—title: "PGLS_volt_final" output: html_document —

```r
library(MASS)
library(ape)
library(geiger)
library(nlme)
library(phytools)
```

```
## Loading required package: maps
```

PGLS + volt

```r
dataVol <- read.csv("PGLS_volt.csv", row.names = 1)
treeVol <- read.tree("tree_all_species_volt.phy.phy")
name.check(treeVol, dataVol)
```

```
## [1] "OK"
```

```r
socialityVol <- dataVol[, "Sociality"]
phaseVol <- dataVol["Phase"]
latitudeVol <- dataVol["LatitudeDegress"]
voltVol <- dataVol["Voltinism"]
nestVol <- dataVol["Nest"]

names(socialityVol) <- names(latitudeVol) <- names(phaseVol) <- names(voltVol) <- names(nestVol) <- rownames
(dataVol)

datacor = dataVol[,1:5]
cor(datacor)
```

```
##                 Sociality      Phase        Nest  Voltinism
## Sociality      1.00000000  0.6348315  0.05366109  0.5014286
## Phase          0.63483149  1.0000000  0.18713562  0.4028905
## Nest           0.05366109  0.1871356  1.00000000  0.1259164
## Voltinism      0.50142858  0.4028905  0.12591640  1.0000000
## LatitudeDegress -0.06071826 -0.4289020 -0.35791573 -0.2444416
##                 LatitudeDegress
## Sociality          -0.06071826
## Phase              -0.42890202
## Nest               -0.35791573
## Voltinism          -0.24444163
## LatitudeDegress     1.00000000
```

```r
PGLSmodel1 <- gls(phaseVol ~ socialityVol + latitudeVol + voltVol + nestVol, correlation = corBrownian(phy =
treeVol), data = dataVol, method = "ML")
anova(PGLSmodel1)
```

```
## Denom. DF: 95
##               numDF  F-value p-value
## (Intercept)      1  2.11831  0.1488
## socialityVol     1  7.45229  0.0076
## latitudeVol      1 64.54790  <.0001
## voltVol          1  1.21389  0.2733
## nestVol          1  0.26591  0.6073
```

```r
coef(PGLSmodel1)
```

```
##  (Intercept) socialityVol  latitudeVol      voltVol      nestVol
##   2.07035110   0.45862744  -0.04328632   0.20797252   0.12359839
```

```r
stepAIC(gls(phaseVol ~ socialityVol + latitudeVol + voltVol + nestVol, correlation = corBrownian(phy = treeV
ol), data = dataVol, method = "ML"), direction="both")
```

```
## Start:  AIC=219.25
## phaseVol ~ socialityVol + latitudeVol + voltVol + nestVol
##
##                Df    AIC
## - nestVol       1 217.53
## - voltVol       1 218.27
## <none>            219.25
## - socialityVol  1 220.41
## - latitudeVol   1 253.56
##
## Step:  AIC=217.53
## phaseVol ~ socialityVol + latitudeVol + voltVol
##
##                Df    AIC
## - voltVol       1 216.80
## <none>            217.53
## - socialityVol  1 218.56
## + nestVol       1 219.25
## - latitudeVol   1 251.67
##
## Step:  AIC=216.8
## phaseVol ~ socialityVol + latitudeVol
##
##                Df    AIC
## <none>            216.80
## + voltVol       1 217.53
## + nestVol       1 218.27
## - socialityVol  1 221.45
## - latitudeVol   1 266.02
```

```
## Generalized least squares fit by maximum likelihood
##   Model: phaseVol ~ socialityVol + latitudeVol
##   Data: dataVol
##   Log-likelihood: -104.3993
##
## Coefficients:
##  (Intercept) socialityVol  latitudeVol
##   2.47545618   0.58847808  -0.04687125
##
## Correlation Structure: corBrownian
##  Formula: ~1
##  Parameter estimate(s):
## numeric(0)
## Degrees of freedom: 100 total; 97 residual
## Residual standard error: 2.432226
```

Best model phase ~ sociality + latitude

```
PGLSmodel1R <- gls(phaseVol ~ socialityVol + latitudeVol, correlation = corBrownian(phy = treeVol), data = d
ataVol, method = "ML")
anova(PGLSmodel1R)
```

```
## Denom. DF: 97
##             numDF  F-value p-value
## (Intercept)     1  2.12973  0.1477
## socialityVol    1  7.49247  0.0074
## latitudeVol     1 64.89593  <.0001
```

```
coef(PGLSmodel1R)
```

```
##  (Intercept) socialityVol  latitudeVol
##   2.47545618   0.58847808  -0.04687125
```

```
PGLS0 <- gls(phaseVol ~ 1,correlation = corBrownian(phy = treeVol), data = dataVol, method = "ML")
anova(PGLSmodel1R,PGLS0)
```

```
##           Model df    AIC      BIC   logLik   Test  L.Ratio p-value
## PGLSmodel1R    1  4 216.7987 227.2194 -104.3993
## PGLS0          2  2 268.5470 273.7574 -132.2735 1 vs 2 55.74833  <.0001
```

Multiple predictors

```
PGLSmodel2 <- gls(phaseVol ~ socialityVol*voltVol + latitudeVol*voltVol + socialityVol*latitudeVol + nestVol
, correlation = corBrownian(phy = treeVol), data = dataVol, method = "ML")
anova(PGLSmodel2)
```

```
## Denom. DF: 92
##                        numDF  F-value p-value
## (Intercept)               1  2.70488  0.1035
## socialityVol              1  9.51587  0.0027
## voltVol                   1 31.02556  <.0001
## latitudeVol               1 52.94610  <.0001
## nestVol                   1  0.33954  0.5615
## socialityVol:voltVol      1  0.20600  0.6510
## voltVol:latitudeVol       1 26.40054  <.0001
## socialityVol:latitudeVol  1  2.69958  0.1038
```

```
coef(PGLSmodel2)
```

```
##             (Intercept)              socialityVol                   voltVol
##              0.46397832               -2.20919976                1.66002218
##             latitudeVol                   nestVol      socialityVol:voltVol
##              0.07592633                0.09055532                1.09783547
##     voltVol:latitudeVol  socialityVol:latitudeVol
##             -0.08753587                0.02597198
```

```
stepAIC(gls(phaseVol ~ socialityVol*voltVol + latitudeVol*voltVol + socialityVol*latitudeVol + nestVol, corr
elation = corBrownian(phy = treeVol), data = dataVol, method = "ML"), direction="both")
```

```
## Start:  AIC=197.6
## phaseVol ~ socialityVol * voltVol + latitudeVol * voltVol + socialityVol *
##     latitudeVol + nestVol
##
##                           Df    AIC
## - nestVol                  1 195.78
## <none>                       197.60
## - socialityVol:latitudeVol 1 198.49
## - socialityVol:voltVol     1 199.18
## - voltVol:latitudeVol      1 222.89
##
## Step:  AIC=195.78
## phaseVol ~ socialityVol + voltVol + latitudeVol + socialityVol:voltVol +
##     voltVol:latitudeVol + socialityVol:latitudeVol
##
##                           Df    AIC
## <none>                       195.78
## - socialityVol:latitudeVol 1 196.50
## - socialityVol:voltVol     1 197.18
## + nestVol                  1 197.60
## - voltVol:latitudeVol      1 221.00
```

```
## Generalized least squares fit by maximum likelihood
##   Model: phaseVol ~ socialityVol + voltVol + latitudeVol + socialityVol:voltVol +     voltVol:latitudeVo
l + socialityVol:latitudeVol
##   Data: dataVol
##   Log-likelihood: -89.88821
##
## Coefficients:
##           (Intercept)              socialityVol                     voltVol
##            0.34901472                -2.05531933                  1.74146522
##           latitudeVol     socialityVol:voltVol      voltVol:latitudeVol
##            0.07893949                 1.04313198                 -0.08747446
## socialityVol:latitudeVol
##            0.02409995
##
## Correlation Structure: corBrownian
##  Formula: ~1
##  Parameter estimate(s):
## numeric(0)
## Degrees of freedom: 100 total; 93 residual
## Residual standard error: 2.103696
```

Best model phaseVol ~ socialityVol + voltVol + latitudeVol + socialityVol:voltVol + voltVol:latitudeVol + socialityVol:latitudeVol

```
PGLSmodel2R <- gls(phaseVol ~ socialityVol + voltVol + latitudeVol + socialityVol:voltVol + voltVol:latitude
Vol + socialityVol:latitudeVol, correlation = corBrownian(phy = treeVol), data = dataVol, method = "ML")
anova(PGLSmodel2R)
```

```
## Denom. DF: 93
##                          numDF  F-value p-value
## (Intercept)                  1  2.72947  0.1019
## socialityVol                 1  9.60236  0.0026
## voltVol                      1 31.30756  <.0001
## latitudeVol                  1 53.42734  <.0001
## socialityVol:voltVol         1  0.26570  0.6075
## voltVol:latitudeVol          1 26.91822  <.0001
## socialityVol:latitudeVol     1  2.56743  0.1125
```

```
coef(PGLSmodel2R)
```

```
##           (Intercept)              socialityVol                     voltVol
##            0.34901472                -2.05531933                  1.74146522
##           latitudeVol     socialityVol:voltVol      voltVol:latitudeVol
##            0.07893949                 1.04313198                 -0.08747446
## socialityVol:latitudeVol
##            0.02409995
```

```
anova(PGLSmodel2R,PGLS0)
```

```
##              Model df      AIC      BIC     logLik   Test  L.Ratio p-value
## PGLSmodel2R      1  8 195.7764 216.6178  -89.88821
## PGLS0            2  2 268.5470 273.7574 -132.27351 1 vs 2 84.77061  <.0001
```