Mathematics Colloquium

A New Covariance Function for Spatio-Temporal Data Analysis with Applications

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4:10 p.m.
Neill 5W

Time Series methods are often used for the analysis of data coming from various fields, such as economics, finance, environment and medical sciences, atmospheric pollution and sensor networking etc. One of the important objects in time series analysis is to develop methods for understanding the underlying dynamics of the given data, and based on this knowledge to find suitable linear (or non linear) time series models which could be used for obtaining optimal forecasts. There is an extensive literature on model building, forecasting of time series. Many times the data we come across is not only a function of time t, but also a function of the spatial location $\mathbf{s}$.

The problem of interest here is that of finding an estimate of unobservable data at a given location when spatial data at neighboring locations are available. This is known as Kriging in mining literature. The estimation requires knowledge of spatial covariance function (or a suitable spatial model). Several functions have been proposed, methods of estimation of the parameters which characterize these functions have been developed. One well known class of covariance function is Matern Class, which is often used. Extension of these to data which is a function of space and time is not that straight forward, and addition of an extra temporal dimension leads to several computational problems and finding a positive definite covariance function becomes more complicated.

Our object here is to obtain a class of spatio-temporal covariance functions and use the function obtained to obtain optimal forecasts. To achieve these objectives, we use Discrete Fourier Transforms of the data rather than the data itself which will substantially reduces the number of arithmetic operations required to compute the statistics. Let us denote the measurement at time $t \in Z$, at the location $\mathbf{s}$ by $Z(\mathbf{s}, t)$. We assume $\mathbf{s} \in R^2$. Here Z is the set of integers and R is the real line. Suppose we have an observation regularly collected at several locations, say m locations, and at n time points. Our first object is to validate the data at location, say at s_0 using the data we collected in the neighborhood of it. To achieve this objective, we need a spatio-temporal covariance function, and in this paper we derive an expression for such a function when the process satisfies a partial second order stochastic differential equation. In order to obtain this covariance function we assume the process is spatially, temporally second order stationary and also it is isotropic. For details we refer to Subba Rao and Terdik (2013arXiv1311.1981S).

Refreshments served at 3:30 p.m.

Hacker Reading Lounge - Neill 216

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