Class 1: Introduction to Frequentist and Bayesian Mixed/Hierarchical Modelling

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https://goo.gl/fCH4cU

Let's get started

- Tell me who you are, what you are working on, and what you hope to get out of the week
- Timetable for the week
- Prerequisites

How this course works

- ▶ This course lives on GitHub, which means anyone can see the slides, code, etc, and make comments on it
- ▶ The timetable html document provides links to all the pdf slides and practicals
- ▶ The slides and the practicals are all written in Rmarkdown format, which means you can load them up in Rstudio and see how everything was created
- ▶ Let me know if you spot mistakes, as these can be easily updated on the GitHub page
- ▶ There is a IFBM.Rproj R project file from which you should be able to run all the code

Course format and other details

- Lectures will take place in the morning, practical classes in the afternoon
- Timetable very flexible
- Please ask lots of questions
- Some good books:
    - *lme4: Mixed-effects modeling with R* by Bates
    - *Data Analysis using Regression and Hierarchical Models* by Gelman and Hill
   - *Bayesian Data Analysis* by Gelman et al

What is a mixed model?

- **A model** is just a representation/approximation of the real world, here expressed in equations
- **Mixed** means that the model is built up of *fixed* and *random* effects
- **Fixed effects** do not vary between groups,
- **Random effects** vary between groups such that their variation is controlled and can be removed

Thinking about mixed models: example 1
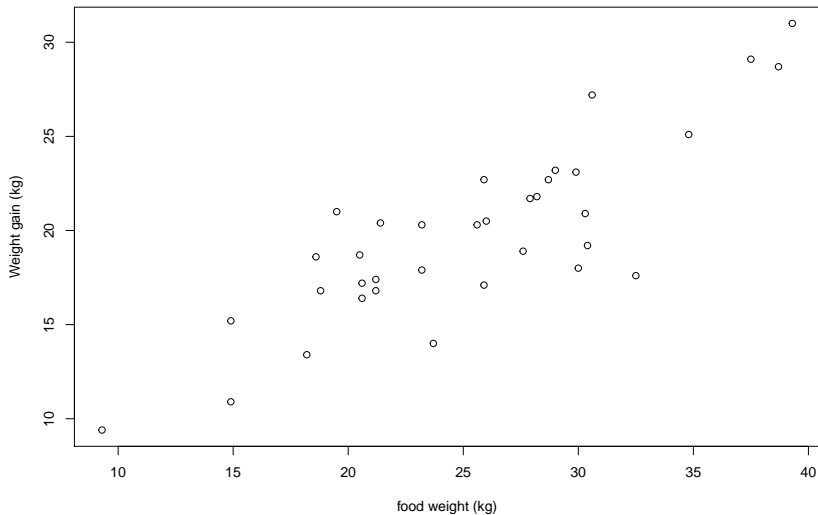
More information:
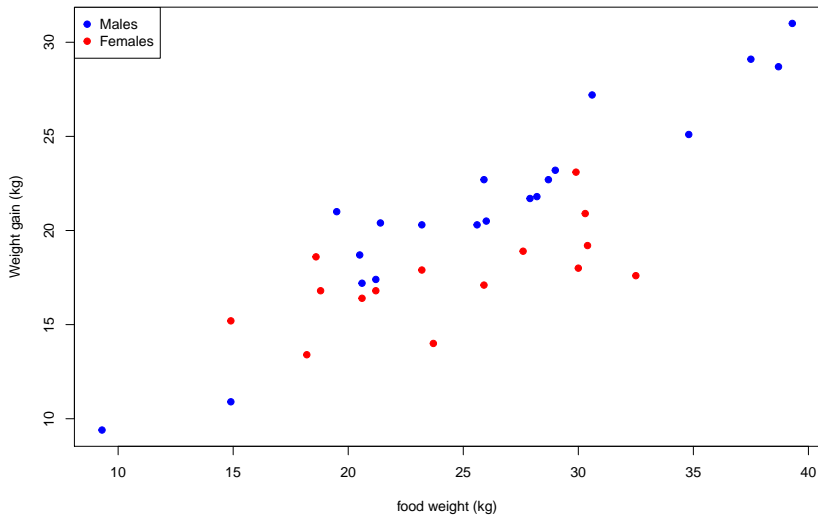
Example 2: 8 Schools

We have 8 schools in a region, with a relative performance score
(column score) compared to the national average and a standard
deviation (sigma) based on 3 repeated visits

```
##   school score sigma
## 1      1    28    15
## 2      2     8    10
## 3      3    -3    16
## 4      4     7    11
## 5      5    -1     9
## 6      6     1    11
## 7      7    18    10
## 8      8    12    18
```

- ▶ If you had to pick an overall score for this region how would you calculate it?
- ▶ If you had to guess the score of a new measurement for school 1 what value would you use?

Example 3: Earnings data

1192 observations on earnings (in USD) and various measurements about ethnicity, age, height, etc

```
##    earn age eth height height_cm        y  x x_centered
## 1 50000   2   3     74    187.96 10.81978 74   6.932011
## 2 60000   3   3     66    167.64 11.00210 66  -1.067989
## 3 30000   1   3     64    162.56 10.30895 64  -3.067989
## 4 51000   2   3     63    160.02 10.83958 63  -4.067989
## 5  9000   1   3     64    162.56  9.10498 64  -3.067989
## 6 29000   2   3     62    157.48 10.27505 62  -5.067989
```

▶ Does height affect earnings?
▶ Are there different rates of change for different groups (e.g. age/ethnic groups)?

Example 4: Swiss Willow Tit data

3 replicate measurements on whether Swiss Willow Tits were found
with covariates on forest cover and elevation

```
##   rep.1 rep.2 rep.3 c.2 c.3 elev forest dur.1 day.2 day.3 length alt
## 1     0     0     0   0   0  420      3   240    58    73    6.2 Low
## 2     0     0     0   0   0  450     21   160    39    62    5.1 Low
## 3     0     0     0   0   0 1050     32   120    47    74    4.3 Med
## 4     0     0     0   0   0 1110     35   180    44    71    5.4 Med
## 5     0     0     0   0   0  510      2   210    56    73    3.6 Low
## 6     0     0     0   0   0  630     60   150    56    73    6.1 Low
```

▶ How do the covariates affect the chance of finding the birds?
▶ Are these effects linear?
▶ What do we do with the missing data?

More data sets in the data directory

- ▶ The data directory contains a few more data sets which we will play with throughout the week
- ▶ The data_descriptions.txt file shows what they contain
- ▶ If you have some spare time it's worth loading them in, exploring relationships, and fitting some simple models

Summary

► In mixed models we try to avoid fitting models to separate parts of the data as much as possible

► By fitting models together we **borrow strength** from the different groups in the data and reduce uncertainty

► (Later in the week) Bayesian models allow us to incorporate all the available information to answer the key question(s) of interest