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>
> #random seven minute sampling
>
> #repeatabilities for axy1 file, adults only
> ##KEEP IN MIND: Some squirrels had axy conducted when they were in different ageclasses (e.g., A and Y)
> ###these squirrels cause imbalances when looking at ageclass summaries
> #original code by A. R. Martinig
> #last edited May 8, 2024 by A. R. Martinig
>
> #run the following prior to running script:
> start-up code.R
Error: unexpected symbol in "start-up code.R"
> axy data subsets.R
Error: unexpected symbol in "axy data"
> PCA generation code - axy.R
Error: unexpected symbol in "PCA generation"
> local density (global datasets).R
Error: unexpected symbol in "local density"
> familiarity axy (global datasets).R
Error: unexpected symbol in "familiarity axy"
>
> #create working dataframe
> adult_axy_all<-left_join(axy1, clean_axy, by=c("squirrel_id"="squirrel_id", "axy_yr"="axy_yr"))%>%
+   left_join((tbl(con, "flastall2") %>% select(squirrel_id, grid=gr) %>% collect()), by="squirrel_id") %>% #to bring in the grid information
+   filter(axy_ageclass=="A") %>%
+   mutate(
+         grid=ifelse(grid=="SUX", "SU", grid),
+      grid_yr=paste(grid, axy_yr, sep=""),
+      axy_yr=axy_yr-2014) %>%
+  group_by(squirrel_id) %>% #convert these variables to among-ind effects
+  mutate(b.axy.local.density=mean(axy.local.density),
+      b.axy_avg_fam=mean(axy_avg_fam, na.rm=T)) %>%
+  ungroup()
>
> summary(adult_axy_all)
  squirrel_id       axy_date              axy_yr        axy_month     axy_season            tod                feed            forage
 Min.   :10418   Min.   :2014-05-18   Min.   :0.000   Min.   :5.00   Length:4507        Length:4507        Min.   :0.0000   Min.   :0.00000
 1st Qu.:12733   1st Qu.:2014-09-14   1st Qu.:0.000   1st Qu.:6.00   Class :character   Class :character   1st Qu.:0.0000   1st Qu.:0.00000
 Median :20488   Median :2017-08-27   Median :3.000   Median :7.00   Mode  :character   Mode  :character   Median :0.0000   Median :0.00000
 Mean   :18895   Mean   :2017-08-09   Mean   :3.051   Mean   :7.18                                         Mean   :0.1664   Mean   :0.04216
 3rd Qu.:22290   3rd Qu.:2019-07-03   3rd Qu.:5.000   3rd Qu.:9.00                                         3rd Qu.:0.0000   3rd Qu.:0.00000
 Max.   :25225   Max.   :2022-09-24   Max.   :8.000   Max.   :9.00                                         Max.   :1.0000   Max.   :1.00000

    nestmove       nestnotmove       notmoving           travel          axy_id              sex                byear          dyear
 Min.   :0.0000   Min.   :0.0000   Min.   :0.00000   Min.   :0.0000   Length:4507        Length:4507        Min.   :2006   Min.   :2010
 1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.00000   1st Qu.:0.0000   Class :character   Class :character   1st Qu.:2011   1st Qu.:2016
 Median :0.0000   Median :0.0000   Median :0.00000   Median :0.0000   Mode  :character   Mode  :character   Median :2014   Median :2018
 Mean   :0.1333   Mean   :0.3632   Mean   :0.08099   Mean   :0.2139                                         Mean   :2014   Mean   :2018
 3rd Qu.:0.0000   3rd Qu.:1.0000   3rd Qu.:0.00000   3rd Qu.:0.0000                                         3rd Qu.:2016   3rd Qu.:2019
 Max.   :1.0000   Max.   :1.0000   Max.   :1.00000   Max.   :1.0000                                         Max.   :2020   Max.   :2022

   litter_id       axy_age      axy_ageclass        prop_feeding     prop_foraging     prop_nestmoving   prop_nestnotmoving prop_notmoving
 Min.   :  37   Min.   :2.000   Length:4507        Min.   :0.00000   Min.   :0.00000   Min.   :0.00000   Min.   :0.0000     Min.   :0.00000
 1st Qu.:4891   1st Qu.:2.000   Class :character   1st Qu.:0.07143   1st Qu.:0.00000   1st Qu.:0.07143   1st Qu.:0.2143     1st Qu.:0.00000
 Median :5258   Median :3.000   Mode  :character   Median :0.14286   Median :0.00000   Median :0.07143   Median :0.3571     Median :0.07143
 Mean   :5206   Mean   :3.428                      Mean   :0.17061   Mean   :0.04190   Mean   :0.13067   Mean   :0.3513     Mean   :0.08461
 3rd Qu.:5894   3rd Qu.:4.000                      3rd Qu.:0.21429   3rd Qu.:0.07143   3rd Qu.:0.21429   3rd Qu.:0.5000     3rd Qu.:0.14286
 Max.   :9751   Max.   :8.000                      Max.   :0.71429   Max.   :0.50000   Max.   :0.92857   Max.   :0.9286     Max.   :1.00000
 NA's   :2516
  prop_travel           PC1                PC2          axy.local.density  axy_avg_fam         grid            grid_yr          b.axy.local.density
 Min.   :0.00000   Min.   :-2.9988   Min.   :-4.8257   Min.   :0.000     Min.   :   0.0   Length:4507        Length:4507        Min.   :0.000
 1st Qu.:0.07143   1st Qu.:-1.1866   1st Qu.:-0.5806   1st Qu.:0.000     1st Qu.:   0.0   Class :character   Class :character   1st Qu.:0.000
 Median :0.21429   Median :-0.3026   Median : 0.1107   Median :0.565     Median :   0.0   Mode  :character   Mode  :character   Median :0.565
 Mean   :0.22180   Mean   :-0.1365   Mean   : 0.0497   Mean   :1.139     Mean   : 189.1                                          Mean   :1.139
 3rd Qu.:0.35714   3rd Qu.: 0.8434   3rd Qu.: 0.7199   3rd Qu.:1.883     3rd Qu.: 307.9                                          3rd Qu.:1.883
 Max.   :0.92857   Max.   : 4.2316   Max.   : 5.0095   Max.   :5.839     Max.   :1140.8                                          Max.   :5.839

 b.axy_avg_fam
 Min.   :   0.0
 1st Qu.:   0.0
 Median :   0.0
 Mean   : 189.1
 3rd Qu.: 324.9
 Max.   :1140.8

> tail(adult_axy_all)
# A tibble: 6 × 33
  squirrel_id axy_date   axy_yr axy_month axy_season tod    feed forage nestmove nestnotmove notmoving travel axy_id          sex   byear dyear
```

```
        <dbl> <date>      <dbl>     <int> <chr>      <chr> <int>  <int>    <int>       <int>     <int>  <int> <chr>            <chr> <int> <int>
1       25216 2022-09-19      8         9 autumn     day       0      1        0           0         0      0 25216-2022-09-19 F      2020  2022
2       25216 2022-09-20      8         9 autumn     day       0      0        0           0         0      1 25216-2022-09-20 F      2020  2022
3       25216 2022-09-21      8         9 autumn     day       0      0        0           1         0      0 25216-2022-09-21 F      2020  2022
4       25216 2022-09-22      8         9 autumn     day       1      0        0           0         0      0 25216-2022-09-22 F      2020  2022
5       25216 2022-09-23      8         9 autumn     day       0      0        0           0         0      1 25216-2022-09-23 F      2020  2022
6       25216 2022-09-24      8         9 autumn     day       1      0        0           0         0      0 25216-2022-09-24 F      2020  2022
  litter_id axy_age axy_ageclass prop_feeding prop_foraging prop_nestmoving prop_nestnotmoving prop_notmoving prop_travel   PC1     PC2
      <int>   <int> <chr>               <dbl>         <dbl>          <dbl>              <dbl>          <dbl>       <dbl> <dbl>   <dbl>
1        NA       2 A                   0.214        0.0714          0.357             0.0714          0           0.286  0.994  1.60
2        NA       2 A                   0.0714       0.0714          0.357             0.0714          0           0.429  1.09   2.02
3        NA       2 A                   0.643        0               0                 0.214           0.0714      0.0714 0.907 -2.04
4        NA       2 A                   0.214        0               0.0714            0.214           0           0.5    1.22  -0.0513
5        NA       2 A                   0.214        0               0.214             0.214           0           0.357  0.568  0.686
6        NA       2 A                   0.571        0               0                 0.0714          0.0714      0.286  1.82  -1.82
  axy.local.density axy_avg_fam grid  grid_yr b.axy.local.density b.axy_avg_fam
              <dbl>       <dbl> <chr> <chr>                 <dbl>         <dbl>
1                 0           0 JO    JO2022                    0             0
2                 0           0 JO    JO2022                    0             0
3                 0           0 JO    JO2022                    0             0
4                 0           0 JO    JO2022                    0             0
5                 0           0 JO    JO2022                    0             0
6                 0           0 JO    JO2022                    0             0
>
> (adult_axy_all) %>% as_tibble() %>% dplyr::count(squirrel_id) %>% nrow() #177 adults
[1] 177
> (adult_axy_all) %>% as_tibble() %>% dplyr::count(squirrel_id, axy_yr, axy_date) %>% nrow() #4507 deployment days
[1] 4507
> nrow(adult_axy_all) #4507 records
[1] 4507
>
> table(adult_axy_all$grid_yr) #28 levels

AG2018 AG2019 BT2017 BT2019 BT2021 BT2022 JO2015 JO2017 JO2019 JO2020 JO2021 JO2022 KL2014 KL2015 KL2016 KL2017 KL2020 KL2021 KL2022 LL2014 LL2017
   131     35     54    240     49    111     53    197    648     12     15    153    218    194    187     91     77     54     19    877    207
LL2018 LL2019 SU2014 SU2015 SU2016 SU2021 SU2022
   136    121    226    153     84     69     96
> table(adult_axy_all$axy_yr) #9 levels

   0    1    2    3    4    5    6    7    8
1321  400  271  549  267 1044   89  187  379
> table(adult_axy_all$grid) #6 levels

  AG   BT   JO   KL   LL   SU
 166  454 1078  840 1341  628
>
> ########################################
> #############       Adults         ##############
> #############      n = 177         ##############
> ########################################
>
> ############################
> ######## PC1 models ########
> ############################
>
> ############################
> #non-adjusted repeatability
> ############################
>
> m1a<-lmer(PC1 ~ (1|squirrel_id) + (1|grid_yr), data=adult_axy_all)
> summary(m1a)
Linear mixed model fit by REML ['lmerMod']
Formula: PC1 ~ (1 | squirrel_id) + (1 | grid_yr)
   Data: adult_axy_all

REML criterion at convergence: 12992.4

Scaled residuals:
    Min      1Q  Median      3Q     Max
-3.9594 -0.6695 -0.0221  0.6394  3.7033

Random effects:
 Groups      Name        Variance Std.Dev.
 squirrel_id (Intercept) 0.3675   0.6062
 grid_yr     (Intercept) 0.6567   0.8104
 Residual                0.9439   0.9716
Number of obs: 4507, groups:  squirrel_id, 177; grid_yr, 28

Fixed effects:
            Estimate Std. Error t value
(Intercept)  -0.1046     0.1654  -0.632
>
> plot(m1a)
> hist(resid(m1a))
>
> #for axy PC1
> sm1<-arm::sim(m1a,1000)
> smfixef=sm1@fixef
> smranef=sm1@ranef
> smfixef=coda::as.mcmc(smfixef)
> MCMCglmm::posterior.mode(smfixef)
(Intercept)
```

```
-0.09814333
> coda::HPDinterval(smfixef)
                lower     upper
(Intercept) -0.4333513 0.2165283
attr(,"Probability")
[1] 0.95
>
> ##among-individual variance
> bID<-sm1@ranef$squirrel_id
> bvar<-as.vector(apply(bID, 1, var)) ##between individual variance posterior distribution
> bvar<-coda::as.mcmc(bvar)
> MCMCglmm::posterior.mode(bvar) ## mode of the distribution
     var1
0.3626719
> coda::HPDinterval(bvar)
         lower     upper
var1 0.3179733 0.4105463
attr(,"Probability")
[1] 0.95
>
> ##residual variance
> rvar<-sm1@sigma^2
> rvar<-coda::as.mcmc(rvar)
> MCMCglmm::posterior.mode(rvar)
     var1
0.9401265
> coda::HPDinterval(rvar)
        lower    upper
var1 0.902406 0.977966
attr(,"Probability")
[1] 0.95
>
> ##repeatability
> rID<-bvar/(bvar+rvar)
> MCMCglmm::posterior.mode(rID)
     var1
0.2724757
> coda::HPDinterval(rID)
         lower    upper
var1 0.2537105 0.305498
attr(,"Probability")
[1] 0.95
>
> ############################
> #adjusted repeatability
> ############################
>
> m1b<-lmer(PC1 ~  sex + b.axy.local.density + b.axy_avg_fam + (1|squirrel_id) + (1|grid_yr), data=adult_axy_all)
> summary(m1b)
Linear mixed model fit by REML ['lmerMod']
Formula: PC1 ~ sex + b.axy.local.density + b.axy_avg_fam + (1 | squirrel_id) +      (1 | grid_yr)
   Data: adult_axy_all

REML criterion at convergence: 13011.8

Scaled residuals:
    Min      1Q  Median      3Q     Max
-3.9583 -0.6692 -0.0225  0.6376  3.7018

Random effects:
 Groups      Name        Variance Std.Dev.
 squirrel_id (Intercept) 0.3750   0.6124
 grid_yr     (Intercept) 0.6357   0.7973
 Residual                0.9438   0.9715
Number of obs: 4507, groups:  squirrel_id, 177; grid_yr, 28

Fixed effects:
                     Estimate Std. Error t value
(Intercept)         -0.2011986  0.1830378  -1.099
sexM                 0.0831021  0.1291366   0.644
b.axy.local.density  0.0392142  0.0578528   0.678
b.axy_avg_fam        0.0001381  0.0002538   0.544

Correlation of Fixed Effects:
            (Intr) sexM   b.xy..
sexM        -0.166
b.xy.lcl.dn -0.333 -0.070
b.axy_vg_fm -0.160 -0.068 -0.181
>
> plot(m1b)
> hist(resid(m1b))
>
> #for axy PC1
> sm1<-arm::sim(m1b,1000)
> smfixef=sm1@fixef
> smranef=sm1@ranef
> smfixef=coda::as.mcmc(smfixef)
> MCMCglmm::posterior.mode(smfixef)
       (Intercept)               sexM b.axy.local.density       b.axy_avg_fam
      -0.1866624554        0.0439182711        0.0473637411        0.0001101122
> coda::HPDinterval(smfixef)
                            lower        upper
```

```
(Intercept)         -0.5222905575 0.1479239625
sexM                -0.1673729927 0.3282384176
b.axy.local.density -0.0751424679 0.1525054558
b.axy_avg_fam       -0.0003020702 0.0006450489
attr(,"Probability")
[1] 0.95
>
> ##among-individual variance
> bID<-sm1@ranef$squirrel_id
> bvar<-as.vector(apply(bID, 1, var)) ##between individual variance posterior distribution
> bvar<-coda::as.mcmc(bvar)
> MCMCglmm::posterior.mode(bvar) ## mode of the distribution
     var1
0.3770855
> coda::HPDinterval(bvar)
         lower     upper
var1 0.3262278 0.4224728
attr(,"Probability")
[1] 0.95
>
> ##residual variance
> rvar<-sm1@sigma^2
> rvar<-coda::as.mcmc(rvar)
> MCMCglmm::posterior.mode(rvar)
     var1
0.9310983
> coda::HPDinterval(rvar)
         lower     upper
var1 0.9022302 0.9819032
attr(,"Probability")
[1] 0.95
>
> ##repeatability
> rID<-bvar/(bvar+rvar)
> MCMCglmm::posterior.mode(rID)
     var1
0.2831912
> coda::HPDinterval(rID)
         lower     upper
var1 0.2592934 0.3124756
attr(,"Probability")
[1] 0.95
>
>
>
> ##############################
> ######## PC2 models ########
> ##############################
>
> ##############################
> #non-adjusted repeatability
> ##############################
>
> m2a<-lmer(PC2 ~ (1|squirrel_id) + (1|grid_yr), data=adult_axy_all)
> summary(m2a)
Linear mixed model fit by REML ['lmerMod']
Formula: PC2 ~ (1 | squirrel_id) + (1 | grid_yr)
   Data: adult_axy_all

REML criterion at convergence: 13354.8

Scaled residuals:
    Min      1Q  Median      3Q     Max
-4.8661 -0.5626  0.0100  0.6157  4.6608

Random effects:
 Groups      Name        Variance Std.Dev.
 squirrel_id (Intercept) 0.14755  0.3841
 grid_yr     (Intercept) 0.08744  0.2957
 Residual                1.06428  1.0316
Number of obs: 4507, groups:  squirrel_id, 177; grid_yr, 28

Fixed effects:
            Estimate Std. Error t value
(Intercept) -0.008053   0.069603  -0.116
>
> plot(m2a)
> hist(resid(m2a))
>
> #for axy PC2
> sm2<-arm::sim(m2a,1000)
> smfixef2=sm2@fixef
> smranef2=sm2@ranef
> smfixef2=coda::as.mcmc(smfixef2)
> MCMCglmm::posterior.mode(smfixef2)
(Intercept)
-0.01077718
> coda::HPDinterval(smfixef2)
                lower     upper
(Intercept) -0.1642794 0.1048953
attr(,"Probability")
[1] 0.95
```

```
>
> ##among-individual variance
> bID2<-sm2@ranef$squirrel_id
> bvar2<-as.vector(apply(bID2, 1, var)) ##between individual variance posterior distribution
> bvar2<-coda::as.mcmc(bvar2)
> MCMCglmm::posterior.mode(bvar2) ## mode of the distribution
     var1
0.1505086
> coda::HPDinterval(bvar2)
         lower     upper
var1 0.1248905 0.1761427
attr(,"Probability")
[1] 0.95
>
> ##residual variance
> rvar2<-sm2@sigma^2
> rvar2<-coda::as.mcmc(rvar2)
> MCMCglmm::posterior.mode(rvar2)
    var1
1.061961
> coda::HPDinterval(rvar2)
        lower    upper
var1 1.024376 1.111524
attr(,"Probability")
[1] 0.95
>
> ##repeatability
> rID2<-bvar2/(bvar2+rvar2)
> MCMCglmm::posterior.mode(rID2)
     var1
0.1229884
> coda::HPDinterval(rID2)
         lower     upper
var1 0.1040991 0.1409287
attr(,"Probability")
[1] 0.95
>
> ############################
> #adjusted repeatability
> ############################
>
> m2b<-lmer(PC2 ~  sex + b.axy.local.density + b.axy_avg_fam + (1|squirrel_id) + (1|grid_yr), data=adult_axy_all)
> summary(m2b)
Linear mixed model fit by REML ['lmerMod']
Formula: PC2 ~ sex + b.axy.local.density + b.axy_avg_fam + (1 | squirrel_id) +      (1 | grid_yr)
   Data: adult_axy_all

REML criterion at convergence: 13377.4

Scaled residuals:
    Min      1Q  Median      3Q     Max
-4.8660 -0.5622  0.0096  0.6146  4.6796

Random effects:
 Groups      Name        Variance Std.Dev.
 squirrel_id (Intercept) 0.14793  0.3846
 grid_yr     (Intercept) 0.09475  0.3078
 Residual                1.06441  1.0317
Number of obs: 4507, groups:  squirrel_id, 177; grid_yr, 28

Fixed effects:
                     Estimate   Std. Error t value
(Intercept)          0.033054363  0.090496561   0.365
sexM                -0.057620126  0.087750094  -0.657
b.axy.local.density -0.017988778  0.037878072  -0.475
b.axy_avg_fam        0.000005432  0.000172540   0.031

Correlation of Fixed Effects:
            (Intr) sexM   b.xy..
sexM        -0.236
b.xy.lcl.dn -0.429 -0.100
b.axy_vg_fm -0.193 -0.047 -0.253
>
> plot(m2b)
> hist(resid(m2b))
>
> #for axy PC2
> sm2<-arm::sim(m2b,1000)
> smfixef2=sm2@fixef
> smranef2=sm2@ranef
> smfixef2=coda::as.mcmc(smfixef2)
> MCMCglmm::posterior.mode(smfixef2)
       (Intercept)                sexM b.axy.local.density       b.axy_avg_fam
      -0.0319357086       -0.0620934201       -0.0351084207       -0.0001258499
> coda::HPDinterval(smfixef2)
                           lower        upper
(Intercept)         -0.1244650911 0.2157659679
sexM                -0.2269167142 0.1022400018
b.axy.local.density -0.0943220309 0.0549102350
b.axy_avg_fam       -0.0003147934 0.0003327204
attr(,"Probability")
[1] 0.95
```

```
>
> ##among-individual variance
> bID2<-sm2@ranef$squirrel_id
> bvar2<-as.vector(apply(bID2, 1, var)) ##between individual variance posterior distribution
> bvar2<-coda::as.mcmc(bvar2)
> MCMCglmm::posterior.mode(bvar2) ## mode of the distribution
     var1
0.1539951
> coda::HPDinterval(bvar2)
         lower     upper
var1 0.1226592 0.1754616
attr(,"Probability")
[1] 0.95
>
> ##residual variance
> rvar2<-sm2@sigma^2
> rvar2<-coda::as.mcmc(rvar2)
> MCMCglmm::posterior.mode(rvar2)
    var1
1.066948
> coda::HPDinterval(rvar2)
        lower    upper
var1 1.023713 1.109267
attr(,"Probability")
[1] 0.95
>
> ##repeatability
> rID2<-bvar2/(bvar2+rvar2)
> MCMCglmm::posterior.mode(rID2)
     var1
0.1201204
> coda::HPDinterval(rID2)
         lower     upper
var1 0.1055663 0.1447904
attr(,"Probability")
[1] 0.95
> #random seven minute sampling
>
> #repeatabilities for axy1 file, yearlings only
> ##KEEP IN MIND: Some squirrels had axy conducted when they were in different ageclasses (A and Y)
> ###these squirrels cause imbalances when looking at ageclass summaries
> #original code by A. R. Martinig
> #last edited May 8, 2024 by A. R. Martinig
>
> #run the following prior to running script:
> start-up code.R
Error: unexpected symbol in "start-up code.R"
> axy data subsets.R
Error: unexpected symbol in "axy data"
> PCA generation code - axy.R
Error: unexpected symbol in "PCA generation"
> local density (global datasets).R
Error: unexpected symbol in "local density"
> familiarity axy (global datasets).R
Error: unexpected symbol in "familiarity axy"
>
> #create working dataframe
> yearling_axy_all<-left_join(axy1, clean_axy, by=c("squirrel_id"="squirrel_id", "axy_yr"="axy_yr"))%>%
+   left_join((tbl(con, "flastall2") %>% select(squirrel_id, grid=gr) %>% collect()), by="squirrel_id") %>% #to bring in the grid information
+   filter(axy_ageclass=="Y") %>%
+   mutate(
+         grid=ifelse(grid=="SUX", "SU", grid),
+     grid_yr=paste(grid, axy_yr, sep=""),
+     axy_yr=axy_yr-2014) %>%
+  group_by(squirrel_id) %>% #convert these variables to among-ind effects
+  mutate(b.axy.local.density=mean(axy.local.density),
+     b.axy_avg_fam=mean(axy_avg_fam, na.rm=T)) %>%
+  ungroup()
>
> summary(yearling_axy_all)
  squirrel_id       axy_date              axy_yr        axy_month      axy_season           tod                feed            forage
 Min.   :19537   Min.   :2014-08-26   Min.   :0.000   Min.   :5.000   Length:1764        Length:1764        Min.   :0.0000   Min.   :0.00000
 1st Qu.:21473   1st Qu.:2015-09-18   1st Qu.:1.000   1st Qu.:7.000   Class :character   Class :character   1st Qu.:0.0000   1st Qu.:0.00000
 Median :23261   Median :2017-09-22   Median :3.000   Median :8.000   Mode  :character   Mode  :character   Median :0.0000   Median :0.00000
 Mean   :22789   Mean   :2017-11-20   Mean   :3.277   Mean   :7.836                                         Mean   :0.1995   Mean   :0.04535
 3rd Qu.:23869   3rd Qu.:2019-06-15   3rd Qu.:5.000   3rd Qu.:9.000                                         3rd Qu.:0.0000   3rd Qu.:0.00000
 Max.   :25314   Max.   :2022-09-15   Max.   :8.000   Max.   :9.000                                         Max.   :1.0000   Max.   :1.00000

    nestmove       nestnotmove       notmoving          travel          axy_id              sex                byear          dyear
 Min.   :0.0000   Min.   :0.0000   Min.   :0.0000   Min.   :0.0000   Length:1764        Length:1764        Min.   :2013   Min.   :2014
 1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.0000   1st Qu.:0.0000   Class :character   Class :character   1st Qu.:2014   1st Qu.:2018
 Median :0.0000   Median :0.0000   Median :0.0000   Median :0.0000   Mode  :character   Mode  :character   Median :2016   Median :2019
 Mean   :0.1037   Mean   :0.3022   Mean   :0.0788   Mean   :0.2704                                         Mean   :2016   Mean   :2018
 3rd Qu.:0.0000   3rd Qu.:1.0000   3rd Qu.:0.0000   3rd Qu.:1.0000                                         3rd Qu.:2018   3rd Qu.:2019
 Max.   :1.0000   Max.   :1.0000   Max.   :1.0000   Max.   :1.0000                                         Max.   :2021   Max.   :2022

   litter_id       axy_age  axy_ageclass        prop_feeding     prop_foraging     prop_nestmoving   prop_nestnotmoving prop_notmoving
 Min.   :  77   Min.   :1   Length:1764        Min.   :0.00000   Min.   :0.00000   Min.   :0.00000   Min.   :0.0000     Min.   :0.00000
 1st Qu.:5801   1st Qu.:1   Class :character   1st Qu.:0.07143   1st Qu.:0.00000   1st Qu.:0.00000   1st Qu.:0.1429     1st Qu.:0.00000
 Median :5982   Median :1   Mode  :character   Median :0.21429   Median :0.00000   Median :0.07143   Median :0.2857     Median :0.00000
 Mean   :6323   Mean   :1                      Mean   :0.20218   Mean   :0.04912   Mean   :0.10844   Mean   :0.2920     Mean   :0.08281
 3rd Qu.:7779   3rd Qu.:1                      3rd Qu.:0.28571   3rd Qu.:0.07143   3rd Qu.:0.14286   3rd Qu.:0.4286     3rd Qu.:0.07143
```

```
 Max.   :9878   Max.   :1                     Max.   :0.71429   Max.   :0.57143   Max.   :0.85714   Max.   :1.0000     Max.   :1.00000
 NA's   :1165
  prop_travel          PC1               PC2            axy.local.density  axy_avg_fam         grid              grid_yr          b.axy.local.density
 Min.   :0.0000   Min.   :-3.0923   Min.   :-4.82566   Min.   :0.0000    Min.   :  0.00   Length:1764        Length:1764        Min.   :0.0000
 1st Qu.:0.1429   1st Qu.:-0.7033   1st Qu.:-0.64712   1st Qu.:0.0000    1st Qu.:  0.00   Class :character   Class :character   1st Qu.:0.0000
 Median :0.2857   Median : 0.3601   Median :-0.08124   Median :0.1883    Median :  0.00   Mode  :character   Mode  :character   Median :0.1883
 Mean   :0.2712   Mean   : 0.3489   Mean   :-0.12698   Mean   :1.2580    Mean   : 24.27                                          Mean   :1.2580
 3rd Qu.:0.3571   3rd Qu.: 1.4466   3rd Qu.: 0.49123   3rd Qu.:2.2602    3rd Qu.: 30.67                                          3rd Qu.:2.2602
 Max.   :1.0714   Max.   : 6.1135   Max.   : 4.63782   Max.   :5.8388    Max.   :241.94                                          Max.   :5.8388

 b.axy_avg_fam
 Min.   :  0.00
 1st Qu.:  0.00
 Median :  0.00
 Mean   : 24.27
 3rd Qu.: 30.67
 Max.   :241.94

>
> (yearling_axy_all) %>% as_tibble() %>% dplyr::count(squirrel_id) %>% nrow() #86 individuals
[1] 86
> (yearling_axy_all) %>% as_tibble() %>% dplyr::count(squirrel_id, axy_yr, axy_date) %>% nrow() #1764 deployment days
[1] 1764
> nrow(yearling_axy_all) #1764 records
[1] 1764
>
> ########################################
> #############     Yearlings        #############
> #############      n = 86         ##############
> ########################################
>
> ############################
> ######## PC1 models ########
> ############################
>
> ############################
> #non-adjusted repeatability
> ############################
>
> m1a<-lmer(PC1 ~ (1|squirrel_id) + (1| grid_yr), data=yearling_axy_all)
> summary(m1a)
Linear mixed model fit by REML ['lmerMod']
Formula: PC1 ~ (1 | squirrel_id) + (1 | grid_yr)
   Data: yearling_axy_all

REML criterion at convergence: 5362.5

Scaled residuals:
    Min      1Q  Median      3Q     Max
-4.1666 -0.6365  0.0268  0.6536  5.7066

Random effects:
 Groups      Name        Variance Std.Dev.
 squirrel_id (Intercept) 0.4098   0.6402
 grid_yr     (Intercept) 0.6057   0.7783
 Residual                1.0890   1.0435
Number of obs: 1764, groups:  squirrel_id, 86; grid_yr, 21

Fixed effects:
            Estimate Std. Error t value
(Intercept)   0.3163     0.1988   1.591
>
> plot(m1a)
> hist(resid(m1a))
>
> #for axy PC1
> sm1<-arm::sim(m1a,1000)
> smfixef=sm1@fixef
> smranef=sm1@ranef
> smfixef=coda::as.mcmc(smfixef)
> MCMCglmm::posterior.mode(smfixef)
(Intercept)
  0.3014787
> coda::HPDinterval(smfixef)
                  lower     upper
(Intercept) -0.07356281 0.7035421
attr(,"Probability")
[1] 0.95
>
> ##among-individual variance
> bID<-sm1@ranef$squirrel_id
> bvar<-as.vector(apply(bID, 1, var)) ##between individual variance posterior distribution
> bvar<-coda::as.mcmc(bvar)
> MCMCglmm::posterior.mode(bvar) ## mode of the distribution
    var1
0.389511
> coda::HPDinterval(bvar)
         lower     upper
var1 0.3077407 0.5018129
attr(,"Probability")
[1] 0.95
>
```

```
> ##residual variance
> rvar<-sm1@sigma^2
> rvar<-coda::as.mcmc(rvar)
> MCMCglmm::posterior.mode(rvar)
    var1
1.089622
> coda::HPDinterval(rvar)
        lower  upper
var1 1.017982 1.1589
attr(,"Probability")
[1] 0.95
>
> ##repeatability
> rID<-bvar/(bvar+rvar)
> MCMCglmm::posterior.mode(rID)
     var1
0.2853129
> coda::HPDinterval(rID)
        lower     upper
var1 0.220916 0.3196099
attr(,"Probability")
[1] 0.95
>
>
> ############################
> #adjusted repeatability
> ############################
>
> m1b<-lmer(PC1 ~  sex + b.axy.local.density + b.axy_avg_fam + (1|squirrel_id) + (1| grid_yr), data=yearling_axy_all)
> summary(m1b)
Linear mixed model fit by REML ['lmerMod']
Formula: PC1 ~ sex + b.axy.local.density + b.axy_avg_fam + (1 | squirrel_id) +      (1 | grid_yr)
   Data: yearling_axy_all

REML criterion at convergence: 5374.4

Scaled residuals:
    Min      1Q  Median      3Q     Max
-4.1287 -0.6327  0.0323  0.6572  5.7075

Random effects:
 Groups      Name        Variance Std.Dev.
 squirrel_id (Intercept) 0.4091   0.6396
 grid_yr     (Intercept) 0.5904   0.7684
 Residual                1.0890   1.0436
Number of obs: 1764, groups:  squirrel_id, 86; grid_yr, 21

Fixed effects:
                    Estimate Std. Error t value
(Intercept)         0.120113   0.253785   0.473
sexM                0.260278   0.201919   1.289
b.axy.local.density 0.106198   0.088345   1.202
b.axy_avg_fam       -0.002071   0.001728  -1.198

Correlation of Fixed Effects:
            (Intr) sexM   b.xy..
sexM        -0.332
b.xy.lcl.dn -0.531  0.122
b.axy_vg_fm -0.030 -0.088 -0.298
>
> plot(m1b)
> hist(resid(m1b))
>
> #for axy PC1
> sm1<-arm::sim(m1b,1000)
> smfixef=sm1@fixef
> smranef=sm1@ranef
> smfixef=coda::as.mcmc(smfixef)
> MCMCglmm::posterior.mode(smfixef)
       (Intercept)              sexM b.axy.local.density       b.axy_avg_fam
       0.131105691         0.280932039         0.114164126        -0.002761908
> coda::HPDinterval(smfixef)
                          lower       upper
(Intercept)         -0.432772595 0.560158085
sexM                -0.140880227 0.650917497
b.axy.local.density -0.068502398 0.268472156
b.axy_avg_fam       -0.005158306 0.001219401
attr(,"Probability")
[1] 0.95
>
> ##among-individual variance
> bID<-sm1@ranef$squirrel_id
> bvar<-as.vector(apply(bID, 1, var)) ##between individual variance posterior distribution
> bvar<-coda::as.mcmc(bvar)
> MCMCglmm::posterior.mode(bvar) ## mode of the distribution
     var1
0.4172186
> coda::HPDinterval(bvar)
        lower     upper
var1 0.3017474 0.5105022
attr(,"Probability")
[1] 0.95
```

```
>
> ##residual variance
> rvar<-sm1@sigma^2
> rvar<-coda::as.mcmc(rvar)
> MCMCglmm::posterior.mode(rvar)
    var1
1.079914
> coda::HPDinterval(rvar)
       lower    upper
var1 1.022036 1.154952
attr(,"Probability")
[1] 0.95
>
> ##repeatability
> rID<-bvar/(bvar+rvar)
> MCMCglmm::posterior.mode(rID)
     var1
0.2653749
> coda::HPDinterval(rID)
        lower     upper
var1 0.2187713 0.3223825
attr(,"Probability")
[1] 0.95
>
>
> ############################
> ######## PC2 models ########
> ############################
>
> ############################
> #non-adjusted repeatability
> ############################
>
> m2a<-lmer(PC2 ~ (1|squirrel_id) + (1| grid_yr), data=yearling_axy_all)
> summary(m2a)
Linear mixed model fit by REML ['lmerMod']
Formula: PC2 ~ (1 | squirrel_id) + (1 | grid_yr)
   Data: yearling_axy_all

REML criterion at convergence: 5026.5

Scaled residuals:
    Min      1Q  Median      3Q     Max
-5.0639 -0.5146 -0.0028  0.5857  4.3218

Random effects:
 Groups      Name        Variance Std.Dev.
 squirrel_id (Intercept) 0.12634  0.3554
 grid_yr     (Intercept) 0.03343  0.1828
 Residual                0.94646  0.9729
Number of obs: 1764, groups:  squirrel_id, 86; grid_yr, 21

Fixed effects:
            Estimate Std. Error t value
(Intercept) -0.09007    0.06809  -1.323
>
> plot(m2a)
> hist(resid(m2a))
>
> #for axy PC2
> sm2<-arm::sim(m2a,1000)
> smfixef2=sm2@fixef
> smranef2=sm2@ranef
> smfixef2=coda::as.mcmc(smfixef2)
> MCMCglmm::posterior.mode(smfixef2)
(Intercept)
-0.07656733
> coda::HPDinterval(smfixef2)
                 lower      upper
(Intercept) -0.2193116 0.03687876
attr(,"Probability")
[1] 0.95
>
> ##among-individual variance
> bID2<-sm2@ranef$squirrel_id
> bvar2<-as.vector(apply(bID2, 1, var)) ##between individual variance posterior distribution
> bvar2<-coda::as.mcmc(bvar2)
> MCMCglmm::posterior.mode(bvar2) ## mode of the distribution
     var1
0.1306963
> coda::HPDinterval(bvar2)
        lower     upper
var1 0.1015318 0.1700994
attr(,"Probability")
[1] 0.95
>
> ##residual variance
> rvar2<-sm2@sigma^2
> rvar2<-coda::as.mcmc(rvar2)
> MCMCglmm::posterior.mode(rvar2)
     var1
0.9586522
```

```
> coda::HPDinterval(rvar2)
        lower    upper
var1 0.887338 1.013778
attr(,"Probability")
[1] 0.95
>
> ##repeatability
> rID2<-bvar2/(bvar2+rvar2)
> MCMCglmm::posterior.mode(rID2)
     var1
0.1212475
> coda::HPDinterval(rID2)
          lower     upper
var1 0.09544939 0.1508833
attr(,"Probability")
[1] 0.95
>
>
> ############################
> #adjusted repeatability
> ############################
>
> m2b<-lmer(PC2 ~  sex + b.axy.local.density + b.axy_avg_fam + (1|squirrel_id) + (1| axy_yr), data=yearling_axy_all)
> summary(m2b)
Linear mixed model fit by REML ['lmerMod']
Formula: PC2 ~ sex + b.axy.local.density + b.axy_avg_fam + (1 | squirrel_id) +      (1 | axy_yr)
   Data: yearling_axy_all

REML criterion at convergence: 5039.9

Scaled residuals:
    Min      1Q  Median      3Q     Max
-5.0642 -0.5162 -0.0064  0.5841  4.2926

Random effects:
 Groups      Name        Variance Std.Dev.
 squirrel_id (Intercept) 0.12627  0.3553
 axy_yr      (Intercept) 0.03133  0.1770
 Residual                0.94666  0.9730
Number of obs: 1764, groups:  squirrel_id, 86; axy_yr, 9

Fixed effects:
                     Estimate  Std. Error t value
(Intercept)         -0.12520391  0.10448264  -1.198
sexM                 0.01067667  0.11248738   0.095
b.axy.local.density -0.00002671  0.04069846  -0.001
b.axy_avg_fam        0.00117492  0.00105907   1.109

Correlation of Fixed Effects:
            (Intr) sexM   b.xy..
sexM        -0.267
b.xy.lcl.dn -0.446 -0.057
b.axy_vg_fm -0.039 -0.105 -0.385
>
> plot(m2b)
> hist(resid(m2b))
>
> #for axy PC2
> sm2<-arm::sim(m2b,1000)
> smfixef2=sm2@fixef
> smranef2=sm2@ranef
> smfixef2=coda::as.mcmc(smfixef2)
> MCMCglmm::posterior.mode(smfixef2)
       (Intercept)                sexM b.axy.local.density       b.axy_avg_fam
      -0.1238086141        0.0285487903        0.0011842565        0.0008896445
> coda::HPDinterval(smfixef2)
                           lower      upper
(Intercept)         -0.3216842994 0.08265029
sexM                -0.2010264018 0.22929281
b.axy.local.density -0.0804943808 0.07172732
b.axy_avg_fam       -0.0008408058 0.00325706
attr(,"Probability")
[1] 0.95
>
> ##among-individual variance
> bID2<-sm2@ranef$squirrel_id
> bvar2<-as.vector(apply(bID2, 1, var)) ##between individual variance posterior distribution
> bvar2<-coda::as.mcmc(bvar2)
> MCMCglmm::posterior.mode(bvar2) ## mode of the distribution
     var1
0.1253534
> coda::HPDinterval(bvar2)
          lower     upper
var1 0.09233423 0.1586295
attr(,"Probability")
[1] 0.95
>
> ##residual variance
> rvar2<-sm2@sigma^2
> rvar2<-coda::as.mcmc(rvar2)
> MCMCglmm::posterior.mode(rvar2)
     var1
```

```
0.9353863
> coda::HPDinterval(rvar2)
        lower    upper
var1 0.8912875 1.018269
attr(,"Probability")
[1] 0.95
>
> ##repeatability
> rID2<-bvar2/(bvar2+rvar2)
> MCMCglmm::posterior.mode(rID2)
     var1
0.1135096
> coda::HPDinterval(rID2)
          lower    upper
var1 0.09180485 0.146809
attr(,"Probability")
[1] 0.95
2024-05-09 13:41:03.429 R[25852:600500] allowedContentsTypes : UTType pdf does not have a valid preferredFilenameExtension and will be ignored when
validating the file name
>
```