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10/23/2016

Notes

Reading 3

Spatio-temporal regression on compositional

covariates: modeling vegetation in a gypsum outcrop

**Abstract**

-vegetation cover and substrate typology over lattices (grid) from ground photos

-two ecology issues:

1) how typologies differ in terms of suitability for veg

2) if suitability varies over time

-compositional covariates within Bayesian hierarchical framework

-spatio-temporal model for temporal pattern of veg suitability-accounts for correlation

-time-varying regression coefficients, spatial, temporal, and spatio-temporal random effects (stochastic processes)- use Gaussian Markov Random Field models

**1.) Introduction**

-eco-outcomes, species richness, abundance and veg cover is based on high-res referenced data

-veg cover relationship within a rupicolous basophilic habitat (volcanic material rich?)

-examine moss, litter, soil, bare rock

-Gaussian Markov Random Fields model space and time

-*clr* (centered log ratio) representation is convenient because each coefficient can be related to original component

-*ilr* (isometric log-ratio) orthogonal coordinates and full-rank design matrix

-this paper handles compositional covariates by using *ilr* transformed covariates and obtaining *clr* coefficients in a Bayesian hierarchical framework

**2.) Motivating example**

-plant communities on weathered rock and outcrops in Italy

-lol species richness and **Shannon** (Irish wise river’s) diversity were positively affected by increasing in substrate heterogeneity (Andrea Velli’s) provide data

-vegetation follows climatic trends- decreases until summer, increases until winter

**3.) Model**

-­modeling regression coefficients and random effects- based on Intrinsic Gaussian Markov Random Fields

-temporal dependence of coefficients, pending smooth covariate effect

-smooth temporal behavior ensured by Random Walk priors- consider integrate the **Wiener** process

-Four types of spatio-temporal interactions from Knorr-Held depending on if plots have no relationship, if temporal plots show different temporal trends/no space dependence, spatial trends/no time dependence, or both space/time dependence

-Schrodle and Held- identifiability can be ensured by computing null space of structure matrix-uses eigenvectors as linear constraints

*3.1) Managing compositional covariates*

-managed with compositional algebra- spatio-temporal subscripts are dropped to focus on simple linear alge**bra**

-design matrix of proportional representation of compositions is singular due to sum-to-one constraint

-mitigated by transition from D-dimensional simplex to unconstrained real space

-computational expensive to model regression coefficients along time

-therefore use *ilr* coordinates in obtaining the *clr* coefficients by exploiting the relationship between the two

-estimation of regression coefficients are obtained by computing the Moore-Penrose inverse

-“Relationship (4) demonstrates an intuitive dependence structure characterizing ˜β that is readily interpretable and particularly appealing in the context of regression on compositional covariates.”

*3.2) Computational Details* (egast)

-two strategies for joint posterior approx.: MCMC sampling and Integrated Nested Laplace Approximations (INLA)

-INLA is well suited for GMRF, but large number of linear constraints making this computational exhaustive while crashing computers

-MCMC used and preserves full conditionals in GMRF form-these are lost in non-normal likelihood

-Bayesian linear regression model- Gibbs sampler involves standard MCMC tools- they adjust the Gibbs for their own purposes

**4.) Application**

*4.1) Model selection*

-use 10 different competing models

-neglecting spatio-temporal interactions produces very poor performances

*4.2) Results*

-moss encourages vegetation cover when compared with other substrates typologies

-soil is almost zero but increases over time, reaching a positive relative suitability by winter

-bare rock shows decreasing, litter presents constant average suitability over time