BYM models

Patrick Brown

April 2016

```
require('diseasemapping')

## Loading required package: diseasemapping

data('kentucky')
kentucky = terra::unwrap(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:

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

- 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

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(
     sd=c(u=1, alpha=0.05),
     propSpatial = c(u=0.5, alpha=0.8)),
  verbose=TRUE), silent=TRUE)
```

```
## Warning in inla.model.properties.generic(inla.trim.family(model), mm[names(mm) == : M
##   Use this model with extra care!!! Further warnings are disabled.
```
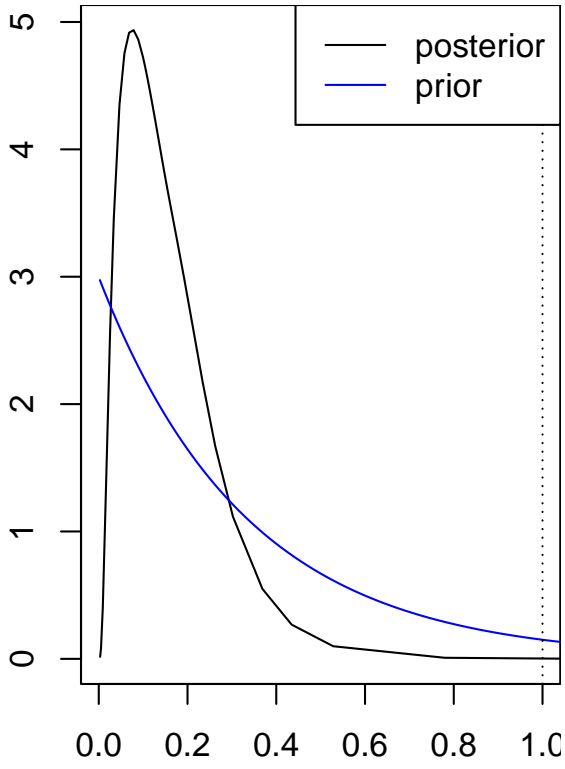
Here penalized complexity priors are used with $pr(\sqrt{\sigma_1^2 + \sigma_2^2} > 1) = 0.05$ and

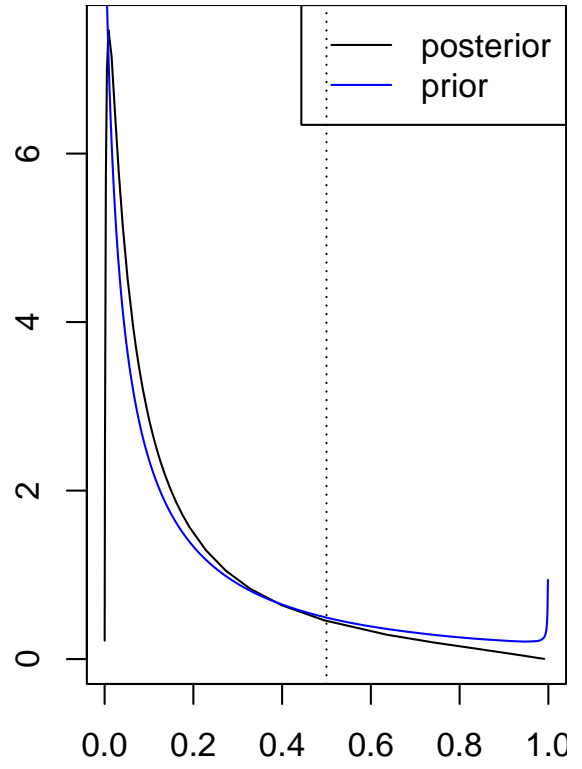$$pr(\sigma_1/\sqrt{\sigma_1^2 + \sigma_2^2} < 0.5) = 0.8.$$

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

	mean	0.025quant	0.975quant
(Intercept)	0.088	-0.360	0.544
poverty	0.009	-0.012	0.030
sd	0.154	0.026	0.435
propSpatial	0.189	0.005	0.740

```
## map images will be cached in  /var/folders/1s/zkmc02qn4k18r6jdtbb459hc0000gn/T//Rtmpp
```
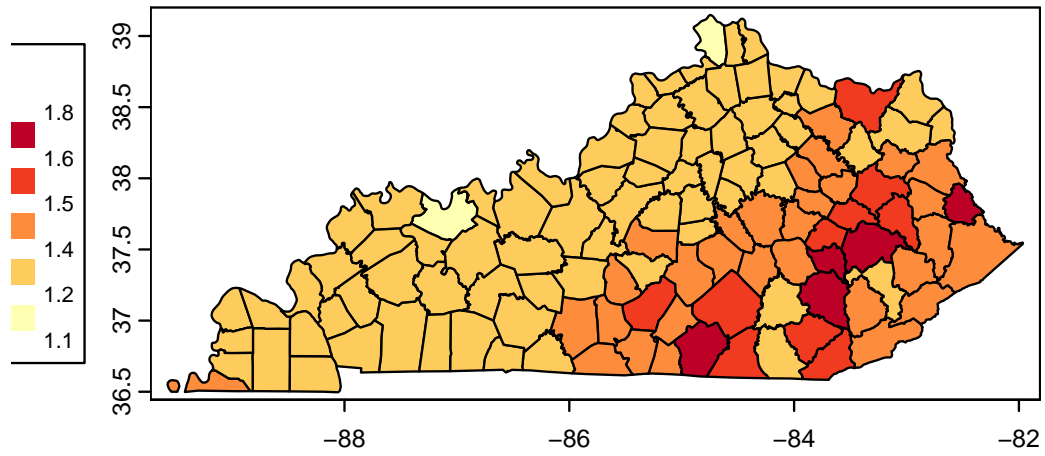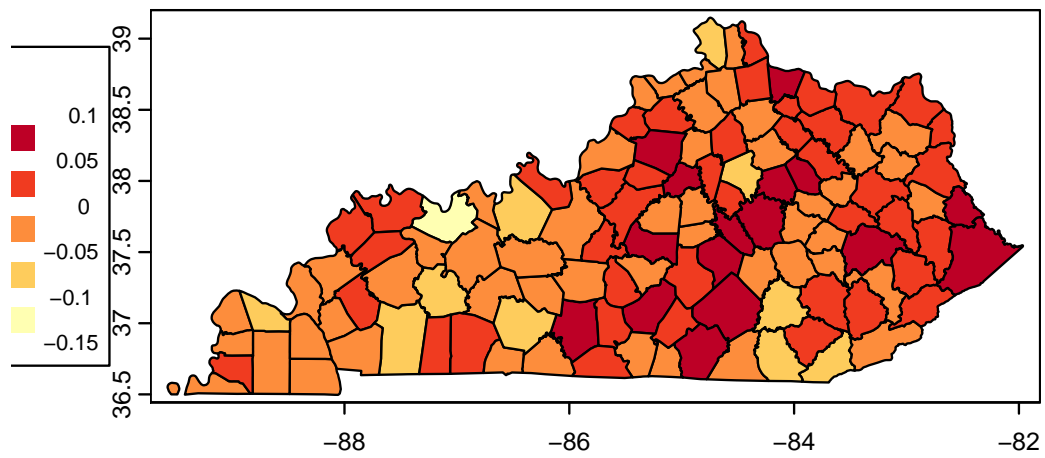
(a) sd

(b) prop spatial

Figure 1: PC priors variance parameters

(a) fitted

(b) random

Figure 2: Random effects and fitted values