

Databases: Concepts of designing a database



The small print

Prerequisites

Time in the workshop is precious – it is an opportunity for you to interact with the workshop leader and other participants through questions and discussions and to share your experiences and concerns. To make the most of this time we sometimes ask you to carry out learning activities ahead of the workshop so that everyone comes into the class with the same basic knowledge. We keep this prior learning to a minimum and often make use of online videos. Online videos provided through ‘Molly’ can be accessed by University members anytime, anywhere, through a browser or app.

Your course booking will tell you if any prior learning activity is required. If you don’t have an environment where you can do this learning, you can come along to one of our ‘quiet’ sessions. These are scheduled every week in normal term-time, and are a quiet space where you can work through ‘Molly’ videos or other workshop resources.

If you arrive for a workshop without having done the prior learning, the workshop leader may suggest that you come back on another session.

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About the workshop designer

Pamela Stanworth has over a decade’s experience working on databases with researchers and departments across the University. She brings a pragmatic approach to building projects that are effective, reliable and sustainable.

Pamela’s roots are in engineering, working with blue-chip industrial companies, technical consultancy and small businesses. Her commitment in teaching and consulting is to enable people to use appropriate technology in their work, efficiently and to a high standard.]

Revision history

Version	Date	Author	Comments
3.0	February 2021	Pamela Stanworth	Revised for online workshop

About this workshop

If you were building your dream house, you would need to learn not only practical building skills such as bricklaying and plumbing, but also you need to draw up a design before starting work. The same applies to a database – time spent on drawing up a workable design will transform the value of the structure you create.

This workshop helps you understand how relational databases work, and the important concepts that control them. If you need to design a new database, or re-design an existing database, these concepts underpin your planning.

What you will learn

We will discuss the value of relational databases in managing and analysing data. Using worked examples and hands-on activities we will explore why data must be organised into tables with joins. We will work through the steps you must follow when analysing your situation and devising a database structure.

We will include pointers to other workshops and further resources that will help you go on later to create and manage a database.

What you need to know

The ideas and techniques covered in this workshop will apply to a range of tools. We will illustrate using *Access for Windows*, which is widely available. However, the concepts will be the same or similar, whatever relational database software you decide to use.

If you need to review these activities, Molly is a great place to get guidance. There is an activity with relevant Molly videos in the IT Learning Portfolio: visit skills.it.ox.ac.uk/it-learning-portfolio and search for “database concepts activity”.

The resources you need

Sample scenarios that you can use to experiment with will be made available, but you may like to apply the concepts to your own situation.

The resources for most workshops, including any pre-course activity, are in the IT Learning Portfolio: visit skills.it.ox.ac.uk/it-learning-portfolio and search for “database concepts activity”.

Further information

Getting extra help

Course Clinics

The IT Learning Centre offers bookable clinics where you can get pre- or post-course advice. Contact us using courses@it.ox.ac.uk.

Study Videos from Molly

Molly is our collection of self-service courses and resources. This includes providing LinkedIn Learning video-based courses free to all members of the University. Visit skills.it.ox.ac.uk/molly and sign in with your Single Sign-On (SSO) credentials.

Some courses recommend pre- and/or post-course activities to support your learning. You can watch the online videos anywhere, anytime, and even download them onto a tablet or smartphone for off-line viewing.

If you need a quiet place to work through learning activities away from distractions, the IT Learning Centre offers 'quiet' sessions where you can book a place. These are scheduled frequently during normal term times.

About the IT Learning Portfolio online

Many of the resources used in the IT Learning Centre courses and workshops are made available as Open Educational Resources (OER) via our Portfolio website at skills.it.ox.ac.uk/it-learning-portfolio.

Find the pre-course activity for this course in the IT Learning Portfolio: visit skills.it.ox.ac.uk/it-learning-portfolio and search for "database concepts activity".

About the IT Learning Centre

The IT Learning Centre delivers over 100 IT-related teacher-led courses, which are provided in our teaching rooms and online, and we give you access to thousands of on-line self-service courses through Molly (powered by LinkedIn Learning).

Our team of teachers have backgrounds in academia, research, business and education and are supported by other experts from around the University and beyond.

Our courses are open to all members of the University at a small charge. Where resources allow, we can deliver closed courses to departments and colleges, which can be more cost-effective than signing up individually. We can also customize courses to suit your needs.

Our fully equipped suite of seven teaching and training rooms are usually available for hire for your own events and courses.

For more information, contact us at courses@it.ox.ac.uk.

About IT Customer Services

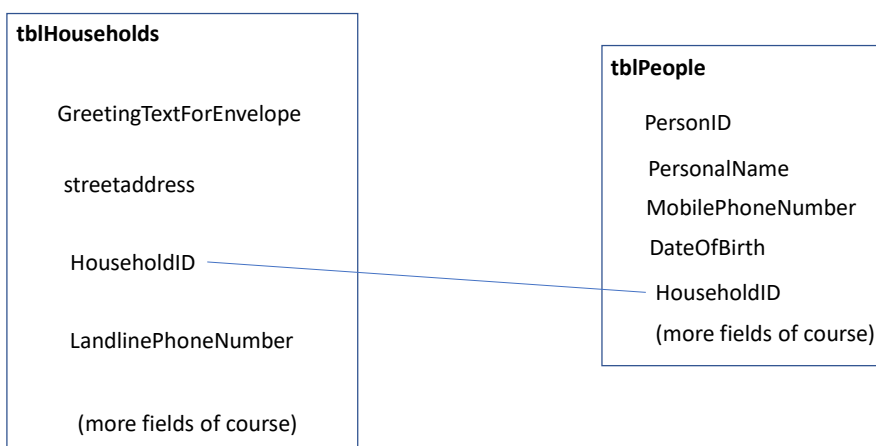
The IT Learning Centre is part of the Customer Services Group. The group provides the main user support services for the department, assisting all staff and students within the University as well as retired staff and other users of University IT services. It supports all the services offered by IT Services plus general IT support queries from any user, working in collaboration with local IT support units.

The Customer Services Group also offers a data back-up service; an online shop; and a PC maintenance scheme. Customer Services is further responsible for desktop computing services – for staff and in public/shared areas – throughout UAS and the Bodleian Libraries.

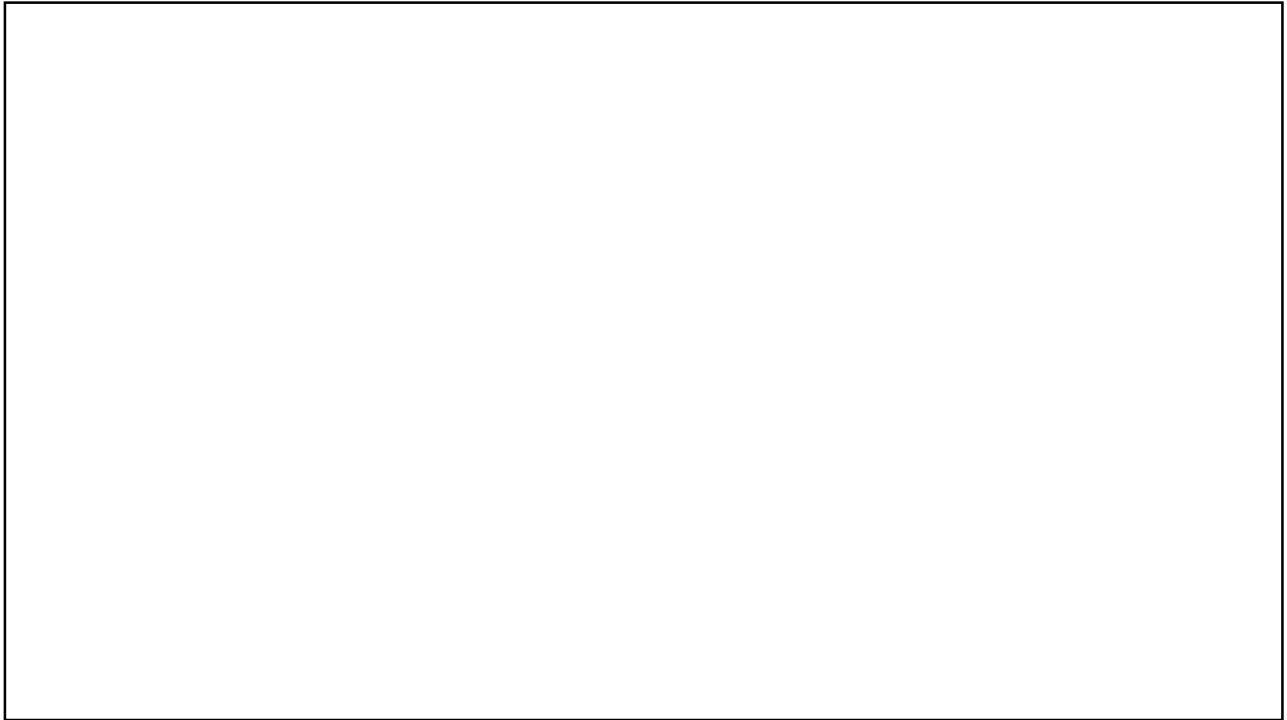
This is Blue group

1

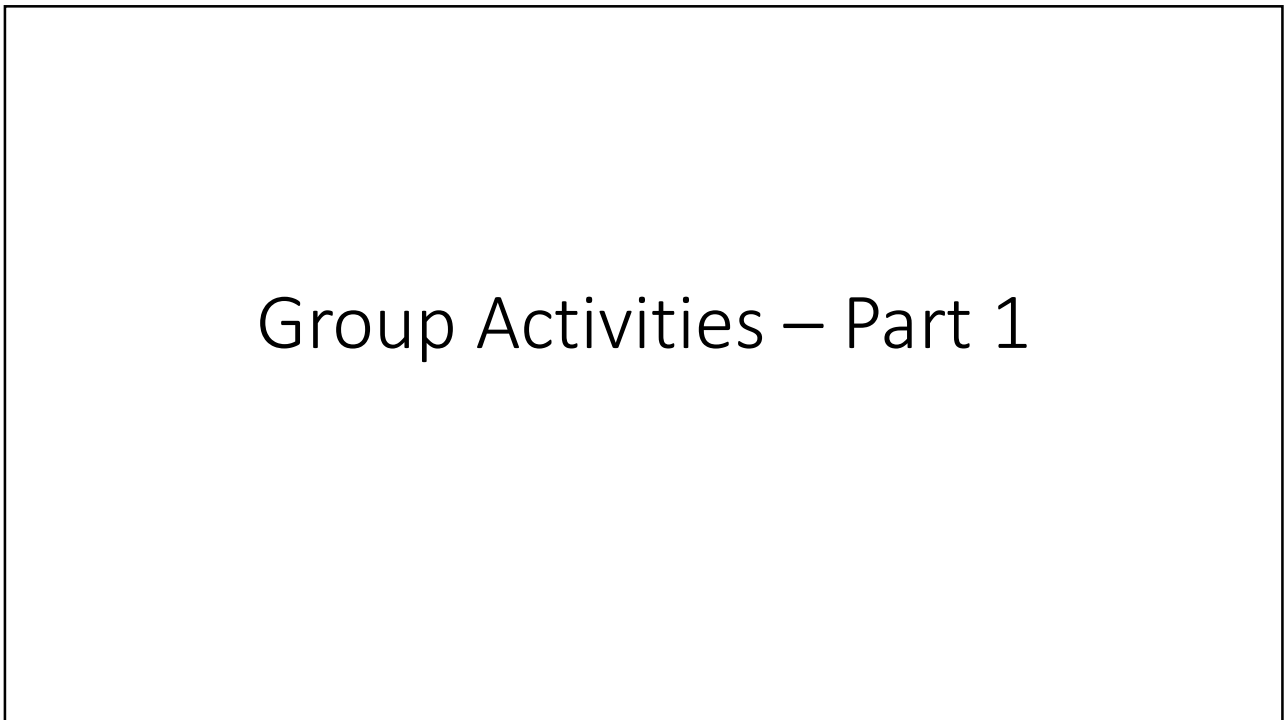
Here is an example of a database diagram, created using PowerPoint's simple tools
You are going to create similar diagrams, to suit some scenarios
Read on ...



2



3



4

1 - William Gladstone's Diaries

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. Each person was associated with a political party or group.

The diaries have now 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 text provided on the next slide, choose which are likely to be needed as fields, discard any irrelevant ones and write more text boxes for other fields that you think of.

Then move the fields around. Move them into groups which belong together, and allocate them to tables (draw simple boxes).

For each field in a table, discuss and decide on the data type (text, number, date, yes/no etc.).

5

Create your diagram for the **Gladstone Diaries** database here
Move the text boxes
Add, delete or change fields as needed

GroupName

PersonMet

GroupID

GroupJoined

MeetingDate

PersonID

PartyPolicies

MeetingLocation

PoliticalGroupID

Monarch

FirstName

ConversationID

GroupLeader

LastName

MeetingStartTime

Notes

MeetingRemarks

6

2 - HL Consultants and Projects

HL Consultants Ltd 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 design a database to store this information efficiently. On the next slide, sketch out the tables needed, and name the fields in each.

Consultant ID	Project no	Hours	Project name	Consultant name	Project location	Hourly rate
21	A92	450	Apollo	Gray	Glasgow	£ 100.00
25	Z50	90	Zeus	Brown	Edinburgh	£ 90.00
33	Z50	20	Zeus	White	Edinburgh	£ 95.00
37	M75	135	Mercury	Green	Aberdeen	£ 150.00

7

Create your diagram for the **HL project consultants** database here

8

3 - Room bookings

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.

Create a diagram on the next slide.

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 or in the slide Notes.

9

Create your diagram for the **Room Bookings** database here

10

End of group work 1

Stop here, and resume the main meeting
when your teacher invites you back

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Group Activities – Part 2

(don't start these until your teacher has explained,
this comes later in the workshop)

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1 - Highland Holidays

Highland Holidays rent out holiday chalets. They need a system that will keep records of 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.

On the next blank slide, 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.

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Create your diagram for the **Highland Holidays** database here

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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.

There will be more fields with information about the beaches and the species.

Can you suggest a relational structure for the data shown?

Name your tables and fields and show how they are related.

DateMeasured	BeachName	SpeciesName	CountOfSpecies
12/08/2003	Five Mile	Turanicus Rond	28
12/08/2003	Five Mile	Saurosa B.	65
12/08/2003	Five Mile	Saurosa Majori	25
17/08/2003	Five Mile	G. Japonica	43
17/08/2003	Five Mile	G. Diabocatus	72
17/08/2003	Five Mile	Saurosa B.	47
20/08/2003	Five Mile	Turanicus Rond	10
20/08/2003	Five Mile	Saurosa B.	14
20/08/2003	Five Mile	Saurosa Majori	15
12/08/2003	GreyStones	Turanicus Rond	53
12/08/2003	GreyStones	Saurosa B.	56
12/08/2003	GreyStones	G. Diabocatus	39
17/08/2003	GreyStones	Saurosa Majori	31
17/08/2003	GreyStones	G. Japonica	32
17/08/2003	GreyStones	G. Diabocatus	7
20/08/2003	GreyStones	Turanicus Rond	16
20/08/2003	GreyStones	Saurosa Majori	18
20/08/2003	GreyStones	G. Diabocatus	20
12/08/2003	North Tideway	Turanicus Rond	26
12/08/2003	North Tideway	Saurosa B.	62
12/08/2003	North Tideway	G. Diabocatus	64
17/08/2003	North Tideway	Saurosa Majori	61
17/08/2003	North Tideway	G. Diabocatus	58
17/08/2003	North Tideway	Turanicus Rond	52
20/08/2003	North Tideway	Saurosa B.	50
20/08/2003	North Tideway	Saurosa Majori	44
20/08/2003	North Tideway	G. Diabocatus	42
12/08/2003	Beasdale	Turanicus Rond	46
12/08/2003	Beasdale	Saurosa B.	41
17/08/2003	Beasdale	Saurosa Majori	40

15

Create your diagram for the **Shellfish Species** database here

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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 for a relational database. Break the data down (normalise) into related tables so the information can be managed in a relational database.

OrderNo	Date	CustNo	Name	Address	ProdNo	Desc	Price	Qty
1	05/10/2007	22	Smith	London	A95	Jacket	£ 55.00	4
					G17	Coat	£ 120.00	8
					K10	Suit	£ 90.00	5
2	19/10/2007	47	Jones	Paris	G17	Coat	£ 120.00	9
					D77	Shirt	£ 35.00	20
3	37/10/2007	25	West	Glasgow	E30	Tie	£ 5.00	25
					D77	Shirt	£ 35.00	4

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Create your diagram for the **Slater Menswear** database here

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4 - Choir Performance Pieces

A choirmaster 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?

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Create your diagram for the **Choir** database here

20

5 - 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.

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Create your diagram for the **Car maintenance** database here

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6 - Castellan Course Administration

Castellan Ltd is a large insurance company whose training department runs internal training courses. Courses cover subjects such as employee induction, fire evacuation procedures, 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.

Course Code	Course Title	Start Date	Attendee-1		Attendee-2		Attendee-3		Attendee-4		Attendee-5	
			Name	Dept	Name	Dept	Name	Dept	Name	Dept	Name	Dept
IND1	Staff Induction	27/03/2007	Neil Smith	Accounts								
FIR1	Fire Safety	29/03/2007	Peter Brown	Admin	Joshua Ndola	IT	H Singh	Senior	Sonia Tonn	HR	Jim and Sue	IT
ACC1	Intro to MS Access	24/04/2007	Jenny Wong	IT	Peter Brown	Admin						

23

Create your diagram for the **Course administration** database here

24

7 - Airline Reservation System

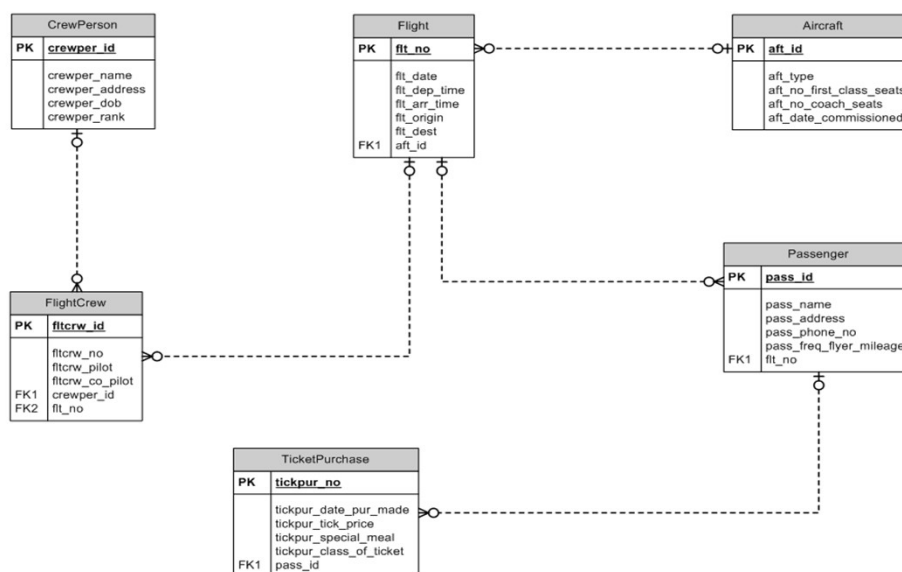
An airline needs to improve its reservation system. This should include details of passengers and the tickets they purchase, showing the flight information. Crew are allocated to each flight, drawn from the 60 people employed. The airline owns 6 planes, so it needs to record which craft is used for each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

Study the proposed relationship diagram on the next slide: 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?

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Proposed design for **Airline Reservation** database



26

Create your own diagram for the **Airline Reservation** database here if you prefer

27

end

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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*



Welcome to the IT Learning Centre

You are in the right place ...

We'll be starting soon

1

Databases: Concepts of database design

Pamela Stanworth
pamela.stanworth@it.ox.ac.uk






2

Ready To Learn?




Today's session takes place in a video-call using *Teams*
 You can turn on Live Captions using 
 Don't plan to multi-task 

3

Resources for your learning

Activities for you to practice today

Videos with today's topics in Molly

Follow-up work

Continue with exercises after the session

Bookable Course Clinics later



4

Road map for
“Concepts of database design”

Demo: a finished database

Where to start

A database with multiple tables

Group work: some scenarios

Joins between tables

Some more difficult cases

A workflow for designing a database

Group work: more scenarios

Recap and next steps

5

Demo: A finished database



6



High Street Dental Surgery

7

Database Tables




8



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



9

Collect the data into tables

DISTANCE LEARNING STUDENT DATABASE

Student				
enrolment_id	name	enrolment_id	enrolment_id	region
1	Almroed	2012	5138	5
2	Thomson	2012	5131	5
3	Ellis	2013	5122	4
4	Ellis	2013	5128	4
5	Stevens	2013	5121	4
10	Ellis	2013	5121	4
18	Page	2012	4471	1
41	Reynolds	2013	4129	1
49	Sharp	2013	4129	1
57	Page	2013	5129	4

Enrolment				
enrolment_id	enrolment_id	enrolment_id	enrolment_id	enrolment_id
1	5	5	5	5
2	5	5	5	5
3	5	5	5	5
4	5	5	5	5
5	5	5	5	5
10	5	5	5	5
18	5	5	5	5
41	5	5	5	5
49	5	5	5	5
57	5	5	5	5

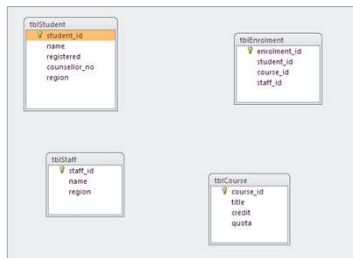
Staff				
staff_id	name	region	staff_id	staff_id
1132	Stevens	5	1132	1132
2626	Stevens	5	2626	2626
4129	Stevens	5	4129	4129
5121	Stevens	5	5121	5121
5124	Stevens	5	5124	5124
5481	Stevens	5	5481	5481
7772	Stevens	5	7772	7772
8441	Stevens	5	8441	8441

Course				
course_id	name	credits	credits	credits
1	Law	60	60	60
2	Law	60	60	60
3	Law	60	60	60
4	Law	60	60	60
5	Law	60	60	60

10

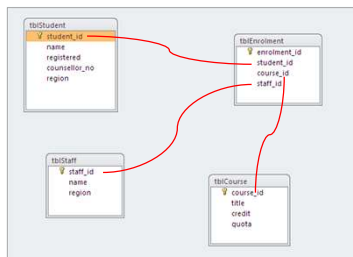
Decide on fields Collect them into tables

Assign a data type to each field



11

Join related fields between tables



12

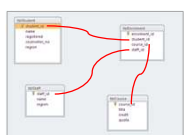


Group work 1

Work on the scenarios, in groups of 2 or 3
Activities are set up in the slides in your small group

About 8 minutes on each scenario

Resume at 10:30



13

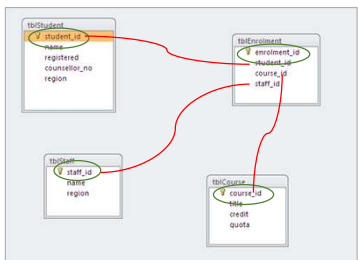
Joins between tables



14



Tables and fields



15



Primary key



Every table must have a primary key field
A field that never has duplicate values
Used for joining between tables

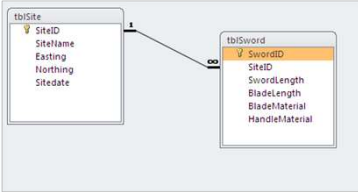
Usually a field that auto-numbers



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Archaeology and swords example



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SwordID	SiteID	SwordLength	BladeLength	BladeMaterial	HandleMaterial
1	2	1.05	0.8	bronze	bronze
2	3	0.67	0.3	iron	wood
3	5	0.5	0.1	bronze	wood
4	2	1.2	1.1	unknown	iron
5	4	1.04	0.9	steel	steel
6	5	0.95	0.7	iron	wood
7	1	0.92	0.7	bronze	wood
8	6	0.8	0.6	unknown	iron
9	7	0.73	0.5	iron	iron
10	3	0.45	0.4	bronze	wood
11	4	0.5	0.4	bronze	bronze
12	1	1.2	0.8	iron	wood

SiteID	SiteName	Easting	Northing	SiteDate
1	Hereford	349926	240344	12th century
2	Okehampton	258796	095203	65 - 200 AD
3	Pickering	479647	483943	Civil War
4	Fordhouses	390736	302946	14th century
5	Houseteads	336709	555434	100-400 AD
6	Colchester A	596314	226571	100-400 AD
7	Colchester B	602646	222634	100-400 AD

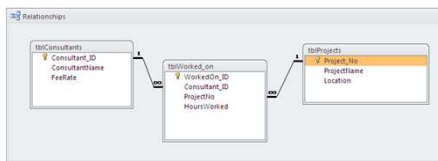
18

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?

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Project Consultants example



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tblConsultants	tblProjects
Consultant_ID	Project_No
1 Grey	1 Apollo Glasgow
2 Brown	2 Zeus Edinburgh
3 White	3 Mercury Aberdeen
4 Green	4 Athena Bury
5 Black	5 Luna Lincoln

tblWorkedOn
WorkedOn_ID
1
2
3
4
5
6
7
8
9
10

22

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 consultant/s who have worked in Bury

24

Swords

Site found	Orkneyhampton
Sword Length (metres)	1.2
Blade Length (metres)	1.1
Blade Material	unknown
Handle Material	iron

Records: 1 of 12 | Search

25

Archaeological Sites

Site Name	Pickering		
Location	Eastling	Northling	11828
Site date	Civil War		
SwordLength	BladeLength	BladeMaterial	HandleMaterial
0.67	0.3	iron	wood
0.45	0.4	bronze	wood

Records: 1 of 2 | Search

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Concepts of database design



Take a break
Resume at 11.15

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Find the resources for the workshop
in our IT Learning Portfolio



Download the files (and more) from
the IT Learning Portfolio at
skills.it.ox.ac.uk/it-learning-portfolio



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Joins between tables



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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

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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



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A workflow for database design



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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

Data management: Concepts of Database Design

IT Learning Centre

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Library catalogue scenario

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

catalogNum	ISBN	title	author
YearOfPub	PublisherName	address	TelNum
cardNumber	name	address	TelNum
DateOut	DueDate	ReturnedDate	FeeDue

How can this data be organised into tables?

34

Library catalogue scenario

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

catalogNum	ISBN	title	author
YearOfPub	PublisherName	address	TelNum
cardNumber	name	address	TelNum
DateOut	DueDate	ReturnedDate	FeeDue

35

11

IT Centre Learning

iT services

UNIVERSITY OF OXFORD

Library catalogue scenario

tblBooks

[catalogNum, ISBN, title, author, YearOfPub]

tblPublishers

[PublisherName, address, TelNum]

tblBorrowers

[cardNumber, name, address, TelNum]

tblBorrowing-Event

[DateOut, DueDate, ReturnedDate, FeeDue]

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Library catalogue scenario

tblBooks

[catalogNum, ISBN, title, author, YearOfPub, BookID]

tblPublishers

[PublisherName, address, TelNum, PublisherID]

tblBorrowers

[BorrowerID, cardNumber, name, address, TelNum]

tblBorrowing-Event

[DateOut, DueDate, ReturnedDate, FeeDue, BorrowingID]

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Library catalogue scenario

tblBooks

[BookID, catalogNum, ISBN, title, author, YearOfPub, PublisherID]

tblPublishers

[PublisherName, address, TelNum, PublisherID]

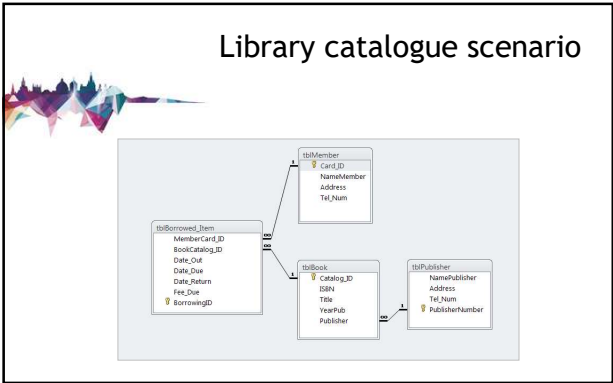
tblBorrowers

[BorrowerID, cardNumber, name, address, TelNum]

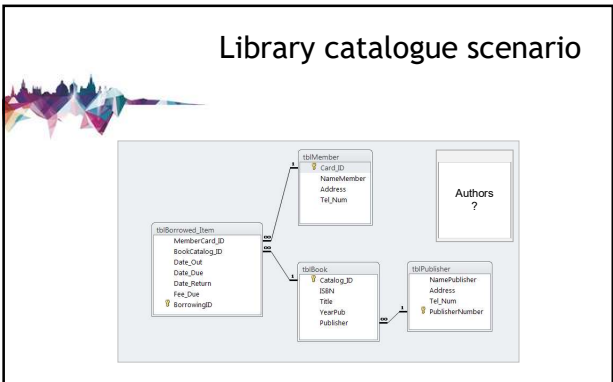
tblBorrowed-items

[DateOut, DueDate, ReturnedDate, FeeDue, BorrowingID, BookID, BorrowerID]

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39



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Group work 2

Work on the scenarios in your groups

This time, use the *Designing* workflow

Resume at 12:20

Designing a Database

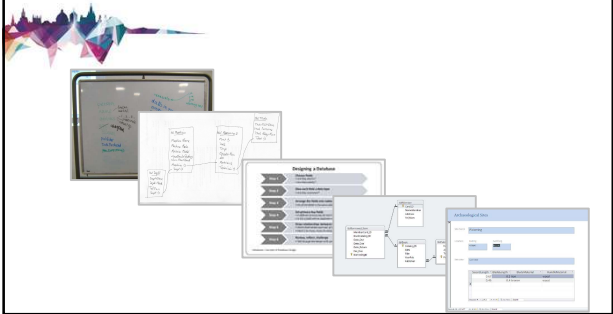
- Step 1: Choose fields
What data do you need?
- Step 2: Give each field a data type
What is the data?
- Step 3: Arrange the fields into tables
What are the relationships between the data?
- Step 4: Set primary key fields
What is the main key for each table?
- Step 5: Draw relationships between tables
What are the relationships between the data?
- Step 6: Review tables and fields
Check the data types and relationships.
- Step 7: Review tables and fields
Check the data types and relationships.

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Reflect

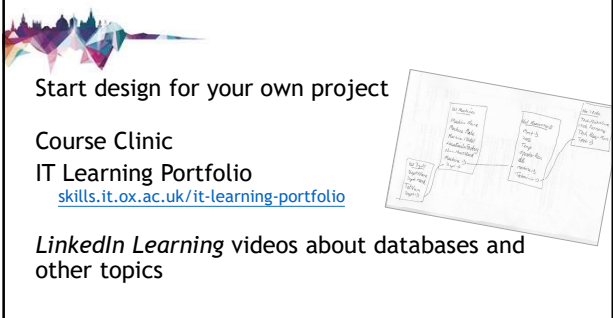



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Reflect

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Where next?

Start design for your own project

Course Clinic
IT Learning Portfolio
skills.it.ox.ac.uk/it-learning-portfolio

LinkedIn Learning videos about databases and other topics



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Find the resources for the workshop in our IT Learning Portfolio

Download the files (and more) from
the IT Learning Portfolio at
skills.it.ox.ac.uk/it-learning-portfolio





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