

Example: Incidence of lip cancer in 56 areas in Scotland.

Data on the number of lip cancer cases in 56 counties in Scotland were obtained. Expected lip cancer counts E_i were available.

Covariate was the proportion of the population in each county working in agriculture.

Model included only one random effect b_i to introduce spatial association between counties.

Two counties are neighbors if they have a common border (i.e., they are adjacent).

Three counties that are islands have no neighbors and for those, WinBUGS sets the random spatial effect to be 0. The relative risk for the islands is thus based on the baseline rate α_0 and on the value of the covariate x_i .

We wish to smooth and map the relative risks RR.

Model

```
model {  
  
  # Likelihood  
  for (i in 1 : N) {  
    O[i] ~ dpois(mu[i])  
    log(mu[i]) <- log(E[i]) + alpha0 + alpha1 * X[i]/10 +  
b[i]  
    RR[i] <- exp(alpha0 + alpha1 * X[i]/10 + b[i])  
    # Area-specific relative risk (for maps)  
  }  
  
  # CAR prior distribution for random effects:  
  b[1:N] ~ car.normal(adj[], weights[], num[], tau)  
  for(k in 1:sumNumNeigh) {  
    weights[k] <- 1  
  }  
  
  # Other priors:  
  alpha0 ~ dflat()  
  alpha1 ~ dnorm(0.0, 1.0E-5)  
  tau ~ dgamma(0.5, 0.0005) # prior on  
precision # standard  
  sigma <- sqrt(1 / tau) deviation  
}
```

[Data](#) click on one of the arrows to open data

[Inits](#) click on one of the arrows to open initial values

```

list(N = 56,
O = c( 9, 39, 11, 9, 15, 8, 26, 7, 6, 20,
13, 5, 3, 8, 17, 9, 2, 7, 9, 7,
16, 31, 11, 7, 19, 15, 7, 10, 16, 11,
5, 3, 7, 8, 11, 9, 11, 8, 6, 4,
10, 8, 2, 6, 19, 3, 2, 3, 28, 6,
1, 1, 1, 1, 0, 0),
E = c( 1.4, 8.7, 3.0, 2.5, 4.3, 2.4, 8.1, 2.3, 2.0, 6.6,
4.4, 1.8, 1.1, 3.3, 7.8, 4.6, 1.1, 4.2, 5.5, 4.4,
10.5, 22.7, 8.8, 5.6, 15.5, 12.5, 6.0, 9.0, 14.4, 10.2,
4.8, 2.9, 7.0, 8.5, 12.3, 10.1, 12.7, 9.4, 7.2, 5.3,
18.8, 15.8, 4.3, 14.6, 50.7, 8.2, 5.6, 9.3, 88.7, 19.6,
3.4, 3.6, 5.7, 7.0, 4.2, 1.8),
X = c(16, 16, 10, 24, 10, 24, 10, 7, 7, 16,
7, 16, 10, 24, 7, 16, 10, 7, 7, 10,
7, 16, 10, 7, 7, 1, 7, 7, 10, 10,
7, 24, 10, 7, 7, 0, 10, 1, 16, 0,
1, 16, 16, 0, 1, 7, 1, 1, 0, 1,
1, 0, 1, 1, 16, 10),
num = c(3, 2, 1, 3, 3, 0, 5, 0, 5, 4,
0, 2, 3, 3, 2, 6, 6, 6, 5, 3,
3, 2, 4, 8, 3, 3, 4, 4, 11, 6,
7, 3, 4, 9, 4, 2, 4, 6, 3, 4,
5, 5, 4, 5, 4, 6, 6, 4, 9, 2,
4, 4, 4, 5, 6, 5),
adj = c(
19, 9, 5,
10, 7,
12,
28, 20, 18,
19, 12, 1,
17, 16, 13, 10, 2,
29, 23, 19, 17, 1,
22, 16, 7, 2,
5, 3,
19, 17, 7,
35, 32, 31,
29, 25,
29, 22, 21, 17, 10, 7,
29, 19, 16, 13, 9, 7,
56, 55, 33, 28, 20, 4,
17, 13, 9, 5, 1,
56, 18, 4,
50, 29, 16,
16, 10,
39, 34, 29, 9,
56, 55, 48, 47, 44, 31, 30, 27,
29, 26, 15,
43, 29, 25,
56, 32, 31, 24,
45, 33, 18, 4,
50, 43, 34, 26, 25, 23, 21, 17, 16, 15, 9,
55, 45, 44, 42, 38, 24,
47, 46, 35, 32, 27, 24, 14,
31, 27, 14,
55, 45, 28, 18,
54, 52, 51, 43, 42, 40, 39, 29, 23,
46, 37, 31, 14,
41, 37,
46, 41, 36, 35,
54, 51, 49, 44, 42, 30,
40, 34, 23,
52, 49, 39, 34,
53, 49, 46, 37, 36,
51, 43, 38, 34, 30,
42, 34, 29, 26,
49, 48, 38, 30, 24,
55, 33, 30, 28,
53, 47, 41, 37, 35, 31,
53, 49, 48, 46, 31, 24,

```

```

49, 47, 44, 24,
54, 53, 52, 48, 47, 44, 41, 40, 38,
29, 21,
54, 42, 38, 34,
54, 49, 40, 34,
49, 47, 46, 41,
52, 51, 49, 38, 34,
56, 45, 33, 30, 24, 18,
55, 27, 24, 20, 18),
sumNumNeigh = 234)

```

Results

See maps.