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Automatic mapping in emergency conditions with space-limited covariance functions

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In this talk we discuss a fast Bayesian extension to the kriging algorithm which has been used successfully for automatic mapping in emergency conditions in the Spatial Interpolation Comparison 2004 (SIC2004) exercise. We extend the sparse sequential Gaussian process method through the application of space-limited covariance functions, which can be used as an alternative to the commonly used covariance models. In the presence of extreme values, we show that space-limited covariance functions maintain the smoothness locally but at the same time lead to a more robust, and compact, global model. We show the performance of this technique on synthetic data and outline a number of computational benefits such an approach brings. To test the relevance to automatic mapping we apply the method to the data used in a recent comparison of interpolation techniques (SIC2004) to predict the dispersal of background ambient gamma radiation. In SIC2004 it was shown that automatic mapping in routine conditions can be achieved successfully using a variety of statistically principled techniques. Emergency conditions were introduced into the dataset in the form of a simulated release of a contaminant. This contaminant essentially introduced a small, but localised, number of extreme values into the dataset. The various entries in the contest showed a wide range of behaviours for the emergency conditions, however, one common feature was that each method was significantly less accurate when predicting at the given test locations. Many of the entries used the squared-exponential covariance function which has infinite spatial support and imposes a strong smoothing effect. In many natural processes, the covariance between locations effectively tends to zero beyond a certain separation distance. An alternative choice of covariance function, and one that may seem more appropriate for such an application, is the family of space-limited covariance functions. We test this hypothesis on the SIC2004 data.