields to be included in each. Show how the tables are related. Note any assumptions or simplifications you agree on.

2 - Shellfish Species Survey

A zoologist visits 10 different beaches, looking for 35 species of shellfish. On each visit, he records how many of each species he finds at each beach.

Can you suggest a better structure than that shown?

Name some better tables and fields and show how they are related.
3 - Slater Menswear

The table below shows a sample of data collected by the Menswear Sales department of an independent shop. Provisionally, data has been collected in a spreadsheet.

Analyse the data and produce a data model that can be implemented in a relational database. Break the data table down (normalise) into related tables so the information can be managed in a relational database.

<table>
<thead>
<tr>
<th>OrderNo</th>
<th>Date</th>
<th>CustNo</th>
<th>Name</th>
<th>Address</th>
<th>ProdNo</th>
<th>Desc</th>
<th>Price</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>05/10/2007</td>
<td>22</td>
<td>Smith</td>
<td>London</td>
<td>A95</td>
<td>Jacket</td>
<td>£ 55.00</td>
<td>4</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>19/10/2007</td>
<td>47</td>
<td>Jones</td>
<td>Paris</td>
<td>G17</td>
<td>Coat</td>
<td>£ 120.00</td>
<td>9</td>
</tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>37/10/2007</td>
<td>25</td>
<td>West</td>
<td>Glasgow</td>
<td>E30</td>
<td>Tie</td>
<td>£ 5.00</td>
<td>25</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

4 - Video Hire

Oxford DVD Rentals is a small company who rent out DVD movies.

To rent a DVD, a person has to register and pay a membership fee (£10 for 1 month, £50 for 6 months or £70 for a year).

Design a database where the staff can record details of individual members, details of each DVD stocked and who rents each one.

The maximum duration of a rental is 7 days.
5 - Choir Performance Pieces

A choir master is setting up a database of the music his choir performs. For each piece, he needs to know details about the piece itself (title, composer and so on), and where and when it has been performed.

A typical concert consists of around 10 pieces, and some popular pieces are presented repeatedly. He also needs a list of his choristers with their contact information.

Which tables should he set up? Suggest suitable fields. How would the tables be related?

6 - Car Maintenance

Design a database to help a car maintenance workshop manage its business.

When a customer brings along a car for repair or service, staff need to check its service history (i.e. the work they have done on this vehicle in the past). They keep a note of every piece of work done on the vehicle, and which member of the team carried out each task.

This database does not manage any costing, pricing or salary information.
Castellan Ltd is a large insurance company whose training department runs internal training courses. Courses cover subjects such as employee induction, fire evacuation procedures, health & safety, as well as training on the bespoke computer systems used within the company. In addition, the department advises staff on external training for general software packages and coordinates bookings for these.

Until now, records have been collected in an Excel spreadsheet. Analyse the present system and produce a more flexible data model.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Start Date</th>
<th>Attendee-1 Name</th>
<th>Attendee-1 Dept</th>
<th>Attendee-2 Name</th>
<th>Attendee-2 Dept</th>
<th>Attendee-3 Name</th>
<th>Attendee-3 Dept</th>
<th>Attendee-4 Name</th>
<th>Attendee-4 Dept</th>
<th>Attendee-5 Name</th>
<th>Attendee-5 Dept</th>
</tr>
</thead>
<tbody>
<tr>
<td>IND1</td>
<td>Staff Induction</td>
<td>27/03/2007</td>
<td>Neil Smith</td>
<td>Accounts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIR1</td>
<td>Fire Safety</td>
<td>29/03/2007</td>
<td>Peter Brown</td>
<td>Accounts</td>
<td>Joshua Ndola</td>
<td>IT</td>
<td>H Singh</td>
<td>Admin</td>
<td>Sonia Tonn</td>
<td>HR</td>
<td>Jim and Sue</td>
<td>IT</td>
</tr>
<tr>
<td>ACC1</td>
<td>Intro to MS Access</td>
<td>24/04/2007</td>
<td>Jenny Wong</td>
<td>Desktop Services</td>
<td>Peter Brown</td>
<td>Payroll</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>IND1</td>
<td>Staff Induction</td>
<td>15/04/2007</td>
<td>H Singh</td>
<td>Admin</td>
<td>Paula Fisher</td>
<td>Payroll</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Databases: Concepts of Database Design

IT Learning Programme
An airline needs to improve its reservation system. This should include details of passengers and the tickets they purchase, showing the flight information. Crew are allocated to each flight, drawn from the 60 people employed. The airline owns 6 planes, so indicate which craft is used for each flight.

Study the relationship diagram overleaf: can you work out what each table is for and what each join line means? Consider whether you agree with the way data is organised into tables with relationships. Is anything missing? What would you add or simplify?
8 – Airline Reservation System

Databases: Concepts of Database Design

IT Learning Programme
1. **Highland Holidays**

**Question**
Highland Holidays rent out holiday chalets. They need a system that will produce invoices for their customers, showing which chalet has been booked and for how long, and thus the amount of money owed.

Design a database that includes this and perhaps some other relevant data, organised into tables.

Sketch out the tables needed, and the fields to be included in each. Show how the tables are related.

Note any assumptions or simplifications you agree on.

**Model Answer**

![Database Diagram]

The database includes tables for chalets, bookings, customers, and invoices. The diagram shows the relationships between these tables, with foreign keys linking them as follows:

- **tblChalet** to **tblBooking** via `chno_id`
- **tblBooking** to **tblCustomer** via `custNo`
- **tblBooking** to **tblInvoice** via `booking_id`

**Assumptions or Simplifications**
- Assumes a fixed number of chalets and customers for simplicity.
- Assumes chalets have a fixed number of rooms and guests.
- Assumes customers have a fixed contact information.
2. Shellfish Species Survey

Question
A zoologist visits 10 different beaches, looking for 35 species of shellfish. On each visit, he records how many of each species he finds at each beach.

Can you suggest a better structure than that shown?

Name some better tables and fields and show how they are related.

Model Answer
3. Slater Menswear

Question

The table below shows a sample of data collected by the Menswear Sales department of an independent shop. Provisionally, data has been collected in the form of a spreadsheet.

Analyse the data and produce a data model that can be implemented in a relational database. Break the data table down (normalise) into related tables so the information can be managed in a relational database.

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<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>G17</td>
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<tr>
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<td></td>
<td>K10</td>
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<td>5</td>
</tr>
<tr>
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<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>D77</td>
<td>Shirt</td>
<td>£ 35.00</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>37/10/2007</td>
<td>25</td>
<td>West</td>
<td>Glasgow</td>
<td>E30</td>
<td>Tie</td>
<td>£ 5.00</td>
<td>20</td>
</tr>
</tbody>
</table>

Model Answer
4. Video Hire

Question
Oxford DVD Rentals is a small company who rent out DVD movies. To rent a DVD, a person has to register and pay a membership fee (£10 for 1 month, £50 for 6 months or £70 for a year).

Design a database where the staff can record details of individual members, details of each DVD stocked and who rents each one.

The maximum duration of a rental is 7 days.

Model Answer
5. Choir Performance Pieces

**Question**
A choir master is setting up a database of the music his choir performs. For each piece, he needs to know details about the piece itself (title, composer and so on), and where and when it has been performed.

A typical concert consists of around 10 pieces, and some popular pieces are presented repeatedly. He also needs a list of his choristers with their contact information.

Which tables should he set up? Suggest suitable fields. How would the tables be related?

**Model Answer**
6. Car maintenance

Question
Design a database to help a car maintenance workshop manage its business.

When a customer brings along a car for repair or service, staff need to check its service history (i.e. the work they have done on this vehicle in the past). They keep a note of every piece of work done on the vehicle, and which member of the team carried out each task.

This database does not manage any costing, pricing or salary information.

Model Answer
7. Castellan Course Admin

Question
Castellan Ltd is a large insurance company whose training department runs internal training courses. Courses cover subjects such as employee induction, fire evacuation procedures, health and safety, as well as training in the bespoke computer systems used within the company. In addition, the department is advises staff on external training for general software packages and coordinates bookings for these.

Until now, records have been collected in an Excel spreadsheet. Analyse the present system and produce a data model.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Start Date</th>
<th>Attendee-1 Name</th>
<th>Dept</th>
<th>Attendee-2 Name</th>
<th>Dept</th>
<th>Attendee-3 Name</th>
<th>Dept</th>
<th>Attendee-4 Name</th>
<th>Dept</th>
<th>Attendee-5 Name</th>
<th>Dept</th>
</tr>
</thead>
<tbody>
<tr>
<td>IND1</td>
<td>Staff Induction</td>
<td>27/03/2007</td>
<td>Neil Smith</td>
<td>Accounts</td>
<td>Joshua Ndola</td>
<td>IT</td>
<td>H Singh</td>
<td>Admin</td>
<td>Sonia Tonn</td>
<td>HR</td>
<td>Jim and Sue</td>
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<td>Fire Safety</td>
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<td>Jenny Wong</td>
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</tr>
</tbody>
</table>

Model Answer
8. **Airline Reservation System**

**Question**
An airline needs to improve its reservation system. This should include details of passengers and the tickets they purchase, showing the flight information. Crew are allocated to each flight, drawn from the 60 people employed. The airline owns 6 planes, so indicate which craft is used for each flight.

Study the relationship diagram overleaf: can you work out what each table is for and what each join line means? Consider whether you agree with the way data is organised into tables with relationships. Is anything missing? What would you add or simplify?

**Model Answer**

![Database diagram](image-url)
Designing a Database

Step 1: List all the fields you will need
- Are there plenty - have you included everything?
- Separate the facts - are they atomic?

Step 2: Give each field a data type
- Are they consistent?

Step 3: Arrange the fields into tables
- Do all the fields in the same table describe the same item?

Step 4: Set primary key fields
- Each table has a different primary key
- This field can never have duplicate values

Step 5: Draw relationships between tables
- Which field relates each pair of tables?
- Mark 1-to-many, many-to-many, 1-to-1 relationships

Step 6: Review, reflect, challenge
- Talk through the design with someone else

Databases: Concepts of Database Design

IT Learning Programme