Exercises Day 3

Your name

2026-01-28

Exercise 1

a) Yesterday, we created two models for the cognitive training study, one with age and one without. Use the model provided below and compare its fit with and without Age as a fixed effect.

```
load("CogTrainingData.RData")

Model_1 = lmer(RT ~ TrialType*Session*Group + Age + (1 | Subject) + (1 | Item), data=Cog_training_Data)
Model_2 = lmer(RT ~ TrialType*Session*Group + (1 | Subject) + (1 | Item), data=Cog_training_Data)

anova(Model_1, Model_2)
```

```
## refitting model(s) with ML (instead of REML)

## Data: Cog_training_Data
## Models:
## Model_2: RT ~ TrialType * Session * Group + (1 | Subject) + (1 | Item)
## Model_1: RT ~ TrialType * Session * Group + Age + (1 | Subject) + (1 | Item)
##         npar    AIC    BIC  logLik deviance  Chisq Df Pr(>Chisq)
## Model_2   11 422198 422290 -211088   422176
## Model_1   12 422199 422299 -211087   422175 1.3272  1     0.2493
```

The inclusion of age has only a marginal effect on the fit of the model as the AIC values are almost identical.

b) You have another variable called Gender and you would like to control for it as a random slope. To reduce the complexity of the model, you also focus only on the forced training group and create a new model for them. How would you add Gender to the new model and does its inclusion change the fit of the model?

```
Cog_training_Data2 <-
  Cog_training_Data %>%
  filter(Group =="Forced")

Model_3 = lmer(RT ~ TrialType*Session + (1 | Subject) + (1 | Item), data=Cog_training_Data2)
Model_4 = lmer(RT ~ TrialType*Session + (1 | Subject) + (1+Gender| Item), data=Cog_training_Data2)

anova(Model_3, Model_4)
```

```
## refitting model(s) with ML (instead of REML)
```

```
## Data: Cog_training_Data2
## Models:
## Model_3: RT ~ TrialType * Session + (1 | Subject) + (1 | Item)
## Model_4: RT ~ TrialType * Session + (1 | Subject) + (1 + Gender | Item)
##         npar    AIC    BIC  logLik deviance Chisq Df Pr(>Chisq)
## Model_3    7 216385 216439 -108185   216371
## Model_4    9 216387 216457 -108185   216369 1.711  2     0.4251
```

Gender should be added to the Item random effect, as it is not fully crossed with Subject. It's addition to the model does not change the fit significantly.

c) You created the maximal model below, but it does not converge. Try to reduce its complexity until it converges. What model do you end up with?

Running the model above takes alot of time so I recommend only running it in a seperate chunk in order to not restart it every time for this exercise.

```
Model_6 = lmer(RT ~ TrialType*Session*Group + Age + SES + (1| Subject) + (1 | Item), data=Cog_training_
summary(Model_6)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: RT ~ TrialType * Session * Group + Age + SES + (1 | Subject) +
##     (1 | Item)
##    Data: Cog_training_Data
##
## REML criterion at convergence: 422125
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.4271 -0.6390 -0.1568  0.4431  5.5324
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  Subject  (Intercept)  7194.5   84.82
##  Item     (Intercept)   129.5   11.38
##  Residual             28683.1  169.36
## Number of obs: 32191, groups:  Subject, 85; Item, 16
##
## Fixed effects:
##                                         Estimate Std. Error t value
## (Intercept)                              479.521     84.860   5.651
## TrialTypeRepeat                          293.179      8.946  32.773
## Session                                  -42.766      3.291 -12.997
## GroupVoluntary                             9.462     20.277   0.467
## Age                                        3.621      3.283   1.103
## SES                                        1.673      6.712   0.249
## TrialTypeRepeat:Session                  -51.986      5.516  -9.424
## TrialTypeRepeat:GroupVoluntary            -6.097     12.782  -0.477
## Session:GroupVoluntary                    -5.601      4.744  -1.181
## TrialTypeRepeat:Session:GroupVoluntary    11.416      7.890   1.447
##
## Correlation of Fixed Effects:
##             (Intr) TrlTyR Sessin GrpVln Age    SES    TrTR:S TTR:GV Sss:GV
```

```
## TrialTypRpt -0.036
## Session     -0.059  0.554
## GroupVlntry -0.260  0.150  0.245
## Age         -0.874  0.000  0.000  0.189
## SES         -0.376  0.000  0.000 -0.052 -0.090
## TrlTypRpt:S  0.035 -0.952 -0.596 -0.146  0.000  0.000
## TrlTypRp:GV  0.025 -0.700 -0.387 -0.219  0.000  0.000  0.666
## Sssn:GrpVln  0.041 -0.384 -0.694 -0.353  0.000  0.000  0.413  0.560
## TrlTyR:S:GV -0.025  0.665  0.417  0.212  0.000  0.000 -0.699 -0.951 -0.601
```

In order for the model to converge, it was necessary to remove all random slopes.

Exercise 2

Use lmerTest to see the output of Model 1 in exercise 1a. How did the output change what do the new values represent. Explain the output for the variables Session and Age.

```
library(lmerTest)
```

```
##
## Attache Paket: 'lmerTest'
```

```
## Das folgende Objekt ist maskiert 'package:lme4':
##
##     lmer
```

```
## Das folgende Objekt ist maskiert 'package:stats':
##
##     step
```

```
Model_1 = lmer(RT ~ TrialType*Session*Group + Age + (1 | Subject) + (1 | Item), data=Cog_training_Data)

summary(Model_1)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: RT ~ TrialType * Session * Group + Age + (1 | Subject) + (1 |
##     Item)
##    Data: Cog_training_Data
##
## REML criterion at convergence: 422130.7
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.4269 -0.6389 -0.1568  0.4430  5.5326
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  Subject  (Intercept)  7111.3   84.33
##  Item     (Intercept)   129.5   11.38
```

```
##  Residual             28683.1  169.36
## Number of obs: 32191, groups:  Subject, 85; Item, 16
##
## Fixed effects:
##                                         Estimate Std. Error        df t value
## (Intercept)                              487.473     78.184    82.759   6.235
## TrialTypeRepeat                          293.179      8.946 32089.600  32.773
## Session                                  -42.766      3.291 32087.866 -12.997
## GroupVoluntary                             9.725     20.148   108.499   0.483
## Age                                        3.695      3.251    81.836   1.137
## TrialTypeRepeat:Session                  -51.986      5.516 32089.017  -9.424
## TrialTypeRepeat:GroupVoluntary            -6.096     12.782 32089.293  -0.477
## Session:GroupVoluntary                    -5.601      4.744 32087.750  -1.180
## TrialTypeRepeat:Session:GroupVoluntary    11.415      7.890 32088.639   1.447
##                                        Pr(>|t|)
## (Intercept)                            1.82e-08 ***
## TrialTypeRepeat                         < 2e-16 ***
## Session                                 < 2e-16 ***
## GroupVoluntary                            0.630
## Age                                       0.259
## TrialTypeRepeat:Session                 < 2e-16 ***
## TrialTypeRepeat:GroupVoluntary            0.633
## Session:GroupVoluntary                    0.238
## TrialTypeRepeat:Session:GroupVoluntary    0.148
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) TrlTyR Sessin GrpVln Age    TrTR:S TTR:GV Sss:GV
## TrialTypRpt -0.039
## Session     -0.064  0.554
## GroupVlntry -0.302  0.151  0.246
## Age         -0.984  0.000  0.000  0.185
## TrlTypRpt:S  0.038 -0.952 -0.596 -0.147  0.000
## TrlTypRp:GV  0.027 -0.700 -0.387 -0.221  0.000  0.666
## Sssn:GrpVln  0.044 -0.384 -0.694 -0.355  0.000  0.413  0.560
## TrlTyR:S:GV -0.026  0.665  0.417  0.213  0.000 -0.699 -0.951 -0.601
```

lmerTest adds degrees of freedom and p-values to the output. For session it shows a significant p-value below 0.05 and df of 32000, for age a not significant p-value of 0.259 and df of 81. The p-value is based on the t-value, while degrees of freedom depends on the number of data points for the specific variable.