

BYM with PC priors

Patrick Brown

April 2016

```
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, 0.000291, 0.000217, 0,  
    0, 0, 1e-06, 1e-06, 3e-06, 8e-06, 1.3e-05, 2.3e-05, 3.5e-05, 5.8e-05, 6.8e-05,  
    7.5e-05, 5.5e-05, 4.1e-05, 3e-05), .Names = c("M_10", "M_15", "M_20", "M_25",  
    "M_30", "M_35", "M_40", "M_45", "M_50", "M_55", "M_60", "M_65", "M_70", "M_75",  
    "M_80", "M_85", "F_10", "F_15", "F_20", "F_25", "F_30", "F_35", "F_40", "F_45",  
    "F_50", "F_55", "F_60", "F_65", "F_70", "F_75", "F_80", "F_85"))  
}
```

```
# 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'

```
kBYMpc = try(bym(formula = observed ~ offset(logExpected) + poverty, kentucky, prior = list(
  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

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

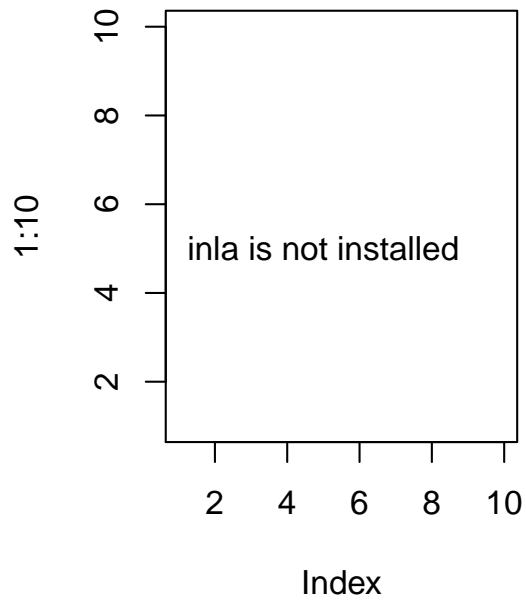


Figure 1: gamma priors sd parameters

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

```
## map images will be cached in /tmp/Rtmph7V2nd/mapmiscCache
```

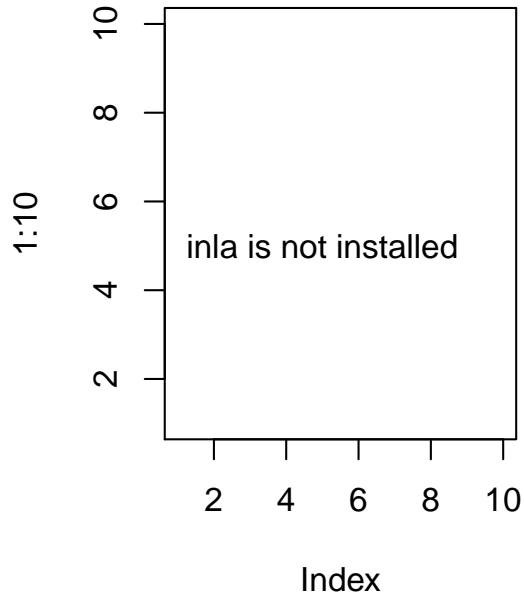


Figure 2: PC priors variance parameters

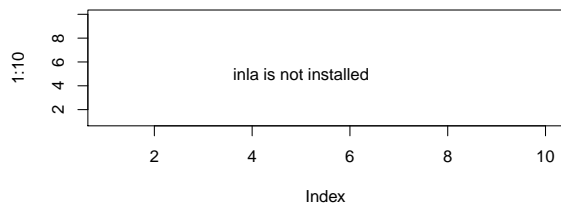


Figure 3: Random effects and fitted values