Formulas for spfood paper

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**Mixed models formulas**

equality coefficient p90/p10, municipality’s population, population growth in each municipality, the number of unemployed each year (January), , sea area (km2) of a municipality, and year

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*Models for updated parameters* \

Aquaculture

\ Fisheries

*Notations for model parameters*

*Hyperparameters*

*Ohter things*

# No interaction model

# Interaction 1 model

All examples are for fisheries, i think i don’t need to write all the same also for aquaculture

# Spatial-temporal model with rw2

# Spatial model with linear trend

# Bernardinelli model

# Tweedie distribution

## Other symbols

# Bernardinelli model

# Final fisheries model

# Final aquaculture model

# Bayesian models: mathematical formulations

## Intrindic Conditional autoregressive (ICAR) model

This model is also known as the Besag model (Besag et al 1996).

Here the conditional distribution of a spatial random effect of unit is formulated as follows (Riebler et al 2016):

The parameter is the precision (inverse of the variance) of the spatial random effect, is a vector of random effects levels (spatial units) that does not include unit , is the number of neighbors of the spatial unit , is a set of neighbors of a unit .

Then, the conditional mean of the random effect is the average of the effects over the neighborhood:

The conditional variance of is proportional to the number of neighbors of the unit :

where is the overall variance of the spatial random effect .

The joint distribution of a spatial random effect is formulated as follows:

## BYM (Convolution) model

The BYM model decomposes the spatial random effect into a sum of structured and unstructured components as:

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where is defined as shown in the Equation 1 above (Besag model), and component in BYM model has a precision parameter . denotes independent (and uncorrelated) Normally distributed random effect component with a separate precision :

In the BYM model, precision parameters and are dependent.

## BYM2 model

BYM2 is a modified BYM model, where structured spatial component is scaled and is denoted as . This scaled spatial component has a common marginal precision , which gives a unified interpretation of spatial variability for different sets and structures of the spatial units (sec. 3.3 i Riebler et al (2016), samt sec.5 i PC-prior paperet fra 2017 (Simpson et al))

The modified spatial random effect is constructed as:

where measures the proportion of the marginal variance attributed to structured spatial variation For further mathematical details of the spatial models, please see Riebler et al 2016.

## Spatial-temporal models

These models are formulated similarly to BYM or BYM2, but are extended to include a parametric temporal component (linear trend, Bernardinelli model) or a non-parametric temporal component (random walk models). Temporal component is based on time points (e.g., years) of observations.

For further mathematical details of the spatial-temporal models, please see Blangiardo et al 2015.

## PC priors specification

The PC priors for the BYM2 models were specified as follows:

See Simpson et al 2017 for further details on the PC priors.

\*\*\*\*\*\*\*\*Comments from Sigrunn, 26.09.2022\*\*\*\*\*\*\*\*\*\*\*\*\*

Når jeg slår opp i referanser ser jeg at mange bare har droppet det første leddet selv om tau.b er stokastisk. Min referanse på uttrykket er opprinnelig fra boka til Rue og Held (2005), likn. 3.30 s. 102, der modellen er formulert som en intrinsic GMRF modell. Vi brukte dette uttrykket både i Riebler et al (2016) og Sørbye og Rue (2014). Jeg ser at modellen også defineres ved n/2 i eksponent noen steder. Det er ok hvis du bare dropper dette igjen, siden leddet tydeligvis ikke trenger å være med.

Når det gjelder BYM så er tau\_u og tau\_v avhengige og jeg ville ikke skrevet “…..common marginal variance tau\_b” i linje 1-2 på s. 2. Det du har skrevet i gult hører til under BYM2. Merk at tau\_b er precision parameter, mens tau\_b^{-1} angir marginal varians. Poenget er at tau\_b har samme tolkning uavhengig av antall noder (spatial units) som er med i grafen, samt selve naboområdestrukturen. Du mister litt av dette ved omskrivingen. Evnt. different sets and structures of the spatial units? Referanser: sec. 3.3 i Riebler et al (2016), samt sec.5 i PC-prior paperet fra 2017 (Simpson et al). \*\*\*\*\*\*\*8