Package 'fertilmodel'

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Type Package

Title Fertility Models

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Depends R (>= 4.0)

Imports nnsolve, stats

Suggests Rfast, Rfast2

Description Four fertility models are fitted using non-linear least squares. These are the Hadwiger, the Gamma, the Model1 and Model2, following the terminology of the following paper: Peristera P. and Kostaki A. (2007). ``Modeling fertility in modern populations". Demographic Research, 16(6): 141--194. <doi:10.4054/DemRes.2007.16.6>. Model based averaging is also supported.

License GPL (>= 2)

NeedsCompilation no

Repository CRAN

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Contents

`fertilmodel-package` *This is an R package that fits 4 fertility models.*

Description

Four fertility models are fitted using non-linear least squares. These are the Hadwiger, the Gamma, the Model1 and Model2, following the terminology of the following paper: Peristera P. and Kostaki A. (2007). Modeling fertility in modern populations. Demographic Research, 16(6): 141–194. <doi:10.4054/DemRes.2007.16.6>.

Details

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Version:	1.5		
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Maintainers

Michail Tsagris <mtsagris@uoc.gr>.

Note

Acknowledgments: This package is dedicated to Sanaa who introduced me to these models and whom I may never see again.

Author(s)

Michail Tsagris <mtsagris@uoc.gr>.

References

Peristera P. and Kostaki A. (2007). Modeling fertility in modern populations. Demographic Research, 16(6), 141–194. <doi:10.4054/DemRes.2007.16.6>.

comb *Model based average of the estimated values from two or more fertility models*

Description

Model based average of the estimated values from two or more fertility models.

Usage

```
comb(models)
```

Arguments

models	A list with possible models.

Value

A list including:

weights	The weights assigned to each model.
fit	The weighted fitted age-specific fertility rates $\hat{f}(x)$.

Author(s)

Michail Tsagris.

R implementation and documentation: Michail Tsagris <mtsagris@uoc.gr>.

See Also

Hadwiger

Examples

```
rate <- c(0.0001, 0.0006, 0.0033, 0.0111, 0.0263, 0.0412, 0.0544, 0.0622,
0.0660, 0.0704,0.0723, 0.0753, 0.0814, 0.0873, 0.0924, 0.0962, 0.0989,
0.1006, 0.0990, 0.0933,0.0831, 0.0747, 0.0634, 0.0529, 0.0424, 0.0326,
0.0242, 0.0172, 0.0115, 0.0073, 0.0040, 0.0022, 0.0012, 0.0006, 0.0003,
0.0002, 0.0001)
age <- 13:49
mod1 <- Hadwiger(rate, age)
mod2 <- Gama(rate, age)
mod3 <- Model1(rate, age)
mod4 <- Model2(rate, age)
a <- list(mod1 = mod1, mod2 = mod2, mod3 = mod3, mod4 = mod4)
comb(a)
```

`fertil.plot` *Plot of the age-specific fertility rates and the estimated values from one or more fertility models*

Description

Plot of the age-specific fertility rates and the estimated values from one or more fertility models.

Usage

```
fertil.plot(rate, age, fit = NULL, grid = FALSE, names = NULL)
```

Arguments

`rate`	A vector with the age-specific fertility rates.
`age`	A vector with the age of the women.
`fit`	Here you can specify nothing (omly plot the fertility rates across the ages), or you can specify a vector or a matrix with fitted values from at least one model.
`grid`	Do you want a grid of vertical and horizontal lines? TRUE or FALSE.
`names`	If you provided fitted models from a model, you can specify the name(s) of the model(s) so that they appear as a legend.

Value

A plot with the age-specific fertility rates across the mothers' age and perhaps the fitted values from at least one model.

Author(s)

Michail Tsagris.

R implementation and documentation: Michail Tsagris <mtsagris@uoc.gr>.

See Also

Hadwiger, comb

Examples

```
rate <- c(0.0000, 0.0005, 0.0023, 0.0073, 0.0175, 0.0283,
0.0420, 0.0523, 0.0601, 0.0712, 0.0789, 0.0865, 0.0939,
0.0991, 0.1052, 0.1115, 0.1155, 0.1178, 0.1211, 0.1159,
0.1104, 0.1031, 0.0916, 0.0776, 0.0639, 0.0498, 0.0387,
0.0281, 0.0185, 0.0117, 0.0067, 0.0038, 0.0020, 0.0011,
0.0007, 0.0003, 0.0002)
age <- 13:49
mod1 <- Hadwiger(rate, age)
mod2 <- Gama(rate, age)
```

```
fertil.plot(rate, age)
fertil.plot(rate, age, cbind(mod1$fit, mod2$fit), grid = TRUE, names = c("Hadwiger", "Gama") )
```

`Hadwiger` *Fertility models*

Description

Fertility models.

Usage

```
Hadwiger(rate, age)
Gama(rate, age)
Model1(rate, age)
Model2(rate, age)
```

Arguments

`rate`	A vector with the age-specific fertility rates.
`age`	A vector with the age of the women.

Details

The following fertility models are fitted: Hadwiger:

$$f(x) = \frac{ab}{c}(\frac{c}{x})^{3/2} \exp[-b^2(\frac{c}{x} + \frac{x}{c} - 2)],$$

where x is the age of the mother at birth, a is associated with total fertility, the parameter b determines the height of the curve and the parameter c is related to the mean age of motherhood.

Gama:

$$f(x) = R\frac{1}{\Gamma(b)c^b}(x-d)^{b-1} \exp(-\frac{x-d}{c}),$$

where d represents the lower age at childbearing, while the parameter R determines the level of fertility.

Model1:

$$f(x) = c_1 \exp[-\frac{(x-\mu)^2}{\sigma^2(x)}],$$

where $\sigma(x) = \sigma_{11}$ if $x \leq \mu$ and $\sigma(x) = \sigma_{12}$ if $x > \mu$. The parameter c_1 describes the base level of the fertility curve and is associated with the total fertility rate, μ reflects the location of the distribution, i.e. the modal age and σ_{11} and σ_{12} reflect the spread of the distribution before and after its peak, respectively.

Model2:

$$f(x) = c_1 \exp[-\frac{(x-\mu_1)^2}{\sigma_1^2}] + c_2 \exp[-\frac{(x-\mu_2)^2}{\sigma_2^2}],$$

where the parameters c_1 and c_2 express the severity i.e. the total fertility rates of the first and the second hump respectively, μ_1 and μ_2 are related to the mean ages of the two subpopulations the one with earlier fertility and the other with fertility at later ages, while σ_1 and σ_2 reflect the variances of the two humps.

Value

A list including:

`param`	The vector of the estimated parameters.
`sse`	The sum of squars of the errors $\sum_{i=1}^{n}(f_x - \hat{f}(x))^2$, where f_x denotes the observed age-specific fertility rates and $\hat{f}(x)$ denote the fitted age-specific fertility rates.
`fx`	The fitted values, the fitted age-specific fertility rates $\hat{f}(x)$.
`res`	The residuals, $f_x - \hat{f}_x$.

Author(s)

Michail Tsagris.

R implementation and documentation: Michail Tsagris <mtsagris@uoc.gr>.

References

Peristera P. and Kostaki A. (2007). Modeling fertility in modern populations. Demographic Research, 16(6): 141–194.

See Also

`fertil.plot`, `comb`

Examples

```
rate <- c(0.0001, 0.0006, 0.0033, 0.0111, 0.0263, 0.0412, 0.0544, 0.0622,
0.0660, 0.0704,0.0723, 0.0753, 0.0814, 0.0873, 0.0924, 0.0962, 0.0989,
0.1006, 0.0990, 0.0933,0.0831, 0.0747, 0.0634, 0.0529, 0.0424, 0.0326,
0.0242, 0.0172, 0.0115, 0.0073, 0.0040, 0.0022, 0.0012, 0.0006, 0.0003,
0.0002, 0.0001)
age <- 13:49
mod1 <- Hadwiger(rate, age)
mod2 <- Gama(rate, age)
mod3 <- Model1(rate, age)
mod4 <- Model2(rate, age)
```

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