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

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

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

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

Here, a is the halflife parameter, k the shape-parameter and β the scaling.

Hyperparameters

This model has three hyperparameters, the scaling β , halflife a and shape k,

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

and the priors are given for θ_1, θ_2 and θ_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
status experimental
\mathbf{pdf} \operatorname{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 \sim -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