

# Gompertz

## Parametrisation

The Gompertz distribution has log survival function

$$\log S(y) = -\frac{\mu}{\alpha} (\exp(\alpha y) - 1)$$

for response  $y \geq 0$ ,  $\mu > 0$  and  $\alpha > 0$ . The cumulative distribution function and the density then follows as

$$F(y) = 1 - \exp \left[ -\frac{\mu}{\alpha} (\exp(\alpha y) - 1) \right]$$

and

$$f(y) = \mu \exp \left[ \alpha y - \frac{\mu}{\alpha} (\exp(\alpha y) - 1) \right].$$

## Link-function

The parameter  $\mu$  is linked to the linear predictor  $\eta$  as:

$$\mu = \exp(\eta)$$

## Hyperparameters

The shape parameter  $\alpha$  is represented as

$$\alpha = \exp(S\theta)$$

and the prior is defined on  $\theta$ . The constant  $S$  currently set to 0.1 to avoid numerical instabilities in the optimization, since small changes of  $\alpha$  can make a huge difference.

## Specification

- `family="gompertz"` for regression models and `family="gompertz.surv"` for survival models.
- Required arguments:  $y$  (to be given in a format by using `inla.surv()` for survival models )

## Hyperparameter spesification and default values

`doc gompertz distribution`

`hyper`

`theta`

`hyperid 105101`

`name shape`

`short.name alpha`

`output.name.intern alpha_intern for Gompertz`

`output.name alpha parameter for Gompertz`

`initial -1`

`fixed FALSE`

`prior normal`

`param 0 1`

`to.theta function(x, sc = 0.1) log(x) / sc`

```

        from.theta function(x, sc = 0.1) exp(sc * x)
status experimental
survival FALSE
discrete FALSE
link default log neglog
pdf gompertz
doc gompertz distribution
hyper
  theta1
    hyperid 106101
    name shape
    short.name alpha
    output.name.intern alpha_intern for Gompertz-surv
    output.name alpha parameter for Gompertz-surv
    initial -10
    fixed FALSE
    prior normal
    param 0 1
    to.theta function(x, sc = 0.1) log(x) / sc
    from.theta function(x, sc = 0.1) exp(sc * x)
  theta2
    hyperid 106102
    name beta1
    short.name beta1
    output.name beta1 for Gompertz-Cure
    output.name.intern beta1 for Gompertz-Cure
    initial -5
    fixed FALSE
    prior normal
    param -4 100
    to.theta function(x) x
    from.theta function(x) x
  theta3
    hyperid 106103
    name beta2
    short.name beta2
    output.name beta2 for Gompertz-Cure
    output.name.intern beta2 for Gompertz-Cure
    initial 0
    fixed FALSE

```

```

    prior normal
    param 0 100
    to.theta function(x) x
    from.theta function(x) x
theta4
    hyperid 106104
    name beta3
    short.name beta3
    output.name beta3 for Gompertz-Cure
    output.name.intern beta3 for Gompertz-Cure
    initial 0
    fixed FALSE
    prior normal
    param 0 100
    to.theta function(x) x
    from.theta function(x) x
theta5
    hyperid 106105
    name beta4
    short.name beta4
    output.name beta4 for Gompertz-Cure
    output.name.intern beta4 for Gompertz-Cure
    initial 0
    fixed FALSE
    prior normal
    param 0 100
    to.theta function(x) x
    from.theta function(x) x
theta6
    hyperid 106106
    name beta5
    short.name beta5
    output.name beta5 for Gompertz-Cure
    output.name.intern beta5 for Gompertz-Cure
    initial 0
    fixed FALSE
    prior normal
    param 0 100
    to.theta function(x) x
    from.theta function(x) x
theta7
    hyperid 106107
    name beta6
    short.name beta6

```

```

output.name beta6 for Gompertz-Cure
output.name.intern beta6 for Gompertz-Cure
initial 0
fixed FALSE
prior normal
param 0 100
to.theta function(x) x
from.theta function(x) x
theta8
  hyperid 106108
  name beta7
  short.name beta7
  output.name beta7 for Gompertz-Cure
  output.name.intern beta7 for Gompertz-Cure
  initial 0
  fixed FALSE
  prior normal
  param 0 100
  to.theta function(x) x
  from.theta function(x) x
theta9
  hyperid 106109
  name beta8
  short.name beta8
  output.name beta8 for Gompertz-Cure
  output.name.intern beta8 for Gompertz-Cure
  initial 0
  fixed FALSE
  prior normal
  param 0 100
  to.theta function(x) x
  from.theta function(x) x
theta10
  hyperid 106110
  name beta9
  short.name beta9
  output.name beta9 for Gompertz-Cure
  output.name.intern beta9 for Gompertz-Cure
  initial 0
  fixed FALSE
  prior normal
  param 0 100
  to.theta function(x) x
  from.theta function(x) x

```

```

theta11
  hyperid 106111
  name beta10
  short.name beta10
  output.name beta10 for Gompertz-Cure
  output.name.intern beta10 for Gompertz-Cure
  initial 0
  fixed FALSE
  prior normal
  param 0 100
  to.theta function(x) x
  from.theta function(x) x

status experimental

survival TRUE

discrete FALSE

link default log neglog

pdf gompertz

```

## Example

In the following example we estimate the parameters in a simulated case

```

library(flexsurv)
library(INLA)

n <- 1000
alpha <- 1.0
intercept <- 1.1
beta <- 1.2
x <- rnorm(n, sd = 0.2)
eta <- intercept + beta*x
mu <- exp(eta)
event <- rep(1,n)
y <- rgompertz(n, rate = mu, shape = alpha)

r <- inla(y ~ 1 + x,
          family = "gompertz", data=data.frame(y, x))
r.surv <- inla(inla.surv(y, event) ~ 1 + x,
               family = "gompertzsurv", data=data.frame(y, event, x))

## should be 'small'
print(r$mlik - r.surv$mlik)

```

## Notes