Assignment 4 STAT 315-463: Multivariable Statistical Methods and Applications

```
library(here)
library(lattice)
library(lme4)
library(ggplot2)
```

```
# Data preparation
tern14 <- read.table("Terns2014.csv", header = TRUE, sep = ',', na.strings = "na")
head(tern14)
```

```
##    Band Age Wing Weight ID
## 1 64151   5   28   40.0  1
## 2 64151   6   35   48.0  1
## 3 64151   7   36   48.5  1
## 4 64151   9   55   58.5  1
## 5 64151  10   61   65.0  1
## 6 64151  12   76   71.0  1
```

```
tabulate(tern14$ID)
```

```
##  [1] 12 12  3  3  6  9 10  3  3  6  2  8  4  9  2 10  2  7  2 12  8  9  4  2  7
## [26]  3  5  4  2  5  9  3 11 11  4  6  4  7  9  7  2  8 12 12  3 10  8  7  6  7
## [51]  5  8  7  6  5  3  4  6  2  6  6  3  4  3  3
```

Model 1: Random intercepts

```
Model.1 <- lmer(Age ~ Wing + (1|ID), data = tern14)
summary(Model.1)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: Age ~ Wing + (1 | ID)
##    Data: tern14
##
## REML criterion at convergence: 1135.7
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.4005 -0.4709 -0.0712  0.4367  5.6895
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
```

```
##  ID       (Intercept) 4.2721   2.0669
##  Residual             0.5619   0.7496
## Number of obs: 391, groups:  ID, 65
##
## Fixed effects:
##             Estimate Std. Error t value
## (Intercept) 2.976157   0.283128   10.51
## Wing        0.147138   0.001146  128.34
##
## Correlation of Fixed Effects:
##      (Intr)
## Wing -0.395
```

Model 2: Random slopes

```
Model.2 <- lmer(Age ~ Wing + (0 + Wing|ID), data = tern14)
summary(Model.2)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: Age ~ Wing + (0 + Wing | ID)
##    Data: tern14
##
## REML criterion at convergence: 1166.5
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.0715 -0.4559 -0.0779  0.4010  4.2163
##
## Random effects:
##  Groups   Name Variance  Std.Dev.
##  ID       Wing 0.0005676 0.02382
##  Residual      0.5962503 0.77217
## Number of obs: 391, groups:  ID, 65
##
## Fixed effects:
##             Estimate Std. Error t value
## (Intercept) 2.527025   0.122949   20.55
## Wing        0.153688   0.003315   46.35
##
## Correlation of Fixed Effects:
##      (Intr)
## Wing -0.405
```

Model 3: Random slopes and intercepts

```
Model.3 <- lmer(Age ~ Wing + (1 + Wing|ID), data = tern14)
```

```
## Warning in checkConv(attr(opt, "derivs"), opt$par, ctrl = control$checkConv, :
## Model failed to converge with max|grad| = 0.439389 (tol = 0.002, component 1)
```

```
summary(Model.3)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: Age ~ Wing + (1 + Wing | ID)
##    Data: tern14
##
## REML criterion at convergence: 932.9
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.2764 -0.4639 -0.0748  0.4586  4.9026
##
## Random effects:
##  Groups   Name        Variance  Std.Dev. Corr
##  ID       (Intercept) 3.4346907 1.85329
##           Wing        0.0003303 0.01817  -0.38
##  Residual             0.2256019 0.47498
## Number of obs: 391, groups:  ID, 65
##
## Fixed effects:
##             Estimate Std. Error t value
## (Intercept) 2.697838   0.262709   10.27
## Wing        0.150908   0.002669   56.54
##
## Correlation of Fixed Effects:
##      (Intr)
## Wing -0.510
## optimizer (nloptwrap) convergence code: 0 (OK)
## Model failed to converge with max|grad| = 0.439389 (tol = 0.002, component 1)
```