

Multilevel modeling worksheet: Exercise 1

Don't worry if you can't complete everything. Much of the material here is adapted from Chapter 18 of my book:

Baguley, T. (2012). *Serious stats: A guide to advanced statistics for the behavioral sciences*. London: Palgrave Macmillan.

Alternatively there is more in-depth coverage of multilevel modeling in:

Hox, J. (2010). *Multilevel analysis: Techniques and applications*. Hove: Routledge.

For multilevel modeling in R this book may also be worth looking at:

Finch, W.H., Bolin, J.E. & Kelley, K. (2014). *Multilevel modeling using R*. Boca Raton: CRC Press.

Ask questions if you get stuck!

Fitting a simple nested model in R using the lme4 package

This part of the workshop uses a data set from experimental psychology in which 30 male participants make verbal ratings of the attractiveness of 32 female faces. Note that every participant rated every face. Some previous research suggests that males will lower their pitch when presented with attractive female faces. The file `pitch.csv` contains the following variables:

<i>Participant</i>	a unique identifier for each participant
<i>Face</i>	a unique identifier for each face stimulus
<i>context</i>	context of the rating (1 for short-term and 2 for long-term relationship)
<i>attract</i>	the attractiveness rating
<i>pitch</i>	the fundamental frequency of the attractiveness rating (in Hz)
<i>base</i>	the fundamental frequency of the attractiveness rating (in Hz) at baseline (when no face was presented)

To load the data into RStudio you can use the 'import dataset' button or use the `read.csv()` function directly¹:

```
pitch.dat <- read.csv('pitch.csv')
```

Q1 Fit a two-level random-intercept model with no predictors (a so called empty or null model) with `pitch` as the outcome (Y) variable, a constant (1) as the predictor and Participants as a random effect:

¹ This assumes the data file is in your working directory. The `read.csv()` function also allows you specify a full path name if you prefer. You can check the first few lines of data using the `head()` function - for example: `head(pitch.dat)`

```
install.packages('lme4')
library(lme4)
pitch2.ri <- lmer(pitch ~ 1 + (1|Participants), data=pitch.dat)
summary(pitch2.ri)
```

a) What is the variance associated with level 2 in the model (Participants)?

b) What is the variance associated with level 1 in the model (Residual)?

c) What is the intercept? What does the intercept represent?

Q2 Fit a three-level version of the previous model by editing the random effect of (1|Participants) to 'nest' *Face* under it so it looks like this: (1|Participants/Face). Don't forget to assign the output to a new model object such as pitch3.ri

a) What is the variance associated with level 3 in the model (Participant)?

b) What is the variance associated with level 2 in the model (Face within Participant)?

c) What is the variance associated with level 1 in the model (Residual)?

Q3 Add some fixed effects to the model. In this case we are most interested in the predictors *base* and *attract*. (Note that *base* is a time-varying covariate and couldn't easily be added in a conventional repeated measures ANOVA). Note that the fixed part can added as $\sim 1 + \text{base} + \text{attract}$ or as $\sim \text{base} + \text{attract} + .$ Don't forget to assign the output to a new model object such as pitch3.fe

a) *What is the t statistic associated with the effect of base?*

b) *What is the t statistic associated with the effect of base?*

c) *Can you find a p -value or degrees of freedom associated with this t statistic in the model summary?*

If you have time, explore this model by running the following R code:

```
qqnorm(residuals(pitch3.fe))  
qqnorm(scale(residuals(pitch3.fe)))  
  
qqnorm(ranef(pitch3.fe)[[1]][,1])  
plot(ranef(pitch3.fe))  
  
AIC(pitch3.fe)  
BIC(pitch3.fe)  
anova(pitch3.fe)
```

d) *What do the preceding bits of R code do? (Ask if it isn't obvious ...!)*