

Databases

1. Introduction

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Outline

What is a database

purpose, design, data types

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What is a database

purpose, design, data types

Create database

software, import data

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Query

get data, join tables, SQL language

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Interface

connect to database from other program

Goals

After this database course, you should:

1. **Understand** what a database is, and how it works

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2. Be able to **create** a simple database

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After this database course, you should:

1. **Understand** what a database is, and how it works
2. Be able to **create** a simple database
3. Be able to **get data** from any database

Database

What is a database?

Database



Database

Fisheries data are expensive and important, for general research and to give management advice

Datasets live much longer than computers

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Datasets live much longer than computers

What we DON'T want

- Data only on a laptop: can be lost by accident
- Other people cannot access data
- Difficult to relate with other datasets
- Difficult to manipulate (aggregate, subset, calculate)

Database

Fisheries data are expensive and important, for general research and to give management advice

Datasets live much longer than computers

What we DO want

- Data are safe: can undo mistakes, automatic backups
- Everyone can access data
- Combine different datasets
- Efficient data manipulation (aggregate, subset, calculate)

Databases also

- Handle massive amounts of data
- Compute very fast

Database

Good data management

Archived and made available in a **database**

Good programming

Archived and made available in a **repository**

Good science

Archived and made available in a **journal**

⇒ Takes extra effort, but is worthwhile in the long run

Design

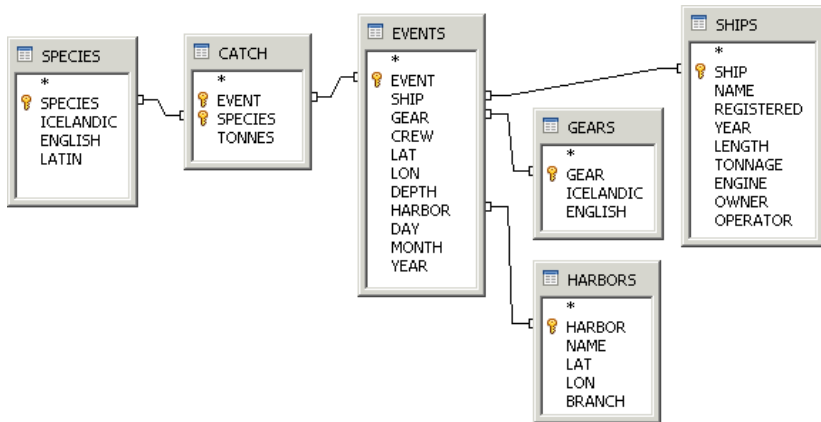
What is a database made of?

Design

Tables

- A database is a collection of **tables**
- Related tables are joined using **key** columns

Design



Design

Tables

- A database is a collection of tables
- Related tables are joined using key columns
- Each table column has one **data type**

Data types

	Bytes	Example
Text		
<code>VARCHAR(<i>length</i>)</code>	<i>length</i>	Some text
Date		
<code>DATE</code>	4	1999-12-31
Number		
<code>SMALLINT</code>	2	−32 768 to 32 767
<code>INTEGER</code>	4	−2 147 483 648 to 2 147 483 647
<code>DECIMAL(<i>signif</i>, <i>round</i>)</code>	<i>signif</i>	123.45

Standard SQL

Data types

	Bytes	Example
Text		
SHORT TEXT	<i>length</i>	Some text
Date		
DATE/TIME	4	1999-12-31
Number		
BYTE	1	0 to 255
INTEGER	2	−32 768 to 32 767
LONG	4	−2 147 483 648 to 2 147 483 647
DOUBLE	8	123.45

Database systems

Where can I find a database?

Database systems

Local database

- **Notes** that are not research data
example: literature database (articles, books, etc.)
- **Copy** of a remote database
example: global fisheries data (FishStat)

Database systems

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Remote database

Web interface

example: FishBase, Google Scholar, Web of Science

Direct access

example: typical fisheries data (catch, surveys, tags, biology)

Database systems

The database system we will focus on is a **remote** database that you have **direct** access to

The database is running on a powerful server that is available 24/7, servicing **multiple users**

The data are **always safely backed up**, even in the case of power failure, flooding, fire, etc.

Database systems

When you work for an **institute**, they already have a database

Building and maintaining a large database is a complicated job;
at larger institutes **database administration** is a full-time position

Important **foundation** of all research and management advice

Database systems

The database administrator gives you **read access** to parts of the database that you need for your work

Data that you work with should be in a **central database** for the institute, not in a personal database on your computer

Software to run a database system

Powerful

IBM DB2

MariaDB

Microsoft SQL Server

MySQL

Oracle

PostgreSQL

brown: free software

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Simple

Firebird

LibreOffice Base

Microsoft Access

SQLite

brown: free software

Interface

The program we use to communicate with the database is called a client, or **interface**

For example, here at Hafro most scientists use **R** as an interface to the Oracle database system

An R script for data analysis often starts with a few lines of code to get a dataset from the database

Interface

Usually, you don't need to think about what software the database system is running on

The database administrator will help you to connect your preferred interface to the database

Access

We will use **Microsoft Access** to learn how a database system works



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Strengths

- Visual interface, good to learn the basics
- More powerful than LibreOffice Base

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Weaknesses

- Proprietary software
- Limited, not a multi-user system
- Differs substantially from standard SQL

Access

We will use **Microsoft Access** to learn how a database system works



Later, we will use **R** as an interface to query data from our Access database



Terminology

Different database systems use different words to describe things

In Access:

- **Field** = table column
- **Record** = table row

Create database

Now we will create our first database

Data

Let's make up some data
[on the projector]

Data

Name	Country	Capital	Siblings	Cars	Movie
...
...
...

Name	what is your first name?
Country	where do you come from?
Capital	what is the capital of that country?
Siblings	how many siblings do you have (incl. yourself)?
Cars	how many cars have you owned?
Movie	have you ever watched an Icelandic movie (yes/no)?

Data

Name	Country	Capital	Siblings	Cars	Movie
...
...
...

What is the data type of each column?

Text SHORT TEXT

Date DATE/TIME

Number BYTE, INTEGER, LONG, DOUBLE
(max) 255 32 767 2 147 483 647 999999.999...

Data

Name	Country	Capital	Siblings	Cars	Movie
...
...
...

Save as **TeamDB.csv**

Check in **text editor** if everything looks correct

Create database

- Create directory `c:/database`
- Start Access
- Create a blank database
- Browse to `c:/database` and name it `TeamDB.accdb`

Import data

- Close the empty table
- External data - Text file `c:\database\TeamDB.csv`
- Delimited, Comma, First row contains field names
- Short text, Short text, Short text, Byte, Byte, Yes/no
- No primary key

Primary key

A **primary key** is the backbone of a database table

Every value in this column must be **unique**

Usually the **first column** of a table

Real data

Logbook data from Icelandic fisheries

- Take a look at [catch.csv](#)
- Find out how many columns (and rows) there are in the data
- Find out what the column data types are
- Import into a new database called [onetable.accdb](#)
- Call the table [Catch](#) and set a two-column primary key

(A two-column primary key means that every row has a unique combination of these two columns)