Seminar: 10/09/23

Christopher K. Wikle
University of Missouri
Curators' Distinguished Professor and Chair
Department of Statistics

Title: Examples from the interface of spatio-temporal statistics and neural modeling

Abstract: Spatio-temporal data are ubiquitous in the sciences, medicine, and engineering, and their study is important for understanding and predicting a wide variety of processes. One of the difficulties with statistical modeling of spatial processes that change in time is the complexity of the dependence structures that must describe how such a process varies, and the presence of high-dimensional complex datasets and large prediction domains. It has long been the case that deep (hierarchical) statistical models have proven helpful for such data, yet these models can be difficult to implement for various reasons. Increasingly, black-box neural ("AI") models are being used for spatio-temporal data as well, capitalizing the strength of those models to learn complex dependence structures. The downside of such models is the requirement for large amounts of training data, interpretability, and uncertainty quantification (although, there are solutions to each of these issues). It is natural to consider hybrid statistical/neural models that address some of these issues. Here, I illustrate by example one approach whereby a reservoir-computing based "neural" model is embedded in a mechanistically motivated dynamic spatio-temporal statistical model for wildfire front evolution. The other example considers embedding a novel statistical model within a useful neural generative modeling framework. Specifically, we develop a new spatial extremes model that has space-scale aware and non-stationary dependence properties and integrate it in the encoding-decoding structure of a variational autoencoder. This autoencoder utilizes deep neural networks in the encoder and decoder architecture and can be used as a spatial or spatio-temporal emulator that characterizes the distribution of potential complex output states (such as climate extremes), including realistic tail behavior.

Paper links:
https://drive.google.com/file/d/16XFO0sNKQp6oADLGbK5yIJhtjLO61JDR/view
https://arxiv.org/abs/2307.08079