Flowering Models Fitted

Loïc Pages

2025-02-28

Introduction

```r
rm(list=ls())
library(knitr)
library(spaMM)
```

```
## Registered S3 methods overwritten by 'registry':
##   method               from
##   print.registry_field proxy
##   print.registry_entry proxy
```

```
## spaMM (Rousset & Ferdy, 2014, version 4.5.30) is loaded.
## Type 'help(spaMM)' for a short introduction,
## 'news(package='spaMM')' for news,
## and 'citation('spaMM')' for proper citation.
## Further infos, slides, etc. at https://gitlab.mbb.univ-montp2.fr/francois/spamm-ref.
```

```r
library(tidyverse)
```

```
## -- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
## v dplyr     1.1.4     v readr     2.1.5
## v forcats   1.0.0     v stringr   1.5.1
## v ggplot2   3.5.1     v tibble    3.2.1
## v lubridate 1.9.4     v tidyr     1.3.1
## v purrr     1.0.2
```

```
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become error
```

```r
library(splines)
library(patchwork)
library(SplinesUtils)

setwd("/media/loic/Commun/0Travail/Stage 2025 ISEM/Models")
```

```r
centauree_data <- read.csv("donnesIPM_short.csv")
centauree_data_complet <- read.csv("donnesIPM.csv")


#Supprimer plantes dont l'age est inconnu
centauree_data <- centauree_data[!is.na(centauree_data$age0), ]
centauree_data$age1 <- ifelse(centauree_data$Stage1=="V",centauree_data$age0+1,NA)

#Forcer l'age maximal à 8
length(centauree_data$age0[centauree_data$age0 >= 8])
```

```
## [1] 93
```

```r
centauree_data$age0[centauree_data$age0 > 8] <- 8

spaMM.options(separation_max=70)
```

```r
annees <- 1995:2022
populations <- c("Po","Au","Pe","E1","E2","Cr")
taille_range <- seq(0.5, 25, by = 0.5)
age_range <- 1:8

fake_data <- expand.grid(
  year = annees,
  Pop = populations,
  Size0Mars = taille_range,
  age0 = age_range
)

fake_data <- fake_data %>%
  mutate(Nrw = row_number())
```

BIC

```r
extractBIC <- function(fit, n){
  extractAIC(fit)[[2]]+(log(n)-2)*DoF(fit)[[3]]
}
```

Test Splines -> poly

```r
survdata <- centauree_data[centauree_data$Flowering0!=1,]
survdata <- survdata[!is.na(survdata$SurvieMars),]

library(nlme)
```

```
##
## Attaching package: ’nlme’

## The following object is masked from ’package:dplyr’:
##
##     collapse
```

```
library(SplinesUtils)
spline_model <- lme(SurvieMars ~ bs(age0, degree=3, knots=6.5)+bs(Size0Mars,df=5), data = survdata, ran
    year = pdSymm(~ Size0Mars),
    Pop = pdSymm(~ age0)))

spl <- RegSplineAsPiecePoly(spline_model, "bs(Size0Mars, df = 5)")
spl2 <- RegSplineAsPiecePoly(spline_model, "bs(age0, degree = 3, knots = 6.5)")

spl$PiecePoly$coef
```

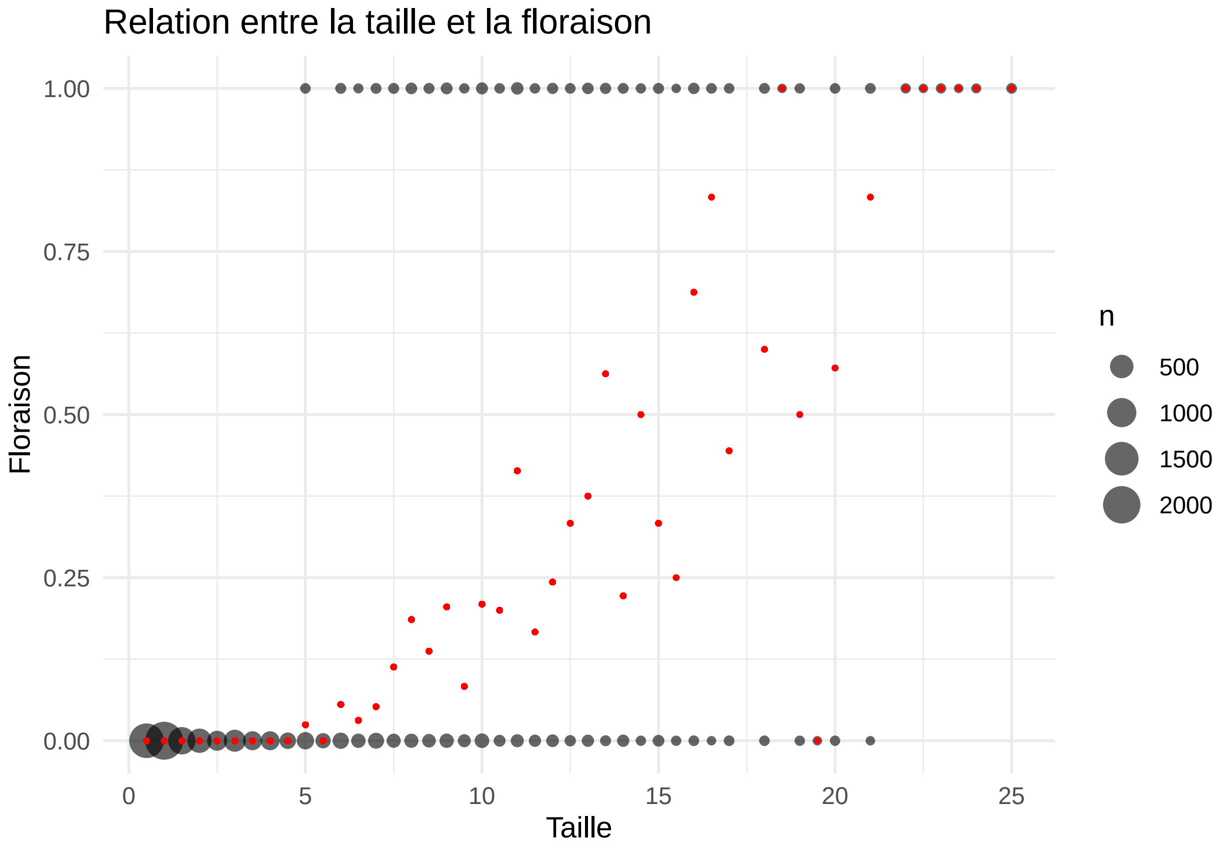
```
##               [,1]        [,2]          [,3]
## [1,] -1.040834e-17  0.06889436  0.1911940010
## [2,]  4.934356e-02  0.16645927  0.0961884958
## [3,]  2.964395e-01 -0.06220810 -0.0080626749
## [4,] -2.390984e-01  0.01804847  0.0002194813
```

```
spl
```

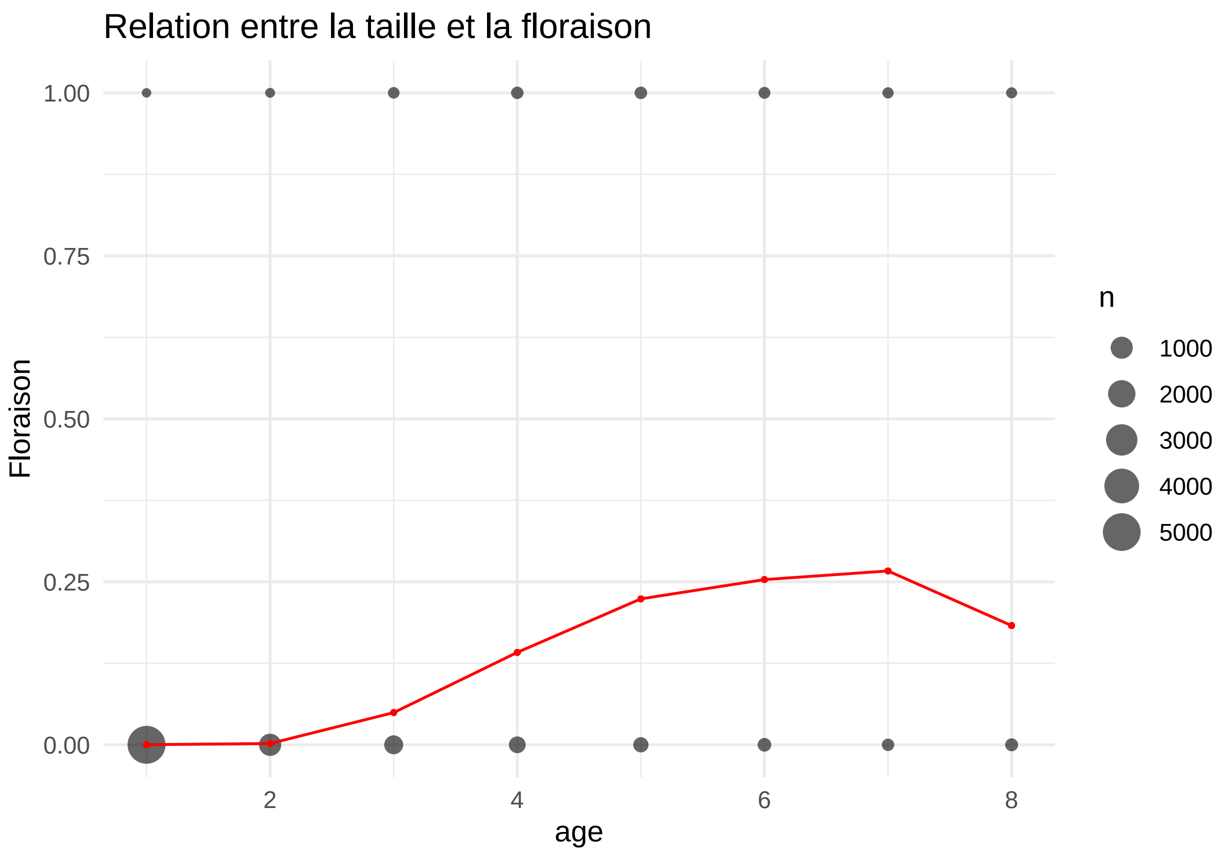
```
## 3 piecewise polynomials of degree 3 are constructed!
## Use ’summary’ to export all of them.
## The first 3 are printed below.
## -1.04e-17 + 0.0493 * (x - 0.5) + 0.296 * (x - 0.5) ^ 2 - 0.239 * (x - 0.5) ^ 3
## 0.0689 + 0.166 * (x - 1) - 0.0622 * (x - 1) ^ 2 + 0.018 * (x - 1) ^ 3
## 0.191 + 0.0962 * (x - 2) - 0.00806 * (x - 2) ^ 2 + 0.000219 * (x - 2) ^ 3
```

Flowering probability

```
centauree_data %>%
  group_by(Size0Mars) %>%
  mutate(floweringProba = sum(Flowering0, na.rm = TRUE) / n()) %>%
  ggplot(aes(x = Size0Mars, y = Flowering0)) +
  geom_count(alpha = 0.6) +
  geom_point(aes(y = floweringProba), color = "red", size = 0.5) +
  labs(title = "Relation entre la taille et la floraison",
    x = "Taille",
    y = "Floraison") +
  ylim(0, 1) +
  theme_minimal()
```



```r
centauree_data %>%
  group_by(age0) %>%
  mutate(floweringProba = sum(Flowering0, na.rm = TRUE) / n()) %>%
  ggplot(aes(x = age0, y = Flowering0)) +
  geom_count(alpha = 0.6) +
  geom_point(aes(y = floweringProba), color = "red", size = 0.5) +
  geom_line(aes(y = floweringProba), color = "red") +
  labs(title = "Relation entre la taille et la floraison",
    x = "age",
    y = "Floraison") +
  ylim(0, 1) +
  theme_minimal()
```



```
Flowglm1 <- fitme(Flowering0 ~  1 + poly(Size0Mars,3) + poly(age0,2) + (age0|Pop),
                  family=binomial,
                  data=centauree_data, method="PQL/L")

Flowglm2 <- fitme(Flowering0 ~  1 + poly(Size0Mars,3) + bs(age0,degree=2,knots=6.5) + (age0|Pop),
                  family=binomial,
                  data=centauree_data, method="PQL/L")

Flowglm3 <- fitme(Flowering0 ~  1 + poly(Size0Mars,3) + poly(age0,3) + (age0|Pop),
                  family=binomial,
                  data=centauree_data, method="PQL/L")

Flowglm4 <- fitme(Flowering0 ~  1 + poly(Size0Mars,3) + poly(age0,2) + (age0|Pop) + (1|year),
                  family=binomial,
                  data=centauree_data, method="PQL/L")

Flowglm5 <- fitme(Flowering0 ~  1 + poly(Size0Mars,3) + bs(age0,degree=3,knots=c(1.5,6.5)) + (age0|Pop)
                  family=binomial,
                  data=centauree_data, method="PQL/L")
```

```
## Warning in (function (formula, resid.formula = NULL, data, prior.weights, :
## 'c(' detected in formula: did you mean cbind() for binomial response or for
## poly()?
```

```r
n <- length(centauree_data$Nrw)
extractAIC(Flowglm1) ; extractBIC(Flowglm1, n)
```

```
##     edf     AIC
##   6.000 843.909
```

```
## [1] 885.552
```

```r
extractAIC(Flowglm2) ; extractBIC(Flowglm2, n)
```

```
##      edf      AIC
##   7.0000 845.6256
```

```
## [1] 894.2091
```

```r
extractAIC(Flowglm3) ; extractBIC(Flowglm3, n)
```

```
##     edf     AIC
##   7.000 845.909
```

```
## [1] 894.4925
```

```r
extractAIC(Flowglm4) ; extractBIC(Flowglm4, n)
```

```
##     edf     AIC
##   6.000 845.909
```

```
## [1] 887.552
```

```r
extractAIC(Flowglm5) ; extractBIC(Flowglm5, n)
```

```
##      edf      AIC
##   9.0000 845.6295
```

```
## [1] 908.094
```

```r
summary(Flowglm1)
```

```
## formula: Flowering0 ~ 1 + poly(Size0Mars, 3) + poly(age0, 2) + (age0 |
##     Pop)
## Estimation of ranCoefs by ML (p_v approximation of logL).
## Estimation of fixed effects by h-likelihood approximation.
## family: binomial( link = logit )
##  ------------ Fixed effects (beta) ------------
##                       Estimate Cond. SE t-value
## (Intercept)             -11.49    1.136 -10.120
## poly(Size0Mars, 3)1     258.56   39.050   6.621
## poly(Size0Mars, 3)2     -86.88   18.999  -4.573
## poly(Size0Mars, 3)3    42.73   12.085   3.536
## poly(age0, 2)1        148.26   24.504   6.051
## poly(age0, 2)2        -57.46    9.260  -6.206
##  --------------- Random effects ---------------
## Family: gaussian( link = identity )
##          --- Random-coefficients Cov matrices:
##  Group        Term    Var.   Corr.
##    Pop (Intercept)   2.175
##    Pop        age0 0.09044 -0.9806
## # of obs: 7635; # of groups: Pop, 6
##  ------------- Likelihood values  -------------
##                         logLik
##        h-likelihood: -416.1972
## logL       (p_v(h)): -412.9545
```

```r
summary(Flowglm2)
```

```
## formula: Flowering0 ~ 1 + poly(Size0Mars, 3) + bs(age0, degree = 2, knots = 6.5) +
##     (age0 | Pop)
## Estimation of ranCoefs by ML (p_v approximation of logL).
## Estimation of fixed effects by h-likelihood approximation.
## family: binomial( link = logit )
##  ------------ Fixed effects (beta) ------------
##                                      Estimate Cond. SE t-value
## (Intercept)                           -12.895    1.320  -9.771
## poly(Size0Mars, 3)1                   258.456   39.149   6.602
## poly(Size0Mars, 3)2                   -86.875   19.030  -4.565
## poly(Size0Mars, 3)3                    42.872   12.145   3.530
## bs(age0, degree = 2, knots = 6.5)1      6.565    1.232   5.328
## bs(age0, degree = 2, knots = 6.5)2      5.304    1.017   5.215
## bs(age0, degree = 2, knots = 6.5)3      4.859    1.197   4.058
##  --------------- Random effects ---------------
## Family: gaussian( link = identity )
##          --- Random-coefficients Cov matrices:
##  Group        Term    Var.   Corr.
##    Pop (Intercept)   2.244
##    Pop        age0 0.09294 -0.9812
## # of obs: 7635; # of groups: Pop, 6
##  ------------- Likelihood values  -------------
##                         logLik
##        h-likelihood: -415.9942
## logL       (p_v(h)): -412.8128
```

```r
summary(Flowglm3)
```

```
## formula: Flowering0 ~ 1 + poly(Size0Mars, 3) + poly(age0, 3) + (age0 |
##     Pop)
## Estimation of ranCoefs by ML (p_v approximation of logL).
## Estimation of fixed effects by h-likelihood approximation.
## family: binomial( link = logit )
##  ------------ Fixed effects (beta) ------------
##                       Estimate Cond. SE   t-value
## (Intercept)         -11.48993    1.300 -8.838688
## poly(Size0Mars, 3)1 258.56487   39.065  6.618867
## poly(Size0Mars, 3)2 -86.87835   19.000 -4.572558
## poly(Size0Mars, 3)3  42.72946   12.086  3.535589
## poly(age0, 3)1      148.17357   39.018  3.797538
## poly(age0, 3)2      -57.41183   19.585 -2.931398
## poly(age0, 3)3       -0.02751    9.031 -0.003046
##  --------------- Random effects ---------------
## Family: gaussian( link = identity )
##          --- Random-coefficients Cov matrices:
##  Group        Term    Var.   Corr.
##    Pop (Intercept)   2.175
##    Pop        age0 0.09045 -0.9806
## # of obs: 7635; # of groups: Pop, 6
##  ------------- Likelihood values  -------------
##                        logLik
##        h-likelihood: -416.1970
## logL       (p_v(h)): -412.9545
```

```
summary(Flowglm4)
```

```
## formula: Flowering0 ~ 1 + poly(Size0Mars, 3) + poly(age0, 2) + (age0 |
##     Pop) + (1 | year)
## Estimation of lambda and ranCoefs by ML (p_v approximation of logL).
## Estimation of fixed effects by h-likelihood approximation.
## family: binomial( link = logit )
##  ------------ Fixed effects (beta) ------------
##                     Estimate Cond. SE t-value
## (Intercept)           -11.49    1.136 -10.120
## poly(Size0Mars, 3)1   258.56   39.050   6.621
## poly(Size0Mars, 3)2   -86.88   18.999  -4.573
## poly(Size0Mars, 3)3    42.73   12.085   3.536
## poly(age0, 2)1        148.26   24.504   6.051
## poly(age0, 2)2        -57.46    9.260  -6.206
##  --------------- Random effects ---------------
## Family: gaussian( link = identity )
##          --- Random-coefficients Cov matrices:
##  Group        Term    Var.   Corr.
##    Pop (Intercept)   2.175
##    Pop        age0 0.09044 -0.9806
##            --- Variance parameters (’lambda’):
## lambda = var(u) for u ~ Gaussian;
##    year  :  9.682e-07
##              --- Coefficients for log(lambda):
##  Group        Term Estimate Cond.SE
##   year (Intercept)   -13.85   129.6
## # of obs: 7635; # of groups: Pop, 6; year, 28
##  ------------- Likelihood values  -------------
##                        logLik
##        h-likelihood: -248.0580
## logL       (p_v(h)): -412.9545
```

```
summary(Flowglm5)
```

```
## formula: Flowering0 ~ 1 + poly(Size0Mars, 3) + bs(age0, degree = 3, knots = c(1.5,
##     6.5)) + (age0 | Pop)
## Estimation of ranCoefs by ML (p_v approximation of logL).
## Estimation of fixed effects by h-likelihood approximation.
## family: binomial( link = logit )
##  ------------ Fixed effects (beta) ------------
##                                             Estimate Cond. SE t-value
## (Intercept)                                  -10.363    1.417  -7.314
## poly(Size0Mars, 3)1                          265.304   39.010   6.801
## poly(Size0Mars, 3)2                          -89.882   18.908  -4.754
## poly(Size0Mars, 3)3                           44.773   12.179   3.676
## bs(age0, degree = 3, knots = c(1.5, 6.5))1   -3.186    1.741  -1.830
## bs(age0, degree = 3, knots = c(1.5, 6.5))2    2.266    1.567   1.447
## bs(age0, degree = 3, knots = c(1.5, 6.5))3    3.739    1.532   2.441
## bs(age0, degree = 3, knots = c(1.5, 6.5))4    2.365    1.491   1.587
## bs(age0, degree = 3, knots = c(1.5, 6.5))5    2.148    1.449   1.482
##  --------------- Random effects ---------------
## Family: gaussian( link = identity )
##          --- Random-coefficients Cov matrices:
##  Group        Term    Var.   Corr.
##    Pop (Intercept)   2.349
##    Pop        age0 0.09775 -0.9816
## # of obs: 7635; # of groups: Pop, 6
##  ------------- Likelihood values  -------------
##                        logLik
##       h-likelihood: -413.8448
## logL       (p_v(h)): -410.8147
```

```
Flowpredict1 <- predict(Flowglm1, newdata = fake_data)[,1]
Flowpredict2 <- predict(Flowglm2, newdata = fake_data)[,1]
Flowpredict3 <- predict(Flowglm3, newdata = fake_data)[,1]
Flowpredict4 <- predict(Flowglm4, newdata = fake_data)[,1]
Flowpredict5 <- predict(Flowglm5, newdata = fake_data)[,1]
```

```
plot_flow <- function(data = fake_data, prediction, var, c1, valc1 = 1, c2, valc2 = "Au", fact, mindat,
  data %>%
    mutate(flow_predi = prediction) %>%
    filter(!!sym(c1) == valc1, !!sym(c2) == valc2) %>%
    ggplot(aes(x = .data[[var]], y = flow_predi)) +
    geom_vline(xintercept=maxdat, lty="dotted")+
    geom_vline(xintercept=mindat, lty="dotted")+
    geom_line(aes(color = as.factor(.data[[fact]]))) +
    theme_minimal() +
    ylim(0, 1)
}
```

Floraison en fonction de la taille

En fixant la population : voir l'effet année

```r
var <- "Size0Mars"
c1 <- "age0"
c2 <- "Pop"
valc2 <- "Au"
fact <- "year"
```

En fixant l'année : voir l'effet population

```r
var <- "Size0Mars"
c1 <- "age0"
c2 <- "year"
valc2 <- 2000
fact <- "Pop"
```

Floraison en fonction de l'age

En fixant la population : voir l'effet année

```r
var <- "age0"
c1 <- "Size0Mars"
c2 <- "Pop"
valc2 <- "Au"
fact <- "year"
```

En fixant l'année : voir l'effet population

```r
var <- "age0"
c1 <- "Size0Mars"
c2 <- "year"
valc2 <- 2000
fact <- "Pop"
```