

Package ‘rcbayes’

May 9, 2026

Title Estimate Rogers-Castro Migration Age Schedules with Bayesian Models

Version 0.3.0

Description A collection of functions to estimate Rogers-Castro migration age schedules using 'Stan'. This model which describes the fundamental relationship between migration and age in the form of a flexible multi-exponential migration model was most notably proposed in Rogers and Castro (1978) <[doi:10.1068/a100475](https://doi.org/10.1068/a100475)>.

License MIT + file LICENSE

Encoding UTF-8

RoxygenNote 7.3.2

Biarch true

Depends R (>= 3.4.0)

Imports methods, Rcpp (>= 0.12.0), RcppParallel (>= 5.0.1), rstan (>= 2.26.0), rstantools (>= 2.1.1), Rdpack, dplyr, rlang, stats, tibble, tidybayes, magrittr, shiny, shinythemes

LinkingTo BH (>= 1.66.0), Rcpp (>= 0.12.0), RcppEigen (>= 0.3.3.3.0), RcppParallel (>= 5.0.1), rstan (>= 2.26.0), StanHeaders (>= 2.26.0)

Suggests knitr, rmarkdown, ggplot2

SystemRequirements GNU make

VignetteBuilder knitr

RdMacros Rdpack

NeedsCompilation yes

Author Jessie Yeung [aut, cre] (ORCID: <<https://orcid.org/0000-0002-0319-6892>>),
Monica Alexander [aut] (ORCID: <<https://orcid.org/0000-0002-8135-3435>>),
Tim Riffe [aut] (ORCID: <<https://orcid.org/0000-0002-2673-4622>>)

Maintainer Jessie Yeung <jessieyeung1@gmail.com>

Repository CRAN

Date/Publication 2025-08-28 02:40:02 UTC

Contents

rcbayes-package	2
init_rc	2
interact_rc	5
mig_calculate_rc	5
mig_estimate_rc	7

Index	10
--------------	-----------

rcbayes-package	<i>The 'rcbayes' package.</i>
-----------------	-------------------------------

Description

A collection of functions to estimate Rogers-Castro migration age schedules using 'Stan'. This model which describes the fundamental relationship between migration and age in the form of a flexible multi-exponential migration model was most notably proposed in Rogers and Castro (1978) [doi:10.1068/a100475](https://doi.org/10.1068/a100475).

A DESCRIPTION OF THE PACKAGE

Author(s)

Maintainer: Jessie Yeung <jessieyeung1@gmail.com> ([ORCID](#))

Authors:

- Monica Alexander ([ORCID](#))
- Tim Riffe ([ORCID](#))

References

Stan Development Team (2020). RStan: the R interface to Stan. R package version 2.21.2. <https://mc-stan.org>

init_rc	<i>Set initial values for Rogers-Castro migration model</i>
---------	---

Description

Choose initial values for parameters in the Rogers-Castro model in a strategic way based on your data. Provide these initial values to improve convergence of model. Intended to be used with `rcbayes::mig_estimate_rc` as an additional input into 'Stan'.

Usage

```
init_rc(
  ages,
  migrants,
  pop,
  mx,
  pre_working_age,
  working_age,
  retirement,
  post_retirement,
  nchains = 4,
  net_mig
)
```

Arguments

ages	numeric. A vector of integers for ages.
migrants	numeric. A vector of integers for observed age-specific migrants.
pop	numeric. A vector of integers for age-specific population or sample sizes, of which "migrants" experienced a migration event.
mx	numeric. A vector of age-specific migration rates.
pre_working_age	logical (TRUE/FALSE). Whether or not you are including pre working age component.
working_age	logical (TRUE/FALSE). Whether or not you are including working age component.
retirement	logical (TRUE/FALSE). Whether or not you are including retirement age component.
post_retirement	logical (TRUE/FALSE). Whether or not you are including post retirement age component.
nchains	numeric. A positive integer specifying the number of Markov chains. Should be 4 unless changed otherwise.
net_mig	numeric. Deprecated argument, use migrants instead.

Value

A list of length nchains. Each element of the list is a list of numeric values. Within the inner lists, there is one element for every model parameter.

Examples

```
# Ex. 1: Using ages, migrants, and population
ages <- 0:80
migrants <- c(202,215,167,188,206,189,164,
             158,197,185,176,173,167,198,
```

```

203, 237, 249, 274, 319, 345, 487,
491, 521, 505, 529, 527, 521, 529,
507, 484, 467, 439, 399, 399, 380,
368, 310, 324, 289, 292, 270, 269,
285, 254, 245, 265, 257, 258, 263,
253, 346, 293, 332, 346, 349, 355,
386, 346, 344, 352, 331, 320, 307,
320, 310, 258, 254, 243, 256, 263,
183, 169, 172, 160, 166, 113, 132,
111, 130, 110, 113)
pop <- c(105505, 105505, 105505, 105505, 105505,
106126, 106126, 106126, 106126, 106126,
100104, 100104, 100104, 100104, 100104,
114880, 114880, 114880, 114880, 114880,
136845, 136845, 136845, 136845, 136845,
136582, 136582, 136582, 136582, 136582,
141935, 141935, 141935, 141935, 141935,
134097, 134097, 134097, 134097, 134097,
130769, 130769, 130769, 130769, 130769,
133718, 133718, 133718, 133718, 133718,
154178, 154178, 154178, 154178, 154178,
145386, 145386, 145386, 145386, 145386,
126270, 126270, 126270, 126270, 126270,
108314, 108314, 108314, 108314, 108314,
79827, 79827, 79827, 79827, 79827, 59556,
59556, 59556, 59556, 59556, 59556)

#compute initial values
iv <- init_rc(ages=ages, migrants=migrants, pop=pop,
pre_working_age=TRUE,
working_age=TRUE,
retirement=TRUE,
post_retirement=TRUE)

# Ex 2: Using ages and mx
ages <- 0:80
mx <- c(0.001914601, 0.002037818, 0.001582863, 0.001781906,
0.001952514, 0.001780902, 0.001545333, 0.001488796,
0.001856284, 0.001743211, 0.001758172, 0.001728203,
0.001668265, 0.001977943, 0.002027891, 0.002063022,
0.002167479, 0.002385097, 0.002776811, 0.003003134,
0.003558771, 0.003588001, 0.003807227, 0.003690307,
0.003865687, 0.003858488, 0.003814558, 0.003873131,
0.003712056, 0.003543659, 0.003290238, 0.003092965,
0.002811146, 0.002811146, 0.002677282, 0.002744282,
0.002311759, 0.002416161, 0.002155156, 0.002177528,
0.002064710, 0.002057062, 0.002179416, 0.001942356,
0.001873533, 0.001981783, 0.001921955, 0.001929434,
0.001966826, 0.001892041, 0.002244159, 0.001900401,
0.002153355, 0.002244159, 0.002263617, 0.002441776,
0.002655001, 0.002379872, 0.002366115, 0.002421141,
0.002621367, 0.002534252, 0.002431298, 0.002534252,
0.002455057, 0.002381964, 0.002345034, 0.002243477,

```

```
0.002363499, 0.002428126, 0.002292457, 0.002117078,  
0.002154659, 0.002004334, 0.002079497, 0.001897374,  
0.002216401, 0.001863792, 0.002182820, 0.001847001,  
0.001897374)
```

```
# compute initial values  
iv <- init_rc(ages=ages, mx=mx,  
             pre_working_age=TRUE,  
             working_age=TRUE,  
             retirement=TRUE,  
             post_retirement=TRUE)
```

interact_rc

Run Interactive Rogers-Castro App

Description

Run an interactive Rogers-Castro app. Use interactive sliders to see how parameters affect the Rogers-Castro age schedules.

Usage

```
interact_rc()
```

Value

No return value, called for interactive widget

Examples

```
## Not run:  
interact_rc()  
  
## End(Not run)
```

mig_calculate_rc

Calculate Rogers-Castro migration age schedule

Description

Given a set of ages and parameters, calculate the migration age schedule based on the Rogers and Castro formula. Choose between a 7, 9, 11 or 13 parameter model.

Usage

```
mig_calculate_rc(ages, pars)
```

Arguments

- ages numeric. A vector of ages for migration rates to be calculated.
- pars numeric. A named list of parameters. See below for details.

Details

In the full 13 parameter model, the migration rate at age x , $m(x)$ is defined as

$$m(x) = a1*exp(-1*alpha1*x)+a2*exp(-1*alpha2*(x-mu2)-exp(-1*lambda2*(x-mu2)))+a3*exp(-1*alpha3*x)$$

The first, second, third and fourth pieces of the equation represent pre-working age, working age, retirement and post-retirement age patterns, respectively. Models with less parameters gradually remove terms at the older ages. Parameters in each family are:

- pre-working age: a1, alpha1
- working age: a2, alpha2, mu2, lambda2
- retirement: a3, alpha3, mu3, lambda3
- post retirement: a4, lambda4

For a specific family to be included, values for all parameters in that family must be specified.

Value

A vector the same length as ages. Values represent migration rate for each age in ages.

References

Rogers A, Castro LJ (1981). *Model migration schedules*. RR-81-030.

Examples

```
pars <- c(a1= 0.09, alpha1= 0.1, a2= 0.2,
alpha2= 0.1, mu2= 21, lambda2= 0.39, a3= 0.001,
alpha3= 1, mu3= 67, lambda3= 0.6, c= 0.01)
ages <- 0:75
mx <- mig_calculate_rc(ages = ages, pars = pars)

plot(ages, mx, type = 'l')
```

mig_estimate_rc	<i>Estimate Rogers-Castro migration age schedule</i>
-----------------	--

Description

Given a set of ages and observed age-specific migrants, estimate the parameters of a Roger-Castro model migration schedule. Choose between a 7, 9, 11 or 13 parameter model.

Usage

```

mig_estimate_rc(
  ages,
  migrants,
  pop,
  mx,
  sigma,
  pre_working_age,
  working_age,
  retirement,
  post_retirement,
  net_mig,
  ...
)

```

Arguments

ages	numeric. A vector of integers for ages.
migrants	numeric. A vector of integers for observed age-specific migrants.
pop	numeric. A vector of integers for age-specific population or sample sizes, of which "migrants" experienced a migration event.
mx	numeric. A vector of age-specific migration rates.
sigma	numeric. Standard deviation of migration rates for Normal model. Argument is option, standard deviation is estimated if Normal model is run without being specified.
pre_working_age	logical (TRUE/FALSE). Whether or not to include pre working age component.
working_age	logical (TRUE/FALSE). Whether or not to include working age component.
retirement	logical (TRUE/FALSE). Whether or not to include retirement age component.
post_retirement	logical (TRUE/FALSE). Whether or not to include post retirement age component.
net_mig	numeric. Deprecated argument, use migrants instead.
...	additional inputs to stan, see <code>?rstan::stan</code> for details.

Value

A list of length 3. The first element, `pars_df`, is a data frame that provides parameter estimates with 95% credible intervals. The second element, `fit_df`, is a data frame that shows the data and estimated migration rates at each age. The third element, `check_converge`, is a data frame that provides the R-hat values and effective sample sizes.

Examples

```
# Ex 1: Run poisson model using ages, migrants, and population
ages <- 0:80
migrants <- c(202,215,167,188,206,189,164,
             158,197,185,176,173,167,198,
             203,237,249,274,319,345,487,
             491,521,505,529,527,521,529,
             507,484,467,439,399,399,380,
             368,310,324,289,292,270,269,
             285,254,245,265,257,258,263,
             253,346,293,332,346,349,355,
             386,346,344,352,331,320,307,
             320,310,258,254,243,256,263,
             183,169,172,160,166,113,132,
             111,130,110,113)
pop <- c(105505,105505,105505,105505,105505,
        106126,106126,106126,106126,106126,
        100104,100104,100104,100104,100104,
        114880,114880,114880,114880,114880,
        136845,136845,136845,136845,136845,
        136582,136582,136582,136582,136582,
        141935,141935,141935,141935,141935,
        134097,134097,134097,134097,134097,
        130769,130769,130769,130769,130769,
        133718,133718,133718,133718,133718,
        154178,154178,154178,154178,154178,
        145386,145386,145386,145386,145386,
        126270,126270,126270,126270,126270,
        108314,108314,108314,108314,108314,
        79827,79827,79827,79827,79827,59556,
        59556,59556,59556,59556,59556)

# fit the model
res <- mig_estimate_rc(ages = ages, migrants = migrants, pop = pop,
                      pre_working_age = TRUE,
                      working_age = TRUE,
                      retirement = TRUE,
                      post_retirement = FALSE,
                      #optional inputs into stan
                      control = list(adapt_delta = 0.95, max_treedepth = 10),
                      iter = 10, chains = 1 #to speed up example
                      )

# plot the results and data
plot(ages, migrants/pop, ylab = "migration rate", xlab = "age")
```

```
lines(ages, res[["fit_df"]]$median, col = "red")
legend("topright", legend=c("data", "fit"), col=c("black", "red"), lty=1, pch = 1)

# Ex 2: Run normal model using ages and mx
ages <- 0:80
mx <- c(0.001914601, 0.002037818, 0.001582863, 0.001781906,
        0.001952514, 0.001780902, 0.001545333, 0.001488796,
        0.001856284, 0.001743211, 0.001758172, 0.001728203,
        0.001668265, 0.001977943, 0.002027891, 0.002063022,
        0.002167479, 0.002385097, 0.002776811, 0.003003134,
        0.003558771, 0.003588001, 0.003807227, 0.003690307,
        0.003865687, 0.003858488, 0.003814558, 0.003873131,
        0.003712056, 0.003543659, 0.003290238, 0.003092965,
        0.002811146, 0.002811146, 0.002677282, 0.002744282,
        0.002311759, 0.002416161, 0.002155156, 0.002177528,
        0.002064710, 0.002057062, 0.002179416, 0.001942356,
        0.001873533, 0.001981783, 0.001921955, 0.001929434,
        0.001966826, 0.001892041, 0.002244159, 0.001900401,
        0.002153355, 0.002244159, 0.002263617, 0.002441776,
        0.002655001, 0.002379872, 0.002366115, 0.002421141,
        0.002621367, 0.002534252, 0.002431298, 0.002534252,
        0.002455057, 0.002381964, 0.002345034, 0.002243477,
        0.002363499, 0.002428126, 0.002292457, 0.002117078,
        0.002154659, 0.002004334, 0.002079497, 0.001897374,
        0.002216401, 0.001863792, 0.002182820, 0.001847001,
        0.001897374)

# fit the model
res <- mig_estimate_rc(ages = ages, mx = mx,
                      pre_working_age = TRUE,
                      working_age = TRUE,
                      retirement = TRUE,
                      post_retirement = FALSE,
                      #optional inputs into stan
                      control = list(adapt_delta = 0.95, max_treedepth = 10),
                      iter = 10, chains = 1 #to speed up example
                      )
```

Index

`init_rc`, [2](#)

`interact_rc`, [5](#)

`mig_calculate_rc`, [5](#)

`mig_estimate_rc`, [7](#)

`rcbayes` (`rcbayes-package`), [2](#)

`rcbayes-package`, [2](#)