18th EYSM, 26-30 August 2013, Osijek, Croatia

Some advances in Bayesian spatial prediction and sampling design

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Abstract

TIn my talk, I will report on recent work with my colleagues G. Spoeck and H. Kazianka in the area of Bayesian spatial prediction and design [1]-[4].

The Bayesian approach not only offers more flexibility in modeling but also allows us to deal with uncertain distribution parameters, and it leads to more realistic estimates for the predicted variances. We report on some experiences gained with our approach during a European project on "Automatic mapping of radioactivity in case of emergency". We then go on and apply copula methodology to Bayesian spatial modeling and derive predictive distributions. Moreover, I report on recent results on finding objective priors for the crucial nugget and range parameters of the widely used Matern-family of covariance functions. Furtheron, I briefly consider the challenges in stepping from the purely spatial setting to spatio-temporal modeling and prediction.

Finally, I will consider the problem of choosing an "optimal" spatial design, i.e. finding an optimal spatial configuration of the observation sites minimizing the total mean squared error of prediction over an area of interest. Using Bessel-sine/cosine- expansions for random fields we arrive at a design problem which is equivalent to finding optimal Bayes designs for linear regression models with uncorrelated errors, for which powerful methods and algorithms from convex optimization theory are available. I will also indicate problems and challenges with optimal Bayesian design when dealing with more complex design criteria such as minimizing the averaged expected lengths of predictive intervals over the area of interest.

References

[1] H. Kazianka and J. Pilz (2011). Bayesian spatial modeling and interpolation using copulas. *Computers & Geosciences*. **37**(3): 310–319.

[2] H. Kazianka and J. Pilz (2012). Objective Bayesian analysis of spatial data taking account of nugget and range parameters. *The Canadian Journal of Statistics*. **40**(2): 304–327.

[3] J. Pilz, H. Kazianka and G. Spoeck (2012). Some advances in Bayesian spatial prediction and sampling design. *Spatial Statistics*. **1**: 65–81.

[4] G. Spoeck and J. Pilz (2013). *Spatial sampling design based on spectral approximations of the error process. In: Spatio-temporal design: Advances in Efficient Data Acquisition (W.G. Mueller and J. Mateu, Eds.)*. Wiley, New York, 72–102.