STAT 541A - STATISTICAL MODELLING OF MULTIVARIATE EXTREMES
2016/2017 – Term 2

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Lecture times: Mon/Wed 1:30-3:00pm in ESB 4192 (Jan- mid Feb, 2017)

Course description: The statistical analysis of extreme values is of great importance in diverse fields of application, including finance and insurance, civil and reliability engineering, hydrology and environmental sciences. The largest insurance claims may lead to the insurer's insolvency; high waves together with strong wind may lead to a dike failure. These examples illustrate situations in which it is of interest and concern not just the typical behaviour of the underlying physical process but rather the behaviour of its extremes. Since, by definition, extreme observations are rare, there is too little data for adequate statistical modeling and inference in the context of extremes. To address this challenge, one can rely on asymptotic theory, known as Extreme Value Theory (EVT). The aim of the course is to motivate and demonstrate the use of EVT and its extensions as a basis for extreme value data modeling, with a greater emphasis on data analysis and associated inference techniques. Univariate set-up will be used as a starting point, followed by introduction to concepts and tools for modeling of multivariate extremes.

Learning outcomes: On completion of the course, you will be familiar with probabilistic foundations of multivariate extreme value theory, including univariate theory for the marginals and multivariate extremal dependence structure. You will acquire a basic toolkit to perform extreme value analyses in one dimension (the block maxima approach and peaks-over-threshold method) and in multiple dimensions via parametric modeling of tail dependence structures.

Prerequisites: Sufficient background in basic probability theory and statistics (Stat 547 and 560 or their equivalents). Some experience with statistical software Splus/R will be helpful.

Assessment: assignments (70%) and a course project (30%).

References:

- Coles, S. G., *An Introduction to Statistical Modeling of Extreme Values*, Springer Series in Statistics, Springer-Verlag, London, 2001.
- Beirlant, J., Goegebeur, Y., Segers, J., and Teugels, J., *Statistics of Extremes: Theory and Applications*, Wiley Series in Probability and Statistics, Wiley, Chichester, UK, 2004.
- de Haan, L. and Ferreira, A., *Extreme Value Theory*: *An Introduction*, Springer, 2006.
- Resnick, S.I., *Extreme Values, Regular Variation and Point Processes*, Springer, 1987.

Tentative course outline:

1. Univariate extreme value analysis
   - 1.1 Univariate extreme value theory
   - 1.2 Inference: block maxima approach
   - 1.3 Threshold exceedances
   - 1.4 Peaks-over-threshold method

2. Multivariate extreme value theory
   - 2.1 Ordering of multivariate data
   - 2.2 Limit distributions and the exponent
   - 2.3 Tail dependence (summary) measures
   - 2.4 Asymptotic independence

3. Statistics of multivariate extremes
   - 3.1 Parametric models for coordinate-wise maxima
   - 3.2 Bivariate threshold models
   - 3.3 Inference in asymptotic independence case