

Random walk model of order 2 (RW2)

Parametrization

The random walk model of order 2 (RW2) for the Gaussian vector $\mathbf{x} = (x_1, \dots, x_n)$ is constructed assuming independent second-order increments:

$$\Delta^2 x_i = x_i - 2x_{i+1} + x_{i+2} \sim \mathcal{N}(0, \tau^{-1})$$

The density for \mathbf{x} is derived from its $n - 2$ second-order increments as

$$\pi(\mathbf{x}|\tau) \propto \tau^{(n-2)/2} \exp \left\{ -\frac{\tau}{2} \sum (\Delta^2 x_i)^2 \right\} \quad (1)$$

$$= \tau^{(n-2)/2} \exp \left\{ -\frac{1}{2} \mathbf{x}^T \mathbf{Q} \mathbf{x} \right\} \quad (2)$$

where $\mathbf{Q} = \tau \mathbf{R}$ and \mathbf{R} is the structure matrix reflecting the neighbourhood structure of the model.

It is also possible to define a *cyclic* version of the RW2 model.

Hyperparameters

The precision parameter τ is represented as

$$\theta = \log \tau$$

and the prior is defined on θ .

Specification

The RW2 model is specified inside the `f()` function as

```
f(<whatever>, model="rw2", values=<values>, cyclic=<TRUE,FALSE>,
```

The (optional) argument `values` is a numeric or factor vector giving the values assumed by the covariate for which we want the effect to be estimated. See the example for RW1 for an application.

Hyperparameter specification and default values

hyper

theta

name log precision

short.name prec

prior loggamma

param 1 5e-05

initial 4

fixed FALSE

to.theta function(x) log(x)

from.theta function(x) exp(x)

constr TRUE

nrow.ncol FALSE

augmented FALSE

```
aug.factor 1
aug.constr
n.div.by
n.required FALSE
set.default.values FALSE
pdf rw2
```

Example

```
n=100
z=seq(0,6,length.out=n)
y=sin(z)+rnorm(n,mean=0,sd=0.5)
data=data.frame(y=y,z=z)

formula=y~f(z,model="rw2")
result=inla(formula,data=data,family="gaussian")
```

Notes

- The RW2 is a intrinsic with rank deficiency 2.
- The RW2 model for irregular locations are supported although not described here.
- The $\frac{n-r}{2} \log(|R|^*)$ -part (with $r = 2$) of the normalisation constant is not computed, hence you need to add this part to the log marginal likelihood estimate, if you need it.