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MS RAPTOR BIOLOGY

EEB 622 HW 5
08 MARCH 2019

Q1: STAN PACKAGE

A.DOWNLOAD PACKAGES

```
> require(rstan)
Loading required package: rstan
Loading required package: ggplot2
Loading required package: StanHeaders
rstan (Version 2.18.2, GitRev: 2e1f913d3ca3)
> require(rstanarm)
Loading required package: rstanarm
Loading required package: Rcpp
rstanarm (Version 2.18.2, packaged: 2018-11-08 22:19:38 UTC)
 > require(shinystan)
Loading required package: shinystan
Loading required package: shiny
This is shinystan version 2.5.0
```

B. STAN CODE

FUNCTION: stan_lmer()
DISCUSSION: https://discourse.mc-stan.org/t/nested-effects-in-stan-vs-stan-lmer/1997

*I might need to generate a simulated model based on training data prior to running my model. I imagine that my model needs to consider random effects that may either be nested or crossed. This discussion which, as far as I can understand, will be helpful in helping me better make decisions in setting my priors on both fixed and random effects.

Q2: DALL ET AL. 2005: ARE ANIMALS BAYESIANS? WHY OR WHY NOT?

*Based on the article by Dall et al. (2005), I am compelled to believe that animals are Bayesians because they make use of information they have acquired personally (which may incur energetic and temporal costs) or socially (which they may obtain genetically or from their companions). Specifically, my focal species (migratory raptors) are Bayesians given that their migratory behavior is informed by *priors*. For example, first-year birds that undergo their first migration journey tend to move based on their genetic predisposition but then, update these priors throughout their lifetime by learning from experienced migrants (adults) and through their own experience. Although not properly documented so far, experienced migrants (adults) lead migratory flocks during migration (i.e., being first to fly out off a thermal to search for another thermal which helps them reduce energetic costs of flapping). However, with the high variability in environmental conditions, migrating raptors are forced to regularly transform these priors to posteriors (e.g., delayed onset of spring/autumn migration due to shifts in prey availability) and consequently, use these posteriors to shape their movement decisions (i.e., shift in migration timing).

Q3: PROBABILITY THAT PIXEL IS FROM EARTH

```
> #A: PROBABILITY THAT PIXEL IS FROM PLANET EARTH
> #P(H|D)=P(D|H)P(H)/P(D)
> #Given:
> P_Earth=0.3 # P(pixel is from Earth given that it is 70% water)=0.30
```

```
> P_Mars=1 #P(pixel is from Mars given that it is 100% land)=1.0
> P_EarthorMars=0.5 #P(pixel is from Earth or Mars)=0.5
> P_Earthland=0.23 #given posterior probability that pixel is from Earth
> P_pixel=(P_Earth*P_EarthorMars)+(P_Mars*P_EarthorMars)
> P_pixel #P(pixel is from Earth or Mars given priors)=P(pixel is Earth)*P(pi
xel is from Earth or Mars)+ P(pixel is from Mars)*P(pixel is from Earth or Ma
rs)
[1] 0.65
> P_pixel_Earth=P_Earth*P_Elandprior
> P_pixel_Earth #P(pixel is from Earth given priors)
[1] 0.195
> P_Elanddata=P_Earth*P_Elandprior/P_Earthland
> P_Elanddata #P(pixel is from Earth given posterior probability=0.23)
[1] 0.8478261
> P_Elandcalc=P_Earth*P_Elandprior/P_Elanddata
> P_Elandcalc #proofed calculation of posterior probability that pixel is fro
m Earth
[1] 0.23
```

*** Given the prior probabilities and posterior probability, we can assume that there is ~20% probability that the pixel is from Earth.**

Q4: PANDA DATA

A.PROBABILITY THAT NEXT BIRTH IS TWINS

```
> #P(H|D)=P(D|H)P(H)/P(D)
> #Given:
> P_specA_twins=0.1    #P(species A produce twins)
> P_specB_twins=0.2    #P(species B produce twins)
> P_specAorB=0.5       #P(species being A or B)
> P_twins=(P_specA_twins*P_specAorB)+(P_specB_twins*P_specAorB)     #P(twins
given species A and B probabilities)
> P_twins_specA=(P_specA_twins*P_specAorB)/P_twins
> P_twins_specA #probability that species A will produce twins twice in a row
[1] 0.3333333
> P_twins_specB=(P_specB_twins*P_specAorB)/P_twins
> P_twins_specB #probability that species B will produce twins twice in a row
[1] 0.6666667
> > P_twins2=(P_twins_specA*P_specA_twins) +(P_twins_specB*P_specB_twins)
> P_twins2 #probability that twins will be birthed again
[1] 0.1666667
```

***The probability of twin birth from the panda mother is ~17% given the respective probabilities of twin births from species A and B.**

B. PROBABILITY OF SPECIES A GIVEN BIRTHING DATA (TWINS)

```
> #Given:
> P_specA_twins=0.1    #P(species A produce twins)
> P_specB_twins=0.2    #P(species B produce twins)
> P_specAorB=0.5       #P(species being A or B)
> P_twins=(P_specA_twins*P_specAorB)+(P_specB_twins*P_specAorB)  #P(twins giv
en species A and B probabilities)
> P_twins_specA=(P_specA_twins*P_specAorB)/P_twins
> P_twins_specA
[1] 0.3333333  #probability that species A will produce twins twice in a row
```

***There is 33% that the panda mother is species A given known probabilities for twin births of both species and previous birthing data (twin birth).**

C. PROBABILITY OF SPECIES A ASSUMING IT GIVES BIRTH TO A SINGLETON

```
> #GIVEN:
> P_specA_single=1-P_specA_twins      #P(species A produce singleton)
> P_specB_single=1-P_specB_twins      #P(species B produce singleton)
> P_single=(P_specA_twins*P_specA_single*P_specAorB)+(P_specB_twins*P_specB_s
ingle*P_specAorB)
> P_single                       #P(singleton birth)
[1] 0.125
> P_twintosingle_specA=P_specA_twins*P_specA_single
> P_twintosingle_specA        #P(species A produce twins then singleton)
[1] 0.09
> P_single_specA=(P_twintosingle_specA*P_specAorB)/P_single
> P_single_specA       #P(species A gives birth to singleton after twins)
[1] 0.36
```

***If the panda mother gives birth to a singleton after a twin birth, there is 36% chance that it is species A assuming that there is ~13% of singleton birth for both species.**

D. POSTERIOR PROBABILITY OF PANDA MOTHER BEING SPECIES A

1. Posterior probability discarding birthing information

```
> #GIVEN:
> P_specA_true=0.8 #probability of correct identification of species A
> P_specB_true=0.35 # probability of correct identification of species A
> P_specA_poss=1-P_specB_true #probability of species A given misidentificati
on of species B
> P_specB_poss=1-P_specA_true #probability of species B given misidentificati
on of species A
> #P(H|D)=P(D|H)P(H)/P(D)
> P_AorB=(P_specA_true*P_specAorB)+(P_specB_true*P_specAorB) #total probabili
ty of species A or B
> P_AorB
[1] 0.575
> P_specA_positive=(P_specA_true*P_specAorB)/P_AorB #probability of identifyi
ng species A given positive genetic tests
> P_specA_positive
[1] 0.6956522
```

***We have ~70% confidence that the panda mother is species A given genetic information.**

2. Posterior probability given genetic and birthing data

```
> #GIVEN:
> P_specA_true=0.8 #probability of correct identification of species A
> P_specB_true=0.65 # probability of correct identification of species A
> P_specA_poss=1-P_specB_true #probability of species A given misidentificati
on of species B
> P_specB_poss=1-P_specA_true #probability of species B given misidentificati
on of species A
> P_single_specA=(P_twintosingle_specA*P_specAorB)/P_single #probability of s
pecies A given singleton birth
```

```
> P_posA=P_specA_true*P_single_specA+(P_specA_poss*(1-P_single_specA)) #total
probability of testing positive as species A
> P_trueA=(P_specA_true*P_single_specA)/P_posA
> P_trueA #probability of being species A giving birth to twins and testing p
ositive as species A
[1] 0.5625
```

***Our confidence in correctly identifying the panda mother as species A has reduced to 56% if we take into account our prior knowledge on singleton and twin births.**