

Week 6 2D spatial models

	x	
x	⊗	x
	x	

x	x	x
x	⊗	x
x	x	x

		x		
	x	x	x	
x	x	⊗	x	x
	x	x	x	
		x		

Figure 2: (a) First order neighbors (b) Second order neighbors (c) Third order neighbors

Geostatistics vs. GMRF

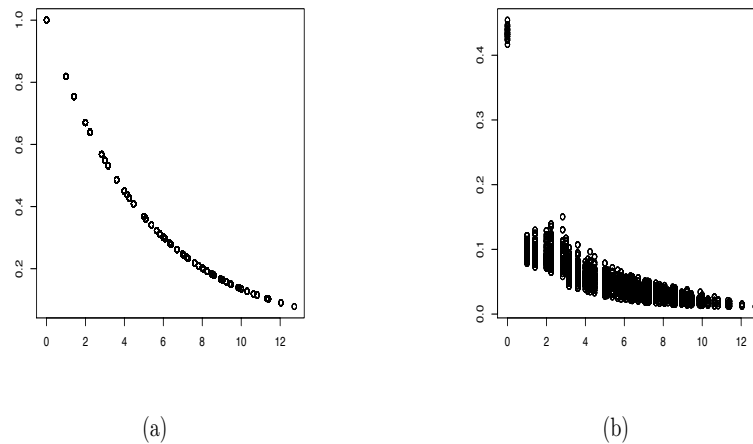


Figure 1: a) covariance function of a Matérn model with nugget=0, range=5, smoothness=.5, and partial sill=1, versus distance b) estimated covariance function of a GMRF with a 1st order neighborhood structure versus distance. Note the different scale in the vertical axis.

HIERARCHICAL SPATIAL MODELS OF ABUNDANCE AND OCCURRENCE FROM IMPERFECT SURVEY DATA

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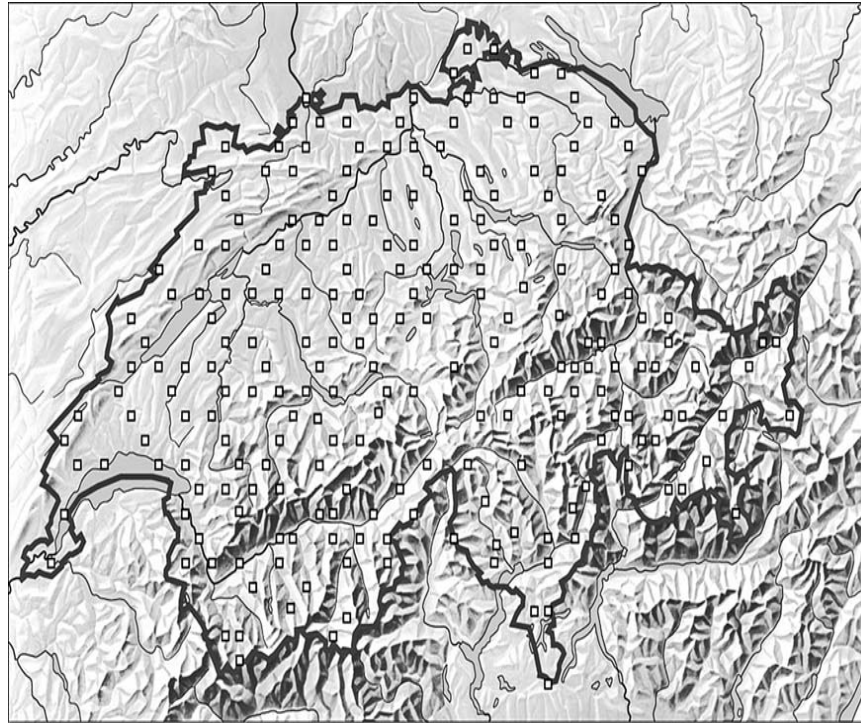


FIG. 1. Locations of 238 1-km² quadrats surveyed in 2002 in the Swiss Survey of Common Breeding Birds.

Multinomial sampling distributions

$$[\mathbf{x}|N, \boldsymbol{\pi}] \propto \frac{N!}{(N - x_{\cdot})!} \left(\prod_{h=1}^7 \pi_h^{x_h} \right) (1 - \boldsymbol{\pi}_{\cdot})^{N - x_{\cdot}}.$$

The likelihood under spatial replication

$$[\mathbf{x}_1, \mathbf{x}_2, \dots, \mathbf{x}_R | (N_i)_{i=1}^R, (\mathbf{p}_i)_{i=1}^R] \\ \propto \prod_{i=1}^R \left\{ \frac{N_i!}{(N_i - x_{i\cdot})!} \left[\prod_h \pi_h(\mathbf{p}_i)^{x_{ih}} \right] \pi_0(\mathbf{p}_i)^{x_{i\cdot}} \right\}.$$

Detection probability models

$$\text{logit}(p_{it}) = \mathbf{f}_{it}' \boldsymbol{\alpha}$$

Spatial models of abundance

$$N_i \sim \text{Poisson}(\lambda)$$

$$\log(\lambda_i) = \mathbf{m}_i' \boldsymbol{\beta}$$

$$u(s) = \mathbf{m}(s)' \boldsymbol{\beta} + \boxed{z(s)} + \varepsilon(s)$$

$$u(s) \equiv \log(\lambda(s))$$

Latent spatial Gaussian
process

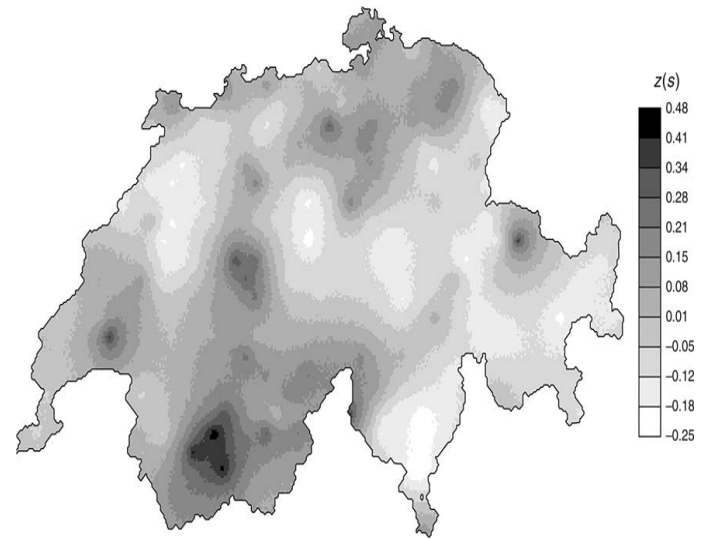
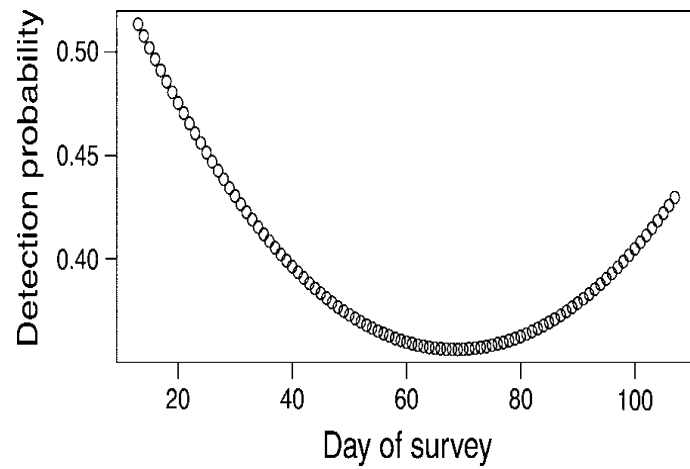


Fig. 7. Estimated posterior means of the spatial process, $z(s)$, centered about the regression mean containing elevation, forest cover, and route length as described in *Models of abundance and detection*.

