The spcopula R-package: Modelling Spatial and Spatio-Temporal dependence with copulas

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Copulas allow us to flexibly build multivariate distributions with mixed margins where the copula describes the multivariate dependence structure coupling the margins. In classical geostatistics, a multivariate Gaussian distribution is typically assumed and dependence is summarized in a covariance matrix implying limitations like elliptical symmetry in the strength of dependence. Copulas allow for instance for dependence structures that are not symmetric, which makes them appealing for modelling temporal dependencies. With the help of asymmetric copulas, one can model dependencies where for instance the pair of a low measurement followed by a high one does have a different strength of dependence than a high value followed by a low measurement. Assuming a Gaussian dependence structure would imply an equal strength of dependence.

A set of R-packages is available that allow to model multivariate distributions with single copulas or through a bivariate decomposition as vine copulas. We implemented the package *spcopula* that offers functions to model spatial and spatio-temporal random fields with the help of spatial and spatio-temporal vine copulas. We developed the spatial vine copulas such that the bivariate copula families in the first tree may change over space, time or space and time allowing not only for a varying strength of dependence but also for changing dependence structures. These distributions can then for instance be used to predict values at unobserved locations, do risk assessment or run simulations.

Being based on the concept of vine copulas, the *spcopula* package incorporates an extensive set of multivariate distributions. The distance weighted mixture of bivariate copulas yielding the bivariate spatial and spatio-temporal copulas does not have any probabilistic restrictions. This makes it potentially powerful for modelling skewed or heavy tailed data with complex dependence structures in the spatial or spatio-temporal domain.