

Extracting Information from Regression Objects

Quantitative Analysis of Vertebrate Populations

Get the data

```
sally <- read.table("Data/Salamander_Demographics.csv", header = TRUE, stringsAsFactors = FALSE, sep =
str(sally)
```

```
## 'data.frame':   3382 obs. of  20 variables:
## $ line   : int  1861 1115 360 2897 1432 372 231 2739 2236 543 ...
## $ page   : int  60 36 12 92 46 12 8 87 72 17 ...
## $ dates  : chr   "4/21/09" "9/9/08" "5/31/08" "5/7/11" ...
## $ month  : int   4 9 5 5 10 5 5 10 5 6 ...
## $ day    : int  21 9 31 7 16 31 27 24 14 5 ...
## $ year   : int  2009 2008 2008 2011 2008 2008 2008 2009 2009 2008 ...
## $ time   : chr   "N" "N" "N" "N" ...
## $ plot   : chr   "5" NA "3" "7" ...
## $ mass   : num   0.427 0.633 0.639 0.921 0.943 ...
## $ svl    : int   33 37 42 43 45 46 47 48 NA NA ...
## $ tl     : int   63 68 63 79 74 NA 75 89 87 NA ...
## $ sex    : chr   NA NA NA NA ...
## $ gravid : chr   "N" "N" "N" "N" ...
## $ group  : chr   NA NA NA NA ...
## $ clutch : int   NA NA NA NA NA NA NA NA NA NA ...
## $ color  : chr   "R" "R" "R" "R" ...
## $ recap  : chr   NA NA NA "N" ...
## $ mark   : chr   NA NA NA NA ...
## $ id     : int  1371 NA 187 2154 1042 198 74 2036 1564 351 ...
## $ damage : chr   "N" "N" "Y" "N" ...
```

Run a regression

Using the Salamander Demographic Data run a regression of the affect of svl on mass

```
library(lme4)
```

```
## Loading required package: Matrix
```

```
lme1 <- lmer(mass ~ 1 + svl + (1 | plot), data = sally)
summary(lme1)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: mass ~ 1 + svl + (1 | plot)
## Data: sally
##
## REML criterion at convergence: -4875.6
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -3.5969 -0.6518 -0.1338  0.5545  5.9471
##
## Random effects:
```

```
## Groups Name Variance Std.Dev.
## plot (Intercept) 7.475e-05 0.008646
## Residual 1.367e-02 0.116939
## Number of obs: 3373, groups: plot, 12
##
## Fixed effects:
## Estimate Std. Error t value
## (Intercept) -0.7566013 0.0127085 -59.54
## svl 0.0384600 0.0003156 121.88
##
## Correlation of Fixed Effects:
## (Intr)
## svl -0.949
```

Examine object and summary object

```
str(lme1)
```

```
## Formal class 'lmerMod' [package "lme4"] with 13 slots
## ..@ resp :Reference class 'lmerResp' [package "lme4"] with 9 fields
## .. ..$ Ptr :<externalptr>
## .. ..$ mu : num [1:3373] 0.512 0.858 0.911 0.968 1.045 ...
## .. ..$ offset : num [1:3373] 0 0 0 0 0 0 0 0 0 0 ...
## .. ..$ sqrtXwt: num [1:3373] 1 1 1 1 1 1 1 1 1 1 ...
## .. ..$ sqrttrwt: num [1:3373] 1 1 1 1 1 1 1 1 1 1 ...
## .. ..$ weights: num [1:3373] 1 1 1 1 1 1 1 1 1 1 ...
## .. ..$ wtres : num [1:3373] -0.0851 -0.2188 0.0104 -0.0252 0.0279 ...
## .. ..$ y : num [1:3373] 0.427 0.639 0.921 0.943 1.073 ...
## .. ..$ REML : int 2
## ..and 28 methods, of which 14 are possibly relevant:
## .. .. allInfo, copy#envRefClass, initialize, initialize#lmResp,
## .. .. initializePtr, initializePtr#lmResp, objective, ptr, ptr#lmResp,
## .. .. setOffset, setResp, setWeights, updateMu, wrss
## ..@ Gp : int [1:2] 0 12
## ..@ call : language lmer(formula = mass ~ 1 + svl + (1 | plot), data = sally)
## ..@ frame : 'data.frame': 3373 obs. of 3 variables:
## .. ..$ mass: num [1:3373] 0.427 0.639 0.921 0.943 1.073 ...
## .. ..$ svl : int [1:3373] 33 42 43 45 47 48 32 32 33 33 ...
## .. ..$ plot: Factor w/ 12 levels "1","3","4","5",...: 4 2 5 7 7 9 3 4 4 4 ...
## .. ..- attr(*, "terms")=Classes 'terms', 'formula' language mass ~ 1 + svl + (1 + plot)
## .. .. ..- attr(*, "variables")= language list(mass, svl, plot)
## .. .. ..- attr(*, "factors")= int [1:3, 1:2] 0 1 0 0 0 1
## .. .. ..- attr(*, "dimnames")=List of 2
## .. .. .. ..$ : chr [1:3] "mass" "svl" "plot"
## .. .. .. ..$ : chr [1:2] "svl" "plot"
## .. .. ..- attr(*, "term.labels")= chr [1:2] "svl" "plot"
## .. .. ..- attr(*, "order")= int [1:2] 1 1
## .. .. ..- attr(*, "intercept")= int 1
## .. .. ..- attr(*, "response")= int 1
## .. .. ..- attr(*, ".Environment")=<environment: R_GlobalEnv>
## .. .. ..- attr(*, "predvars")= language list(mass, svl, plot)
## .. .. ..- attr(*, "dataClasses")= Named chr [1:3] "numeric" "numeric" "character"
## .. .. ..- attr(*, "names")= chr [1:3] "mass" "svl" "plot"
```

```

## .. - attr(*, "predvars.fixed")= language list(mass, svl)
## .. - attr(*, "predvars.random")= language list(mass, plot)
## .. - attr(*, "na.action")=Class 'omit' Named int [1:9] 2 6 9 10 370 876 970 1059 1184
## .. - attr(*, "names")= chr [1:9] "2" "6" "9" "10" ...
## .. - attr(*, "formula")=Class 'formula' language mass ~ 1 + svl + (1 | plot)
## .. - attr(*, ".Environment")=<environment: R_GlobalEnv>
## ..@ flist :List of 1
## ..$ plot: Factor w/ 12 levels "1","3","4","5",...: 4 2 5 7 7 9 3 4 4 4 ...
## .. - attr(*, "assign")= int 1
## ..@ cnms :List of 1
## ..$ plot: chr "(Intercept)"
## ..@ lower : num 0
## ..@ theta : num 0.0739
## ..@ beta : num [1:2] -0.7566 0.0385
## ..@ u : num [1:12] -0.00605 -0.01184 -0.0346 -0.00715 0.18186 ...
## ..@ devcomp:List of 2
## ..$ cmp : Named num [1:10] 8.3661 18.5757 46.0437 0.0542 46.0979 ...
## .. - attr(*, "names")= chr [1:10] "ldL2" "ldRX2" "wrss" "ussq" ...
## ..$ dims: Named int [1:12] 3373 3373 2 3371 12 1 1 1 0 2 ...
## .. - attr(*, "names")= chr [1:12] "N" "n" "p" "nmp" ...
## ..@ pp :Reference class 'merPredD' [package "lme4"] with 18 fields
## ..$ Lamdat:Formal class 'dgCMatrx' [package "Matrix"] with 6 slots
## .. - attr(*, "i") : int [1:12] 0 1 2 3 4 5 6 7 8 9 ...
## .. - attr(*, "p") : int [1:13] 0 1 2 3 4 5 6 7 8 9 ...
## .. - attr(*, "Dim") : int [1:2] 12 12
## .. - attr(*, "Dimnames") : List of 2
## ..$ : NULL
## ..$ : NULL
## .. - attr(*, "x") : num [1:12] 0.0739 0.0739 0.0739 0.0739 0.0739 ...
## .. - attr(*, "factors") : list()
## ..$ LamtUt :Formal class 'dgCMatrx' [package "Matrix"] with 6 slots
## .. - attr(*, "i") : int [1:3373] 3 1 4 6 6 8 2 3 3 3 ...
## .. - attr(*, "p") : int [1:3374] 0 1 2 3 4 5 6 7 8 9 ...
## .. - attr(*, "Dim") : int [1:2] 12 3373
## .. - attr(*, "Dimnames") : List of 2
## ..$ : NULL
## ..$ : chr [1:3373] "1" "2" "3" "4" ...
## .. - attr(*, "x") : num [1:3373] 0.0739 0.0739 0.0739 0.0739 0.0739 ...
## .. - attr(*, "factors") : list()
## ..$ Lind : int [1:12] 1 1 1 1 1 1 1 1 1 1 ...
## ..$ Ptr :<externalptr>
## ..$ RZX : num [1:12, 1:2] 2.86 21.77 22.96 23.7 21.11 ...
## ..$ Ut :Formal class 'dgCMatrx' [package "Matrix"] with 6 slots
## .. - attr(*, "i") : int [1:3373] 3 1 4 6 6 8 2 3 3 3 ...
## .. - attr(*, "p") : int [1:3374] 0 1 2 3 4 5 6 7 8 9 ...
## .. - attr(*, "Dim") : int [1:2] 12 3373
## .. - attr(*, "Dimnames") : List of 2
## ..$ : chr [1:12] "1" "3" "4" "5" ...
## ..$ : chr [1:3373] "1" "2" "3" "4" ...
## .. - attr(*, "x") : num [1:3373] 1 1 1 1 1 1 1 1 1 1 ...
## .. - attr(*, "factors") : list()
## ..$ Utr : num [1:12] 1.83 32.34 34.5 34.68 32.71 ...
## ..$ V : num [1:3373, 1:2] 1 1 1 1 1 1 1 1 1 1 ...
## ..$ VtV : num [1:2, 1:2] 3373 0 128415 5027767

```

```
## ..$ Vtr      : num [1:2] 2388 96249
## ..$ X        : num [1:3373, 1:2] 1 1 1 1 1 1 1 1 1 1 ...
## ..$ attr(*, "dimnames")=List of 2
## ..$ : chr [1:3373] "1" "3" "4" "5" ...
## ..$ : chr [1:2] "(Intercept)" "sv1"
## ..$ attr(*, "assign")= int [1:2] 0 1
## ..$ attr(*, "msgScaleX")= chr(0)
## ..$ Xwts      : num [1:3373] 1 1 1 1 1 1 1 1 1 1 ...
## ..$ Zt        :Formal class 'dgCMatrix' [package "Matrix"] with 6 slots
## ..$ @ i       : int [1:3373] 3 1 4 6 6 8 2 3 3 3 ...
## ..$ @ p       : int [1:3374] 0 1 2 3 4 5 6 7 8 9 ...
## ..$ @ Dim     : int [1:2] 12 3373
## ..$ @ Dimnames=List of 2
## ..$ : chr [1:12] "1" "3" "4" "5" ...
## ..$ : chr [1:3373] "1" "2" "3" "4" ...
## ..$ @ x       : num [1:3373] 1 1 1 1 1 1 1 1 1 1 ...
## ..$ @ factors : list()
## ..$ beta0     : num [1:2] 0 0
## ..$ delb      : num [1:2] -0.7566 0.0385
## ..$ delu      : num [1:12] -0.00605 -0.01184 -0.0346 -0.00715 0.18186 ...
## ..$ theta     : num 0.0739
## ..$ u0        : num [1:12] 0 0 0 0 0 0 0 0 0 0 ...
## ..and 45 methods, of which 31 are possibly relevant:
## .. b, beta, CcNumer, copy#envRefClass, initialize, initializePtr,
## .. installPars, L, ldL2, ldRX2, linPred, P, ptr, RX, RXdiag, RXi,
## .. setBeta0, setDelb, setDelu, setTheta, setZt, solve, solveU, sqrL,
## .. u, unsc, updateDecomp, updateL, updateLamtUt, updateRes,
## .. updateXwts
## ..$ optinfo:List of 7
## ..$ optimizer: chr "bobyqa"
## ..$ control  :List of 1
## ..$ iprint   : int 0
## ..$ derives  :List of 2
## ..$ gradient: num -9.4e-05
## ..$ Hessian  : num [1, 1] 1817
## ..$ conv     :List of 2
## ..$ opt      : int 0
## ..$ lme4     : list()
## ..$ feval    : int 17
## ..$ warnings : list()
## ..$ val      : num 0.0739
```

Examine object and summary object

```
lme1_sum <- summary(lme1)
str(lme1_sum)
```

```
## List of 18
## $ methTitle   : chr "Linear mixed model fit by REML"
## $ objClass    : atomic [1:1] lmerMod
## ..$ attr(*, "package")= chr "lme4"
## $ devcomp     :List of 2
## ..$ cmp       : Named num [1:10] 8.3661 18.5757 46.0437 0.0542 46.0979 ...
```

```

## ..- attr(*, "names")= chr [1:10] "ldL2" "ldRX2" "wrss" "ussq" ...
## ..$ dims: Named int [1:12] 3373 3373 2 3371 12 1 1 1 0 2 ...
## ..- attr(*, "names")= chr [1:12] "N" "n" "p" "nmp" ...
## $ isLmer      : logi TRUE
## $ useScale    : logi TRUE
## $ logLik      :Class 'logLik' : 2438 (df=4)
## $ family      : NULL
## $ link        : NULL
## $ ngrps       : Named num 12
## ..- attr(*, "names")= chr "plot"
## $ coefficients: num [1:2, 1:3] -7.57e-01 3.85e-02 1.27e-02 3.16e-04 -5.95e+01 ...
## ..- attr(*, "dimnames")=List of 2
## .. ..$ : chr [1:2] "(Intercept)" "sv1"
## .. ..$ : chr [1:3] "Estimate" "Std. Error" "t value"
## $ sigma       : num 0.117
## $ vcov        :Formal class 'dpoMatrix' [package "Matrix"] with 5 slots
## .. ..@ x      : num [1:4] 1.62e-04 -3.81e-06 -3.81e-06 9.96e-08
## .. ..@ Dim     : int [1:2] 2 2
## .. ..@ Dimnames:List of 2
## .. .. ..$ : chr [1:2] "(Intercept)" "sv1"
## .. .. ..$ : chr [1:2] "(Intercept)" "sv1"
## .. ..@ uplo    : chr "U"
## .. ..@ factors :List of 1
## .. .. ..$ correlation:Formal class 'corMatrix' [package "Matrix"] with 6 slots
## .. .. .. ..@ sd      : num [1:2] 0.012708 0.000316
## .. .. .. ..@ x      : num [1:4] 1 -0.949 -0.949 1
## .. .. .. ..@ Dim     : int [1:2] 2 2
## .. .. .. ..@ Dimnames:List of 2
## .. .. .. .. ..$ : chr [1:2] "(Intercept)" "sv1"
## .. .. .. .. ..$ : chr [1:2] "(Intercept)" "sv1"
## .. .. .. ..@ uplo    : chr "U"
## .. .. .. ..@ factors :List of 1
## .. .. .. .. ..$ Cholesky:Formal class 'Cholesky' [package "Matrix"] with 5 slots
## .. .. .. .. .. ..@ x      : num [1:4] 1 0 -0.949 0.316
## .. .. .. .. .. ..@ Dim     : int [1:2] 2 2
## .. .. .. .. .. ..@ Dimnames:List of 2
## .. .. .. .. .. .. ..$ : NULL
## .. .. .. .. .. .. ..$ : NULL
## .. .. .. .. .. ..@ uplo    : chr "U"
## .. .. .. .. .. ..@ diag    : chr "N"
## $ varcor      :List of 1
## ..$ plot: num [1, 1] 7.47e-05
## ..- attr(*, "dimnames")=List of 2
## .. ..$ : chr "(Intercept)"
## .. ..$ : chr "(Intercept)"
## ..- attr(*, "stddev")= Named num 0.00865
## .. ..- attr(*, "names")= chr "(Intercept)"
## ..- attr(*, "correlation")= num [1, 1] 1
## .. ..- attr(*, "dimnames")=List of 2
## .. .. ..$ : chr "(Intercept)"
## .. .. ..$ : chr "(Intercept)"
## ..- attr(*, "sc")= num 0.117
## ..- attr(*, "useSc")= logi TRUE
## ..- attr(*, "class")= chr "VarCorr.merMod"

```

```
## $ AICtab      : Named num -4876
##   ..- attr(*, "names")= chr "REML"
## $ call        : language lmer(formula = mass ~ 1 + svl + (1 | plot), data = sally)
## $ residuals   : Named num [1:3373] -0.7273 -1.8714 0.0887 -0.2155 0.2384 ...
##   ..- attr(*, "names")= chr [1:3373] "1" "3" "4" "5" ...
## $ fitMsgs     : chr(0)
## $ optinfo     :List of 7
##   ..$ optimizer: chr "bobyqa"
##   ..$ control  :List of 1
##   .. ..$ iprint: int 0
##   ..$ derivs   :List of 2
##   .. ..$ gradient: num -9.4e-05
##   .. ..$ Hessian : num [1, 1] 1817
##   ..$ conv     :List of 2
##   .. ..$ opt : int 0
##   .. ..$ lme4: list()
##   ..$ feval    : int 17
##   ..$ warnings : list()
##   ..$ val      : num 0.0739
## - attr(*, "class")= chr "summary.merMod"
```

Get Fitted and Residuals and Plot

```
resids <- lme1_sum$residuals # or resid(lme1)
```

Get random effects

```
ranef(lme1)
```

```
## $plot
##      (Intercept)
## 1  -4.469993e-04
## 3  -8.752929e-04
## 4  -2.557974e-03
## 5  -5.282905e-04
## 7   1.344498e-02
## 8   3.561947e-03
## 9  -5.901732e-03
## Off  4.735069e-04
## T   -3.444650e-04
## T1  -7.681686e-03
## T2   7.829357e-04
## T3   7.307164e-05
```