Results of the spatial BYM model with stochastic restriction (1)

1 Implementation of the BYM model with stochastic restriction (1)

```
data {
  int<lower=0> N;
  int<lower=0> N_edges;
  int<lower=1, upper=N> node1[N_edges];  // node1[i] adjacent to node2[i]
  int<lower=1, upper=N> node2[N_edges];  // and node1[i] < node2[i]

  int<lower=0> y[N];              // count outcomes
//  vector[N] x;                    // predictor
  int<lower=0, upper=0> cero;
  vector<lower=0>[N] E;           // exposure
}
transformed data {
  vector[N] log_E = log(E);
}
parameters {
  real beta0;                // intercept
//  real beta1;                // slope

  real<lower=0> sigma_theta;   // sd of heterogeneous effects
  real<lower=0> sigma_phi;     // sd of spatial effects

  vector[N] theta_std;       // standardized heterogeneous effects
  vector[N] phi_std; // raw, standardized spatial effects
}
transformed parameters {
  vector[N] theta = theta_std * sigma_theta;         // non-centered parameterization
  vector[N] phi = phi_std * sigma_phi;
  real mean_phi_std = mean(phi_std);
}
model {
//  y ~ poisson_log(log_E + beta0 + beta1 * x + theta + phi);

  y ~ poisson_log(log_E + beta0 + theta + phi);

  target += -0.5 * dot_self(phi_std[node1] - phi_std[node2]);

  theta_std ~ normal(0, 1);
  cero ~ normal(mean_phi_std, 0.0001);
}
generated quantities {
//  vector[N] mu = exp(log_E + beta0 + beta1 * x + phi + theta);
  vector[N] mu = exp(log_E + beta0 + phi + theta);
  vector[N] SMR = exp(beta0 + phi + theta);
}
```

2 Fitting the model to Spain's mortality data

```
library(rstan)
library(spdep)
# options(mc.cores = parallel::detectCores())
options(mc.cores = 3)

source("mungeCARdata4stan.R")
load("../../Mortalidad nacional/DatosSinTemporal.Rdata")
Veci<-nb2WB(CartoMuniSinIslas.nb)
nbs = mungeCARdata4stan(Veci$adj, Veci$num);
N = nbs$N;
node1 = nbs$node1;
node2 = nbs$node2;
N_edges = nbs$N_edges;

tcomp02 <- system.time(mod.BYM <- stan_model("BYM_StanFast.stan"))
# Compilation in 66 seconds

save(mod.BYM, file = "mod.Stan.BYM.Fast.Rdata")
# load("mod.Stan.BYM.NoPriors3.Rdata")

Ejecuta.BYM.Stan<-function(Sexo, Causa){
  y <- MorTabu[Sexo,Causa, ]
  E <- Esperados[Sexo,Causa, ]

  datos <- list(N ,N_edges, node1, node2, y, E, cero=0)
  param <- c("SMR", "mu", "sigma_phi", "sigma_theta", "beta0")
  Res.t <- system.time(Res <- sampling(object = mod.BYM, data = datos, chains = 3, iter = 4400,
                                       warmup = 400, thin = max(1, floor(3 * (4400 - 400) / 1000)),
                                       cores = 3, pars = param))

  Res.BYM[[Sexo]][[Causa]] <<- list()
  Res.BYM[[Sexo]][[Causa]]$tiempo <<- Res.t
  Res.BYM[[Sexo]][[Causa]]$summary <<- Res
  Res.BYM[[Sexo]][[Causa]]$RR <<- summary(Res)$summary[1:7907, 1]
  Res.BYM[[Sexo]][[Causa]]$P.RR <<- apply(extract(Res, pars = "SMR")$SMR, 2, function(x){mean(x > 1)})
}

Res.BYM <- list(Hombres = list(), Mujeres = list())

for(i in c(9:18, 22, 28, 30, 31, 33, 35:37, 41)){
  Ejecuta.BYM.Stan(1, i)
  save(Res.BYM, file = "Res.BYM-StanFast.Rdata")
}
```

3 Descriptive principals

Cause	Time	sigma_phi	sigma_theta	max.Rhat	min.n_eff
(9) Mouth and pharynx	2611.2	0.335 [0.298,0.3779]	0.0879 [0.0328,0.1271]	1.02	279.06
(10) Esophagus	2629.5	0.2958 [0.2622,0.3302]	0.0446 [0.0023,0.0913]	1.02	233.56

Cause	Time	sigma_phi	sigma_theta	max.Rhat	min.n_eff
(11) Stomach	2689.5	0.3253 [0.2998,0.3528]	0.0264 [0.0011,0.0641]	1.01	421.04
(12) Colon	2793.2	0.2394 [0.2135,0.2674]	0.1018 [0.0839,0.1187]	1.01	485.65
(13) Rectum	2775.6	0.2032 [0.1681,0.2419]	0.1206 [0.0941,0.1462]	1.06	69.83
(14) Liver	2759.0	0.3106 [0.2763,0.348]	0.1469 [0.1218,0.1699]	1.01	298.03
(15) Pancreas	2674.3	0.2135 [0.183,0.2487]	0.0613 [0.017,0.0923]	1.02	245.94
(16) Other digestives	2592.2	0.2023 [0.1556,0.2488]	0.0467 [0.0023,0.1007]	1.02	254.41
(17) Larynx	2595.2	0.3481 [0.3076,0.3909]	0.0825 [0.015,0.1268]	1.01	304.56
(18) Lung	2854.9	0.3598 [0.3363,0.3827]	0.0841 [0.0629,0.103]	1.02	439.96
(22) Other skin	2579.8	0.2377 [0.1838,0.2906]	0.047 [0.0016,0.1145]	1.03	251.35
(28) Prostate	2710.3	0.2006 [0.1729,0.2296]	0.0572 [0.0135,0.0836]	1.01	305.22
(30) Kidney	2621.6	0.2912 [0.2462,0.3399]	0.0451 [0.0026,0.0944]	1.02	265.03
(31) Bladder	2621.3	0.3064 [0.273,0.3406]	0.0776 [0.0355,0.1072]	1.02	433.16
(33) Brain	2674.3	0.1512 [0.1167,0.1931]	0.086 [0.0509,0.1161]	1.04	149.32
(35) Poorly defined	2653.3	0.2252 [0.1966,0.2554]	0.0979 [0.0757,0.1182]	1.01	488.26
(36) Other lymphatics	2660.4	0.176 [0.1415,0.2093]	0.0752 [0.0485,0.0982]	1.02	356.67
(37) Leukemias	2614.5	0.1482 [0.1112,0.1868]	0.0667 [0.0158,0.0994]	1.02	273.92
(41) Other tumors	2655.4	0.3014 [0.2611,0.3424]	0.0458 [0.002,0.0951]	1.02	350.70
Median	2655.4	0.24	0.08	1.02	298.03