Full-Bayesian Estimation of Spatio-temporal Models of Relative Suicide Risk in Japan

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1 Introduction

1.1 Important Properties of Suicide Death Data

- count data of rare events aggregated in time and space
  - Poisson models
- small area statistics and (temporal/spatial) dependency
  - Bayesian methods
- Underlying socio-economic factors

1.2 Aims

We obtain preliminary results from statistical analyses of spatio-temporal variation of suicide mortalities. We use count data at middle-level aggregation in space and time: secondary medical service area, 5yrs. Spatial/temporal dependency and socio-economic covariate effects are taken into account in modelling suicide risk. Finally, we examine a suitable model by model selection statistics.

2 Our Approach

We use a full Bayesian approach to model differential changes in suicide death by secondary medical service areas in Japan and time (1988-2007). R and WinBUGS are used for MCMC sampling.

2.1 Basic Set-up

Assume that crude suicide death rate in area i and its age group k can be represented by

$$R_{i,k,t} = \theta_{i,t} \cdot R_{s,k,t}$$

where $R_{s,k,t}$ is the crude suicide death rate in the reference population and its age group k and $\theta_{i,t}$ is the relative suicide risk in area i, and, in addition, that

$$O_{i,k,t} \,|\, R_{i,k,t} \sim \mathrm{Pois}(N_{i,k,t} \cdot R_{i,k,t})$$

where $O_{i,k,t}$ is the suicide death count in area i and age group k and $N_{i,k,t}$ is area i's population. We then have

$$O_{i,t} \,|\, \theta_{i,t} \sim \text{Pois}(E_{i,t} \cdot \theta_{i,t}), \qquad \text{cond. indpt. over } i.$$

2.2 An Example of Selected Models

We fitted 14 models (Model A-N) and their variants with the choice of covariates. Three main types of these models are: spatially-dependent random-effect models, persistence models, and covariate models. For instance, Model N is

$$Z_{i,t} = \log \theta_{i,t} = \mu + \gamma_i t + s_i + U_{i,t} + \beta_t X_{i,t}, \tag{2.1}$$

where

$$\boldsymbol{P}\left(s_i \,|\, {\sigma_s}^2\right) \propto {\sigma_s}^{-N} \exp\left[-\frac{1}{2{\sigma_s}^2}\sum_{j<i} v_{ij}(s_i - s_j)^2\right],$$

is an ICAR-type spatially-structured random effect and

$$\gamma_i \overset{\text{i.i.d.}}{\sim} \mathcal{N}\left(\gamma, {\sigma_{\gamma.u}}^2\right), \qquad {\sigma_{\gamma.u}}^2 \sim \mathcal{IG}(0.001, 0.001) \tag{2.2}$$

is an exchangeable spatial random coefficient of linear trend, and

$$U_{i,t} \overset{\text{i.i.d.}}{\sim} \mathcal{N}\left(0, {\sigma_U}^2\right), \qquad {\sigma_U}^2 \sim \mathcal{IG}(0.001, 0.001)$$

is an exhangeable spatio-temporal random effect, and where

$$\beta_t = \beta_{t-1} + \omega_t$$

with

$$\begin{aligned} &\beta_1 \sim \mathcal{N}(0, V), \qquad \text{for } t = 1 \\ &\beta_t \sim \mathcal{N}\left(\beta_{t-1}, {\sigma_\beta}^2\right), \quad {\sigma_\beta}^2 \sim \mathcal{IG}(0.001, 0.001), \qquad \text{for } t > 1. \end{aligned}$$

3 Results

A summary of results will be presented in the poster session.

Selected References

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