Bym model for spatial effects

Parametrization

This model is simply a union of the besag model u and a iid model v, so that

$$x = \begin{pmatrix} v + u \\ u \end{pmatrix}$$

Note that the length of x is $2n$ if the length of u (and v) is n. The benefite is that this allows to get the posterior marginals of the sum of the spatial and iid model; otherwise it offers no advantages.

Hyperparameters

The hyperparameters are the precision τ_1 of the iid model (v) and the precision τ_2 of the besag model (u). The precision parameters are represented as

$$\theta = (\theta_1, \theta_2) = (\log \tau_1, \log \tau_2)$$

and the prior is defined on θ.

Specification

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

```
f(<whatever>,model="bym",graph=<graph>,
  hyper=<hyper>, adjust.for.con.comp = TRUE,
  scale.model = FALSE)
```

The neighbourhood structure of `x` is passed to the program through the `graph` argument.

The option `adjust.for.con.comp` adjust the model if the graph has more than one connected compoment, and this adjustment can be disabled setting this option to `FALSE`. This means that `constr=TRUE` is interpreted as a sum-to-zero constraint on *each* connected component and the `rankdef` parameter is set accordingly.

The logical option `scale.model` determine if the besag-model-part of the model u should be scaled to have an average variance (the diagonal of the generalized inverse) equal to 1. This makes prior spesification much easier. Default is `FALSE` so that the model is not scaled.

Hyperparameter spesification and default values

doc The BYM-model (Besag-York-Mollier model)

hyper

theta1

hyperid 10001
name log unstructured precision
short.name prec.unstruct
prior loggamma
param 1 5e-04
initial 4
fixed FALSE
to.theta `function(x) log(x)`
from.theta `function(x) exp(x)`

theta2

hyperid 10002

name log spatial precision

short.name prec.spatial

prior loggamma

param 1 5e-04

initial 4

fixed FALSE

to.theta `function(x) log(x)`

from.theta `function(x) exp(x)`

constr TRUE

nrow.ncol FALSE

augmented TRUE

aug.factor 2

aug.constr 2

n.div.by

n.required TRUE

set.default.values TRUE

pdf bym

Example

For examples of application of this model see the `Bym` example in Volume I.

Details on the implementation

This gives some details of the implementation, which depends on the following variables

nc1 Number of connected components in the graph with size 1. These nodes, *singletons*, have no neighbours.

nc2 Number of connected components in the graph with size ≥ 2.

scale.model The value of the logical flag, if the model should be scaled or not. (Default FALSE)

adjust.for.con.comp The value of the logical flag if the `constr=TRUE` option should be reinterpreted.

The case `(scale.model==FALSE && adjust.for.con.comp == FALSE)`

The option `constr=TRUE` is interpreted as a sum-to-zero constraint over the whole graph. Singletons are given a uniform distribution on $(-\infty, \infty)$ before the constraint.

The case `(scale.model==TRUE && adjust.for.con.comp == FALSE)`

The option `constr=TRUE` is interpreted as a sum-to-zero constraint over the whole graph. Let $Q = \tau R$ be the standard precision matrix from the `besag`-model with precision parameter τ. Then R, except the singletons, are scaled so that the geometric mean of the marginal variances is 1, and R is modified so that singletons have a standard Normal distribution.

The case `(scale.model==FALSE && adjust.for.con.comp == TRUE)`

The option `constr=TRUE` is interpreted as one sum-to-zero constraint over each of the `nc2` connected components of size ≥ 2. Singletons are given a uniform distribution on $(-\infty, \infty)$.

The case `(scale.model==TRUE && adjust.for.con.comp == TRUE)`

The option `constr=TRUE` is interpreted as `nc2` sum-to-zero constraints for each of the connected components of size ≥ 2. Let $Q = \tau R$ be the standard precision matrix from the `besag`-model with precision parameter τ. Then R, are scaled so that the geometric mean of the marginal variances in each connected component of size ≥ 2 is 1, and modified so that singletons have a standard Normal distribution.

Notes

The term $\frac{1}{2}\log(|R|^*)$ of the normalisation constant is not computed, hence you need to add this part to the log marginal likelihood estimate, if you need it. Here R is the precision matrix with a unit precision parameter for the Besag part of the model.