Abstracts for the PhD Course on Extremes in Space and Time, May 27-30

Extremes and sums of regularly varying observations

Bojan Basrak (University of Zagreb)

In the first part, we show how the dependence structure of extremes in a stationary regularly varying sequence can be described, using the concept of the tail process. This is illustrated on some standard time series models.

In the second part, we show how point process theory for extremes extends from iid to dependent sequences, aslong as their dependence vanishes when time goes on. We discuss appropriate formal conditions and show how they lead to various asymptotic results for such sequences. Due to the dependence, their extremes clusterasymptoticallyin a way which is captured by the corresponding tail process.

Finally, we plan to discuss the convergence of sums for dependent regularly varying sequences and present some new functional limit theorems.

Applications of Tail Dependence

Dan Cooley (Colorado State University)

We will present recent applications which require modeling the tail dependence of a random vector.

In the first application, we aim to predict air pollution levels at an unobserved location given nearby measurements and given that the observed values are large. Specifically, we aim to estimate the conditional distribution of the pollution level at the unobserved location. We rely on the framework of regular variation to approximate the conditional distribution, given that the observed values are large. Using a fitted model for the angular measure of the regular-varying random vector, we apply our method to nitrogen dioxide measurements in metropolitan Washington DC. We show that our method is superior to standard linear prediction methods of approximating the conditional distribution when observed values are large.

In the second application, we investigate the Pineapple Express phenomenon, a weather regime which can lead to extreme and destructive precipitation on North America's Pacific Coast. Our first aim is to study climate models' ability to reproduce these events. By applying bivariate extreme value theory, we measure the amount of tail dependence between the climate model output and observations. In an attempt to better understand and quantify the processes

which lead to Pineapple Express events, we develop a daily "PEindex" based on mean sea-level pressure fields. We show this index to be tail dependent to the observed precipitation data. We investigate the possible behavior of Pineapple Express events as produced by climate models' future projections.

Modeling Both Climate and Weather Spatial Effects for Extreme Precipitation

Dan Cooley (Colorado State University)

Weather data are characterized by two types of spatial effects: climate effects that occur on a regional scale and weather effects that occur on a local scale. In terms of a statistical model, one can view climate effects as how the marginal distribution varies by location and the weather effects as characterizing the joint behavior. We extend recent work in spatial hierarchical models for extremes by employing a max-stable random process at the data level of the hierarchy, thereby accounting for the weather spatial effects which had often been ignored. Because the known max-stable process models can be written in closed form only for the bivariate case, we employ composite likelihood methods to implement them in our hierarchical model. Appropriate uncertainty estimates are obtained via an information sandwich approach.

Max-stable random fields: Theory and examples

Zakhar Kabluchko (University of Ulm)

In these lectures we will give an introduction to max-stable random fields. A random field is called max-stable if the pointwise maximum of any number of independent copies of the field has the same distribution as the original field, up to a linear transformation. We will give an introduction to the structure theory of max-stable fields covering such topics as de Haan's spectral representation, stochastic integrals with respect to a max-stable random measure, connection between stationary max-stable fields and non-singular flows, ergodic properties of max-stable random fields, and so on. We will also consider a number of examples of max-stable random fields including mixed moving maximum random fields, Brown-Resnick fields, positive recurrent fields, max-stable processes driven by Levy processes, among others.

Selection bias in naturalistic driving studies

Holger Rootzén (Chalmers University Gothenburg)

This talk is based on joint work with Jenny Jonasson, AstraZeneca, and Jonas Bärgman and Dmitrii Zholud, Chalmers.

In a "naturalistic driving study" ordinary cars or trucks with ordinary drivers are equipped with cameras which film driver behavior and the surrounding traffic; radars which measure the distance to road edges and other cars; GPS instruments; and sensors which measure things like brake and gas pedal actions. The vehicles are then operated just as if the instrumentation wasn't there, but if accidents occur, the instrumentation documents what happened in extensive detail. This is then used to improve traffic safety. Such studies which involve thousands of cars and several years of driving per car are underway. However, even for such large studies, the number of crashes is low, and one additionally tries to exploit information also from "near-crashes". Naturalistic driving studies are believed to contribute to the steadily falling number of fatal traffic accidents in countries like Sweden or the US. In this talk I discuss how extreme value statistics can be used to 1) help verify the underlying assumption that preventing near-crashes will also prevent real crashes, 2) find variables, in particular related to inattention, which influence accident risk, 3) estimate risks for, and distributions of severity of crashes, in different traffic situations and for different drivers, and 4) how to handle the censoring which occurs when visual behavior only is measured in short (6-second) time intervals. Preliminary result include that there are severe problems of selection bias and that extrapolation from near-crashes to crashes has to be made with great care. They also indicate that some commonly used inattention measures have little predictive value. One use of analyses like this one is as a basis for collision avoidance systems. Theis area puts difficult and important challenges to many parts of extreme value statistics.

References:

[1] J. Jonasson and H. Rootzén (2013): Internal validation of near-crashes in naturalistic driving studies: a continuous and multivariate approach. Submitted

[2] J. Bärgman, H. Rootzén, and D. Zholud (2013): Analysis of glance-off-road durations from the 100car naturalistic driving study. In preparation.

Large deviation for (pseudo)-regenerative Markov chains

Olivier Wintenberger (Paris Dauphine)

We introduce the cluster index of a multivariate regularly varying stationary sequence and characterize the index in terms of the spectral tail process. This index plays a major role in limit theory for partial sums of regularly varying sequences. We illustrate the use of the cluster index by characterizing precise large deviation results for sums of multivariate functions acting on a stationary Markov chains under a drift condition.