

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>,  
  prior=c(<prior.model.theta>),  
  param=c(<param.prior.theta1>))
```

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.

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",prior="loggamma",param=c(1,0.01))  
result=inla(formula,data=data,family="gaussian")
```

Notes

The RW2 is a intrinsic random field with rank deficiency of 2.

There exist also support to define irregular RW2 models.