Intro to mixed effects models

Motivating example: performance anxiety

We have data from a 2010 study on performance anxiety in 37 undergraduate music majors. For each musician, data was collected on anxiety levels before different performances (between 2 and 15 performances were measured for each musician), with variables including:

- `id`: a unique identifier for the musician
- `na`: negative affect score (a measure of anxiety)
- `perform_type`: whether the musican was performing in a large ensemble, small ensemble, or solo

> How can we model the relationship between performance type and anxiety?

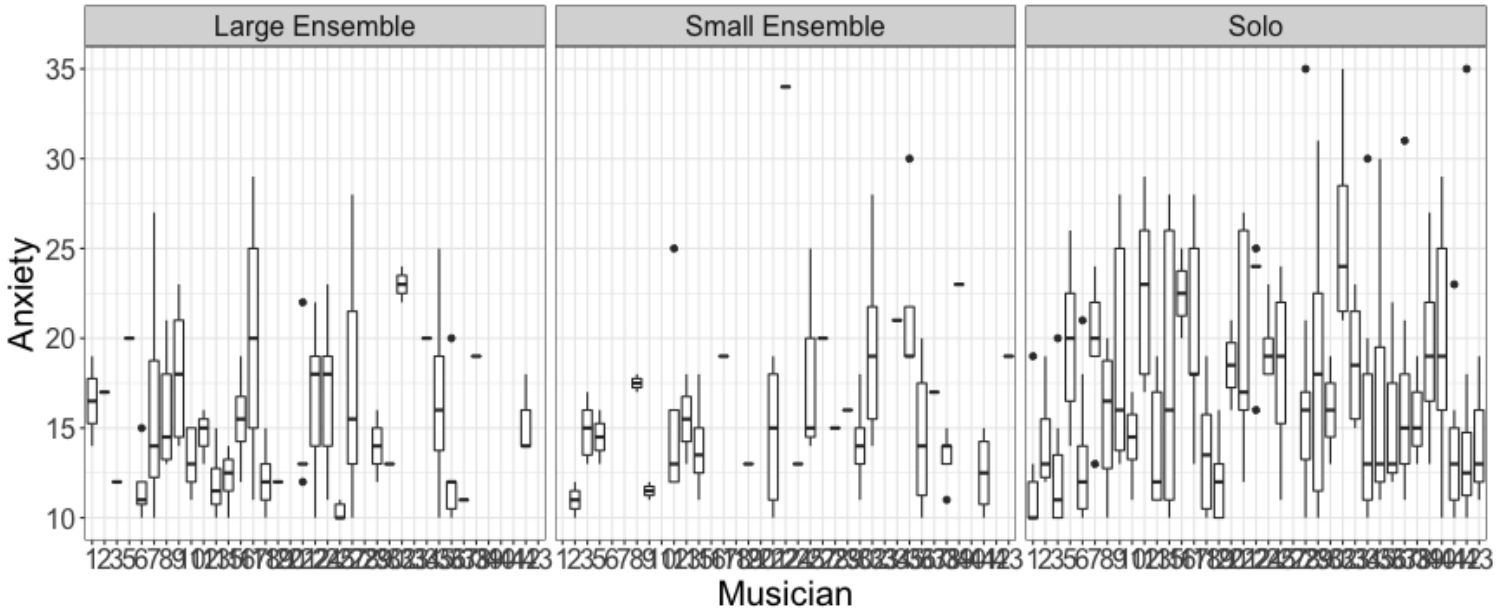
A linear model for anxiety

$$Anxiety_i = \beta_0 + \beta_1 \, SmallEnsemble_i + \beta_2 \, Solo_i + \varepsilon_i$$

$$\varepsilon_i \overset{iid}{\sim} N(0, \sigma^2_\varepsilon)$$

> What assumptions does this linear model make? Are all the assumptions reasonable?

Exploratory data analysis



Does it look like anxiety is correlated within musicians?

Changing the model

$$Anxiety_i = \beta_0 + \beta_1 \, SmallEnsemble_i + \beta_2 \, Solo_i + \varepsilon_i$$

$\varepsilon_i \overset{iid}{\sim} N(0, \sigma^2_\varepsilon)$

> How can we change the model to account for correlation within musicians?

A mixed effects model

$$Anxiety_{ij} = \beta_0 + u_i + \beta_1\, SmallEnsemble_{ij} + \beta_2\, Solo_{ij} + \varepsilon_{ij}$$

$$u_i \overset{iid}{\sim} N(0, \sigma_u^2) \qquad \varepsilon_{ij} \overset{iid}{\sim} N(0, \sigma_\varepsilon^2)$$

Fitting the model in R

```
library(lme4)
m1 <- lmer(na ~ perform_type + (1|id),
           data = music)
summary(m1)
```

```
...
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  id       (Intercept)  5.56    2.358
##  Residual             21.75    4.664
## Number of obs: 497, groups:  id, 37
## Fixed effects:
##                                Estimate Std. Error t value
## (Intercept)                     14.9654     0.5920  25.278
## perform_typeSmall Ensemble       0.7709     0.7210   1.069
## perform_typeSolo                 2.0142     0.5521   3.648
...
```

Assumptions

$$Anxiety_{ij} = \beta_0 + u_i + \beta_1\, SmallEnsemble_{ij} + \beta_2\, Solo_{ij} + \varepsilon_{ij}$$

$$u_i \overset{iid}{\sim} N(0, \sigma_u^2) \qquad \varepsilon_{ij} \overset{iid}{\sim} N(0, \sigma_\varepsilon^2)$$

> What assumptions does this mixed effects model make?