

Modelling Dependence in Space and Time with Vine Copulas

abstract of an expanded abstract for the conference *Geostats 2012*

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keywords: spatial dependencies, multivariate copulas, vine copulas

Copulas are capable of modelling any kind of dependence between random variables detached from their margins. The ability to capture the dependencies of extreme values made them popular in finance. Extreme values can also be found in many spatial datasets and their non-Gaussian dependence structures can easily be captured with copulas. Exploiting copulas improves the interpolation of skewed and heavy tailed data.

In the context of interpolation, a copula's dimension depends on the number of points involved in a local neighbourhood. It is desirable to build these multidimensional copulas out of bivariate ones, as those are quite well understood and are easy to estimate. Copulas derived in this fashion are called *vine copulas*.

We adapted vine copulas to the spatial case introducing a distance dependent *bivariate spatial copula* in the first tree. Our approach solves two major constraints of recent geostatistical models using copulas. A vine copula is not limited to a single family nor to copulas that are capable of describing the whole range from high dependencies to independence. In general, any bivariate copula family can be considered for each pair of variables. Unfortunately, the number of bivariate copulas to be estimated increases quadratically with the vine copula's dimension. In order to reduce the computational burden we developed efficient procedures estimating many bivariate copulas at once, and we investigated different truncation techniques.

Focusing on the interpolation of spatially under-sampled spatio-temporal random fields, we incorporated the information contained in the time series of each location in our approach. The asymmetric dependencies typically present in the temporal domain can easily be captured incorporating asymmetric copulas. Thus, the vine copula is capable of capturing spatial and temporal dependencies of the process. Spatio-temporal vine copulas enable us to model multivariate data over space and time in a very flexible way.

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