Abstract: Modeling of a multivariate spatial process generally involves quantifying the spatial dependence within and between distinct process components through marginal and cross-covariance functions, respectively. These marginal and cross-covariance functions, collectively termed as multivariate covariance functions, play an important role in spatial analysis, such as fitting a Gaussian process model to a multivariate spatial process and performing spatial prediction. For an advantageous multivariate spatial modeling, the specification of multivariate covariance function should be flexible enough to comprehend inherent features of the multivariate spatial data, such as nontrivial coherence, asymmetric dependence between distinct variables, etc. However, the valid choice of multivariate covariance function is limited to the class of nonnegative definite matrix-valued functions, which makes covariance modeling a challenging task.

In the first part of this talk, I will introduce a semiparametric approach for multivariate covariance function estimation with approximate Matérn marginals and highly flexible cross-covariance functions via their spectral representations. The proposed construction is endowed with flexibility in modeling the cross-spectral features due to B-spline based specification of the underlying coherence functions. The efficiency of the proposed semiparametric approach in recovering the true multivariate spatial dependence is illustrated through a simulation study.

In the second part of this talk, I will introduce a novel approach to allow flexible asymmetries in the cross-covariances of any stationary multivariate covariance function. The proposed approach involves modeling the phase component of the cross-spectral features to allow for asymmetric cross-covariances. We show the capability of our proposed model to improve spatial predictions against traditionally used models, under the presence of asymmetric spatial dependence, through multiple simulation studies.

Finally, I will illustrate the application of the proposed models on a real dataset of particulate matter concentration (PM2.5) and meteorological variables such as wind speed and relative humidity. The real data example shows that the proposed models outperform traditionally used models, in terms of model fit and spatial predictions.

Related material:

- https://doi.org/10.1111/biom.13323
- https://doi.org/10.1007/s13253-020-00414-2