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

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

```
# Read in data file
tern14 <- read.table("Terns2014.csv", header = TRUE, sep = ',', na.strings = "na")
```

```
Model <- lm(Age ~ Wing, data = tern14)
summary(Model)
```

```
##
## Call:
## lm(formula = Age ~ Wing, data = tern14)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.7934 -1.6505 -0.4569  1.6717  6.0860
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.955282   0.278493   10.61   <2e-16 ***
## Wing        0.146032   0.002535   57.61   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.101 on 389 degrees of freedom
## Multiple R-squared:  0.8951, Adjusted R-squared:  0.8948
## F-statistic:  3319 on 1 and 389 DF,  p-value: < 2.2e-16
```

```
AIC(Model)
```

```
## [1] 1694.202
```

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
```

```
AIC(Model.1)
```

```
## [1] 1143.745
```

In Model 1, we are looking at the fixed effect of **Wing** with the random intercepts. Besides, the AIC value of this mixed linear model indicates that it fits better than the model that ignores individual effects. From the results above, we can see that

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)
```