

Efficient models for correlated data via convolutions of intrinsic processes

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Abstract

Gaussian processes (GP) have proven to be useful and versatile stochastic models in a wide variety of applications including computer experiments, environmental monitoring, hydrology, and climate modeling. A GP model is determined by its mean and covariance functions. In most cases, the mean is specified to be a constant, or some other simple linear function, while the covariance function is governed by a few parameters. A Bayesian formulation is attractive since it allows for formal incorporation of uncertainty regarding the parameters governing the GP. However, estimation of these parameters can be problematic. Large datasets, posterior correlation, and inverse problems can all lead to difficulties in exploring the posterior distribution. Here we propose an alternative model which is quite tractable computationally—even with large datasets or indirectly observed data—while still maintaining the flexibility and adaptiveness of traditional GP models. This model is based on convolving simple Markov random fields with a smoothing kernel. We consider applications in hydrology and aircraft prototype testing.