LogLogistic likelihood

Parametrisation

The LogLogistic distribution has cumulative distribution function

$$F_0(y) = \frac{1}{1 + \lambda y^{-\alpha}}, \qquad y > 0$$

if variant=0, or

$$F_1(y) = \frac{1}{1 + (\lambda y)^{-\alpha}}, \quad y > 0$$

if variant=1, where

 $\alpha > 0$ is a shape parameter, and

 $\lambda > 0$ is a scale parameter.

Link-functions

The parameter λ is linked to the linear predictor, by default as

$$\lambda = \exp(\eta)$$

Hyperparameters

The α parameter is represented as

$$\theta = \log \alpha$$

and the prior is defined on θ .

Specification

- family="loglogistic" (regression) or "loglogistic.surv" (survival)
- variant=0 (default) or 1, chosing between parameterisation F_0 or F_1 .
- Required arguments: y (regression) or an inla.surv-object using inla.surv() (for survival data)

Hyperparameter spesification and default values

Regression:

doc The loglogistic likelihood

hyper

theta

hyperid 80001
name log alpha
short.name alpha
output.name alpha for loglogistic observations
output.name.intern log alpha for loglogistic observations
initial 1
fixed FALSE

```
prior loggamma
         param 25 25
         to.theta function(x) log(x)
         from.theta function(x) exp(x)
survival FALSE
discrete FALSE
link default log neglog
pdf loglogistic
   Survival:
{
m doc} The loglogistic likelihood (survival)
hyper
    theta1
        hyperid 80011
         name log alpha
         short.name alpha
         output.name alpha for loglogisticsurv observations
         output.name.intern log alpha for loglogisticsurv observations
         initial 1
         fixed FALSE
         prior loggamma
         param 25 25
         to.theta function(x) log(x)
         from.theta function(x) exp(x)
    theta2
         hyperid 80012
         name beta1
         short.name beta1
         output.name beta1 for logLogistic-Cure
         output.name.intern beta1 for logLogistic-Cure
        initial -5
         fixed FALSE
         prior normal
         param -4 100
         to.theta function(x) x
         from.theta function(x) x
    theta3
         hyperid 80013
         name beta2
         short.name beta2
         output.name beta2 for logLogistic-Cure
         output.name.intern beta2 for logLogistic-Cure
```

```
initial 0
    fixed FALSE
    prior normal
    param 0 100
    to.theta function(x) x
    from.theta function(x) x
theta4
    hyperid 80014
    name beta3
    short.name beta3
    output.name beta3 for logLogistic-Cure
    output.name.intern beta3 for logLogistic-Cure
    initial 0
    fixed FALSE
    prior normal
    param 0 100
    to.theta function(x) x
    from.theta function(x) x
theta5
    hyperid 80015
    name beta4
    short.name beta4
    output.name beta4 for logLogistic-Cure
    output.name.intern beta4 for logLogistic-Cure
    initial 0
    fixed FALSE
    prior normal
    param 0 100
    to.theta function(x) x
    from.theta function(x) x
theta6
    hyperid 80016
    name beta5
    short.name beta5
    output.name beta5 for logLogistic-Cure
    output.name.intern beta5 for logLogistic-Cure
    initial 0
    fixed FALSE
    prior normal
    param 0 100
    to.theta function(x) x
    from.theta function(x) x
theta7
    hyperid 80017
```

```
name beta6
    short.name beta6
    output.name beta6 for logLogistic-Cure
    output.name.intern beta6 for logLogistic-Cure
    initial 0
    fixed FALSE
    prior normal
    param 0 100
    to.theta function(x) x
    from.theta function(x) x
theta8
    hyperid 80018
    name beta7
    short.name beta7
    output.name beta7 for logLogistic-Cure
    output.name.intern beta7 for logLogistic-Cure
    initial 0
    fixed FALSE
    prior normal
    param 0 100
    to.theta function(x) x
    from.theta function(x) x
theta9
    hyperid 80019
    name beta8
    short.name beta8
    output.name beta8 for logLogistic-Cure
    output.name.intern beta8 for logLogistic-Cure
    initial 0
    fixed FALSE
    prior normal
    param 0 100
    to.theta function(x) x
    from.theta function(x) x
theta10
    hyperid 80020
    name beta9
    short.name beta9
    output.name beta9 for logLogistic-Cure
    output.name.intern beta9 for logLogistic-Cure
    initial 0
    fixed FALSE
    prior normal
    param 0 100
```

```
to.theta function(x) x
         from.theta function(x) x
     theta11
         hyperid 80021
         name beta10
         short.name beta10
         output.name beta10 for logLogistic-Cure
         output.name.intern beta10 for logLogistic-Cure
         initial 0
         fixed FALSE
         prior normal
         param 0 100
         to.theta function(x) x
         from.theta function(x) x
survival TRUE
discrete FALSE
link default log neglog
pdf loglogistic
Example
In the following example we estimate the parameters in a simulated case
rloglogistic = function(n, lambda,
                                      alpha, variant=0)
    u = runif(n)
    if (variant == 0) {
        y = (lambda/(1.0/u - 1.0))^(1.0/alpha)
    } else if (variant == 1) {
        y = (1.0/(1.0/u -1.0))^(1.0/alpha) / lambda
    } else {
        stop("ERROR")
    }
}
n = 1000
alpha = 2.1
x = c(scale(runif(n)))
eta = 1.1+2.2*x
lambda = exp(eta)
for(variant in 0:1) {
    print(paste("variant=", variant))
    y = rloglogistic(n, lambda = lambda,
                     alpha = alpha,
                     variant = variant)
```

```
formula = y \sim 1 + x
   r=inla(formula,
           family ="loglogistic",
           data=data.frame(y, x),
           control.family = list(variant = variant))
   print("REGRESSION")
   print(summary(r))
   event = rep(1,n)
   formula=inla.surv(y,event) ~ 1 + x
   r=inla(formula,
           family ="loglogisticsurv",
           data = list(y=y, event=event, x=x),
           control.family = list(variant = variant))
   print("SURVIVAL")
   print(summary(r))
}
```

Notes

• Loglogisticsurv model can be used for right censored, left censored, interval censored data. If the observed times y are large/huge, then this can cause numerical overflow in the likelihood routine. If you encounter this problem, try to scale the observatios, time = time / max(time) or similar.