Lab 12

4/14/25

Rules

In groups of 2 to 4, mostly as assigned in class, complete the following questions.

Previous data wrangling:

```
GripStrengthMeasurements <- read_excel("GripStrengthMeasurementsS25.xlsx")
GS <- GripStrengthMeasurements %>% drop_na(GripStrength) #Mostly cleans out
empty rows

GS2 <- GS %>% drop_na(Arm)
GS2 <- GS2 %>% mutate(Arm = forcats::fct_collapse(Arm,
                                                   Up = c("Up", "up"),
                                                   Down = c("Down", "down"),
                                                   "90" = c("90", "90 degree")),
                    SubjectID = forcats::fct_collapse(SubjectID,
                                                MDEarl = c("MDEarl","MDEar")),
                    Arm = factor(Arm),
                    Hand = factor(Hand),
                    OrderF = factor(Order)
)

GS2 <- GS2 %>% mutate(Hand.Arm = factor(str_c(Hand, Arm)))

GS2 <- GS %>% drop_na(Arm)
GS2 <- GS2 %>% mutate(Arm = forcats::fct_collapse(Arm,
                                                   Up = c("Up", "up"),
                                                   Down = c("Down", "down"),
                                                   "90" = c("90", "90 degree")),
                    SubjectID = forcats::fct_collapse(SubjectID,
                                                MDEarl = c("MDEarl","MDEar")),
                    Arm = factor(Arm),
                    Hand = factor(Hand),
                    OrderF = factor(Order)
)
```

Part II from Lab 11 with new numbers: Merging (`left_join`-ing) the demographics data

The following code will read in and (eventually) join the demographics data.

```
dim(GS2)
```

```
## [1] 263   6
```

```r
Demographics <- read_excel("DemographicsS25.xlsx")
Demographics <- Demographics %>% dplyr::select(-c(12:13)) #Because of a
"note" left in column 13...
dim(Demographics)
```

```
## [1] 44 11
```

1) The following code highlights a potential issue with one of the subject IDs. Fix the problem in the Demographics data.frame using R code.

```r
data.frame(sort(unique(GS2$SubjectID)), sort(unique(Demographics$SubjectID)))
```

```
##    sort.unique.GS2.SubjectID.. sort.unique.Demographics.SubjectID..
## 1                      ABH1997                              ABH1997
## 2                     AFEDU2020                            AFEDU2020
## 3                   AustinLions                          AustinLions
## 4                  AZBlackhawks                         AZBlackhawks
## 5                        AZRams                               AZRams
## 6                   BelknapBull                          BelknapBull
## 7                  BostonLakers                         BostonLakers
## 8              BostonWolverines                     BostonWolverines
## 9                CAJustinBieber                       CAJustinBieber
## 10          CenntenialWarriors                  CentennialWarriors
## 11              COMichealFranti                      COMichealFranti
## 12                       DCSNAP                               DCSNAP
## 13               DenverCoyotes                        DenverCoyotes
## 14                 DenverGalaxy                         DenverGalaxy
## 15                     FLTaller                             FLTaller
## 16                       GASNAP                               GASNAP
## 17                        HYENA                                HYENA
## 18               IAGarthBrooks                        IAGarthBrooks
## 19                        IDAJR                                IDAJR
## 20                        IDPAD                                IDPAD
## 21                      LACROIX                              LACROIX
## 22                LADeathGrips                              LADeath
## 23                       MDEarl                               MDEarl
## 24                   NDLawrence                           NDLawrence
## 25                  NewYorkLaeeb                         NewYorkLaeeb
## 26                   NMSnuggies                           NMSnuggies
## 27                         NVKP                                 NVKP
## 28                 OrlandoChamp                         OrlandoChamp
## 29               ORMichelangelo                       ORMichelangelo
## 30                     PATaller                             PATaller
## 31               SanDiegoBobcat                       SanDiegoBobcat
## 32                       UTSNAP                               UTSNAP
## 33              VancouverMcLaren                     VancouverMcLaren
## 34                       VTPink                               VTPink
## 35                     WATaller                             WATaller
## 36                 WinonaBadgers                        WinonaBadgers
```

```
## 37                    WIWiggles                                     WIWiggles
## 38                    WYBeavers                                     WYBeavers
## 39                         WYIW                                          WYIW
## 40                    WYJourney                                     WYJourney
## 41                   WYSlipKnot                                    WYSlipKnot
## 42                       WYSNAP                                        WYSNAP
## 43                     WYTaller                                      WYTaller
## 44                          ZOO                                           ZOO
```

```
which(sort(unique(GS2$SubjectID)) != sort(unique(Demographics$SubjectID)))
```

```
## [1] 10 22
```

```
# Fix the problem in Demographics to match GS2:
Demographics <- Demographics %>% mutate(SubjectID =
                                          forcats::fct_recode(SubjectID,
LADeathGrips = "LADeath"),
                                        SubjectID =
                                          forcats::fct_recode(SubjectID,
CenntenialWarriors =

"CentennialWarriors"))

#Check that problem was fixed:
data.frame(sort(unique(GS2$SubjectID)), sort(unique(Demographics$SubjectID)))
```

```
##    sort.unique.GS2.SubjectID.. sort.unique.Demographics.SubjectID..
## 1                      ABH1997                                ABH1997
## 2                     AFEDU2020                             AFEDU2020
## 3                   AustinLions                           AustinLions
## 4                  AZBlackhawks                          AZBlackhawks
## 5                        AZRams                                AZRams
## 6                   BelknapBull                           BelknapBull
## 7                  BostonLakers                          BostonLakers
## 8              BostonWolverines                      BostonWolverines
## 9                CAJustinBieber                        CAJustinBieber
## 10           CenntenialWarriors                    CenntenialWarriors
## 11              COMichealFranti                       COMichealFranti
## 12                       DCSNAP                                DCSNAP
## 13               DenverCoyotes                         DenverCoyotes
## 14                DenverGalaxy                          DenverGalaxy
## 15                     FLTaller                              FLTaller
## 16                       GASNAP                                GASNAP
## 17                        HYENA                                 HYENA
## 18               IAGarthBrooks                         IAGarthBrooks
## 19                        IDAJR                                 IDAJR
## 20                        IDPAD                                 IDPAD
## 21                      LACROIX                               LACROIX
## 22                 LADeathGrips                          LADeathGrips
## 23                       MDEarl                                MDEarl
## 24                   NDLawrence                            NDLawrence
```

```
## 25                 NewYorkLaeeb                          NewYorkLaeeb
## 26                  NMSnuggies                            NMSnuggies
## 27                        NVKP                                  NVKP
## 28                 OrlandoChamp                          OrlandoChamp
## 29               ORMichelangelo                        ORMichelangelo
## 30                    PATaller                              PATaller
## 31               SanDiegoBobcat                        SanDiegoBobcat
## 32                      UTSNAP                                UTSNAP
## 33             VancouverMcLaren                      VancouverMcLaren
## 34                      VTPink                                VTPink
## 35                    WATaller                              WATaller
## 36                WinonaBadgers                         WinonaBadgers
## 37                   WIWiggles                             WIWiggles
## 38                   WYBeavers                             WYBeavers
## 39                        WYIW                                  WYIW
## 40                   WYJourney                             WYJourney
## 41                  WYSlipKnot                            WYSlipKnot
## 42                      WYSNAP                                WYSNAP
## 43                    WYTaller                              WYTaller
## 44                         ZOO                                   ZOO
```

```
Demographics <- Demographics %>% mutate(Weights = factor(Weights),
                                        GripTesterID = factor(GripTesterID))

Demographics <- Demographics %>% mutate(Weights = fct_collapse(Weights,
no = c("no",  "No"),
               yes = c("yes", "Yes")))

#Join Demographics to the GS2 repeated measures data
combined <- left_join(x = GS2, y = Demographics, by = "SubjectID")

combinedR <- combined %>% drop_na()

combinedR <- combinedR %>% mutate(forearm_bins   =
                                  factor(cut_number(ForearmLength, n = 3)),
                                  epworth_bins =
                                  factor(cut_number(Epworth, n = 3)),
                                  balance_bins =
                                  factor(cut_number(BalanceTime, n = 3))
                                 )
dim(combinedR)
```

```
## [1] 257  19
```

```
dim(combined)
```

```
## [1] 263  16
```

```
dim(GS2)
```

```
## [1] 263   6
```

```r
tally(~SubjectID, data = combinedR)
```

```
## SubjectID
##            ABH1997           AFEDU2020         AustinLions
AZBlackhawks
##                  6                   6                   6
6
##             AZRams         BelknapBull        BostonLakers
BostonWolverines
##                  6                   6                   6
6
##      CAJustinBieber CenntenialWarriors    COMichealFranti
DCSNAP
##                  6                   6                   5
6
##       DenverCoyotes        DenverGalaxy            FLTaller
GASNAP
##                  6                   6                   6
6
##              HYENA       IAGarthBrooks               IDAJR
IDPAD
##                  6                   6                   6
6
##            LACROIX        LADeathGrips              MDEarl
NDLawrence
##                  6                   6                   0
6
##        NewYorkLaeeb          NMSnuggies                NVKP
OrlandoChamp
##                  6                   6                   6
6
##      ORMichelangelo            PATaller      SanDiegoBobcat
UTSNAP
##                  6                   6                   6
6
##    VancouverMcLaren              VTPink            WATaller
WinonaBadgers
##                  6                   6                   6
6
##          WIWiggles           WYBeavers                WYIW
WYJourney
##                  6                   6                   6
6
##         WYSlipKnot              WYSNAP            WYTaller
ZOO
##                  6                   6                   6
6
```

2) What is the sample size before and after the `left_join`? How many subjects are in the data set as analyzed in `combinedR`?

Sample size was 263 before left_join and 263 after. The combinedR group had the NAs removed after join which lowered the sample size to 257. There are 44 unique subjects in the dataset in CombinedR.

```
unique(combinedR$SubjectID)

##  [1] GASNAP              WYSNAP              UTSNAP              DCSNAP
##  [5] COMichealFranti     LADeathGrips        NMSnuggies
CAJustinBieber
##  [9] ORMichelangelo      VTPink              WYSlipKnot
IAGarthBrooks
## [13] WYJourney           WIWiggles           NDLawrence          WATaller
## [17] FLTaller            PATaller            WYTaller            NVKP
## [21] IDAJR               WYIW                IDPAD               LACROIX
## [25] VancouverMcLaren    ZOO                 HYENA               AFEDU2020
## [29] ABH1997             BelknapBull         DenverGalaxy
CenntenialWarriors
## [33] OrlandoChamp        AustinLions         BostonWolverines
WinonaBadgers
## [37] NewYorkLaeeb        DenverCoyotes       SanDiegoBobcat      AZRams
## [41] BostonLakers        AZBlackhawks        WYBeavers
## 44 Levels: ABH1997 AFEDU2020 AustinLions AZBlackhawks AZRams ... ZOO

dim(combinedR)

## [1] 257  19

dim(combined)

## [1] 263  16

dim(GS2)

## [1] 263   6
```

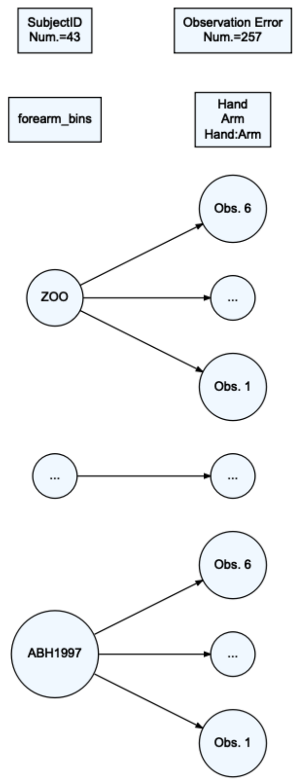
3) Now we can incorporate forearm binned variables into the model using the `forearm_bins`, which we will treat as a fixed effect. Make a `model_diagram` from the provided model (I like to add the option of `heightVal = 800`) and explain/discuss the location of the fixed effects in it.

Hand, Arm, and Hand:Arm are located at the top of the right column of the model diagram. This is because these are indicated at the observation level, not the subject level. The 6 observations per individual are a combination of hand and arm. The forearm bins are located in the left column as they are splitting the individuals into groups based on their forearm size, as a proxy for height. These groups were then split down into the 6 hand and arm observations per individual.

```
combinedR <- combinedR %>% mutate(
              forearm_bins = fct_recode(forearm_bins,
                                        low = "[9.25,10]",
                                        medium = "(10,11]",
```

```
                                                   high = "(11,13.1]")
            )
lmer2 <- lmer(GripStrength ~ Hand*Arm + forearm_bins + (1|SubjectID), data =
combinedR)

model_diagram(lmer2, heightVal = 800)
```



4) The following provides the theoretical and estimated fixed effect part of the model, except does not add the subscripts for the fixed effects or define the distributions of the random effects (see all locations with ?). Add the definition of the random effects and subscripts in the appropriate places based on the previous model diagram.

```
lmer2 %>% tbl_regression(intercept = T)
```

Characteristic	Beta	95% CI[1]	p-value
(Intercept)	47	38, 56	<0.001
Hand			
D	—	—	
ND	-3.7	-5.9, -1.6	<0.001
Arm			
90	—	—	
Down	0.25	-1.9, 2.4	0.8
Up	2.0	-0.14, 4.2	0.067
forearm_bins			
low	—	—	
medium	12	-1.7, 25	0.085
high	35	21, 48	<0.001
Hand * Arm			
ND * Down	1.4	-1.7, 4.4	0.4
ND * Up	1.5	-1.6, 4.5	0.3

[1]CI = Confidence Interval

- Theoretical model: $GripStrength_{ij} = \mu_{ij} + Subject_i + \epsilon_{ij}$
  - where $Subject_i \sim N\left(0, \sigma^2_{subject}\right)$ and $\epsilon_{ij} \sim N(0, \sigma^2_{\epsilon})$ and $i = 1, \dots, I$ subjects and $j = 1, \dots, n_i$ for the j^{th} observation on the i^{th} subject.
- Estimated model for μ_{ij}:
  - Result: $\hat{\mu}_{ij} = 47 - 3.7 I_{Hand=ND,ij} + 0.25 I_{Arm=Down,ij} + 2.0 I_{Arm=Up,ij} + 12 I_{forearmbins=medium,i} + 35 I_{forearm_bins=high,i} + 1.4 I_{Hand=ND,ij} I_{Arm=Down,ij} + 1.5 I_{Hand=ND,ij} I_{Arm=Up,ij}$

Part 2 (all new questions): Summarizing/exploring mixed models

In mixed models, the random effect variances create some extra opportunities and challenges when trying to summarize the model. The following models will also incorporate the `GripTesterID` so we can control for differences in the different machines used.

First, the random effects can be used to calculate the intra-class correlation (ICC) as discussed on page 16 of the Mixed Models Part A notes.

5) For the model `lmer3` below, report the estimated subject variance and estimated residual variance.

```
lmer3 <- lmer(GripStrength ~ Hand*Arm + forearm_bins + GripTesterID +
(1|SubjectID), data = combinedR)

summary(lmer3)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: GripStrength ~ Hand * Arm + forearm_bins + GripTesterID + (1 |
##     SubjectID)
##    Data: combinedR
##
## REML criterion at convergence: 1681.5
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.76250 -0.56395  0.04184  0.55084  2.99852
##
## Random effects:
##  Groups    Name        Variance Std.Dev.
##  SubjectID (Intercept) 258.08   16.065
##  Residual               25.53    5.052
## Number of obs: 257, groups:  SubjectID, 43
##
## Fixed effects:
##                    Estimate Std. Error       df t value Pr(>|t|)
## (Intercept)         49.7050     6.5861  36.8617   7.547 5.49e-09
## HandND              -3.7474     1.0974 209.0198  -3.415 0.000766
## ArmDown              0.2535     1.0896 209.0036   0.233 0.816271
## ArmUp                2.0070     1.0896 209.0036   1.842 0.066908
## forearm_binsmedium  14.9673     6.1736  36.0023   2.424 0.020481
## forearm_binshigh    35.8431     6.2432  36.0007   5.741 1.54e-06
## GripTesterIDD2     -20.3543     8.4488  36.0137  -2.409 0.021229
## GripTesterIDD3       2.8831     7.8507  36.0172   0.367 0.715588
## GripTesterIDD4       3.4540     8.4488  36.0137   0.409 0.685095
## GripTesterIDD5     -10.6640     8.7142  36.0103  -1.224 0.228996
## HandND:ArmDown       1.3893     1.5464 209.0118   0.898 0.370014
## HandND:ArmUp         1.4870     1.5464 209.0118   0.962 0.337389
##
## Correlation of Fixed Effects:
##             (Intr) HandND ArmDwn ArmUp  frrm_bnsm frrm_bnsh GTIDD2 GTIDD3
## HandND      -0.080
## ArmDown     -0.083  0.496
## ArmUp       -0.083  0.496  0.500
## frrm_bnsmdm -0.332 -0.001  0.000  0.000
## frrm_bnshgh -0.262 -0.001  0.000  0.000  0.471
## GrpTstrIDD2 -0.631 -0.002  0.000  0.000 -0.102    -0.110
## GrpTstrIDD3 -0.699 -0.002  0.000  0.000 -0.009    -0.174     0.580
## GrpTstrIDD4 -0.631 -0.002  0.000  0.000 -0.102    -0.110     0.541  0.580
## GrpTstrIDD5 -0.559 -0.002  0.000  0.000 -0.230    -0.238     0.543  0.578
## HndND:ArmDw  0.057 -0.710 -0.705 -0.352  0.001     0.001     0.001  0.001
## HndND:ArmUp  0.057 -0.710 -0.352 -0.705  0.001     0.001     0.001  0.001
##             GTIDD4 GTIDD5 HND:AD
## HandND
## ArmDown
## ArmUp
```

```
## frrm_bnsmdm
## frrm_bnshgh
## GrpTstrIDD2
## GrpTstrIDD3
## GrpTstrIDD4
## GrpTstrIDD5  0.543
## HndND:ArmDw  0.001  0.001
## HndND:ArmUp  0.001  0.001  0.504
```

- $\hat{\sigma}^2_{subject} = 258.08$
- $\hat{\sigma}^2_{\epsilon} = 25.53$

6) Use the two variances to calculate the estimated ICC. Show your work.

- Estimated ICC = 258.08 / (258.08 + 25.53) = 0.91

7) Interpret the ICC result in a sentence as you would in a report and then write a sentence to discuss what this suggests about repeated measures on grip strength (something about what the ICC suggests).

Once we account for grip tester, arm position, hand dominance, and forearm length, the estimated correlation of the two grip strength measurements is 0.91. This indicates high correlation between two observations once we account for systematic changes across subjects.

8) We can also explore the estimates for each subject on the random subject effect. These are not to be used to do inferences for differences, but we can qualitatively explore the variability. You can print out the subject random effect estimates using `ranef(modelname)` or you can plot the results with estimates of the uncertainty using `dotplot(ranef(modelname, postVar = T))` or you can make a QQ-plot to use for assessing normality of a single random effect using the provided code. *Fix the title on the QQ-plot*, then find a subject of interest to you in the caterpillar plot, note their ID, and discuss their random effect estimate relative to other subjects.

LACROIX's grip strength is roughly 35 pounds lower than average from the other subjects. Their respective grip strength is roughly 5 pounds lower than the next subject, AustinLion's, strength measurement.

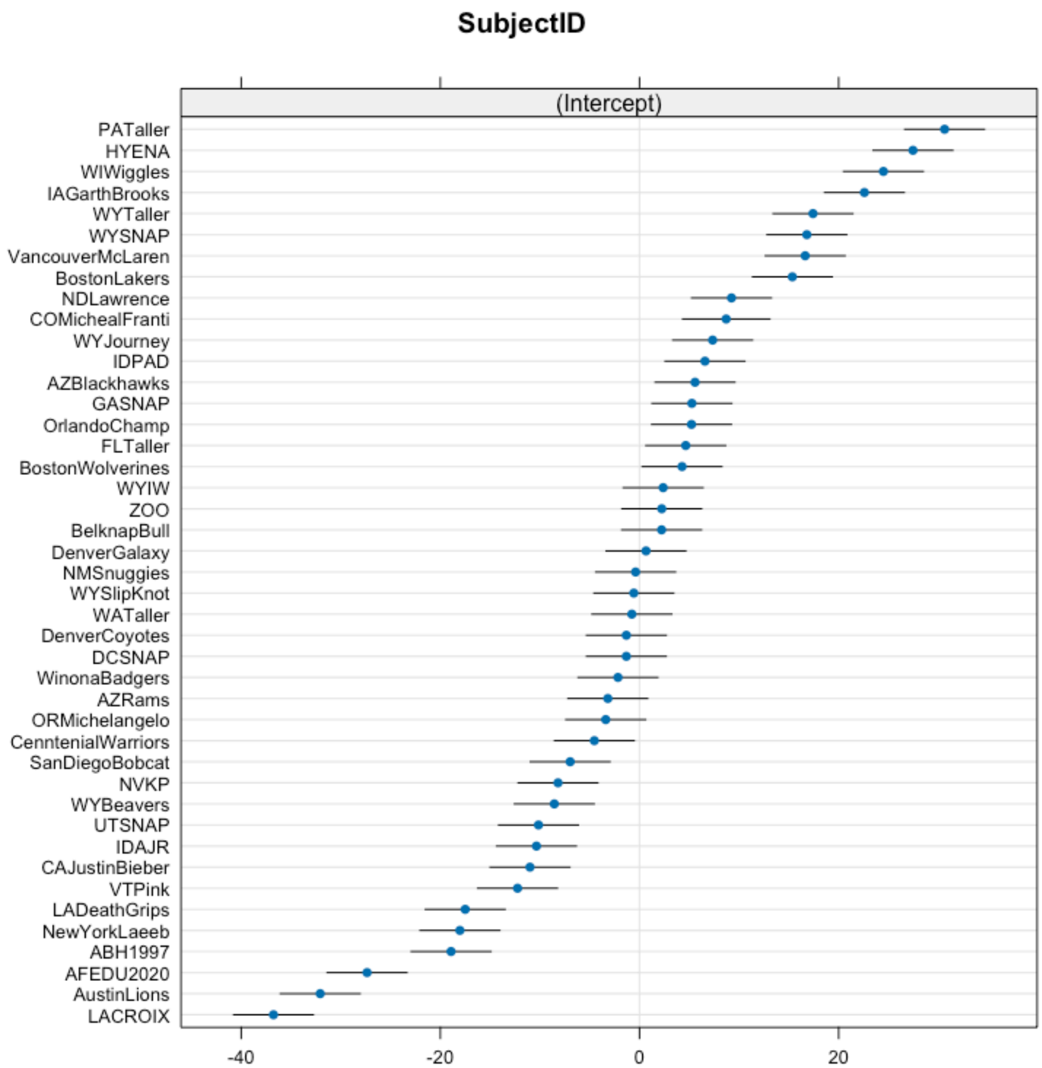
```
ranef(lmer3)

## $SubjectID
##                     (Intercept)
## ABH1997             -18.9222476
## AFEDU2020           -27.3589088
## AustinLions         -32.0617553
## AZBlackhawks          5.5772627
## AZRams               -3.1790597
## BelknapBull           2.2202531
```

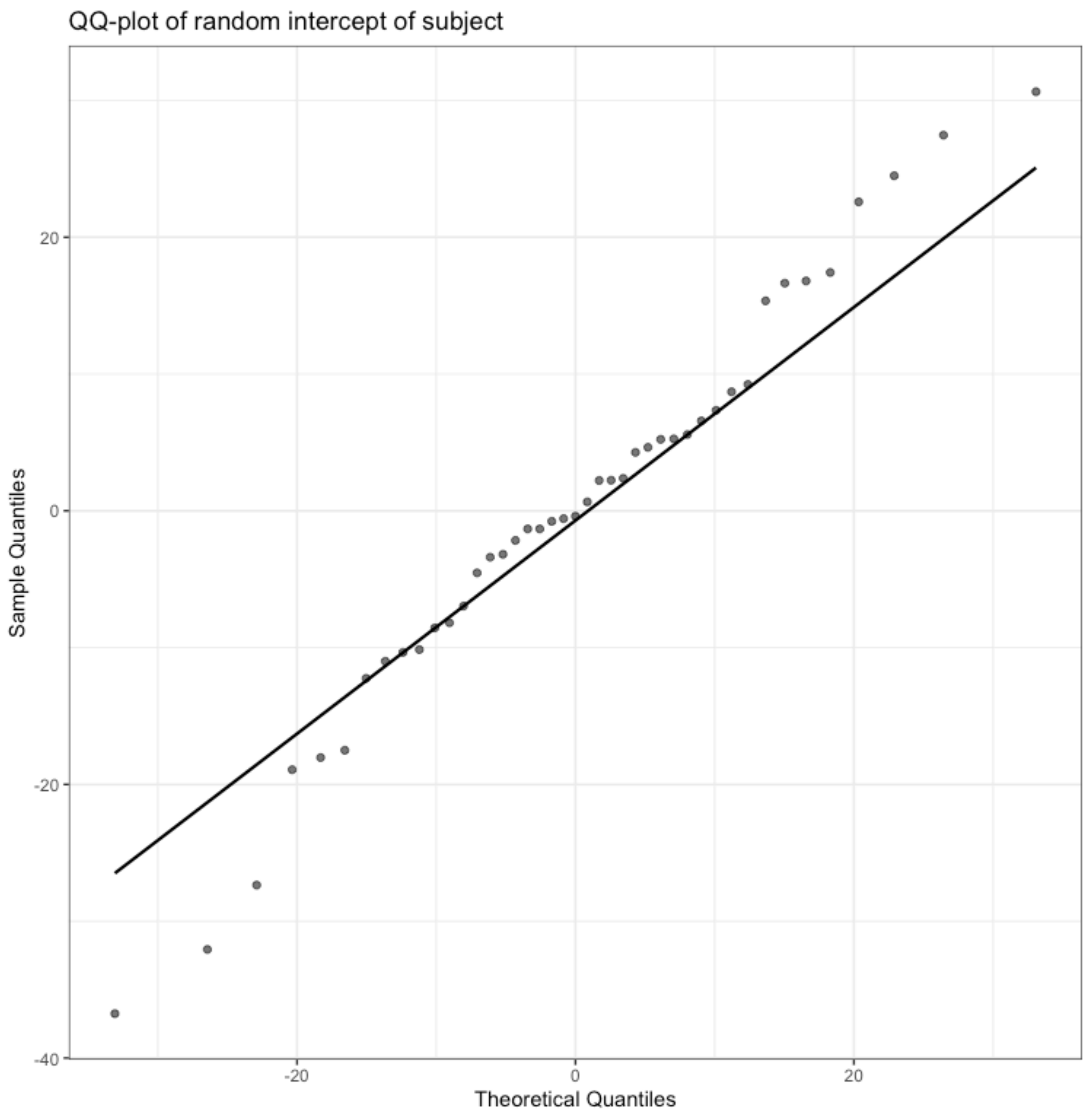
```
## BostonLakers        15.3495004
## BostonWolverines     4.2726050
## CAJustinBieber     -10.9992280
## CenntenialWarriors  -4.5357118
## COMichealFranti      8.7024014
## DCSNAP              -1.3220229
## DenverCoyotes       -1.3213632
## DenverGalaxy         0.6550206
## FLTaller             4.6429109
## GASNAP               5.2603926
## HYENA               27.4618081
## IAGarthBrooks       22.5844403
## IDAJR              -10.3482257
## IDPAD                6.5734899
## LACROIX            -36.7553106
## LADeathGrips       -17.5020184
## NDLawrence           9.2377935
## NewYorkLaeeb       -18.0361838
## NMSnuggies          -0.3916764
## NVKP                -8.1839046
## OrlandoChamp         5.2235946
## ORMichelangelo      -3.3913114
## PATaller            30.6379712
## SanDiegoBobcat      -6.9617152
## UTSNAP             -10.1432711
## VancouverMcLaren    16.6408623
## VTPink             -12.2453523
## WATaller            -0.7685516
## WinonaBadgers       -2.1622432
## WIWiggles           24.4953455
## WYBeavers           -8.5564100
## WYIW                 2.3760186
## WYJourney            7.3447403
## WYSlipKnot          -0.5711354
## WYSNAP              16.8034385
## WYTaller            17.4224954
## ZOO                  2.2352620
##
## with conditional variances for "SubjectID"
```

```r
library(lattice)
dotplot(ranef(lmer3, postVar = T))
```

```
## $SubjectID
```




```r
as.data.frame(ranef(lmer3)) %>% ggplot(aes(sample = condval)) +
  stat_qq_point(alpha = 0.6) +
  stat_qq_line() + theme(aspect.ratio = 1) +
  labs(x = "Theoretical Quantiles",
       y = "Sample Quantiles",
       title = "QQ-plot of random intercept of subject") +
  coord_fixed()
```



9) Calculate and write two sentences to report the two R-squared results for `lmer3`. Be specific about the contents of the model in reporting the results.

The fixed effects of forearm length, hand, arm, and grip tester explain 50.7% of the variation in the grip strengths. The fixed effects with the random effect of subject together explain 95.57% of the variation in grip strength.

```
library(MuMIn)
r.squaredGLMM(lmer3)

##            R2m       R2c
## [1,] 0.5078611 0.9557038
```

Part 3: Three-level model

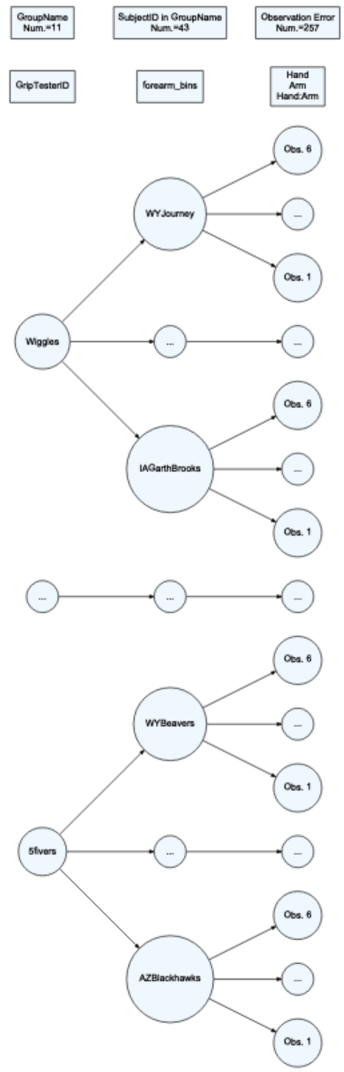
10) The previous model failed to account for groups and that you were nested into groups for taking measurements that might also be systematically different on grip strength. Modify `lmer3` to fit a new model account for group and then make a new `model_diagram` and generate an `Anova` set of F-tests for the model. No discussion.

```
lmer4 <- lmer(GripStrength ~ Hand*Arm + forearm_bins + GripTesterID +
(1|GroupName/SubjectID), data = combinedR)

Anova(lmer4, test.statistic = "F")

## Analysis of Deviance Table (Type II Wald F tests with Kenward-Roger df)
##
## Response: GripStrength
##                    F Df  Df.res    Pr(>F)
## Hand         19.5002  1 209.006 1.613e-05
## Arm           6.5154  2 209.006 0.0017994
## forearm_bins 10.1805  2  33.920 0.0003443
## GripTesterID  1.3293  4   5.739 0.3625960
## Hand:Arm      0.5782  2 209.006 0.5618222

model_diagram(lmer4, heightVal = 800)
```



11) Discuss how the denominator DF from the F-tests loosely/qualitatively relate to the `model_diagram` results for the Grip Tester, forearm, and Hand fixed effects. Report how many unique values were present at each level (provided in the model diagram) and the denominator DF in the discussion. Note that this is not about a formula but about relative size and number of unique observations at each level.

The model diagram shows 11 groups, 43 subjects, and 257 observations. The denominator DF generally make sense because the griptester DF is 5.739, forearm_bins is 33.920, and hand, arm, hand:arm all have denominator DF of 209.006. These relative sizes line up with the unique values in our model diagram for the levels where these groups were applied.

12) Generate an caterpillar plot from your new model. Find your group or a group of interest to you. Discuss the relative location of that group and, if you know something

about the group, discuss whether this result is something you expected given how we formed the groups based on height of the students.

At the group level, the TallerThanYou group had relatively higher estimated mean grip strength than the rest of the groups, and the average. This makes sense as these individuals were the tallest in their class last semester, and included PATaller who had the highest grip strength of all.

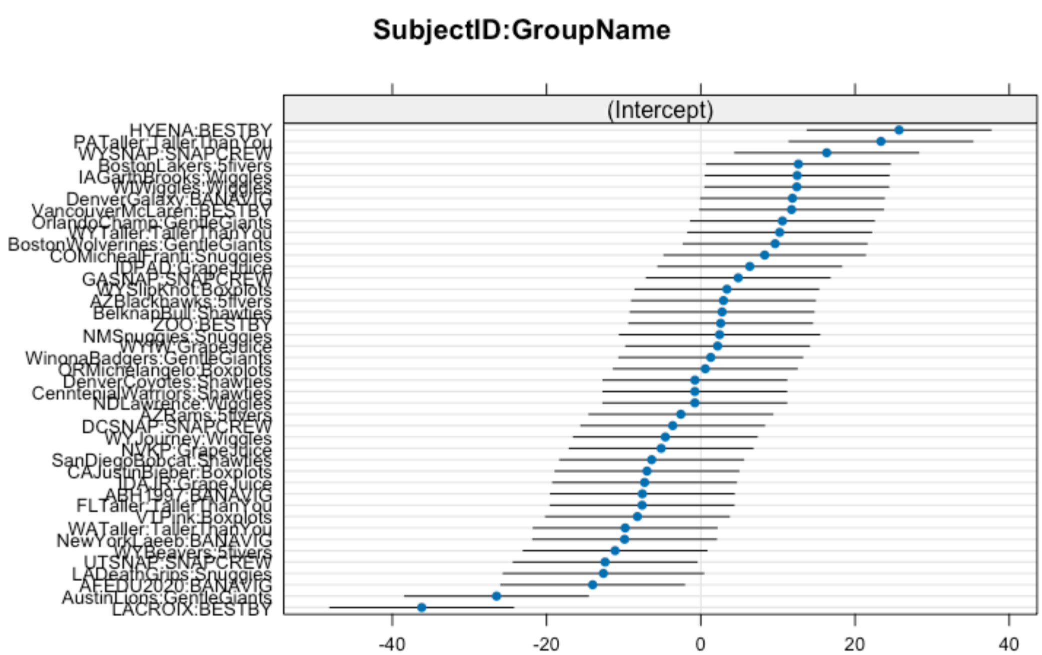
```
ranef(lmer4)
```

```
## $`SubjectID:GroupName`
##                                (Intercept)
## ABH1997:BANAVIG                 -7.5761812
## AFEDU2020:BANAVIG              -14.0182654
## AustinLions:GentleGiants       -26.4846160
## AZBlackhawks:5fivers             2.9398201
## AZRams:5fivers                  -2.5804367
## BelknapBull:Shawties             2.7620350
## BostonLakers:5fivers            12.6558283
## BostonWolverines:GentleGiants    9.6406761
## CAJustinBieber:Boxplots         -6.9782713
## CenntenialWarriors:Shawties     -0.7693745
## COMichealFranti:Snuggies         8.2861776
## DCSNAP:SNAPCREW                 -3.6384098
## DenverCoyotes:Shawties          -0.7592028
## DenverGalaxy:BANAVIG            11.8884391
## FLTaller:TallerThanYou          -7.6098964
## GASNAP:SNAPCREW                  4.8521628
## HYENA:BESTBY                    25.7167890
## IAGarthBrooks:Wiggles           12.5002301
## IDAJR:GrapeJuice                -7.2854334
## IDPAD:GrapeJuice                 6.3532329
## LACROIX:BESTBY                 -36.1847913
## LADeathGrips:Snuggies          -12.6273592
## NDLawrence:Wiggles              -0.7696199
## NewYorkLaeeb:BANAVIG            -9.8808974
## NMSnuggies:Snuggies              2.4384973
## NVKP:GrapeJuice                 -5.1335659
## OrlandoChamp:GentleGiants       10.5861936
## ORMichelangelo:Boxplots          0.5858693
## PATaller:TallerThanYou          23.3673020
## SanDiegoBobcat:Shawties         -6.3671002
## UTSNAP:SNAPCREW                -12.4089004
## VancouverMcLaren:BESTBY         11.7724255
## VTPink:Boxplots                 -8.2172253
## WATaller:TallerThanYou          -9.8045397
## WinonaBadgers:GentleGiants       1.2968216
## WIWiggles:Wiggles               12.4541075
## WYBeavers:5fivers              -11.1125272
## WYIW:GrapeJuice                  2.1799140
```

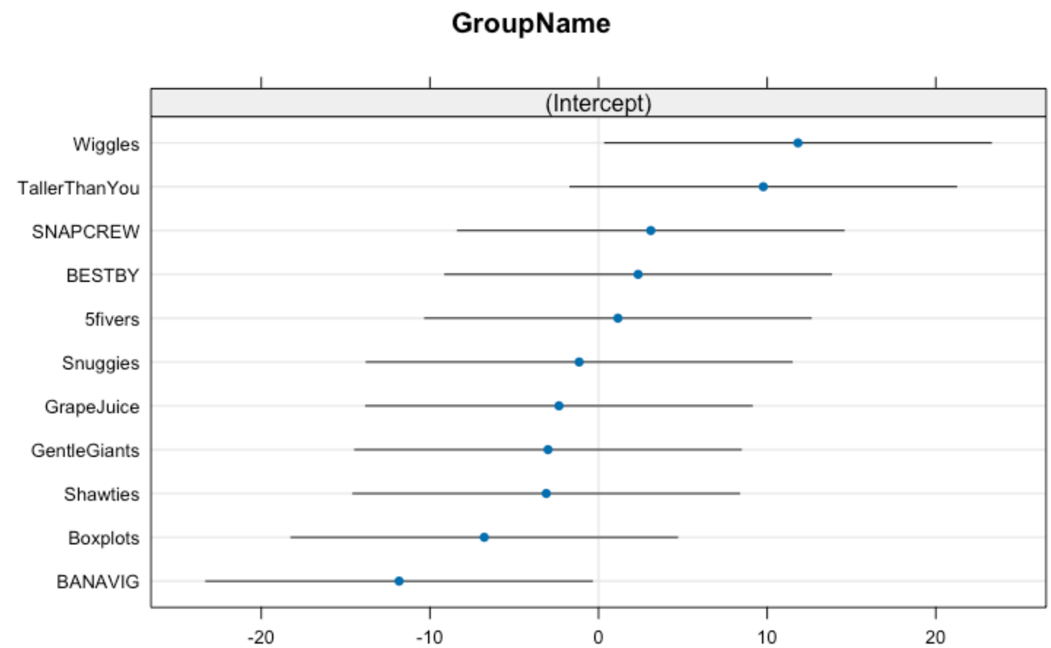
```
## WYJourney:Wiggles               -4.5978128
## WYSlipKnot:Boxplots              3.3898180
## WYSNAP:SNAPCREW                 16.3287899
## WYTaller:TallerThanYou          10.2278681
## ZOO:BESTBY                       2.5814291
##
## $GroupName
##                (Intercept)
## 5fivers           1.148931
## BANAVIG         -11.827506
## BESTBY            2.346463
## Boxplots         -6.775055
## GentleGiants     -2.995643
## GrapeJuice       -2.346463
## Shawties         -3.099938
## SNAPCREW          3.099938
## Snuggies         -1.148931
## TallerThanYou     9.770698
## Wiggles          11.827506
##
## with conditional variances for "SubjectID:GroupName" "GroupName"
```

```r
dotplot(ranef(lmer4, postVar = T))
```

```
## $`SubjectID:GroupName`
```




```
##
## $GroupName
```



13) Note any additional resources used to complete this lab or NONE.

NONE