Abstract:

My seminar at Weizmann Institute illustrates the state of the art for modeling, inference and prediction for Gaussian processes continuously indexed over the sphere (our space) and evolving over time. The choice of the sphere for the reference space is motivated by the increasing availability of global data sets, from remotely sensed networks to climate models ensembles. We illustrate the difference between (a) second order approaches and (b) practical approaches. The former being based on space-time covariance functions, and the latter on explicit description of the dynamics of the space-time process, that is, by specifying its evolution as a function of its past with added spatially dependent noise. I shall dig into approach (a) to illustrate the mathematical difficulties to build positive definite (read: covariance) functions on the sphere cross time. After discussing the general theory based on Fourier analysis on manifolds, I shall illustrate some friendly principles that guide the practitioners to build and implement these new objects. Approach (b) will then be illustrated, making special emphasis on dynamical approaches and on approaches based on the connection between Markov random fields and stochastic differential equations. Concepts will then be illustrated through a global data set of air pollution from the 2015 wildfires in Equatorial Asia, an event that has been classified as one of the worst environmental disasters on record. I conclude the seminar with a collection of research problems for the statistical, mathematics, machine learning and computer science communities that are connected with the presented subject.