BYM with PC priors

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```
require('diseasemapping')

## Loading required package: diseasemapping

data('kentucky')
```

Incidence rates

```
if(FALSE) {
        # must have an internet connection to do the following
        larynxRates= cancerRates("USA", year=1998:2002,site="Larynx")
        dput(larynxRates)
} else {
        larynxRates = structure(c(0, 0, 0, 0, 1e-06, 6e-06, 2.3e-05, 4.5e-05, 9.9e-05,
                                  0.000163, 0.000243, 0.000299, 0.000343, 0.000308
                                  0, 0, 0, 1e-06, 1e-06, 3e-06, 8e-06, 1.3e-05, 2.
                                  5.8e-05, 6.8e-05, 7.5e-05, 5.5e-05, 4.1e-05, 3e-
                                  "M_15", "M_20", "M_25", "M_30", "M_35", "M_40",
                                  "M_55", "M_60", "M_65", "M_70", "M_75", "M_80",
                                  "F_15", "F_20", "F_25", "F_30", "F_35", "F_40",
                                  "F_55", "F_60", "F_65", "F_70", "F_75", "F_80",

}
```

```
# get rid of under 10's
larynxRates = larynxRates[grep("_(0|5)$",names(larynxRates), invert=TRUE)]
# compute Sexpected
kentucky = diseasemapping::getSMR(
    popdata=kentucky,
    model = larynxRates,
```

```
    casedata=larynx,
    regionCode="County")
```

The BYM model

The Besag, York and Mollie model for Poisson distributed case counts is:

$$\begin{aligned} Y_i \sim & \text{Poisson}(O_i \lambda_i) \\ \log(\mu_i) = & X_i \beta + U_i \\ U_i \sim & \text{BYM}(\sigma_1^2, \sigma_2^2) \end{aligned}$$

- Y_i is the response variable for region i
- O_i is the 'baseline' expected count, which is specified
- X_i are covariates
- U_i is a spatial random effect with a spatially structured variance parameter σ_1^2 and a spatially independent variance σ_2^2

Gamma priors on precision

```
kBYM = kBYMpc = try(bym(
                formula = observed ~ offset(logExpected) + poverty,
    data=kentucky,
    priorCI = list(sdSpatial=c(0.1, 5), sdIndep=c(0.1, 5)),
                region.id="County"
))
```

Above, Gamma priors are assigned to $1/\sigma_1^2$ and $1/\sigma_2^2$, with the shape and scale parameters set to produce 2.5% to 97.5% prior intervals of $(0.1, 5)$ for each standard deviation parameter.

```
if(!is.null(kBYM$parameters))
        knitr::kable(kBYM$parameters$summary[,c(1,3,5)], digits=3)
```

BYM with penalised complexity prior

'propSpatial = c(u=0.5, alpha=0.8)' means $pr(\phi < 0.5) = 0.8$, which is different from the specification of 'pc.prec'

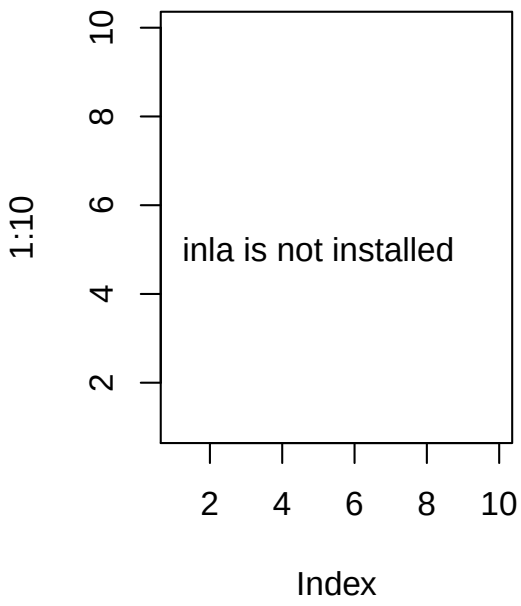

Figure 1: gamma priors sd parameters

```
kBYMpc = try(
bym(
        formula = observed ~ offset(logExpected) + poverty,
    kentucky,
        prior = list(
      sd=c(u=1, alpha=0.05),
      propSpatial = c(u=0.5, alpha=0.8)),
  verbose=TRUE), silent=TRUE)
```

Here penalized complexity priors are used with $pr(\sqrt{\sigma_1^2 + \sigma_2^2} > 1) = 0.05$ and

$$pr(\sigma_1/\sqrt{\sigma_1^2 + \sigma_2^2} < 0.5) = 0.8.$$

```
if(!is.null(kBYMpc$parameters))
        knitr::kable(kBYMpc$parameters$summary[,c(1,3,5)], digits=3)
```

```
## map images will be cached in  /tmp/Rtmpd74fNQ/mapmiscCache
```

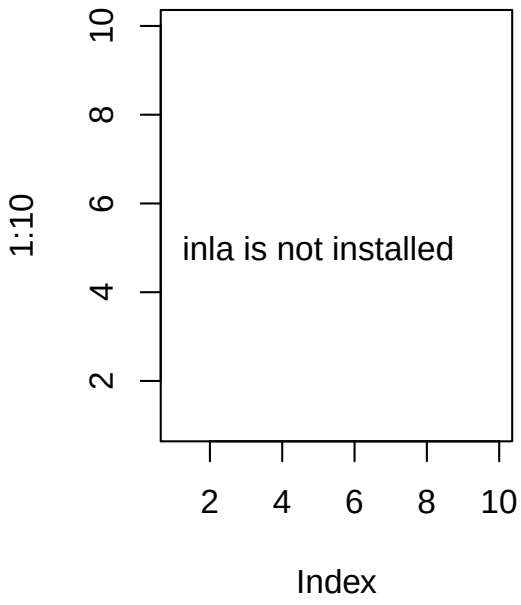

Figure 2: PC priors variance parameters

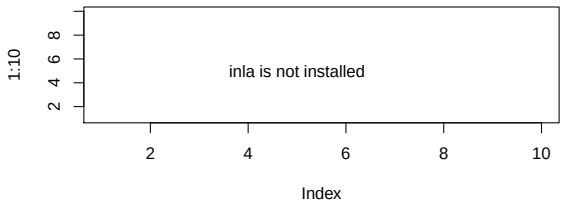

Figure 3: Random effects and fitted values