Statistics with Sparrows - many models, matrices, and some magic

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Linear mixed models part 2 - Solutions

Hypothesis 3

We also believe that horns are a signalling quality in unicorns. We are not sure if it's sexually selected, or maybe something very different or odd. Therefore, we think that 3) Unicorns with longer horns are more likely to mate more often than unicorns with shorter horns

```
plot(d$SexualActivity~d$Hornlength)
plot(d$SexualActivity~d$Sex)
mod<-lmer(SexualActivity~Hornlength+(1|Individual)+(1|Family), data=d)
summary(mod)
plot(mod)
hist(d$SexualActivity)
# here, while individual does not explain any variance (it's so small we can
jus assume it's zero), we have to leave it in to correct for pseudoreplicatio
n. Familiy explains some variance, though. Hornlength is strongly correlated
with sexual activity, with every increase in horn length by 1, unicorns get t
o make 1.03 times more. Not bad. The residual plot looks so odd because sexua
l activity is a count variable. However, because it's somewhat close to norma
l distributed (and does not follow a poisson distribution), we are ok with an
alysing it this way. Otherwise we'd use a GLMM, - but that's tomorrow.
```

Hypothesis 4

4) Unicorns with longer horns have a higher fitness

```
plot(d$LitterSize~d$Hornlength, pch=19, cex=0.8)
hist(d$LitterSize)
plot(d$LitterSize~d$Sex)
plot(d$LitterSize~d$Bodymass)
plot(d$Bodymass~d$Sex)

mod<-lmer(LitterSize~Hornlength+Sex*Bodymass+(1|Individual)+(1|Family), data=
d)
summary(mod)
plot(mod)
```

```
# Uf, this is difficult! It seems as if there is an effect in horn length on litter size, but it's negative! Unicorns with a one unit shorter horn have 0.77 fewer offspring in their litter! But there is also an odd, sex specific effect of bodymass: between unicorns of the same horn length, females have 0.07 more offspring per unit body mass, but males have 0.07-0.09=-0.02 fewer per unit body mass. However, in males that -0.02 is not significantly different from zero (because the standart error of the interaction is 0.04, thus double the effect size of 0.02). Therefore, the effect of body mass we find is that it has a positive effect on litter size in females, and no effect on males! So let's plot the regression lines for unicorns of the same body mass:

plot(d$LitterSize[d$Sex=="female"]~d$Hornlength[d$Sex=="female"], cex=0.8, ylim=c(0,12),xlim=c(-3,3), pch=19, col="red")
points(d$Hornlength[d$Sex=="male"],jitter(d$LitterSize[d$Sex=="male"]), col="blue", pch=19, cex=0.8)

x<-c(-3:3)
x
yfemale<-6.25-0.77*x
lines(x,yfemale, col="red")
ymale<-6.25-0.77*x-0.12
lines(x,ymale, col="blue")

#you can see the regression lines do not differ much by sex, - that is because only the effect of body mass differs by sex. Generally, in this model, correcting for bodymass and sex is probably not too important, given the parameter estimates - they are 0.07 for body mass in females, and 0 in males (because it is not statistically significant). Compare these with the slopes of horn length, these are ten times the effect size! So when we focus on our original hypothesis, we'd probably be fine displaying the model without body mass and sex, as the estimate for horn length would not differ much:

mod<-lmer(LitterSize~Hornlength+(1|Individual)+(1|Family), data=d)
summary(mod)
# and indeed, instead of an estimate of -0.77, we now get one of -0.76. So it's not that much different (althought he SE indicates that our precision can meausre that well). In a paper, I would only show the body mass sex effect if there was a point to be made with that, which is unlikely.

#What is also interesting is that in all models, there is strong evidence for between-individual, and between-family variation! That means, individuals have a similar litter size in subsequent breeding events, and related individuals also have similar litter sizes. That is super interesting as it could mean that litter size, a proxy of reproductive fitness, could be heritable!
```

Given that glizz seems to play an important role in unicorn biology, we also postulate that

Hypothesis 5

5) Glizz is an indicator of quality, and more glizz means a unicorn can secure more copulations

```
# ok, here we define quality with sexual activity.
plot(d$SexualActivity~d$Glizz)

plot(jitter(d$SexualActivity)~d$Glizz)
mod<-lmer(SexualActivity~Glizz*Sex+(1|Individual)+(1|Family),data=d)
summary(mod)

mod<-lmer(SexualActivity~Glizz+Sex+(1|Individual)+(1|Family),data=d)
summary(mod)

mod<-lmer(SexualActivity~Glizz+(1|Individual)+(1|Family),data=d)
summary(mod)

# there is no variation in sexual activity between individuals and familys. W
e can thus take out families:
mod<-lmer(SexualActivity~Glizz+(1|Individual),data=d)
summary(mod)

#here, there is still no variation between individuals, but we keep the rando
m effect in to account for pseudoreplication. Glizz has a small effect on sex
ual activity - but a negative one! It is however just barely statistically si
gnificant - the t-value is 1.9, which is just above the required 1.8 (in larg
e datasets - in small ones it's better to go by 2). The effect size seems sma
ll, but given that sexual activity only varies between 0 and 4, an effect of
0.04 less copulations per unit glizz is ok and reportable. Think of it that w
ay: the total range of Glizz between the most glamorous and bland unicorns is
about 6. So that means these unicorns differ in 6 * 0.04 = 0.25 copulations,
- that's not a lot but it's something that we can grasp biologically speaking
. It is clear that there is a lot of noise, and that it's a small effect, but
there is one.
```

Hypothesis 6

6) Therefore, unicorns with more glizz have a higher fitness

```
plot(d$Glizz,d$LitterSize)
plot(d$Glizz[d$Sex=="female"],jitter(d$LitterSize[d$Sex=="female"]), col="red
",cex=0.8, pch=19)
points(d$Glizz[d$Sex=="male"],jitter(d$LitterSize[d$Sex=="male"]), col="blue"
,cex=0.8, pch=19)

mod<-lmer(LitterSize~Glizz*Sex+(1|Individual)+(1|Family),data=d)
summary(mod)
plot(mod)

plot(d$Glizz[d$Sex=="female"],jitter(d$LitterSize[d$Sex=="female"]), col="red
",cex=0.8, pch=19)
```

```
points(d$Glizz[d$Sex=="male"],jitter(d$LitterSize[d$Sex=="male"]), col="blue"
,cex=0.8, pch=19)
x<-c(-3:3)
yfemales<-6.306+0.44*x
lines(x,yfemales, col="red",lwd=2)
ymales<-6.306+0.44*x-0.15+0.13*x
lines(x,ymales, col="blue",lwd=2)

#plotting the model lines helps us with the interpretation. Females have 0.4
more offspring in their litter for each unit Glizz. in males, that relationsh
ip is somewhat stronger - we have to add 0.13 (interaction effect size) to th
e slope: 0.44+0.13=0.57. The more negative intercept for males (6.31-0.15) al
so indicates that.
#Again, but we knew this - there is variation explained by individual identit
y and family in litter.
```

Hypothesis 7

7) All of this really suggests that of course, we assume that the more a unicorn mates, the higher its fitness.

```
plot(d$LitterSize~d$SexualActivity)
plot(jitter(d$LitterSize[d$Sex=="female"])~jitter(d$SexualActivity[d$Sex=="fe
male"]), col="red", pch=19, cex=0.8, ylim=c(0,12))
points(jitter(d$SexualActivity[d$Sex=="male"]),jitter(d$LitterSize[d$Sex=="ma
le"]), col="blue", pch=19, cex=0.8)

mod<-lmer(d$LitterSize~d$SexualActivity*d$Sex+(1|Individual)+(1|Family), data
=d)
summary(mod)

# Here, we find the expected variancesalso super small - it's about one tenth
of the main effect. (-0.07 vs -0.7). That's not much, but it seems reasonable
to leave it in.

#So litter size surpisingly decreases with sexual activity! That was unexpect
ed! We clearly need to conduct more research into the fascinating biology of
the unicorns!
```