Lab 8 - Linear Mixed Models

Introduction

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R script

- Day3_Lab8_dog_data.Rdata
- Day3_lab8_start.Rmd

Testing linear hypothesis

`multcomp` Package

`glht` (general linear hypotheses testing)

visualizing confidence intervals for β coefficients `ci.lin` `Epi` `tidy`

testing nested models `Anova` `car`

estimating marginal means `emmeans`

Fitting model in R

head(data_dog_weight)

Description: df [6 × 6]

	Id <int>	sex <chr>	measurement <fctr>	weight <int>	age <int>	mother <chr>
1	1	male	day1	320	4	Flor
2	1	male	day2	400	5	Flor
3	1	male	day3	440	6	Flor
4	1	male	day4	500	7	Flor
5	1	male	day5	580	8	Flor
6	1	male	day6	560	9	Flor

6 rows

Q: Does age affects distance in spite of individual variations???

Linear mixed-effects models can be fitted using the `lmer` function in the `lm4` package.

Fitting model in R

Random efect

```
lin_0 <- lmer(distance ~ 1 + (1 | id), data = dental_long)
```

```
summary(lin_0)
```

```
Linear mixed model fit by REML. t-tests use Satterthwaite's method ['lmerModLmerTest']
Formula: weight ~ 1 + (1 | Id)
   Data: data_dog_weight

REML criterion at convergence: 3337.7

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.7037 -0.8175 -0.0672  0.7562  2.4580

Random effects:
 Groups   Name        Variance Std.Dev.
 Id       (Intercept) 16281    127.6
 Residual             59198    243.3
Number of obs: 240, groups:  Id, 20

Fixed effects:
            Estimate Std. Error     df t value Pr(>|t|)
(Intercept)   726.41      32.57  19.00    22.3 4.35e-15 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

estimated variance of the random-effect reflecting between-subject variability

the estimated variance of the error term reflecting within-subject variability

- Correlation between any two repeated measures (ICC)

$$ICC = \frac{\sigma^2_{u_0}}{\sigma^2_{u_0} + \sigma^2}$$

ICC=16281/(16281+59198)=0.21

```
ci.lin(lin_0)
             Estimate   StdErr        z             P     2.5%    97.5%
(Intercept) 726.4083 32.56842 22.30407 3.373541e-110 662.5754 790.2413
```

β_0

Testing variance components

```
ranova(lin_0)
```

ANOVA-like table for random-effects: Single term deletions

Model:
weight ~ (1 | Id)

	npar	logLik	AIC	LRT	Df	Pr(>Chisq)
<none>	3	-1668.9	3343.7			
(1 | Id)	2	-1682.8	3369.7	27.969	1	1.233e-07 ***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

suggests evidence of between-individual heterogeneity, which support evidence for choosing a mixed-effects model instead of a only fixed-effects model.

Graphical presentation of the model