BYM with PC priors

Patrick Brown

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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, 0.000291, 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(kentucky, larynxRates, 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 = 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.

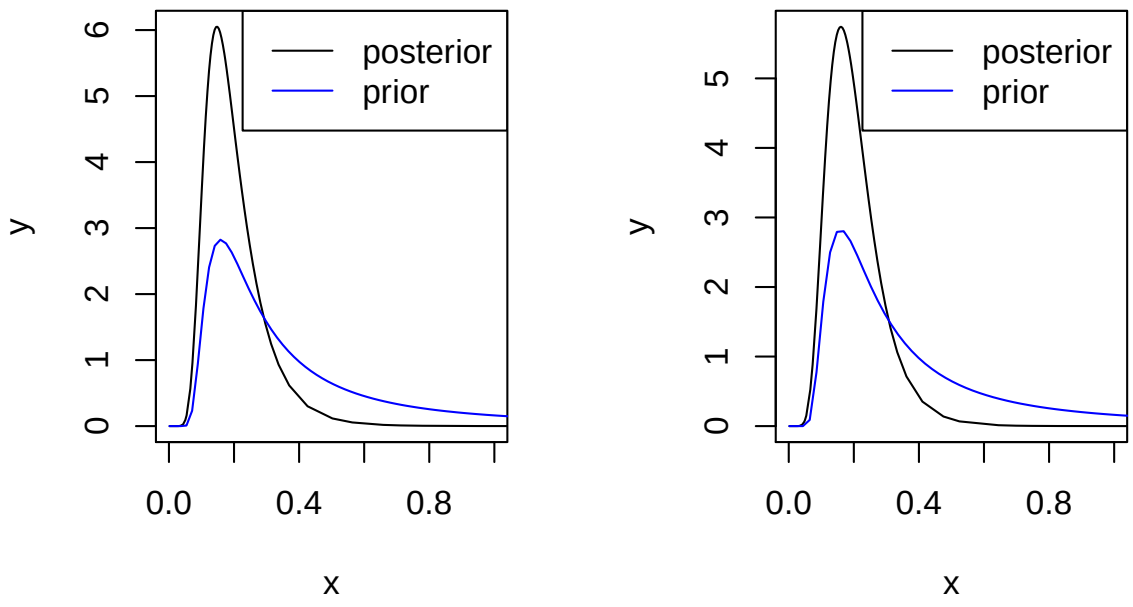
```
if(!is.null(kBYM$parameters))
        knitr::kable(kBYM$parameters$summary[,c(1,3,5)], digits=3)
```

	mean	0.025quant	0.975quant
(Intercept)	0.112	-0.381	0.613
poverty	0.007	-0.017	0.030
sdSpatial	0.193	0.083	0.426
sdIndep	0.198	0.085	0.411

BYM with penalised complexity prior

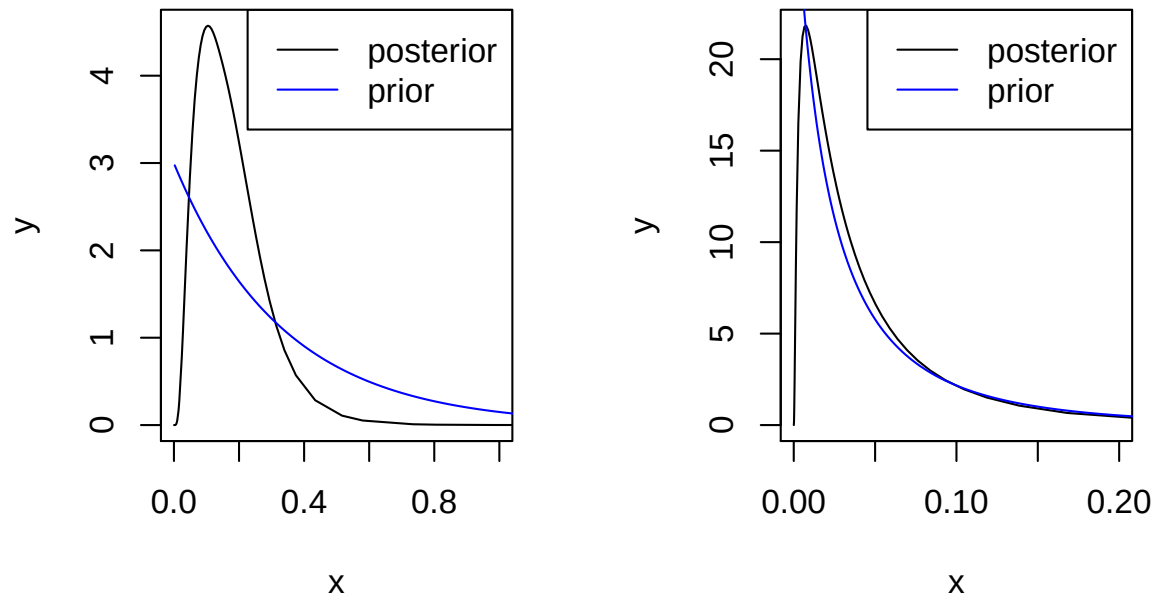
```
kBYMpc = try(bym(formula = observed ~ offset(logExpected) + poverty, kentucky,
    priorCI = list(sd = c(1, 0.05), propSpatial = c(0.2, 0.95))), silent = TRUE)

## Warning in inla.model.properties.generic(inla.trim.family(model), (mm[names(mm)
== :  Model 'bym2' in section 'latent' is marked as 'experimental'; changes may
appear at any time.
##  Use this model with extra care!!!  Further warnings are disabled.
```



(a) spatial (b) indep

Figure 1: gamma priors sd parameters



(a) sd

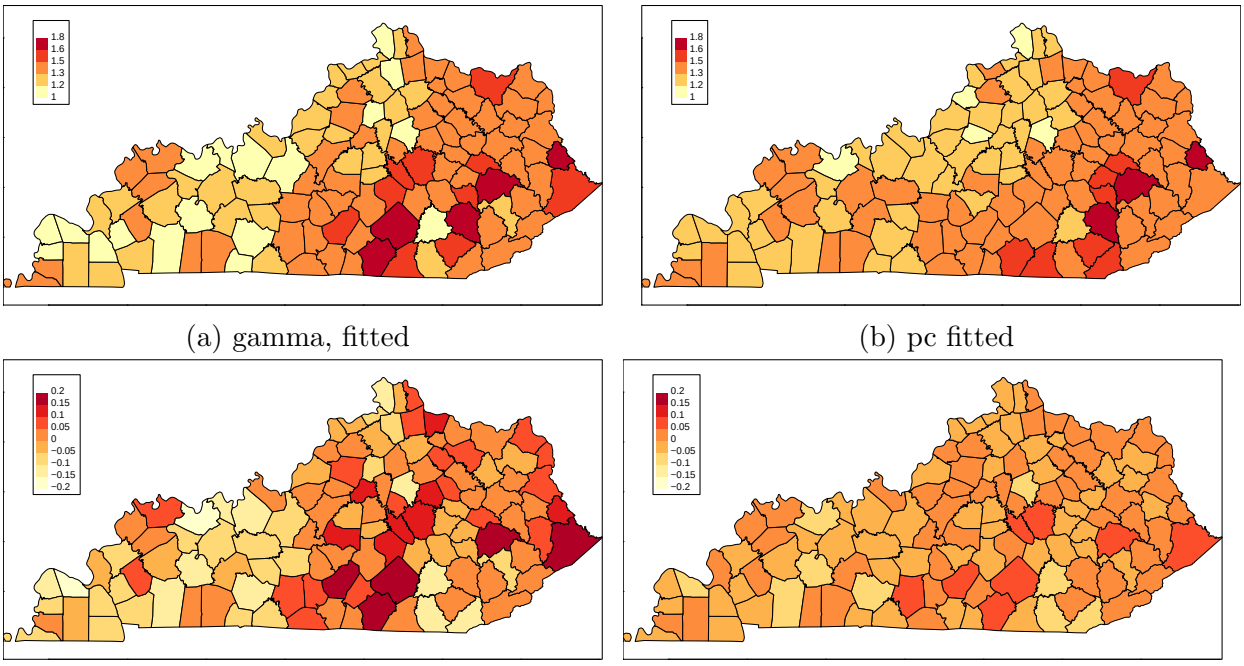
(b) prop spatial

Figure 2: PC priors variance parameters

Here penalized complexity priors are used with $pr(\sqrt{\sigma_1^2 + \sigma_2^2} > 1) = 0.05$ and $pr(\sigma_1/\sigma_0 < 0.2) = 0.95$.

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

	mean	0.025quant	0.975quant
(Intercept)	0.078	-0.356	0.516
poverty	0.009	-0.012	0.030
sd	0.170	0.039	0.434
propSpatial	0.051	0.003	0.224



(a) gamma, fitted

(b) pc fitted

(c) gamma random

(d) pc random

Figure 3: Random effects and fitted values