

## Sigmoidal effect of a covariate

### Parametrization

This model implements a non-linear effect of a positive covariate  $x$  as a part of the linear predictor. It comes in two variants, *sigmoidal*

$$\beta \frac{x^k}{x^k + a^k} \quad \text{or} \quad \beta \frac{z}{z + 1}$$

with  $z = (x/a)^k$ ,  $x \geq 0$ ,  $k > 0$  and  $a > 0$ , and the *reverse-sigmoidal*

$$\beta \frac{a^k}{x^k + a^k} \quad \text{or} \quad \beta \frac{1}{z + 1}.$$

Here,  $a$  is the halflife parameter,  $k$  the shape-parameter and  $\beta$  the scaling.

### Hyperparameters

This model has three hyperparameters, the scaling  $\beta$ , halflife  $a$  and shape  $k$ ,

$$\theta_1 = \beta \quad \theta_2 = \log(a) \quad \theta_3 = \log(k)$$

and the priors are given for  $\theta_1, \theta_2$  and  $\theta_3$ .

### Specification

```
f(x, model="sigm",    hyper = ..., precision = <precision>)
f(x, model="revsigm", hyper = ..., precision = <precision>)
```

where `precision` is the precision for the tiny noise used to implement this as a latent model.

### Hyperparameter specification and default values

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`hyper`

`theta1`

```
hyperid 38001
name beta
short.name b
initial 1
fixed FALSE
prior normal
param 1 10
to.theta function(x) x
from.theta function(x) x
```

`theta2`

```
hyperid 38002
name loghalflife
short.name halflife
initial 3
```

```

    fixed FALSE
    prior loggamma
    param 3 1
    to.theta function(x) log(x)
    from.theta function(x) exp(x)
  theta3
    hyperid 38003
    name logshape
    short.name shape
    initial 0
    fixed FALSE
    prior loggamma
    param 10 10
    to.theta function(x) log(x)
    from.theta function(x) exp(x)

  constr FALSE

  nrow.ncol FALSE

  augmented FALSE

  aug.factor 1

  aug.constr

  n.div.by

  n.required FALSE

  set.default.values FALSE

  pdf sigm

```

## Example

```

sigm = function(x, halflife, shape = 1)
{
  xx = (x/halflife)^shape
  return (xx/(1.0+xx))
}

revsigm = function(x, halflife, shape = 1)
{
  xx = (x/halflife)^shape
  return (1.0/(1.0+xx))
}

n = 1000
lambda = 10
s=0.01
x = rpois(n, lambda = lambda)
halflife = lambda

```

```

shape = 2

y = sigm(x, halflife, shape) + rnorm(n, sd = s)
r = inla(y ~ -1 + f(x, model="sigm"),
        data = data.frame(y, x),
        family = "gaussian",
        control.family = list(
            hyper = list(
                prec = list(
                    initial = log(1/s^2),
                    fixed = TRUE))))

summary(r)

y = revsigm(x, halflife, shape) + rnorm(n, sd = s)
r = inla(y ~ -1 + f(x, model="revsigm"),
        data = data.frame(y, x),
        family = "gaussian",
        control.family = list(
            hyper = list(
                prec = list(
                    initial = log(1/s^2),
                    fixed = TRUE))))

summary(r)

```

## Notes

None