Databases

1. Introduction

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Outline

What is a database

purpose, design, data types

Outline

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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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

$\Rightarrow$ Takes extra effort, but is worthwhile in the long run

Design

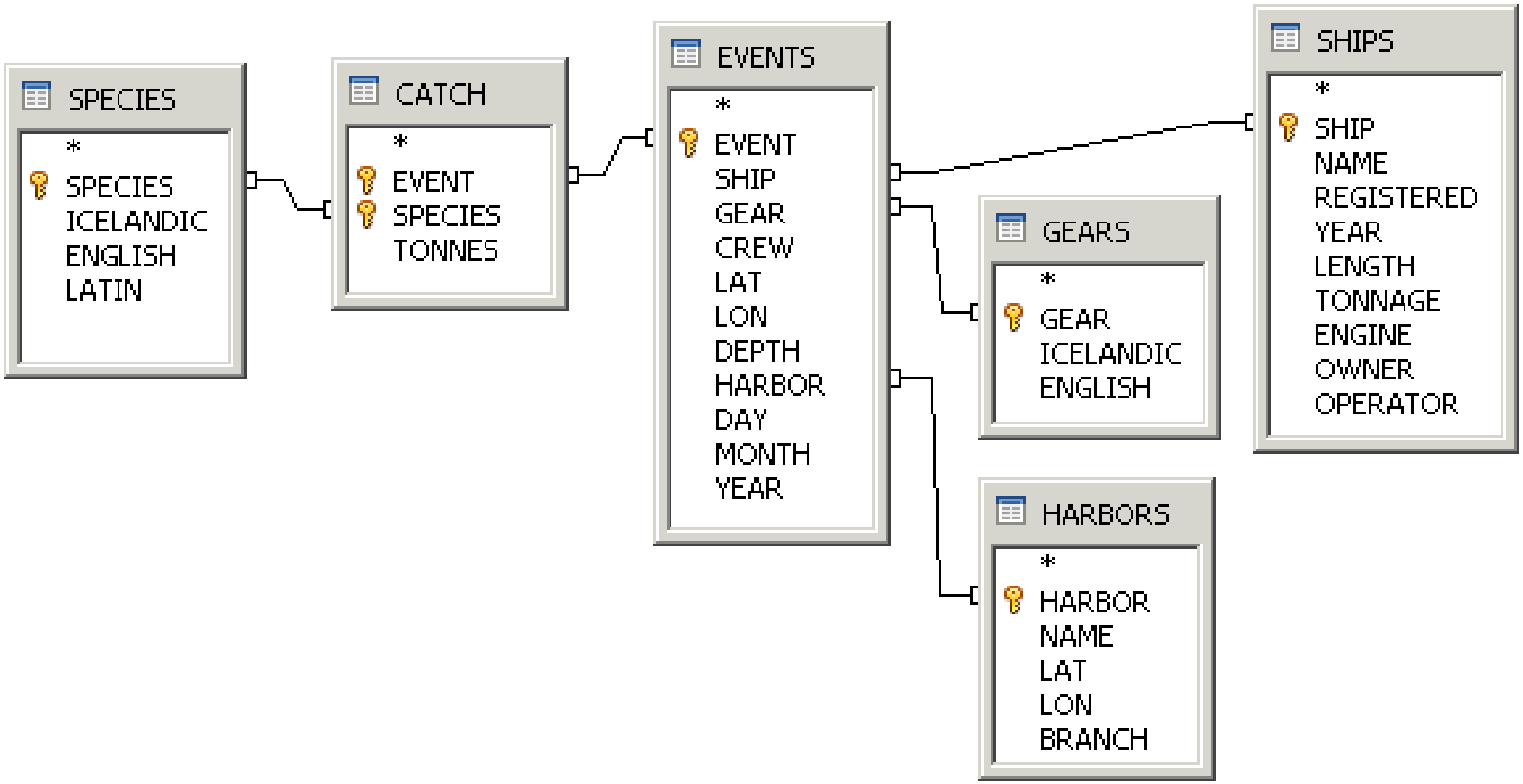
What is a database made of?

Design

Tables

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

Design


SPECIES
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SPECIES
ICELANDIC
ENGLISH
LATIN
CATCH
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EVENT
SPECIES
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NAME
LAT
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BRANCH

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		
VARCHAR*(length)*	*length*	Some text
Date		
DATE	4	1999-12-31
Number		
SMALLINT	2	−32 768 to 32 767
INTEGER	4	−2 147 483 648 to 2 147 483 647
DECIMAL*(signif, round)*	*signif*	123.45

Standard SQL

Data types

	Bytes	Example
Text		
SHORT TEXT	*length*	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)

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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

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- 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)